Stakeholder and Subject Matter Expert Feedback Regarding the Content of a New Jersey Ocean Acidification Action Plan

September 2023

Prepared for the New Jersey Coastal Management Program; New Jersey Department of Environmental Protection

Prepared by:

Janine Barr, Grace Saba Ph.D., Jeanne Herb

Rutgers, The State University of New Jersey

Kirstin Wakefield

Mid-Atlantic Regional Association Coastal Ocean Observing System

Mid-Atlantic Coastal Acidification Network

MARACOOS
Ocean Information for a Changing World
The Mid-Atlantic Regional Association Coastal Ocean Observing System

MACAN
Mid-Atlantic Coastal Acidification Network

RUTGERS
Edward J. Bloustein School of Planning and Public Policy

RUTGERS
New Jersey Climate Change Resource Center

New Jersey DEPARTMENT of ENVIRONMENTAL PROTECTION

NJ COASTAL MANAGEMENT PROGRAM

ACKNOWLEDGMENT

This report was made possible with financial assistance from the Coastal Zone Management Act of 1972, as amended, as administered by the Office of Coastal Management, National Oceanic and Atmospheric Administration (NOAA) Program through the New Jersey Department of Environmental Protection, Coastal Management Program. These environmental data and related items of information have not been formally disseminated by NOAA and do not represent and should not be construed to represent any agency determination, view or policy. This project was undertaken through a contract with the New Jersey Department of Environmental Protection (NJDEP), Coastal Management Program.

The views expressed in this report are the authors' own and do not reflect the official policies or positions of the NJDEP Coastal Management Program, Rutgers University, the Mid-Atlantic Regional Association Coastal Ocean Observing System (MARACOOS), or the Mid-Atlantic Coastal Acidification Network (MACAN). The authors are grateful for the collaborative effort with the New Jersey Coastal Management Program contributing to this report as well as for the involvement of NJDEP employees: Megan Rutkowski, Robert Schuster, Kevin Hassell and other members of the NJDEP Ocean Acidification team. Additionally, the authors are grateful for the important contributions made to this project by the stakeholders who participated in the workshops contributing to the content of this report. .

Suggested citation: *Barr, Janine, Grace Saba PhD, Jeanne Herb, Kirsten Wakefield. Stakeholder and Subject Matter Expert Feedback Regarding the Content of a New Jersey Ocean Acidification Action Plan Prepared for the New Jersey Department of Environmental Protection. Edward J. Bloustein School of Planning and Public Policy; Rutgers, The State University of New Jersey. New Brunswick, NJ New Brunswick, NJ.*

Table of Contents

2

I. Executive Summary

This report summarizes stakeholder and subject matter expert feedback regarding the potential elements and content of a New Jersey Ocean Acidification (OA) Action Plan. 28 individuals participated in this stakeholder engagement process which consisted of three virtual workshop meetings between June and July 2023. Participants agree that OA is an emerging threat in New Jersey that warrants immediate action to prepare for and mitigate risks to New Jersey's culturally important and economically valuable coastal industries including the commercial fishing, recreational fishing, and aquaculture industries which contribute more than $2.5 billion annually to the state's economy. Participants agree the most pressing goal to include in a New Jersey OA Action Plan is the creation of Statewide OA monitoring network that can be sustained long-term to measure local trends in acidification conditions and related biological responses. Additionally, participants agree that it will be important to convene an informal, but structured, OA Coordination Committee to advise the implementation of New Jersey's OA Action Plan goals.

While funding to address OA in New Jersey is currently limited, it is important to allocate available funds to support the implementation of a statewide OA Action Plan. In doing so, the State would bolster existing climate, land use, and water quality goals while supporting coastal communities vulnerable to the negative impacts of OA. Additionally, a statewide OA Action Plan provides an opportunity for New Jersey to identify itself as a leader in OA research, mitigation, and adaptation planning allowing the State to serve as an example for other national and international OA efforts. Opportunities and challenges regarding New Jersey's future OA mitigation and adaptation efforts are detailed below through the lens of stakeholder and subject matter expert concerns and priorities.

II. Ocean Acidification and Developing a New Jersey Ocean Acidification Action Plan

A. Ocean Acidification Basics

The primary cause of ocean acidification (OA) is rising levels of carbon dioxide (CO_2) gas in the atmosphere released when fossil fuels are burned, CO_2 dissolves rapidly in seawater, setting off a chain of chemical reactions that lower pH and make seawater more acidic. The ocean has absorbed roughly 30% of global CO_2 emissions since the beginning of the industrial revolution, lowering average ocean pH by 0.1 units - equal to a 30% increase in acidity. If CO_2 emissions continue at current rates, ocean pH levels are expected to fall another 0.3 to 0.4 pH units by the end of the century, representing an additional 120% decrease and creating an ocean that is more acidic than at any time in the past 20 million years.

While the increase of atmospheric CO_2 is the primary driver of OA in global ocean waters, there are several local drivers on the nearshore coastal shelf and estuaries that contribute to higher levels of acidification in coastal waters. These drivers include freshwater flows (from rivers and stormwater which are naturally more acidic than ocean water and lower coastal pH), inputs of nutrients (from wastewater treatment effluents as well as runoff), and coastal upwelling - all of which trigger coastal and estuarine processes that can exacerbate OA.

Moreover, warming temperatures and increases in precipitation associated with climate change exacerbate these coastal drivers and add to the stress on marine life. An increase in heavy downpours flushes naturally acidic freshwater into the estuaries as well as nutrients that stimulate algal blooms. The algae eventually die, sink to bottom waters, and are consumed by bacteria. This process depletes oxygen in the bottom water and can lead to a dangerous condition known as hypoxia. The process also releases CO_2, which, in turn, increases acidification locally. Periodic upwelling of deeper, colder, more acidic water is an additional source of acidification near the coast (Figure 1).

Although we are not yet observing known significant impacts of OA in New Jersey, OA is an emerging threat to the marine ecosystem and economy.

For marine mollusks, such as oysters, clams, and scallops, OA makes it more difficult for these species to create shells. In both shell-forming and non-shell-forming marine species, OA can disrupt reproduction, growth, and metabolism and can leave organisms more vulnerable to disease, predation, and other climate change-related stressors such as warming waters. Indeed, workshop participants whose livelihoods are associated with the shellfish and fishing industries anecdotally report observable changes in availability of species, including weakfish and mackerel, over time. Participants in the stakeholder process, as well as State and Federal officials in the Mid-Atlantic, view OA as an increasingly emerging threat to the marine ecosystem and economy.

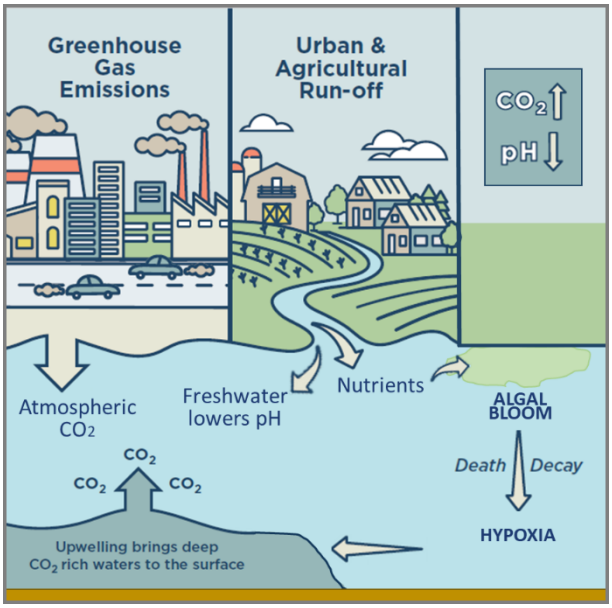


Figure 1. Global carbon emissions are the dominate cause of OA, while local factors can exacerbate local conditions. This schematic highlights some of New Jersey's local factors including freshwater, nutrients, and upwelling events. (Modified from California OA Action Plan, 2018; for more information on local drivers see this NOAA and Mid-Atlantic Sea Grant).

New Jersey's commercial fishing industry is the fifth largest in the United States and provides more than 50,000 jobs. Commercial fishing, recreational fishing, and aquaculture contribute more than $2.5 billion annually to the state's economy. The most economically important shellfish species in New Jersey include the Atlantic sea scallop, ocean quahog, Atlantic surf clam, blue crab, and Eastern oyster. In the United States, southern New Jersey counties rank second highest in economic dependence on shelled mollusks.

B. Summary of State Actions to Develop an OA Action Plan for New Jersey

New Jersey has undertaken a comprehensive set of research, policy analysis, and stakeholder engagement strategies to lay the foundation for development of a comprehensive Ocean Acidification (OA) Action Plan. These strategies include:

1. The New Jersey Department of Environmental Protection (NJDEP) outlined the potential impact OA could have on the economy and natural resources of the state in its 2020 Scientific Report on Climate Change.

2. New Jersey is an active member of the Mid-Atlantic Coastal Acidification Network (MACAN) which is a collective of scientists, tribal, federal, and state agency representatives, resource managers, and affected industry partners who work together to coordinate and guide regional observing, research, and modeling of ocean and coastal acidification.

3. In 2020, the NJDEP Coastal Management Program (CMP) undertook a study in collaboration with Rutgers University that: summarized ocean acidification policies and efforts in 11 states, outlined the potential elements of a New Jersey OA Observation and Research plan, and summarized potential elements of a New Jersey OA Action Plan.

4. In 2021, New Jersey joined the OA Alliance, an International Alliance to Combat OA, which brings together governments and organizations from across the globe dedicated to taking urgent action to protect coastal communities and livelihoods from the threat of ocean acidification and other climate-ocean impacts.

5. In 2021, the NJDEP CMP hosted a stakeholder workshop in collaboration with Rutgers University that: reviewed existing acidification monitoring efforts and gaps in New Jersey state waters; summarized potential approaches to optimize and expand monitoring in New Jersey, including outlining costs, logistics, and next steps needed to develop, coordinate, and maintain a statewide acidification monitoring network; and developed strategies for communication, engagement, and partnerships with industry stakeholders. The workshop resulted in a set of recommendations for developing and maintaining a New Jersey Statewide Monitoring Network (formalized in this 2023 report).

6. Strategy 2.2 of the 2021 New Jersey Climate Change Resilience Strategy, "Manage Agricultural Lands, Forests, and Other Ecosystems for Climate Impacts and Environmental Stressors," commits New Jersey to "develop an ocean acidification action plan to address impacts to fisheries, aquaculture, and ocean resilience."

This report summarizes NJDEP's most recent collaboration with Rutgers University on a stakeholder engagement process to generate recommended elements and content of a New Jersey OA Action Plan. Moreover, the elements and content of a New Jersey OA Action Plan outlined herein incorporate lessons learned throughout NJDEP's OA collaborations with Rutgers University since 2020.

The project team engaging with NJDEP on this effort includes Janine Barr (Rutgers University Bloustein School), Dr. Grace Saba (Rutgers University Department of Marine and Coastal Sciences), Jeanne Herb (Rutgers University Bloustein School), and Kirstin Wakefield (MARACOOS/MACAN). The Rutgers team is grateful for the leadership and support for this project that has been provided by staff at NJDEP including Megan Rutkowski, Kevin Hassell, and Robert Schuster.

III. Summary of 2023 Stakeholder Engagement Process

A. Background

In consultation with NJDEP, the project team was charged with identifying approximately 15 stakeholders and engaging those stakeholders to (1) learn stakeholder concerns and priorities regarding the threat of OA and (2) use stakeholder input to inform the elements and content of a statewide OA Action Plan. The project team engaged stakeholders through three virtual workshop meetings held between June and July 2023.

The project team engaged 15 stakeholders and 9 subject matter experts in the workshop series (see Appendix A for a full list of participants).[1] Stakeholders consisted of individuals whose livelihoods depend on the health of New Jersey's commercial and recreational fisheries and the aquaculture and seafood industries (hereafter "industry members"); organizations involved in coastal management outreach and education, advocacy, and restoration; and academia. Subject matter experts included State and Federal government employees engaged in coastal zone management activities. For the purposes of this report, "participant" will refer to any individual who engaged in the OA workshop series. Seven additional organizations were invited to participate in this OA workshop series but, while supportive of New Jersey taking OA action, declined to participate in the stakeholder process due to capacity constraints.

Stakeholders were provided a stipend for their participation in the workshop series while subject matter experts were not provided a stipend due to conflict-of-interest concerns. All participants were consulted as individuals rather than a representative of their organization or agency; however, subject matter experts were encouraged to provide their thoughts on the policies and regulations to consider when developing a New Jersey OA Action Plan.

1 Beyond the 15 stakeholders and 9 subject matter experts who engaged in the full workshop series, this list includes 4 additional participants who provided input during the workshop process but did not engage in the full workshop series.

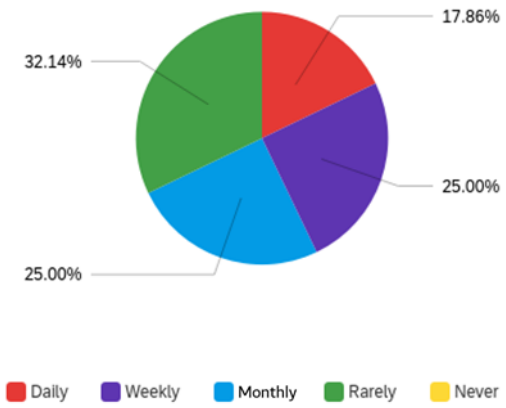


Figure 2. Responses of 28 stakeholders and subject matter experts when asked, "how frequently do you normally think about OA in your line of work?"

The stakeholders and subject matter experts involved in this workshop series had a broad range of experience with OA (Figure 1). While all participants had heard about OA prior to engaging in this workshop series, OA was not universally the most pressing issue each participant encountered in their daily work.

B. Workshop Series Schedule and Themes

Stakeholders and subject matter experts participated in a workshop series consisting of 90-minute Zoom meetings which were held two times per day on June 1, June 28, and July 25, 2023. On each meeting day, participants could choose to attend either a daytime session or evening session based on their availability.

The purpose of the first workshop meeting (June 1) was to identify stakeholder and subject matter expert (1) concerns regarding the threat/impacts of OA and (2) goals regarding OA adaptation and mitigation efforts. Preliminary input from stakeholders and subject matter experts was obtained during the first workshop meeting, but for more robust input, stakeholders and subject matter experts were asked to complete two surveys after the first workshop meeting. The first survey (*i.e.*, Survey 1) asked a series of questions to better understand participants' baseline understanding of OA and their concerns about OA in New Jersey. The second survey (*i.e.*, Survey 2) asked participants to rank 50 existing goals from other states' OA Action Plans based on how important achieving a given goal was for each participant. The NJDEP OA Team reviewed these 50 goals for completeness prior to the survey. [2] The project team received 28 and 26 responses

2 The NJDEP OA Team consists of approximately ten individuals from different offices within the NJDEP, including the NJDEP CMP, with jurisdiction on natural resources that are impacted by, or is a mitigating factor to, OA.

to each survey, respectively. The survey responses and the verbal reflections shared during the first workshop meeting informed the content of the second workshop meeting.

The purpose of the second workshop meeting (June 28) was for the project team to provide a brief overview of responses from Surveys 1 and 2 and then guide participants through "deep dive" discussions on several priority elements for a future OA Action Plan. These deep dive discussions focused on stakeholder and subject matter expert priorities for OA monitoring/data collection, reducing the causes of OA, and building adaptation/resilience to OA. Participants were also given a list ahead of this meeting with the ten goals that were identified as being the most pressing and important goals to achieve based on Survey 2. Participants were asked to complete a short survey (*i.e.*, Survey 3) to rank those 10 goals during the meeting.

Between the second and third workshop meeting, stakeholders and subject matter experts were given an assignment to reflect on the goals that they thought were most important to achieve within five years of an OA Action Plan being published by the State. Responses to this assignment were incorporated into the third workshop meeting.

The purpose of the third workshop meeting (July 25) was for the project team to provide stakeholders and subject matter experts with a preview of recommendations that would be included in this report to NJDEP so that workshop participants could provide any additional input and correct any priorities that were not accurately captured. The project team also facilitated a discussion regarding how stakeholders would like to be engaged in future State OA decision-making.

C. Project Team Reflections on Stakeholder Engagement Process

Independent of the substantive feedback stakeholders and subject matter experts provided on the elements and content of a future OA Action Plan, below are several general reflections that could inform the OA Action Plan drafting process:

1. Fishery-dependent Communities Are Already Living with Remnant Fisheries – Stakeholders reflected that the fisheries off the coast of New Jersey have changed dramatically over the last several decades. One fisherman noted, "I see the environment is not supporting fisheries that once

seemed boundless in New Jersey when I was a boy. The fisheries aren't even a shadow of themselves when I started fishing commercially at 17. [So, I] call these remnant fisheries because we're fishing what is left." This is relevant because fishery-dependent communities recognize what they can fish for is changing and that there are compounded environmental drivers to their observed changes in fish populations. As such, there is overarching concern within the fishing community and among other stakeholders that OA will be another stress on these species and that may be the tipping point for commercially important species and the ecosystem. It will be important to think wholistically about OA when developing a New Jersey OA Action Plan: both temporally (*i.e.*, looking at historical fish populations, landings, and water quality data) and environmentally (*i.e.*, how will other environmental stressors exacerbate the negative impacts of OA).

2. Stakeholders and Subject Matter Experts Foresee Negative Environmental and Socioeconomic Impacts of OA – Most participants agreed that OA will have negative environmental and socioeconomic impacts in New Jersey. While all participants agreed additional research and monitoring is necessary to better predict those impacts, one stakeholder noted, "Many coastal communities have commercial and recreational use of local waters incorporated in their economies and cultures at the foundational level. If OA depresses or drives the collapse of fisheries (commercial and/or recreational) and negatively impacts environmental conditions to the point that it affects social and recreational activities (water quality, fish kills, human health, etc.), it could drastically re-write the state's economy, culture, and charm." The one stakeholder who disagreed noted that they thought the environmental and socioeconomic impacts would "not be significant" but that they would want to better understand the direct threat of OA to "ocean function, fish, and shellfish" and what impact that may have on an average New Jersey citizen before they speculated on future OA impacts.

It is also important to note that there may be current impacts to New Jersey living marine resources that are not yet being observed or directly linked to OA because of the insufficient monitoring and research.

3. Payment for Services and Engagement is Imperative – Stakeholders who participated in the workshop series received an honorarium for their time. Stakeholders reflected that the honorarium was a welcome and much needed consideration in their agreement to participate in this engagement process, particularly for industry members that struggle to make a profit

as commercial fishermen. These honorariums will be key moving forward as stakeholders continue to be formally involved in the creation and implementation of a New Jersey OA Action Plan.

4. Industry Members Want to be Part of the Solution, but their Scientific Credibility has been Challenged in the Past – Many of the solutions outlined in this report involve collaboration with industry members (*e.g.*, commercial fishermen, commercial aquaculture, and recreational fishermen) including working with industry members to collect OA data. This data collection would include carbonate chemistry samples as well as related biologic (*e.g.*, fisheries-related) data. However, a barrier to this community driven data solution is that data generated by industry members does not have a Quality Assurance Project Plan (QAPP) that would allow the State to use this type of "citizen science" data to inform OA decisions. Additionally, industry members would require training prior to collecting carbonate chemistry data to ensure high quality data is collected.

The sentiment of industry members regarding their role in collecting OA data is best expressed by a commercial fisherman who noted, "it takes so long [for a fisherman] to gain the credibility [needed so that when you] give your information [to decision makers] it isn't considered anecdotal. We need [good information provided by fishermen] to become empirical data, which it is if [a trusted fisherman] quantifies it." The stakeholder went on to note, an important precursor to any industry member getting involved in OA data collection is for commercial and recreational fisherman to know that the data they provide to the State will "have teeth [and be used to make a difference in marine resources management]." The QAPP and training mentioned above would go a long way in addressing industry members' concerns.

IV. Stakeholder and Subject Matter Expert Feedback on the Elements and Content of a New Jersey OA Action Plan

The purpose of this workshop series was not to draft an OA Action Plan; rather, the goal was to engage a participatory stakeholder process to assess content of and support for specific elements of a statewide OA Action Plan. Below are the key takeaways generated from stakeholders and subject matter experts from this process.

For context, OA Action Plans describe real, tangible actions that states are taking, or will take, to better understand and respond to the threat of OA including: developing strategies for reducing carbon emissions and local land-based pollution, strengthening monitoring nearshore to better understand and predict local conditions, investing in adaptive measures in partnership with industry or seafood dependent communities, and advancing information sharing strategies that help policy makers respond.

A. Summary of Stakeholder and Subject Matter Expert Interests

Workshop participants provided extensive feedback on the content and elements they would most like to see reflected in a New Jersey OA Action Plan. Participants agreed that the following list of recommendations, if implemented, would result in a robust New Jersey OA Action Plan. The list of recommendations below is provided in no particular order. As such, participants reached consensus that an ideal New Jersey OA Action Plan would: :

1. **Emphasize the importance of achieving existing State climate goals and other State goals which indirectly mitigate the threat of OA –** The State has numerous policies, regulations, and statutes in place to achieve climate and other environmental goals. These goals, if achieved, will also reduce the threat of OA across the State. For example, existing climate goals (achieved through the New Jersey Global Warming Response Act, New Jersey

Executive Order 274, New Jersey Executive Order 315, New Jersey Natural and Working Lands Strategy, New Jersey Natural Climate Solutions Grant Program), existing nutrient runoff management strategies (achieved through the New Jersey 2011 Fertilizer Law, the 2019 New Jersey Clean Stormwater and Flood Reduction Act, the New Jersey Nonpoint Source Management Program Plan), existing strategies to reduce naturally acidic freshwater flows into coastal waters (achieved through the 2020 New Jersey Stormwater Management Rule, the Pinelands Comprehensive Management Plan, and the 2022 re-evaluation requirement of New Jersey MS4s), and existing climate education goals (achieved through the 2020 New Jersey Student Learning Standards).

While the State does not have any existing goals directly tied to OA adaptation or mitigation, participants agreed that addressing the key drivers of OA in New Jersey (*i.e.*, greenhouse gas emissions, nutrient pollution, and freshwater flows) through established climate, nutrient, and stormwater focused goals would indirectly help to mitigate the impacts of OA moving forward. One stakeholder summed up the importance of achieving these existing, diverse goals by stating, "I like that [achieving these existing goals will address] the inputs that contribute to OA. Actions that work to prevent the problem rather than reacting are always more cost effective and provide a greater improvement."

2. Address the root causes of OA and the symptoms – Participants agree while it will be important to be proactive to address the root causes of OA, it will be equally important to be prepared to address the symptoms of OA. Therefore, it would be beneficial to incorporate both mitigation and adaptation actions into a New Jersey OA Action Plan. Moreover, it will be important for a New Jersey OA Action Plan to weigh the unintended consequences of those mitigation and adaptation efforts. For example, one stakeholder noted the importance of ensuring actions that address the root causes of OA such as planting submerged aquatic vegetation (SAV) to sequester blue carbon "not be pursued at the expense of other habitats like marshes and shellfish reefs/beds. [This has been a problem] in areas like Florida where groups that should be united on a common goal have become divided by taking too narrow a focus. Limited dollars can cause this without a strong leader/moderator/strategist."

Furthermore, participants expressed an interest in including OA and its impacts in broader, but related, policy discussions of potential

geoengineering approaches of carbon sequestration as well as ocean-based production of renewable energy (*e.g.*, wind energy, wave/tidal energy, and biofuels).

3. Advocate for building an OA monitoring network and conducting OA research – Continued and expanded monitoring and research are needed to understand the best approaches for OA mitigation and adaptation efforts. Participants expressed a strong interest in the New Jersey OA Action Plan including a requirement that a New Jersey OA monitoring network be formed with the goals of (1) identifying "tipping points" for species, population, and ecosystem health and (2) informing the creation of tools and solutions that will build resilience to the fishing and aquaculture industries. These goals are driven by the fact that protecting the communities most at risk to the impacts of OA was a top priority for these participants.

Specifically, participants noted it would be best for an OA Action Plan to incorporate the 2023 Recommendations for Developing a Statewide New Jersey OA Monitoring Network, including convening an OA Working Group to: (1) inventory current monitoring assets, (2) assess gaps in monitoring, and (3) recommend prioritization and gap filling approaches to optimize the State monitoring network toward decision-making needs. Moreover, the OA Working Group would provide logistical and data management support to ensure the monitoring network delivers timely and decision-relevant information for the State. The OA Working Group would assist the State in efforts to enhance availability for discrete sample analysis, adopt community best practices to ensure data quality control, develop network data management, and coordinate the OA network. Of note is that the Working Group could be labeled a Task Force, Commission, Committee, or Team – whatever nomenclature would allow the Working Group to start taking priority actions for the State as soon as possible. Additional input regarding this idea of a Working Group is reflected in Section IV.B.8 where participants advocate for "Coordination Committee" of OA stakeholders and subject matter experts.

For participant feedback on research priorities, see subsection IV.A.6 below.

4. Stress the importance of using existing data to take action now on OA rather than waiting for additional studies to be completed – Participants expressed concern that the establishment of an OA monitoring network and research efforts may preclude the State from taking immediate OA mitigation

actions while those efforts spin up. Participants agreed there is sufficient existing data and knowledge about the negative impacts of OA, especially about the environmental conditions that could exacerbate OA, to take action now. Participants therefore agreed it would be valuable for an OA Action Plan to identify immediate actions that could be taken to mitigate the threat of OA in New Jersey waters.

5. Prioritize local action and regional coordination/collaboration on OA issues – Participants agree there needs to be a balance of local and regional action for OA mitigation and adaptation efforts to be successful. Local actions can help create "early success stories" that could build support and public interest surrounding OA mitigation and adaptation, while regional actions and coordination with neighboring states in MACAN and beyond are important for building a robust response to OA. One subject matter expert noted, "Local goals that are site specific are more likely to engage local support. [Goals] should be tangible, underscore interconnectedness among components, and be accessible to the local community." Moreover, regional collaboration among east coast states is important to ensure priority needs and partnering opportunities (*e.g.*, Federal grant applications) are realized.

6. Prioritize Monitoring and Research for "Representative" Taxa and Habitats – When participants were asked to identify the species and geographic areas they would most like to see researched regarding OA, the following species and locations were named (in no particular order):

- Shellfish: oyster, hard clam, sea scallop, surf clam, whelk, ribbed mussels
- Finfish: mackerel, bluefish, weakfish, striped bass, Atlantic sturgeon, summer flounder, striped bass, black sea bass, black drum, menhaden, sand lance, tuna (various species)
- Aquatic Vegetation: SAV
- Locations/habitats:
  1) bottom Cold Pool waters during summer season,
  2) nearshore waters particularly in northern New Jersey shelf - off Sandy Hook, near Hudson Canyon (*e.g.*, Hudson Shelf Valley),
  3) estuarine systems (Raritan, Delaware, Barnegat Bays – as there is less data here) and
  4) marsh ecosystems.

Upon additional reflection, participants agreed that while "everyone would love to know what is happening [to every critter and submerged plant] in their backyard, at the end of the day, there isn't enough funding for that." Moreover that, "There are a lot of different layers to what may dictate or correlate highly with sensitivity of these species to elevated levels of CO_2 or OA. So that is something that needs to be underscored here. Given funding/location/personnel/lab capacity, how can we get the most bang for our buck?"

As such, participants agreed that studying representative taxa and habitats would achieve a comprehensive picture in a timely and more cost-effective manner. Additionally, participants noted the importance of gathering existing data as part of the process for identifying the representative taxa and habitats to study. Participants identified categories of species and habitats that they would like to see studied. **For species this included:** offshore vs. inshore, plankton vs. forage species vs. predators, winter vs. summer spawning species, commercial and recreationally important taxa, species with a narrow (*e.g.*, minimal migration beyond New Jersey) and wide (*e.g.*, migration around the Atlantic Ocean) geographic range, protected species (*e.g.*, Atlantic sturgeon), and species at the base of the food chain including phytoplankton (*e.g.*, diatoms) and zooplankton (*e.g.*, radiolaria). Studying species low on the food chain are particularly important because they support species of economic and recreational significance, including for shellfish farmers who rely on phytoplankton blooms to feed their shellfish. **For habitats this included** prioritizing New Jersey coastal bays, nearshore habitats, and offshore habitats that have ecosystem and economic value. Ultimately participants agreed research efforts should be focused on collecting data to support New Jersey's most vulnerable communities (fishermen and shellfish farmers) to maintain local economies and cultures.

7. Underscore that it would be beneficial for all tools, services, and assistance efforts to be co-produced with fishing, aquaculture communities, and other impacted industries – Participants agree that transparent and meaningful engagement and communication with all stakeholders, including at risk communities, will be important moving forward with a New Jersey OA Action Plan and achieving the goals therein. This engagement will ensure the tools and solutions provided to mitigate or adapt to the negative impacts of OA are most useful to at risk communities. One stakeholder summarized this sentiment by noting, "working with the

most at risk/vulnerable communities to help them adapt and respond to change and developing the predictive models to support that work is critical for future success." Indeed, an industry member noted that commercial, recreational, and charter boat fishermen are willing to be engaged and that participating in this kind of collaborative work could provide a financial lifeline for many struggling fishermen. For example, when fishermen are paid an honorarium for consulting on OA issues or are hired hourly to collect OA data, the money helps them make a living wage and keeps them working to support this economically important industry.

8. Emphasize the importance of educating stakeholders on OA issues to galvanize partnerships and political will to address OA – Meaningful education will be important moving forward to foster awareness of and support for this pernicious issue of reducing the threat of OA. Participants reflected that while OA is an urgent issue needing attention, it is, for now, largely an invisible threat. While humans *feel* the impacts of climate change daily with warmer air temperatures and other weather extremes, they won't feel OA and may therefore not perceive it to be an issue needing attention even when New Jersey's fishing and shellfish industries are being negatively impacted and the food on their plate changes. Educating the public on their personal contributions to OA (*e.g.*, fertilizer use, runoff, CO_2 emissions) and how OA impacts the local species and ecosystems that they are connected to will be key. Participants noted education efforts need to start as soon as possible to pave the way for partnerships and political support necessary to take OA mitigation and adaptation actions.

Participants also noted that both formal and informal OA education efforts will be important moving forward. Formal education would occur after the State and partners develop a communication and outreach plan to communicate OA science, impacts, and solutions to targeted stakeholder groups through outreach materials (*e.g.*, fact sheets, websites, videos), interactive activities for schools and public events, and public speaking events. Informal education occurs through "organic, unstructured, and learner-driven" actions. One subject matter expert who conducts OA research in New Jersey with NOAA noted, "The informal piece that I'd like to emphasize is training early career scientists and students to work on [OA projects] [...] especially undergraduates: these are tomorrow's scientists. [After interning with NOAA or in another environmental organization in the State] they can go back to their home universities or go on to graduate

school and have that basis of education, information, and excitement about these kinds of topics."

Education will also be important for those who may be regulated by new OA policies or legislation. As one stakeholder noted, "best management practices and regulations are crucial to addressing OA, however making sure the communities most at risk and most affected [by OA] understand why there are regulations is crucial [because nobody] likes to be told what to do without being told why they are doing it."

9. Frame OA Action Plan on New Jersey Issues and Communities – Participants agree that a New Jersey OA Action Plan would not be effective if it takes the form of a research agenda. While additional research is needed, one stakeholder highlighted that if an OA Action Plan reiterates "more research, more research, more research, that isn't a very motivating message [for stakeholders and community to rally behind.] I'd encourage us to think about this OA Action Plan about being very much about why we care about OA in New Jersey [and why we need to take particular actions to mitigate and adapt to OA.] When I look at other OA Action Plans, I worry that we are just studying the decline of the problem [rather than identifying solutions and finding a path forward.]" As such, participants agree that the most effective New Jersey OA Action Plan would communicate the potential impacts to the commercially, recreationally, and culturally important elements of New Jersey's marine ecosystems and frame its goals based on those important, local elements.

B. Challenges in Creating and Implementing an OA Action Plan

Participants identified the following challenges that may surface when implementing a New Jersey OA Action Plan. Where possible, stakeholder and subject matter expert identified solutions are provided with a corresponding challenge.

1. Local actions cannot stop the rise of global carbon dioxide emissions – The key to mitigating OA over the long term is to dramatically reduce CO_2 emissions by transitioning to renewable energy sources, practicing climate-smart agriculture, using sustainable building materials, eating a

climate-friendly diet, and much else. Efforts isolated within our state border to reduce CO_2 emissions and to mitigate other drivers of OA (*e.g.*, reducing the influx of land-based pollutants into the ocean, protecting and restoring "carbon sinks" such as salt marshes) are not sufficient to counter the negative impact of global CO_2 emissions. Participants recognize this reality but agree, "It is important for New Jersey to do its part in this global scale issue." Furthermore, New Jersey taking action through an OA Action Plan is an opportunity for the State to identify itself as a global leader in OA research, mitigation, and adaptation planning. One stakeholder noted, "Nature knows no political boundaries, so we must work together at regional and national and global levels to achieve meaningful policy, conservation, and action in response to OA." To maximize the effectiveness of State actions, stakeholders suggested collaboration among NJDEP and external stakeholders to ensure the monitoring and research conducted in the region can be used to inform State policies and legislation moving forward.

2. Funding – Sustained funding is imperative to support the monitoring network, research, and NJDEP staff time necessary to implement the OA Action Plan in the short- and long-term. While funding may be elusive, participants identified the following approaches as ones that can be important steps forward:

a. Allocate State Dollars for Seed Funding: Subject matter experts recommended allocating seed funding to set up the OA monitoring network and complete other urgent goals outlined in an OA Action Plan. Seed money is helpful because it can go "many fold further" than most funding streams. It will be important for any form of seed funding to be well thought out by NJDEP such that NJDEP proactively identifies how they will advance the outcomes/products of the seed funding (*e.g.*, if Phase 1 is to establish an OA monitoring network, then Phase 2 could be having funding set aside for staff time to maintain the network and facilitate connections among stakeholders). A subject matter expert also cautioned that it would be detrimental to OA mitigation and adaptation efforts if the State only allocated dollars to seed funding rather than to a sustained funding mechanism: their concern is that the State will say, "we did our part, we gave seed funding, now the State doesn't have any more responsibility."

b. Consider Collaborating on Funding Requests with the "Best" Partner Organizations: A participant cautioned that coordination and

collaboration among the State and stakeholders will be key when applying for Federal grants relevant to OA mitigation and adaptation. Specifically, the participant noted, "it isn't about just getting funding, it is who has the capacity to apply for funding [and thinking about] the red tape in each organization." Such limitations include: who can provide matching funds, what geographic scale aligns with the notice of funding availability, what organization has the appropriate expertise to administer the grant. Collaboration among all interested parties will be helpful especially if the group that is identified as having the best shot at getting the funding doesn't have the capacity to apply. With this constraint in mind, participants noted the utility of partnering with regional organizations, such as MACAN/MARACOOS, when applying for grants. Collaborating with regional organizations has the added benefit of fostering a unified regional response to OA in the Mid-Atlantic.

3. **Timing –** Participants urged adoption of a New Jersey OA Action Plan in the short term given changes in state leadership as a result of 2025 gubernatorial elections. More broadly, participants indicated that timely adoption of an OA Action Plan would have the important benefit of framing OA action as part of a more cohesive and coordinated economy-wide climate strategy which can have tangible implications for communication to diverse stakeholders and audiences.

4. **Coordination Within State Agencies–** Participants have identified several opportunities for State policies to be updated to streamline OA mitigation and adaptation actions (see subsection IV.G). Implementing these suggestions, as well as the goals identified in subsection IV.A, will require coordination among various programs within NJDEP and in other State agencies. Alignment among State agencies will be key in developing and enforcing any OA policy or regulatory change. A possible mechanism identified by the project team to facilitate interagency cooperation is the Interagency Council on Climate Resilience.

5. **Education –** Participants agree public understanding of OA and support for OA mitigation and adaptation efforts is imperative (see section IV.A.8). While developing a communications plan and outreach materials were outside the scope of this workshop series, participants identified the following target audiences and topics for future education materials which could be the basis of any communications materials or plans moving forward:

a. Target Audiences: the public (K through grey), recreational fisheries, commercial fisheries, shellfish industry, municipal planners (*e.g.*, experts that manage what is on the land and infrastructure that contributes to runoff and other drivers of coastal OA), offshore wind industry, stakeholders outside of those immediately impacted by OA, and policy/ decision makers.

b. Topics: the impacts of OA on fish/shellfish landings and food security; impacts of OA to water quality, fish kills, human health, the economy; cultural impacts (shipwrecks, submerged archaeological sites); how OA dovetails with other climate change issues (*e.g.*, combined with sea level rise, how might OA impact coastal infrastructure which in turn, may exacerbate land input of nutrients and worsen OA); impacts of OA to macro-organisms and the underlying microscopic interactions; any information that helps connect the public with the natural world.

6. Technology Limitations – OA monitoring efforts are limited by available in-situ sensor technology that may have extensive maintenance routines and laboratory-based analyses which can be laborious, expensive, slow, and provide low temporal and spatial resolution. One stakeholder noted, "Sensor technology needs to improve. Some of the sensors [in use today] need to be calibrated daily. I can see a future where each offshore wind turbine has an OA sensor, but the technology reality we have right now can't get us there. There have been other sensors that have been developed over the past decade," so as technology improves, it will be easier to expand the OA monitoring network. However, participants request that this limitation not preclude efforts to collect OA baseline data now to inform OA mitigation and adaptation decision making.

7. Goal Fatigue – Having too many goals in an OA Action Plan could result in "goal fatigue" where having too many aspirations preclude any goals from being achieved. In other words, when *everything* is a priority, nothing is a priority. Having too many goals could also contribute to the appearance of conflicting goals among stakeholders, which could hinder success. For these reasons, a New Jersey OA Action Plan may be most effective if there are a conservative number of goals it identifies.

8. Planning Fatigue – Participants recommend that a New Jersey OA Action Plan call for the formation of several "task forces" made of stakeholders relevant to statewide OA actions (*i.e.*, groups of experts to serve as a

consulting body NJDEP can turn to when making future OA mitigation and adaptation decisions) including a monitoring/science task force, an education/outreach task force, and a socioeconomic task force. Participants further reflected that having too many task forces may unnecessarily extend the amount of time spent on planning actions to the detriment of taking actions.

As such, the participants requested that a single group or "Coordinating Committee" of approximately 10 people be formed and serve as the primary communicator with NJDEP. The Coordinating Committee would have subgroups working on specific subject areas (*e.g.*, monitoring/research, engagement/education, and socioeconomics). These subgroups would have a mix of experts including those on the Coordinating Committee and experts independent of the Coordinating Committee to advise on a specific topic or issue. This preference is best captured in this stakeholder's reflection that without one authoritative Coordinating Committee of stakeholders, "messages get muddled and you're afraid about stepping on another group's toes or neglecting to report laterally to them. [...] Because [OA] is so complicated, we need a lot of heads to work together and compile that information. [...] It is information that needs to be wrangled, filtered, and translated. So, I think [having a single coordinating committee with subcommittees reporting to that coordinating committee] is a better product and there is less chance of us tripping over our own feet." Another stakeholder went on to say, "You wouldn't be able to have 20 people on the Coordinating Committee, but you may need 20 people on a science research/monitoring subcommittee to speak for [each species of concern] or the various things you'd want to monitor."

C. Input on OA Action Plan Goal Setting

In addition to the challenges identified above, participants provided reflections on the language that NJDEP may consider incorporating into OA Action Plan goals to ensure goals are meaningful and actionable. These reflections include:

1. **Consider Including Helpful Timelines for Achieving Goals –** Subject matter experts agreed identifying target years to achieve specific goals is helpful for getting tasks done, but that deadlines can prove detrimental in the long run. For example, one subject matter expert noted for the Chesapeake

Bay restoration project, "those dates [for achieving water quality improvement milestones] tend to go by and targets are not met for various reasons. So, the sense of urgency is reduced once that year is surpassed." If target dates are included in future OA Action Plan goals, subject matter experts encourage NJDEP to clearly identify all the goals that would ideally be achieved by a certain target year so OA Action Plan readers understand goals are not mutually exclusive. For example, a subject matter expert noted that if an OA Action Plan goal was to expand the OA monitoring network by 2030, readers may think that "nothing else would [happen] until after 2030" to mitigate or adapt to OA.

One solution to this timeline issue would be to include goals without deadlines. An example goal provided by a subject matter expert was to expand the number of OA monitoring stations by 30%. "That way, we are specific, but not held to a date that may or may not mean something in the future."

Another solution would be for an OA Action Plan to identify loose timeframes for achieving different goals. For example, one existing OA Action Plan divides goals into three categories: near-term, short-term, and long-term. The system has been helpful, however, the subject matter expert implementing the plan noted, "What I am running into now as we are getting into those long-term goals is that…they are things we really should have started a while ago, [because they were processes that took a long time to establish or get through]. By identifying them as long-term goals, they got a little lost in the sauce." Additionally, another subject matter expert expressed concern that, "if we have too many long-term goals, we are more likely not to meet them. If we have shorter term goals that we can be working on, that would be great. [We need a balance of] what has more impact now versus what we can move on over the long term.]" A list of possible goals based on this near-, short-, and long-term formatting is included in Appendix C and has been reviewed by participants.

2. Maximize Implementing OA Goals that are Fair and have "Teeth" – A range of goals have been identified by participants to include in a New Jersey OA Action Plan (see subsection IV.E and Appendix C). Because of this range, a point of discussion during the workshop series focused on the utility of updating regulations/legislation as opposed to implementing policy changes to encourage OA mitigation and adaptation efforts moving forward. The former, updating state regulations/legislation, are actions that have "teeth"

that would obligate action if violations occur (*e.g.*, the 2023 updates to the MS4 permitting requirements). Some stakeholders noted that while regulatory changes may take time, making regulatory changes is necessary to ensure mitigation/adaptation efforts happen in New Jersey.

In contrast, several subject matter experts noted the limitations and unintended consequences that may come from regulating non-fishing industries on OA issues. One subject matter expert cautioned, "OA is a global issue, yet if New Jersey implements stringent restrictions on industry (*e.g.*, land farmers), it will only serve to reduce [our economy] without commensurate benefit of reducing OA agents. State-level policy (regulations specifically) needs to be carefully designed when dealing with a regional/global issue." Moreover, if regulatory controls are placed on non-fishing industries, participants noted it will be important for those regulations to specifically call out the industry, user, or source of OA and identify what those limitations will be. If the language of regulation is not specific, one subject matter expert expressed concern that "everyone who owns property in New Jersey [could be regulated, which] would cost the state more than we would see in impacts." To avoid unintended consequences and to maximize the OA benefits, a subject matter expert recommended using a cost-benefits analysis to make decisions.

Participants also saw value in creating an incentive program to help mitigate the drivers of OA in New Jersey waters. An incentive program being a system where industries, landowners, and other stakeholders that contribute to nonpoint source pollution or emit excessive amounts of CO_2 are provided incentives to mitigate this behavior. Several incentive programs already exist that indirectly reduce these OA drivers (*e.g.*, New Jersey Department of Agriculture's Natural Resources Conservation Service that provides funding and support to reduce nonpoint source pollution across the State, the Regional Greenhouse Gas Initiative which requires fossil fuel power plants with a capacity greater than 25 megawatts to purchase an allowance to offset their CO_2 emissions). One stakeholder also noted that while incentive programs sound good, the environmental benefits from those programs are often slow and not sufficient. In response, a subject matter expert noted that nonpoint source pollution is a big issue to tackle and a more difficult/complex issue to tackle than originally thought.

3. Consider Including Caveat Language that Ensures OA Actions are Informed by Science – Other states have goals in their OA Action Plans

with caveat language such as, "Impose stringent controls to reduce and limit nutrients from sources that are contributing to acidification of coastal marine waters *if determined necessary based on scientific data*," or to, "identify, evaluate, and implement, as *warranted*, opportunities to reduce greenhouse gas emissions [...]" (*emphasis* added). Subject matter experts noted that these example goals could be interpreted in such a way that the States could caveat their way out of taking action. Participants agreed it will be important for language to provide enough wiggle room to ensure the best actions are being taken, but not enough wiggle room such that actions are stalled.

A possible solution is to be specific about the conditions that would make an action "necessary" or "warranted" in the language of a New Jersey OA Action Plan goal. For example, the language could clarify that the State would implement the most impactful or most cost-effective action(s). Cost here could mean monetary or political. One subject matter expert noted, "it could be cost on a vulnerable community or not a cost on another community." Ultimately, participants agreed science informed actions that are equitable are the best path forward.

D. Framing for the New Jersey OA Action Plan

Consistent with the participants' reflection in subsection IV.A.8, the participants supported framing the New Jersey OA Action Plan around the three priority action areas. Priority action areas have been used in other states' OA Action Plans as a way to group specific goals and actions in an organized way.

The priority action areas identified by participants are provided below and reflect the overall sentiment of participants outlined in subsection IV.A.

1. Advance OA Monitoring and Research
2. Reduce the Causes of OA and Build Resilience
3. Expand Public Awareness and Partnerships for Action

E. Priority Actions Based on Stakeholder and Subject Matter Expert Input

Recognizing the challenges that may come with implementing a New Jersey OA Action Plan, the participants identified four goals they would most like to see reflected in the State's OA Action Plan (Table 1). Our industry members (n=3) identified similar goals, but industry members did put a higher priority on goals focused on mitigating the impacts of OA on fisheries as well as actions that would aid fisheries in future OA adaptation efforts. The top three goals identified by industry members are:

1. Identify "near-term actions" that are most important to complete to build OA resilience for most at risk communities and industries and include those in the state OA Action Plan. By 2025, complete those "near-term actions."

2. Use data to predict future responses of commercially important shellfish, finfish, and crustacean species to increased OA and develop OA indicators/ thresholds to guide adaptive action for species and ecosystems.

3. Within the next 5 years, evaluate the potential for increased susceptibility of shellfish/finfish/crustaceans to predation, pathogens, and disease due to synergistic effects of OA and other human induced stressors.

Participants also identified several priority goals based on five categories that align with the recommended elements of an OA Action Plan per OA Alliance guidelines. These five categories are: advancing OA monitoring and research, reducing causes of OA, building adaptation and resilience to OA, expanding public awareness, and building sustained regional and international support (Table 2).

The priorities of the participants, collectively, indicate **it is urgent and important for the New Jersey OA Action Plan to call out the need for, and to identify the specific elements of, (1) an expanded and sustained OA monitoring network, (2) "near-term actions" that can be taken to build OA resilience for most at risk communities and industries, and (3) an education and outreach strategy to inform various stakeholder groups on the threat of and solutions to OA.**

Table 1. Stakeholders and subject matter experts identified four priority goals for a New Jersey OA Action Plan. The percentages in this table represent how many participants ranked an OA goal in their "top three most important goals they'd like to see in a New Jersey OA Action Plan." The priority ranking used below is based on the percentage of participants (n=22) that included a goal in their "top three" list.

Priority of Goal	Percent of Participants who Ranked Goal in Top 3	Goal
1	55%	Establish an expanded and sustained OA monitoring network to measure trends in local acidification conditions and related biological responses by 2030 per the recommendations of the 2021 New Jersey OA Monitoring Network Workshop.
2	50%	Identify "near-term actions" that are most important to complete to build OA resilience for most at risk communities and industries and include those in the state OA Action Plan. By 2025, complete those "near-term actions."
3	41%	Identify funding to provide dedicated capacity and staff time to implement the OA Action Plan, evaluate progress, and periodically update and revise the plan at least every 5-years.
4	37%	Support and achieve ongoing State goals including those related to: reducing nutrient pollution in coastal waterbodies, carbon sequestration in the ocean, and overall climate goals (e.g., reducing emissions).

Table 2. Goals participants identified as top priorities based on six categories of OA goals. The percentages listed adjacent to each goal represent the participants that ranked the corresponding goal as a top three priority in a given category. The (number) after each category title represents the total number of goals in that category participants ranked. Categories with fewer goals to rank have biasedly high percentages because respondents had fewer options to rank (e.g., There were 4 goals in the "expand public awareness about OA" category and 14 goals in the "build adaptation and resilience to OA" category. The higher percentage values in the former are partially driven by the fact that respondents only had 4 options to choose from, as opposed to 14 options.).

Category		Priority Goal
Existing New Jersey Goals (4)	88%	1. Support and reinforce current planning efforts and programs that reduce land based nutrient pollution (e.g., NJ's 2020-2025 Nonpoint Source Manag. Program Plan, NJ's 2020 Stormwater Management Rule).
	77%	2. Achieve existing NJ Climate Goals (e.g., NJ Global Warming response Act which commits NJ to reducing emissions by 80% below 2006 levels by 2050).
	77%	3. Support the Blue Carbon Goals from the NJ Natural and Working Lands Strategy (e.g., support DEP's future Blue Carbon Action Plan).
Advance Monitoring and Research (7)	96%	1. Establish an expanded and sustained OA monitoring network to measure trends in local acidification conditions and related biological responses by 2030 (per the recommendations of the 2021 NJ OA Monitoring Network Workshop)
	85%	2. Using currently available data, develop methods to assess current impacts and predict future responses of commercially important shellfish and crustacean species to OA by 2025 (based on NY Ocean Action Plan)
	54%	3. Collaborate with other East Coast states to speak with one voice in identifying priority needs and partnering opportunities with the Federal government, including those related to ocean resources management and science (based on CA OA Action Plan)
Reduce Causes of OA (13)	54%	1. Impose stringent controls to reduce and limit nutrients and organic carbon from sources that are contributing to acidification of coastal marine waters if determined necessary based on scientific data (based on New York OA Action Plan)
	54%	2. Identify, evaluate, and implement, as warranted, additional opportunities to reduce GHG emissions by coastal and ocean uses and related industries (e.g., tourism, recreation, restaurants) through voluntary, incentive-based, and/or regulatory measures and to secure carbon storage (based on CA OA Action Plan)
	50%	3. Restore 79,800 submerged aquatic vegetation (SAV) acres by 2025. SAVs are natural carbon sinks and include vegetation like underwater grasses (e.g., eelgrass). SAVs reduce the acidity of water by taking up carbon dioxide through photosynthesis (based on Maryland OA Action Plan)
Build Adaptation and Resilience to OA (14)	77%	1. Identify "near-term actions" that are most important to complete to build OA resilience for most at risk communities and industries and include those in the state OA Action Plan. By 2025, complete those "near-term actions" (based on Maryland OA Action Plan)
	58%	2. Conduct ecosystem monitoring and modeling to examine the complex relationships between species impacted by acidification and overall health and resilience of the marine and estuarine systems (based on Maryland OA Action Plan)
	39%	3. Within the next 5 years, evaluate the potential for increased susceptibility of shellfish and crustaceans to predation, pathogens, and disease due to synergistic effects of OA and other human induced stressors (based on New York Ocean Action Plan)

Expand Public Awareness About OA (4)	92%	1. Develop communication tools for OA with a focus on potentially impacted stakeholders, decision makers, and influencers. Engage relevant state communications programs and interested stakeholders in development process (based on Maryland OA Action Plan)
	85%	2. Build a communications plan and outreach materials to communicate OA science, impacts, and solutions; and evaluate the effectiveness of OA communication tools in filling information needs (based on Oregon OA and Hypoxia Action Plan)
	62%	3. Establish guidance and extension-type technical support to speed integration of OA into planning and operations of potentially affected communities and industries (based on CA OA Action Plan).
Build Sustained Regional and International Support (6)	73%	1. Provide dedicated capacity and staff time to Implement the OA Action Plan, evaluate progress, and periodically update and revise the plan at least every 5-years (based on California OA Action Plan)
	65%	2. Identify and target funding to implement the OA Action Plan, including the priority science research needs. Identify and pursue public funding, public/private partnerships, leveraged investments, and identify priorities for other funders (science, federal, private philanthropy) (based on CA OA Action Plan)
	50%	3. Expand partnerships with organizations to build understand about, and take action on, OA including the Mid-Atlantic Coastal Acidification Network (MACAN): a regional platform aimed to develop research and adaptation strategies (based on Maryland OA Action Plan)

F. Elements that Would Benefit New Jersey to Have in an OA Action Plan

Based on participant feedback, below is a list of elements the project team recommends NJDEP include in a future New Jersey OA Action Plan. For an extensive list of stakeholder and subject matter expert recommended elements for an OA Action Plan, please see Appendix C.

1. **Include a Funding Mechanism –** It would be helpful to identify a funding mechanism to provide dedicated NJDEP capacity and staff time to implement a New Jersey OA Action Plan.

2. **Include an Extensive List of Existing OA Relevant State Goals and Policies –** OA mitigation is achievable by meeting existing State goals and policies concerning reducing nutrient pollution in coastal waterbodies, carbon sequestration in the ocean, and overall climate goals (*e.g.*, reducing emissions) (for a more extensive list, see subsection IV.A.1). A New Jersey OA Action Plan could reiterate the State's commitment to meeting these goals and relevance to the threat of OA.

3. **Describe the Drivers of OA –** It would be helpful for an OA Action Plan to clearly articulate the drivers of OA (*e.g.*, greenhouse gas emissions, loss of blue

carbon sinks, runoff) so that stakeholders can reference those drivers from an authoritative State document in future work (*e.g.*, future funding requests).

4. Incorporate Existing Expert Recommendations for a New Jersey OA Monitoring Network – The 2023 Recommendations for Developing a Statewide New Jersey OA Monitoring Network detail five steps to develop a statewide OA monitoring network. In brief, those steps are:

Step 1 – Convene an OA Working Group.

- Task 1 – Inventory Current Monitoring Assets
- Task 2 – Assess Gaps in Monitoring
- Task 3 – Prioritize and Fill Gaps to Improve Network. When gap-filling, it may be beneficial to consider the following monitoring ideals: better connecting chemical and biological monitoring, identifying the end-use for the collected OA data, consider the environmental driver of the data being collected, and collaborating with regional acidification networks.

Step 2 – Enhance availability for discrete sample analysis

Step 3 – Adopt Community Best Practices to Ensure Data Quality Control

Step 4 – Develop Network Data Management

Step 5 – Coordinate the OA Network

Step 1 is relevant to element five below (*i.e.*, "Establish an OA Workgroup/ Coordinating Committee) and is needed to ensure the OA monitoring network is optimized and addresses State management decision-making needs. Steps 2-5 will provide logistic and data management support for the recommended monitoring optimization to ensure the OA Monitoring Network operation and maintenance delivers timely and decision-relevant information for the state.

5. Establish an OA Workgroup/Coordinating Committee and Identify Tasks for the Committee to Complete – A robust New Jersey OA Action may include the creation of an OA Coordination Committee with, at a minimum, a monitoring/research subcommittee, outreach/education subcommittee, and a socioeconomic subcommittee. It is encouraged for members of the OA Coordination Committee to represent the full range of New Jersey ecosystems and for members to have expertise in relevant environmental, socioeconomic, and technology fields. The membership of an OA Coordination Council could include: State agency representatives, academic experts, non-governmental

organizations (*i.e.*, environmental, conservation, environmental justice, etc.), commercial aquaculture and fishermen, private/recreational fishermen, and organizations that represent stakeholders that benefit from New Jersey's strong commercial fishing and aquaculture industries (*e.g.*, restaurants, seafood processors). It is encouraged for non-state employees on the OA Coordination Committee to receive honorariums for their time (see subsection III.C.3).

Example tasks for the OA Coordination Committee and Subcommittees to complete in a timely fashion are listed below per the recommendations of participants. Asterisked goals (**) can also be found in the "2023 Recommendations for Developing a Statewide New Jersey OA Monitoring Network."

a. Monitoring/Research Subcommittee

i. Goals to Achieve No Later than 12-Months After an OA Action Plan is Published

1. **Inventory current monitoring assets,
2. **Assess gaps in monitoring, and
3. **Recommend prioritization and gap filling approaches to enhance the state monitoring network toward decision-making needs.
4. Identify 5-10 sites to establish/enhance monitoring capacity.
5. Create a Research Plan which identifies the priority research to conduct to, ultimately, "predict future responses of commercially important shellfish, finfish, and crustacean species to increased OA and develop OA indicators/thresholds to guide adaptive actions for species and ecosystems."

ii. Goals to Achieve No Later than 36-Months After an OA Action Plan is Published

1. **Enhance availability for discrete sample analysis.
2. **Adopt community best practices to ensure data quality control.
3. **Develop network data management.
4. **Establish and set up coordination of the statewide OA monitoring network.

b. Outreach/Education Subcommittee

i. Goals to Achieve No Later than 12-Months After an OA Action Plan is Published

1. Gather and collate existing education materials relevant to OA.

2. Local Knowledge Collection - Work with local stakeholders (*e.g.*, commercial shellfish/finfish/aquaculture, charter boats, local/regional groups like MACAN) to catalogue local knowledge of fish stocks and stressors.

3. Create an outreach and education plan.

ii. Goals to Achieve No Later than 36-Months After an OA Action Plan is Published

1. Develop education materials on OA and begin to disseminate to key stakeholder groups.

c. Socioeconomic Subcommittee

i. Goals to Achieve No Later than 36-Months After an OA Action Plan is Published

1. Examine impacts of OA to coastal and submerged cultural resources as the increased OA likely causes increased deterioration of resources like shipwrecks and other cultural artifacts.

2. Quantify potential impacts of the loss of shellfish/finfish industry to (1) coastal communities and (2) the physical resources that make up these communities.

6. Identify Broad Research Goals – To promote scientific progress and to assist the OA Coordination Subcommittee on Monitoring/Research, it would be beneficial for an OA Action Plan to include a goal to complete at least three OA research projects on species of concern and/or in geographic areas of concern no later than three years after an OA Action Plan is passed (for a list of suggested research topics and areas, see subsection IV.A.6)

7. Identify Broad Policy Goals – To address participant feedback concerning the urgency of addressing the threat of OA (see subsection IV.A.4), it would be beneficial for an OA Action Plan to include a goal for the State to implement at least three policy changes that incorporate OA risk into decision making process (for a list of suggested policy changes, see subsection IV.G). Some examples include updating living shoreline requirements and enhanced habitat conservation policies. To address participant feedback concerning the time sensitive nature of taking such actions (see subsection IV.B.3), it would

be beneficial for these policies to change no later than three years after an OA Action Plan is passed. The State is encouraged to conduct a cost-benefits analysis when identify what policies to implement as ideal policies would have the most impact on mitigating OA with minimal financial, political, and social costs.

G. Suggested Policy Revisions and Updated Best Management Practices

Throughout the workshop series, participants identified several best management practices (BMPs) and suggested updates to existing State policies that would help minimize environmental stress on estuarine, nearshore, and offshore fishing grounds. These actions would, in turn, build a buffering capacity[3] for species and habitats against OA. Possible BMPs and policy updates are listed below.

BMPs and policy updates that the project team finds most feasible are marked with asterisks (**) and the project team recommends that an asterisked BMP/policy update be used as at least one of the three "broad policy changes" to implement in the 36-month period following the adoption of a New Jersey OA Action Plan (per subsection IV.F.5). Stakeholder comments on each BMP/policy are also included below:

1. BMPs/Policy Updates that Incorporate OA Into Existing Coastal Resilience Initiatives - There are several existing coastal resilience initiatives that would benefit from incorporating OA considerations. These include, but are not limited to:

a. **Consider Updating TE Requirements – NJDEP requires marsh restoration projects to have TE that includes sea level rise. It may be beneficial for NJDEP to require OA considerations be pulled into marsh restoration TE, living shoreline TE, and other relevant TEs. Additionally, it may be beneficial to tie carbon storage into the TE for marsh restoration and living shorelines.

b. **Consider Updating Suggested Marsh Restoration Goals – It may be beneficial for NJDEP to add a requirement for individuals/organizations

3 Buffering capacity here refers to ensuring ecosystems today are as healthy as possible so that when OA occurs, New Jersey's ecosystems and species are in the best condition possible to handle that stress.

conducting marsh restoration projects to monitor OA conditions before and after the completion of a marsh restoration project. This form of data collection would help elucidate the OA water quality and ecosystem benefits derived from these projects and promote future, similar projects.

2. Shellfish BMPs/Policy Updates

a. **Update Living Shoreline Requirements – Living shorelines promote nutrient removal along the New Jersey coastline. However, stakeholders noted it is challenging to create living shorelines in urban areas, areas near CSOs, or areas with underserved communities due to shellfish contamination and consumption issues for environmental justice communities. A stakeholder noted, "Under the current requirements, the only means for restoration to proceed in New Jersey's closed waters [(*i.e.*, waters that are deemed contaminated and closed to shellfish harvesting)] is through compliance with an unprecedented mandate: not only must a project be properly permitted by NJDEP and other relevant agencies, but project managers must also provide 24-7 surveillance all shellfish project sites. This requirement applies to the majority of Raritan Bay and other portions of the Hudson-Raritan Estuary." The stakeholders went on to note, "NJDEP has recently allowed some pilot [living shoreline] projects using oysters to be implemented in Barnegat and Delaware Bays, if the projects use a camera system for one year prior to any animals being placed. Projects must have the required NJDEP and USACE permits before NJDEP will enter into an MOU with the organization, requiring organizations to spend time preparing permit applications for a project site that the NJDEP may choose to reject. Protecting human health is a priority and projects must have a monitoring plan in place to ensure safety. Using camera systems and citizens to help patrol and monitor project sites is a great idea, however going through the arduous permitting process before knowing if the project site is viable seems impractical."

As such, stakeholders have suggested that it would be beneficial for regulations to be updated in a way that (1) eliminates the impractical permitting requirements needed prior to knowing if a living shoreline project is viable and (2) modifies the 24-7 surveillance requirement to be more reasonable.

b. **Consider Adjusting SAV/Aquaculture Regulations – Shellfish leasing activity in SAV habitat is not in compliance with the Coastal Zone Management Rules at N.J.A.C. 7:7-9.6. If there is substantial interest in pairing SAV with shellfish to ameliorate OA impacts to shellfish, this rule would need to be updated accordingly.

c. **Streamline Process for Coupled Aquaculture – Update Coastal Zone Management Rules to allow for seaweed and shellfish to be grown together on the same leased plot. Or, collaborate with the New Jersey Department of Agriculture (NJDA) to expand existing rules that could help guide the seaweed industry future. In New York, Lazy Point Farms has "partnered with seven different local environmental organizations and commercial shellfish farmers interested in diversifying their crops to grow kelp on an experimental basis to further explore the potential environmental and economic impact the kelp industry could have in New York."

d. Enhance Interagency Coordination to Promote Shellfish Restoration – Coordinate with the New Jersey Department of Transportation (NJDOT) and the offshore wind industry to fund establishment and base operations of an SAV Technology/Restoration Center currently being discussed for the Mid-Atlantic. One stakeholder mentioned that this center could also provide some support for shellfish restoration.

NJDEP may also consider coordinating with NJDA to provide continued support for the NJ COASTAL Aquaculture Project (*Conservation Opportunities Advancing Sustainable Technologies for Aquaculture Leases*). The purpose of the project, funding by the USDA's Natural Resources Conservation Service (NRCS) is to promote aquatic habitat on shellfish leases and enhance water quality throughout the coastal bays of New Jersey by increasing producer participation in NRCS conservation programs.

3. Habitat Conservation BMPs/Policy Updates – The purpose of these BMPs is to help restore New Jersey's benthic marine environment and reduce human activities and practices that are destructive.

a. Conserve Wetlands During Offshore Wind Development – Stakeholders expressed concern that OSW permitting allows for the removal of wetlands. Consider tightening permitting conditions to protect these

vulnerable ecosystems that may mitigate the impacts of OA by reducing runoff to coastal waters.

b. Beach Replenishment Policy Updates – Consider implementing a "take a ton, replace a ton" (TATRAT) beach replenishment policy. One stakeholder noted, "removal of sand from near shore [...] destroys natural benthic systems and removes a natural storm barrier [(*i.e.*, large sand lumps)] that slows shoreside erosion. Biological movement of sands deposited on the shoreline creates further damage via silting effect [to nearby benthic habitats]. [Alternatively, to TATRAT, NJDEP could consider] legislation to create rocky or other hard substrate to replenish damaged sand berms."

c. Update Dredging and Trawling Policies for Navigable Waters to Address the Threat of OA – Dredging and trawling can destroy benthic habitat structure which is essential to ocean biodiversity and a healthy ecosystem. Stakeholders had several comments regarding substantial shifts they thought were needed in State dredging, trawling, and land use decisions to mitigate the threat of OA, including:

- One industry member suggested a policy to, "eliminate trawling practices which damage the benthos to harvest fin fish, clams, oysters, blue claw crabs, horseshoe crabs, and whelk in the state's waters (*i.e.*, inland waters and the three-mile zone into the ocean). Eliminating trawling in this region would give the benthos time to start to rebuild."
- Another stakeholder noted the importance of reflecting on coastal retreat because, "as long as homes are vulnerable, sand will need to be dredged (in addition to dredging for navigation)."
- On a related note, a third stakeholder remarked that people, "need to back [development] away from coastal bays," as bays need room for wetlands to migrate inland.

In contrast, one stakeholder noted, "[Dredging policies are] being worked on separately, I don't think it's necessary to dabble [with this in an OA Action Plan.]" This includes, (1) the NJDOT New Jersey Atlantic Coastal Regional Sediment Management Plan and (2) updating regional Dredged Material Management Plans. While these updates do not mention the threat of OA, these efforts endeavor to protect the benthic environment and use dredged material in an environmentally and economically

sustainable way. It may be beneficial for there to be enhanced communication among NJDOT, NJDEP, the Army Corps, and other OA stakeholders regarding the impacts of dredging on benthic habitat health and sediment resuspension.

d. Update Dredging Regulations and Policies for Fishing – Consider updating existing fish dredging policies for the fishing industry to reduce habitat-destructive practices (*e.g.*, winter blue crab fishery is destructive).

e. Advance New Jersey Artificial Reef Program – Work with New Jersey Artificial Reef Program to examine the use and effectiveness of obsolete offshore infrastructure for artificial reefs to create climate resilient habitat.

- One industry member suggested a policy to, "use a substantial amount of Wallop Breaux funds for reef building. [And to] purchase vessels and barges [to allow for financially responsible reef building and] reef replenishment [efforts] capable of coral community reestablishment." State owned vessels were a recommendation because it can be an economic burden to rent a private vessel to conduct reef building or restoration work.

4. BMPs/Policy Updates to Support the Fishing and Aquaculture Industries

a. Encourage Aquaculture – Give fisherman the task of assisting with remedial practices by engaging in aquaculture and geoengineered approaches, which enable them to earn income while improving their fishing environment.

- One stakeholder contradicted the utility of this BMP and noted, "Not to be pessimistic, but I would be surprised if many fishermen choose to move into aquaculture."

b. Provide Tax Credits to Fishing and Aquaculture Industries – If fishermen/farmers own carbon capturing materials, consider allowing them to receive tax deductions for the carbon they collect from the ocean.

- One stakeholder noted, "The carbon capturing materials would need to be fleshed out and identified by NJDEP and the OA Coordination Committee [if formed]."

c. Technical Training – Invest in technical training and greater support of extension to the aquaculture/finfish industry regarding OA impacts and resilience opportunities.

- One stakeholder noted that NJDEP and the OA Coordination Committee would need to identify the end goal of this training (*e.g.*, to support career change for these industries, to provide support for future OA driven environmental change).

d. **Foster "Green" Fishing Fleets – Provide funds/grant to support investment in testing carbon neutral fishing practices, use of carbon capturing materials, and helping commercial fishermen to convert their vessels to more green energy.

5. Nutrient Reduction BMPs/Policy Updates

a. **Dovetail with MS4 Program Requirements – Consider building on updated MS4 Permit Requirements to educate permit writers on the threat of OA and incorporate OA considerations into Watershed Improvement Plan Reports.

b. Create New Surface Water Quality Requirements – Assess the need for additional stringent controls to reduce and limit nutrients and organic carbon from sources that are contributing to acidification of coastal marine waters if determined necessary based on scientific data (*e.g.*, a new surface water quality standard). Any additional controls should consider what industry, user, and source of OA would be regulated and if those controls would cost the State more than the projected benefits.

Appendix A – List of Workshop Participants

(Names are repeated below to indicate multiple participants from the same organization or department.)

Industry Members	**Stakeholder**
	1. Commercial Finfish Industry 2. Private Finfish Industry 3. Charter Boat Industry
	Additional
	1. Oyster Farmer
Organizations Involved in Coastal Management Outreach and Education, Advocacy, and Restoration	**Stakeholder**
	1. Barnegat Bay Partnership 2. NJ Sea Grant 3. NY/NJ Harbor Estuary Program, Hudson River Foundation 4. Partnership for the Delaware Estuary (PDE) 5. ReClam the Bay 6. Responsible Offshore Science Alliance (ROSA)
	Subject Matter Expert
	1. Mid-Atlantic Fishery Management Council (MAFMC)
	Additional
	1. NY/NJ Harbor Estuary Program, Hudson River Foundation
Academia	**Stakeholder**
	1. Physical Oceanographer (Stockton University) 2. Coastal Resilience (Monmouth University) 3. Coastal Restoration Consultant (Monmouth University) 4. Haskin Shellfish Research Laboratory (Rutgers University) 5. Jacques Cousteau National Estuarine Research Reserve (Rutgers University)
	Additional
	1. Materials Science and Engineering (Rutgers)
State Government	**Stakeholder**
	1. NJ Sports and Exposition Authority
	Subject Matter Expert
	1. NJDEP, NJ Historic Preservation Office 2. NJDEP, Water Monitoring and Standards Division 3. NJDEP, Water Monitoring and Standards Division 4. NJDA, Office of Aquaculture Coordination 5. DNREC, Ocean Planner 6. NYSDEC, Ocean Coordinator
	Additional
	1. NJDEP, Fish and Wildlife 2. MD-DNR, Coastal and Oceans Resource Planner
Federal Government	**Subject Matter Expert**
	1. NOAA Northeast Fisheries Science Center 2. NOAA Ocean Acidification Program
	Additional
	1. NOAA Ocean Acidification Program

Appendix B – Materials Used to Support Stakeholder Engagement Process

Read Ahead #1 – What is OA and How Will it Affect New Jersey?

Read Ahead #2 – An Introduction to OA Action Plans

Read Ahead #3 – Recommendations for Developing a Statewide New Jersey OA Monitoring Network

Read Ahead #4 – Comparison of Current New Jersey Policies to Elements of Exemplar OA Action Plans

Survey 1 Questions

Survey 2 Questions

Survey 3 Questions

Power Point Presentation Workshop Meeting #1

Power Point Presentation Workshop Meeting #2

Power Point Presentation Workshop Meeting #3

What is Ocean Acidification and How Will it Affect New Jersey?

WHAT CAUSES OCEAN ACIDIFICATION?

Ocean acidification is often described as climate change's "equally evil twin." Like climate change, the principal cause of acidification in the open ocean is an increase in atmospheric carbon dioxide (CO_2), with potentially harmful ecological and economic consequences.

Carbon dioxide gas dissolves rapidly in seawater, setting off a chain of chemical reactions that lower pH and make seawater more acidic. The ocean has absorbed roughly 30% of global CO_2 emissions since the beginning of the industrial era, lowering average ocean pH by 0.1 units - equal to a 30% increase in acidity. If CO_2 emissions continue at current rates, ocean pH levels are expected to fall another 0.3 to 0.4 pH units by the end of the century, representing an additional 120% drop and creating an ocean that is more acidic than at any time in the past 20 million years.

HOW DOES OCEAN ACIDIFICATION AFFECT MARINE LIFE?

Ocean acidification is an emerging threat to the marine ecosystem and economy. Ocean acidification makes it more difficult for marine creatures such as oysters, clams, scallops, lobsters, and crabs to create shells. It can disrupt reproduction, growth, and metabolism in both shell-forming and non-shell-forming species and can leave marine organisms more vulnerable to disease, predation, and climate-related impacts such as warming waters.

WHAT'S AT STAKE IN NEW JERSEY?

Ocean acidification has the potential to disrupt New Jersey's marine ecosystem, particularly fisheries, and the communities that depend on fishing and aquaculture for their livelihoods. While New Jersey isn't seeing significant impacts yet, ocean acidification is regarded as an emerging threat due in part to the importance of fishing and aquaculture to the state's economy.

New Jersey's commercial fishing industry is the fifth largest in the United States and provides more than 50,000 jobs. Commercial fishing, recreational fishing, and aquaculture contribute more than $2.5 billion annually to the state's economy. The most commercially important shellfish species in New Jersey include the Atlantic sea scallop, ocean quahog, Atlantic surfclam, blue crab, and Eastern oyster. In the United States, southern New Jersey counties rank second in economic dependence on shelled mollusks.

WHAT IS KNOWN AND NOT KNOWN ABOUT OCEAN ACIDIFICATION IN NEW JERSEY?

While much is known about ocean acidification generally, the impacts of acidification on many species commonly found in New Jersey waters and on the marine ecosystem as a whole remain largely uninvestigated.

Numerous studies have looked at the effects of acidification on Eastern oysters, but the literature is sparse, if not altogether absent, on other commercially important species. Only one laboratory study focuses on acidification and sea scallops, New Jersey's most valuable shellfish harvest, and only two acidification studies have been conducted on ocean quahog, blue crabs, summer flounder, and longfin squid. Indeed, of the 35 managed species in the mid-Atlantic region, 69% (24 species) have not yet been investigated for acidification impacts.

The critical research questions that remain unanswered in New Jersey are:

- What are the impacts of acidification at various life stages?
- What is the capacity of species to adapt or acclimatize to acidification?
- Are there thresholds at which species are lost to acidification?
- How does acidification affect the food web, population dynamics, and community structure?

HOW DOES OCEAN ACIDIFICATION COMBINE WITH OTHER STRESSORS ON NEW JERSEY'S COASTAL RESOURCES?

Ocean acidification doesn't happen in isolation. It occurs against the backdrop of other climate-related impacts such as warming temperatures and algal blooms that amplify acidification and add to the stress on marine life, especially in coastal waters. An increase in heavy downpours, for example, flushes naturally acidic freshwater into the ocean as well as pollutants such as fertilizer and wastewater that stimulate excess algal growth. The algae eventually die and are consumed by bacteria, which deplete oxygen in the water, leading to a dangerous condition known as hypoxia. The process also releases carbon dioxide, which, in turn, increases acidification. Periodic upwellings of deeper, colder, more acidic water are an additional source of acidification near the coast.

WHAT CAN BE DONE TO ADDRESS OCEAN ACIDIFICATION?

More monitoring and research are needed to better understand ocean acidification and its impacts on the marine ecosystem and economy. And because the ocean doesn't stop at New Jersey's borders, coordinating with scientists, policy makers, and other stakeholders throughout the mid-Atlantic region and beyond is essential for crafting an effective response.

Like climate change, the key to mitigating ocean acidification over the long term is to dramatically reduce carbon dioxide emissions by transitioning to renewable energy, practicing climate-smart agriculture, using sustainable building materials, eating a climate-friendly diet, and much else. Reducing the influx of land-based pollutants into the ocean, which has the additional benefit of reducing harmful algal blooms and hypoxia, will help reduce acidification in the near-shore environment, as will protecting and restoring "carbon sinks" such as salt marshes. In the meanwhile, much work remains to expand awareness of ocean acidification among policy makers, researchers, the fishing industry, and NGOs, and explore ways to help ocean-dependent communities adapt to changing conditions.

WHERE CAN I LEARN MORE ABOUT OCEAN ACIDIFICATION IN NEW JERSEY?

1. NJ Scientific Report on Climate Change

https://nj.gov/dep/climatechange/docs/nj-scientific-report-2020.pdf

The NIDEP's 2020 New Jersey Scientific Report on Climate Change dedicates a section to the chemistry of ocean acidification, the difference between open ocean acidification and coastal acidification, and the impacts of acidification on New Jersey and the mid-Atlantic region.

2. MACAN

https://midacan.org/

The Mid-Atlantic Coastal Acidification Network (MACAN) is a nexus of scientists, tribal, federal, and state agency representatives, resource managers, and industry partners who coordinate observation, research, and modeling of ocean and coastal acidification.

3. MARCO

https://www.midatlanticocean.org/

The Mid-Atlantic Regional Council on the Ocean (MARCO) was established in 2009 by the governors of New York, New Jersey, Delaware, Maryland, and Virginia to improve ocean health and contribute to the region's quality of life and economic vitality. MARCO shares four regional priorities: climate change adaptation, renew energy, marine habitats, and water quality.

4. OA Alliance

https://www.oaalliance.org/

The International Alliance to Combat Ocean Acidification (OA Alliance) brings together governments and organizations from across the globe to protect coastal communities and livelihoods from the threat of ocean acidification and other climate-ocean impacts.

5. ROA

http://roa.midatlanticocean.org/

The Mid-Atlantic Regional Ocean Assessment (ROA) is an information resource developed to support the regional planning process from New York to Virginia. It provides key information on ocean planning, ocean ecosystem, and ocean uses for decision-makers, stakeholders, and the broader public.

6. Webinar: Acidification of New Jersey's Ocean & Coastal Waters

https://go.rutgers.edu/OA.NJ.SummerClimateAcademy.2020

NJ Climate Change Resource Center, Rutgers University (njlimateresourcecenter.rutgers.edu) A webinar hosted by the NJ Climate Change Resource Center during its 2020 Summer Climate Academy.

An Introduction to Ocean Acidification Action Plans

WHAT IS AN OCEAN ACIDIFICATION ACTION PLAN?

Ocean Acidification (OA) Action Plans describe real, tangible actions that members of the International Alliance to Combat OA (hereafter the "OA Alliance") are taking, or will take, to better understand and respond to the threat of ocean acidification. The OA Alliance was established in 2016 in direct response to some of the first observed impacts of OA on US West Coast oyster hatchery production in the mid-2000s.

There are currently over 120 members of the OA Alliance representing national, state, municipal, and indigenous governments. A complete list of members is available online here. When a government joins the OA Alliance, that entity is encouraged to develop an OA Action Plan that addresses the following five goals:

1. ***Advance Scientific Understanding:*** Improve the understanding of OA globally and within the members' region, including support for research and OA observations within their region.

2. ***Reduce Causes of OA:*** Implement actions that will prevent or slow OA through reducing atmospheric emissions of carbon dioxide, reducing inputs of land-based pollutants, and other measures.

3. ***Build Adaptation and Resiliency:*** Implement actions to assist ocean-dependent communities and industries, and marine ecosystems to adapt to increasing acidity in marine waters.

4. ***Expand Public Awareness:*** Engage policy makers, scientists, and the public on the growing threat posed by OA, as well as local actions that may be taken to address OA.

5. ***Build Sustained International Support:*** Secure sustained funding, nationally and regionally, for ongoing, enhanced, and coordinated research and OA observation systems, to continue to inform governments and others about the increasing impacts of OA.

Each OA Action Plan is not expected to have the same framework or structure because Plans should be tailored to meet the conditions of the local environment and the needs of local stakeholders. Joining the OA Alliance imposes no legally binding requirements or obligations

enforceable in any court of law or other tribunal of any sort. Joining the Alliance also does not create any funding expectation on any member governments.

WHAT ENTITIES IN THE UNITED STATES ARE MEMBERS OF THE OA ALLIANCE?

The United States as a nation and nine individual states (New Jersey, California, Hawaii, Maine, Maryland, New York, Oregon, Virginia, and Washington) have joined the OA Alliance as government members. NJ joined the OA Alliance in April 2021.

WHAT ARE THE ELEMENTS OF AN EXEMPLARY OCEAN ACIDIFICATION ACTION PLAN?

Rutgers University previously assessed existing OA Action Plans (see the 2020 report here). Below are three key elements of exemplary OA Action Plans:

1. Introduction – This section is an opportunity to identify what is at stake in NJ regarding the negative impacts of OA and to outline the scope of the state's OA Action Plan. In Maryland, for example, the introduction to their OA Action Plan includes an overview of MD's connection to the Chesapeake Bay, a synopsis of MD's fisheries and coastal economy, an outline of MD's past and present investments to mitigate OA both inshore and offshore, and a summary of existing OA concerns in the state. Building on that format, a robust introduction for NJ's plan may include:

a. A summary of current scientific understanding of the causes and consequences of OA in state waters (*i.e.*, identify OA causes and trends, highlight contributing processes and regional distinctions to OA, identify known species and ecosystem responses to OA);

b. An overview of the value of the fisheries, habitats, and communities at risk in NJ due to OA from an economic and cultural perspective;

c. Background on existing state efforts that mitigate or address the impacts of OA;

d. A description of the stakeholder engagement process implemented to capture existing OA concerns in NJ and how these groups will be engaged moving forward; and

e. The scope of the state's OA Action Plan. Specifically, the scope should identify

how NJ's OA Action Plan goals meet the five OA Alliance Goals and highlight how the NJ OA Action Plan aligns with other ongoing state priorities and climate goals.

2. Vision and Strategies for Action on OA – Pair OA goals with specific strategies and timelines for completion. Adding these elements will increase the likelihood that actions to address OA are taken in a timely manner. Some examples include:

a. Maryland's OA Action Plan – Maryland established three overarching goals that aligned with the state's ongoing nutrient reduction plans and greenhouse gas reduction targets (*i.e.*, Reduce the causes of OA and increase resilience, improve scientific understanding of OA solutions and the ecosystem impacts of OA, and expand public awareness and partnerships for action). For each goal, Maryland identified three measures of success to ensure progress was being made (*e.g.*, in five years MD will put into motion monitoring strategies to resolve key questions about OA). For more information, see the state's OA Action Plan.

b. California's OA Action Plan – For each goal, California explained the underlying rationale for wanting to address that goal, provided a 5-year plan to achieve that goal, and identified a set of trackable actions that needed to be translated into operational steps by state agencies. (See page 15 of the State of California Ocean Acidification Action Plan for additional detail.)

c. Washington's OA Action Plan – Washington established six overall goals based on the five OA Alliance Goals with input from a Blue-Ribbon Panel of experts. Washington listed its goals in a table, provided up to four strategies to accomplish each goal, and identified specific actions to achieve each strategy. Each goal was then addressed in detail in its own subsection of the state's OA Action Plan. Washington also identified "key early actions" that the Panel designated and prioritized as essential next steps for reducing the risks associated with OA. For more information, see Appendix 1 (page 99) of Ocean Acidification: From Knowledge to Action, Washington State's Strategic Response and the state's OA Action Plan.

3. Appendices – Supplement the "Vision and Strategies for Action on OA" with helpful planning, communication, and/or educational documents. Adding appendices to an OA Action Plan allows for additional detailed information and reference materials to be included in the Plan.

a. Timelines: Oregon created a detailed timeline with preliminary estimated funding needs for the actions included in the state's OA Action Plan (see timeline here). Washington created a more general timeline (seen on page 99 here).

b. Communication and Educational Documents: Oregon created two-page documents that could be a helpful model for communicating with NJ Stakeholders about OA issues (*e.g.*, a public engagement flyer, an overview of research needs, a summary of the impacts of OA to local species like oysters). The full repository of related documents is available here.

c. Planning: Entities from California, Oregon, Washington, and British Columbia generated two-page synopses that provide more detail on west coast OA issues. These synopses include: Why West Coast Managers Should Care (here), Why the West Coast is Vulnerable (here), Managing for Resilience to Address OA and Hypoxia (here), The Cost of Inaction (here), Using Modeling to Enhance Understanding (here), Approaches to Reduce Carbon Dioxide in Seawater (here), Existing Water Quality Criteria (here), Establishing Research Priorities (here), and Monitoring Network to Track Change (here). For a full list of resources, including technical guidance and foundational science resources, visit this website.

50

Recommendations for Developing a Statewide New Jersey Ocean Acidification Monitoring Network

HOW WERE THESE RECOMMENDATIONS DEVELOPED?

In 2020, the NJ Department of Environmental Protection (NJDEP) produced the state's first Scientific Report on Climate Change which included a chapter on Ocean Acidification (OA). The chapter included an analysis of gaps in NJ's OA monitoring data, outlined the lack of understanding regarding the ecological impacts of OA on Mid-Atlantic marine life and ecosystems, and identified the need for consistency in OA sampling technology and methodology in NJ to improve data accuracy. Furthermore, in a 2020 report by Rutgers University developing a coordinated OA monitoring network was recommended as an essential foundation for a state OA initiative.

Catalyzed by these reports, Rutgers University and the NJ Coastal Management Program (NJCMP) OA team facilitated a virtual workshop in November 2021 focused on the development of a statewide OA monitoring network. Participants included industry (*e.g.*, commercial shellfisheries, commercial and recreational finfisheries, hatcheries, aquaculture facilities, nurseries), offshore wind developers, state executive branch agencies, federal researchers, academic institutions, and non-profit organizations. The purpose of this workshop was to engage a diverse range of potential OA Monitoring Network participants to:

- Review existing ocean acidification monitoring in New Jersey state waters and current observation gaps;
- Collectively summarize locations, time periods, and potential approaches to optimize and expand monitoring in NJ;
- Discuss required costs, logistics, and next steps needed to develop, coordinate, and maintain a statewide acidification monitoring network; and
- Discuss strategies for communication, engagement, and partnerships with industry.

KEY RECOMMENDATIONS FROM THE 2021 OCEAN ACIDIFICATION MONITORING NETWORK WORKSHOP

Five major recommendations (*i.e.*, steps) are presented here that could be used as a framework to develop a statewide OA Monitoring Network. The formation of an OA Working Group in Step 1 below will accomplish three major tasks that will culminate in recommendations to best optimize the monitoring network to address management decision-making needs. Steps 2-5 will provide logistic and data management support for the recommended monitoring optimization to ensure the OA Monitoring Network operation and maintenance delivers timely and decision-relevant information for the state.

These recommendations have been summarized from the 2021 Recommendations for Developing a Statewide NJ OA Monitoring Network report which is based on stakeholder input provided during the November 2021 workshop described above.

- **Step 1 – Convene an OA Working Group.** The OA Working Group (OAWG) will inventory current monitoring assets (Task 1), assess gaps in monitoring (Task 2), and prioritize and fill gaps to improve network (Task 3). These Tasks will ensure state actions on OA planning and mitigation are informed by sound science.
    - ***Task 1 - Inventory Current Monitoring Assets.*** The inventory should represent what chemical, physical, and biological monitoring already exists (from nearshore freshwater to offshore slope) that can then inform Tasks 2 (gaps analysis) and 3 (strategic gap filling approach).
    - ***Task 2 – Assessment of Gaps in Monitoring.*** Several gaps in observations were recently outlined for the Mid-Atlantic region which include the need: for higher sampling frequency; to enhance special resolution while monitoring across a salinity gradient; for measurements of multiple carbonate chemistry parameters; for high-resolution depth profiling measurements; to observe OA with other stressors; for co-located biological response monitoring; and to evaluate what monitoring is required to understand baseline conditions. With these gaps in mind, the OAWG should use the updated state monitoring inventory (from Task 1) to evaluate which gaps are relevant specifically for New Jersey.

- ***Task 3 – Prioritize and Fill Gaps to Improve Network.*** Before the more technical process of developing or enhancing an OA monitoring network begins, there first needs to be a consensus among scientists and decision makers regarding which questions the network is designed to answer. Data gaps should strategically be filled so that they solve actionable problems rather than gather data for the sake of gathering data (*i.e.*, the monitoring network must support the needs of decision-makers). Therefore, the OAWG should ask for example, what kinds of information will we get from a comprehensive monitoring network and what kinds of decisions can we make from it? And, how can we establish a base understanding of where New Jersey is most vulnerable that capitalizes on the authority NJDEP has to act (*e.g.*, what policy, budgeting, staffing, and research decisions could be supported by OA data).

  The OAWG should also acknowledge the following four considerations for gap-filling:

  1. ***Better connecting chemical and biological monitoring:*** This synergy was considered the most important recommendation for other states developing OA Monitoring Networks and has been highlighted as a top priority by federal research programs such as NOAA OAP (see NOAA OAP Research Plan 2020-2029).

  2. ***The end-use for the collected OA data:*** The type of equipment used to monitor also centers around the questions the network is trying to answer. High quality sensors are most accurate for climate-grade applications, but that accuracy comes with a larger price tag. A possible solution is to establish a few anchor sites with high quality sensors and then several peripheral sites with lower cost sensors to complement the anchor site data.

  3. ***Consider the environmental driver of the data being collected:*** Considerations of platform types and placement of those platforms and sensors should also link carbonate chemistry with their respective drivers (*e.g.*, freshwater inputs, episodic upwelling, water column stratification).

  4. ***Engage regional acidification networks:*** A statewide initiative, and continued participation in regional acidification networks (*i.e.*, Mid-Atlantic Coastal Acidification Network), would be mutually supportive in providing valuable data and increasing science and monitoring capacity.

- **Step 2 – Enhance availability for discrete sample analysis.** At the November 2021 New Jersey OA Monitoring Network Workshop, attendees representing a range of water quality monitoring organizations around the state indicated interest in adding discrete water collection (pH, TA, DIC) to their sampling routine pending sufficient funding to support the effort. While there would be necessary training involved to ensure proper protocols in sample collection, preservation, and storage, **the larger hurdle identified by the workshop participants was the lack of access to a laboratory to process discrete samples that also follows community-accepted quality control standards.** To address this issue, the Workshop attendees request that NJDEP define what constitutes a "certified" lab and that NJDEP compile a list of laboratories from which a monitoring group could easily access and develop partnerships. Additionally, NJDEP could expand capacity at its marine water monitoring lab in Leeds Point to analyze most or all carbonate chemistry samples there.

- **Step 3 – Adopt Community Best Practices to Ensure Data Quality Control.** There was consensus among workshop participants that all state monitoring participants should adopt protocols for data collection and processing that meet state and Federal regulatory requirements to ensure data standardization, ease of synthesis, and applicability to state and Federal OA management decisions. Adopting best practices will require workforce effort and monetary support, particularly to train data collectors and data providers on (1) the adopted procedures in data quality assurance and quality control and (2) integrating the standardized, quality-controlled data into databases for open access.

  Workshop attendees request NJDEP produce data collection standards, methodology for collecting samples, and guidance on the appropriate equipment for collecting and processing such data. Workshop attendees also request NJDEP share a cohesive list of the exact parameters that NJDEP needs measured and the level of importance for each parameter with the OAWG.

  Step 4 – Develop Network Data Management. There was consensus among workshop participants that there is a need to ensure relevant data are submitted to a pre-established OA Monitoring Network portal, allowing for inventory updating and maintenance. Specifically, NJDEP should decide if the monitoring inventory

consists only of data locations (GIS enabled so the locations of data collection can be mapped online easily) and metadata parameters, or if the data should be housed together in a specified data repository. The former option is sufficient for a gaps analysis and, if regularly updated and maintained, would allow for successful evaluation of implemented gap filling measures. The latter option would facilitate ease of data access and synthesis efforts. Either option will require a dedicated project manager to update and maintain, but the latter would require significantly more time and resources.

- **Step 5 – Coordinate the OA Network.** Developing and maintaining a statewide OA monitoring network will require significant coordination to develop the partnerships that will be necessary to optimize the network and to manage the workload to maintain the monitoring inventory described in Step 1 Task 1. A dedicated project manager would be necessary to keep the monitoring inventory up to date. Workshop attendees recommend NJDEP assign the governance or ownership of the OA monitoring network as well as the supervisor(s) and organization/entity that the project manager would report to. This project manager could also serve more broadly as the OA Monitoring Network Coordinator. Workshop attendees request that NJDEP assess and quantify the financial support that could be dedicated to OA Monitoring Network development and operation. Workshop attendees also request NJDEP develop the most cost-effective approach for successful Network coordination.

55

Comparison of Current New Jersey Policies to Elements of Exemplar Ocean Acidification Action Plans

WHAT CURRENT ENVIRONMENTAL POLICIES IN NEW JERSEY HAVE AN IMPACT ON OCEAN ACIDIFICATION?

The New Jersey Department of Environmental Protection (NJDEP) outlined the potential impact that ocean acidification (OA) could have on the economy and natural resources of the state in its 2020 Scientific Report on Climate Change in which it summarized three key findings:

1. Since the industrial age, ocean pH levels have declined and the ocean is now 30% more acidic.

2. If carbon dioxide emissions continue at current rates, ocean pH levels are expected to continue to decrease, creating an ocean that is more acidic than has been observed for the past 20 million years.

3. Southern NJ counties rank second in the United States in economic dependence on shelled mollusks, which will suffer from increasing ocean acidity.

In the 2021 New Jersey Climate Change Resilience Strategy, NJDEP committed to developing an OA Action Plan to address OA impacts to fisheries, aquaculture, and ocean resilience. This 2021 Strategy also highlighted the need to "monitor any shifts [in water quality, biology, and habitat health] induced by OA…so that information can be used to protect [NJ marine resources] and the economy that relies on it." In addition to these commitments, NJ has several existing policies, initiatives, and goals that impact OA in the state, including:

1. NJ Climate Goals

Carbon dioxide gas dissolves rapidly in seawater, setting off a chemical reaction that lowers pH and makes seawater more acidic. The key to mitigating OA over the long term is to dramatically reduce carbon dioxide emissions and remove carbon dioxide from the ocean. NJ has several relevant goals, including:

a. ***The New Jersey Global Warming Response Act –*** commits NJ to reduce emissions by 80% below 2006 levels by 2050.

b. ***NJ Executive Order 274 –*** commits NJ to reduce emissions by 50% below 2006 levels by 2023.

c. ***NJ Executive Order 315 –*** commits NJ to ensure 100% of electricity sold in the state is derived from clean sources of electricity by January 1, 2035.

d. ***NJ Natural and Working Lands Strategy –*** aims to mitigate the effects of climate change in NJ through the protection, restoration, and strategic management of NJ natural and working lands that contribute the most to the storage and sequestration of greenhouse gases (like carbon dioxide) including forests, agricultural lands, wetlands, developed lands, and aquatic resources and habitats. (More information available here.)

e. ***NJ Natural Climate Solutions Grant Program –*** funds on-the-ground projects that create, restore, and enhance NJ's natural carbon sinks such as salt marshes and seagrass beds. (More information available here.)

2. NJ Nutrient Runoff Management Strategies

Watersheds with a high percent of impervious surface coverage contribute to nutrient runoff in New Jersey. Nutrient rich waters can cause eutrophication and exacerbate the impacts of OA in NJ's coastal bays and estuaries, particularly in subsurface or bottom water. The key to mitigating OA is to reduce the amount of nutrients (primarily nitrogen and phosphorous) entering the coastal waters. NJ has several programs that address approaches to mitigate nutrient runoff, including:

a. ***New Jersey Fertilizer Law –*** a 2011 NJ law that restricts fertilizer content standards for nitrogen and phosphorus.

b. ***New Jersey Clean Stormwater and Flood Reduction Act–*** a 2019 NJ law that empowers local government entities to create stormwater utilities and collect fees that can be used to finance the improvement of stormwater infrastructure. (More information available here.)

c. ***NJ Nonpoint Source Management Program Plan (2020-2025) –*** identifies several ongoing nonpoint source management efforts and funding sources through the NJ Water Bank (formerly known as NJ's Clean Water State Revolving Fund), the NJ Department of Agriculture's Natural Resources Conservation Service, the state's

Green Acres and Farmland Preservation programs, and others to reduce nonpoint source pollution. Also identifies several short-term and long-term objectives to address nonpoint source pollution (see page 22 of the Plan here).

d. ***2021 NJ Climate Change Resilience Strategy –*** calls for prioritizing investment in green infrastructure to augment water quality protection and stormwater management, particularly in underserved communities (*e.g.*, green infrastructure vegetation that absorbs storm and/or wastewater). (More information available here.)

3. NJ Strategies to Reduce Naturally Acidic Freshwater Flows into Coastal Waters

Extreme precipitation events as well as overall annual precipitation amounts are predicted to increase for the Mid-Atlantic. This will cause more naturally acidic freshwater to flow into the ocean. NJ has several programs that address freshwater flows into coastal waters, including:

a. ***2020 NJ Stormwater Management Rule –*** in March 2020, NJDEP adopted amendments to NJ's Stormwater Management rules to transform NJ stormwater discharge from direct pipe discharge to stormwater management through green infrastructure.

b. ***Pinelands Comprehensive Management Plan (CMP) –*** the Pinelands represent approximately 20% of NJ's land area and is characterized by low pH, low nutrient streams fed by shallow groundwater. The Pinelands CMP was amended in January 2022 to require stormwater management to meet the 2020 NJ Stormwater Management Rule and include a more stringent nitrogen removal standard.

c. ***2022 Re-evaluation of State's MS4 (Municipal Separate Storm Sewer Systems) Program –*** most municipalities in NJ will need to generate a Watershed Improvement Plan by December 31, 2027 which is aimed at reducing MS4 contribution of pollutants to waterbodies. This goal is primarily achieved by reducing stormwater flows into waterbodies, thus reducing freshwater (and nutrient) discharge. (More information available here.)

4. NJ Climate Education Goals

Actions to adapt to and mitigate the impacts of OA in NJ will require expanded public awareness on the growing threat posed by OA, as well as local actions that may be taken to address OA. NJ has one overarching education mission that is related to OA:

a. ***2020 NJ Student Learning Standards –*** adopted in 2020, these standards require public schools to educate K-12 students about climate change across content areas including visual and performing arts, comprehensive health and physical education, science, social studies, world languages, computer science and design thinking, and career readiness. (More information available here.)

WHAT OCEAN ACIDIFICATION GOALS HAVE OTHER STATES IDENTIFIED IN THEIR OCEAN ACIDIFICATION ACTION PLANS?

Other States have goals in their OA Action Plans that align with the four categories of existing NJ policies relevant to OA. Nationally, the White House's Ocean Climate Action Plan (OCAP) has goals that also align with the four categories. Some examples of these goals from other States and the White House include:

1. **Climate Goals from Other States' OA Action Plans and the White House**

a. ***Maryland OA Action Plan:*** Maryland will restore 79,800 submerged aquatic vegetation (SAV) acres by 2025. SAVs are natural carbon sinks and include vegetation like underwater grasses (*e.g.*, eelgrass). SAVs reduce the acidity of water by taking up carbon dioxide through photosynthesis.

b. ***California OA Action Plan:*** Continue to advance collaborative dialogue on ocean-based production of renewable wind energy, where it is compatible with sustaining healthy ocean ecosystems, fisheries, and coastal economies.

c. ***California OA Action Plan:*** Reduce the carbon footprint of seafood consumption in the state. The first step is to evaluate the potential for and the environmental, economic, and social costs and benefits of incentivizing consumption of locally sourced products (wild capture, aquaculture). If warranted, work with seafood certification and rating programs to integrate carbon footprint information into rating systems and public education products.

d. ***White House OCAP:*** Launch a statewide and/or regional marine carbon dioxide removal (CDR) initiative to serve as a coordination vehicle for public-private funded research activities and to facilitate the creation of new marine CDR demonstration sites with the goal of delineating marine CDR benefits.

2. **Nutrient Runoff Management Goals from Other States' OA Action Plans**

   a. ***Washington State Strategic Response to OA:*** Assess the need for water quality criteria under the Clean Water Act relevant to OA.

   b. ***New York OA Action Plan:*** Impose stringent controls to reduce and limit nutrients and organic carbon from sources that are contributing to acidification of coastal marine waters if determined necessary based on scientific data.

3. **Freshwater Goals from Other States' OA Action Plans**

   a. ***Massachusetts Report on the State OA Crisis:*** Establish a Blue Communities Program to incentivize communities to implement cost-effective green infrastructure projects and incorporate conservation principles (like stormwater management) into local ordinance and zoning laws.

4. **Climate Education Goals from Other States' OA Action Plans**

   a. ***Maryland OA Action Plan:*** Engage the Maryland Commission on Climate Change's Education and Outreach workgroup to support the development of communication tools for OA with a focus on potentially impacted stakeholders, decision makers, and influencers. Workgroup members will also evaluate the effectiveness of OA communications.

Moreover, other States' OA Action Plans and the White House's OCAP identify goals that are different from existing NJ environmental policies. These different goals may be worth considering as part of a NJ OA Action Plan. Some examples of these different goals include:

1. **Invest in State's Ability to Create an OA Monitoring Network**

   a. ***Maryland OA Action Plan:*** By 2025, Maryland will complete all near-term actions identified in the "Maryland OA Research and Monitoring Action Plan" developed as part of this OA Action Plan.

   b. ***Washington State Strategic Response to OA:*** Establish an expanded and sustained OA monitoring network to measure trends in local acidification conditions and related biological responses by 2030.

2. Investigate the Causes and Effects of OA in the State

a. ***Maryland OA Action Plan:*** Conduct ecosystem monitoring and modeling to examine the complex relationships between species impacted by acidification and overall health and resilience of the marine and estuarine systems.

b. ***New York Ocean Action Plan:*** In 5 years, evaluate the potential for physiological stress and increased susceptibility of shellfish and crustaceans to predation, pathogens, and disease due to synergistic effects of OA and other human induced stressors (eutrophication, temperatures, habitat degradation, and exposure to contaminants)

3. Increase the Ecosystem's Ability to Mitigate the Impacts of OA

a. ***Washington State Strategic Response to OA:*** Develop and incorporate acidification indicators and thresholds to guide adaptive action for species and places.

b. ***Oregon OA Action Plan:*** State agencies develop BMPs to ensure actions they regulate minimize additional stress on state estuaries, nearshore, and fishing grounds.

c. ***White House OCAP:*** Consider establishing marine protected areas in a way that does not negatively impact state fisheries or fishermen livelihoods

4. Enhance the Resilience of Fisheries, Aquaculture, and Fishing Communities to OA

a. ***Washington State Strategic Response to OA:*** Investigate genetic mechanisms and selective breeding approaches for acidification tolerance in shellfish and other vulnerable marine species.

b. ***Washington State Strategic Response to OA:*** Investigate and develop commercial-scale water treatment methods or hatchery designs to protect larvae and young fish from OA.

c. ***California OA Action Plan:*** Advance capacities of members of the fishing community to identify and respond to shifts in the relative abundances of different target species.

d. ***Washington State Strategic Response to OA:*** Build capabilities for short-term forecasting and long-term prediction of OA conditions.

e. ***California OA Action Plan:*** As warranted by evaluations of feasibility, cost effectiveness, risks, and benefits, expand applications of the above approaches by investing in technical training and greater support of extension to the aquaculture industry, such as through the State Sea Grant office or University's Cooperative Extension

5. Inform, Educate, and Engage Stakeholders, the Public, and Decision Makers in Addressing OA

a. ***California OA Action Plan:*** Create a forum for agricultural, business, and other stakeholders to engage with coastal resource users and managers in developing and implementing solutions

b. ***Oregon OA and Hypoxia Action Plan:*** Build a communications plan and outreach materials to communicate OA science, impacts, and solutions; and evaluate the effectiveness of OA communication tools in filling information needs

6. Maintain a Sustainable and Coordinated Focus on OA

a. ***Maryland OA Action Plan:*** Expand partnerships with organizations to build understand about, and take action on, OA including the Mid-Atlantic Coastal Acidification Network (MACAN): a regional platform aimed to develop research and adaptation strategies.

b. ***California OA Action Plan:*** Provide dedicated capacity and staff time to Implement the OA Action Plan, evaluate progress, and periodically update and revise the plan at least every 5-years. Agencies and programs participating in the OA Action Plan development process will need to allocate staff time to contribute and build internal expertise about OA and its implications for agency policies and operations.

Survey 1 Questions

1. Who are you? Please include your first and last name below.

2. What stakeholder group do you represent?

Front-Line Communities (commercial shellfish/finfish, charter boat, etc.)

- ❍ Environmental NGO
- ❍ Academia/Research Scientist
- ❍ Shellfish/Fisheries Manager
- ❍ Secondary Impact Communities (restaurant/food distribution)
- ❍ Outreach/Education
- ❍ State/National Expert
- ❍ Other (please specify):

3. How frequently do you normally think about ocean acidification in your line of work?

- ❍ Daily
- ❍ Weekly
- ❍ Montly
- ❍ Rarely
- ❍ Never

4. What information do you wish you knew about ocean acidification? Your wish could be for basic information (e.g., how does the pH scale work?) or anything more complex (e.g., how will OA impact my fishing quota). Feel free to identify any specific research/actions that you think are needed.

5. How do you think ocean acidification will impact your daily work moving forward? Please address the following:

A. What new challenges will you experience, or what existing challenges will be exacerbated?

B. What would you like your role/responsibilities to be regarding ocean acidification monitoring/mitigation/adaptation?

6. How do you think ocean acidification will impact the social, cultural, and economic aspects of NJ moving forward?

7. Are there any other concerns or questions you have about ocean acidification? Please include them below:

Survey 2 Questions

1. Who are you? Please include your first and last name below.

2. What stakeholder group do you represent?

- ❍ Front-Line Communities (commercial shellfish/finfish, charter boat, etc.)
- ❍ Environmental NGO
- ❍ Academia/Research Scientist
- ❍ Shellfish/Fisheries Manager
- ❍ Secondary Impact Communities (restaurant/food distribution)
- ❍ Outreach/Education
- ❍ State/National Expert
- ❍ Other (please specify):

Below are goals that have been pulled from other state's OA Action Plans. Each goal has been placed into one of five bins: advance OA monitoring/ research, reduce causes of OA, build adaptation/resiliency, expand public awareness, and build sustained regional/international support. These bins align with the goals set forth by the OA Alliance.

Please rank the goals in each "bin" based on their importance to you. If you do not see a goal reflected in the list below, please write in the goal and rank it accordingly. For each of your top goals, please provide one or two sentences explaining why that goal is most important to you.

3. Existing Goals:

NJ has several existing policies, regulations, and laws related to reducing the causes of OA. Please rank the goals below based on their importance to you.

For your top "Existing Goals" choice, please provide a brief explanation below as to why that rose to the top of your list. What did you like about that goal? What would you change about that goal?

List of Goals:

1. Existing NJ Policy - Achieve existing NJ Climate Goals (*e.g.*, NJ Global Warming response Act which commits NJ to reducing emissions by 80% below 2006 levels by 2050). (Jeanne/Helaine)

2. Existing NJ Policy - Support the Blue Carbon Goals from the NJ Natural and Working Lands Strategy (*e.g.*, support DEP's future Blue Carbon Action Plan).

3. Existing NJ Policy – Support and reinforce current planning efforts and programs that reduce land based nutrient pollution (*e.g.*, NJ's 2020-2025 Nonpoint Source Management Program Plan, NJ's 2020 Stormwater Management Rule).

4. Existing NJ Policy - Support NJ's climate education goals (*e.g.*, the 2020 NJ Student Learning Standards to require public schools to educate K-12 students on climate change across content areas).

4. Advance Monitoring/Research

Please rank the goals below based on their importance to you.

For your top "Advance Monitoring/Research" choice, please provide a brief explanation below as to why that rose to the top of your list. What did you like about that goal? What would you change about that goal?

List of Goals:

1. Advance Monitoring/Research - Establish an expanded and sustained OA monitoring network to measure trends in local acidification conditions and related biological responses by 2030 per the recommendations of the 2021 NJ OA Monitoring Network Workshop)

2. Advance Monitoring/Research - Collaborate with other East Coast states to speak with one voice in identifying priority needs and partnering opportunities with the Federal government, including those related to ocean resources management and science. (CA OA Action Plan)

3. Advance Monitoring/Research - Using currently available data, develop methods to assess current impacts and predict future responses of commercially important shellfish and crustacean species to increased OA by 2025 (NY Ocean Action Plan)

4. **Advance Monitoring/Research -** Develop and incorporate acidification indicators and thresholds to guide adaptive action for species and places. Note: MACAN is currently working on a related effort to conduct an OA hotspots analysis in the Mid-Atlantic region. (WA Strategic Response to OA)

5. **Advance Monitoring/Research -** Investigate genetic mechanisms and selective breeding approaches for acidification tolerance in shellfish and other vulnerable marine species. (Washington State Strategic Response to OA)

6. **Advance Monitoring/Research -** Investigate and develop commercial-scale water treatment methods or hatchery designs to protect larvae and young fish from OA. (Washington State Strategic Response to OA)

7. **Advance Monitoring/Research -** Determine the association between water and sediment chemistry and shellfish production in hatcheries and in the natural environment.

8. **Advance Monitoring/Research -** Explore research and development to advance a climate-ready fishing fleet and aquaculture operations (WHOCAP

5. Reduce Causes

Please rank the goals below based on their importance to you.

For your top "Reduce Causes" choice, please provide a brief explanation below as to why that rose to the top of your list. What did you like about that goal? What would you change about that goal?

List of Goals:

1. **Reduce Causes -** Restore 79,800 submerged aquatic vegetation (SAV) acres by 2025. SAVs are natural carbon sinks and include vegetation like underwater grasses (*e.g.*, eelgrass). SAVs reduce the acidity of water by taking up carbon dioxide through photosynthesis. (Maryland OA Action Plan)

2. **Reduce Causes -** Continue to advance collaborative dialogue on ocean-based production of renewable wind energy where it is compatible with sustaining healthy ocean ecosystems, fisheries, and coastal economies. (California OA Action Plan)

3. **Reduce Causes -** Expand and decarbonize sustainable US aquaculture production to enhance resilience of US and global seafood system to the impacts of climate change (White House Ocean Climate Action Plan)

4. Reduce Causes - Identify, evaluate, and implement, as warranted, additional opportunities to reduce GHG emissions by coastal and ocean uses and related industries (*e.g.*, tourism, recreation, restaurants) through voluntary, incentive-based, and/or regulatory measures and to secure carbon storage (Based on CA OA Action Plan)

5. Reduce Causes - Reduce the carbon footprint of seafood consumption in the state (after evaluating the potential for and the environmental, economic, and social costs and benefits of incentivizing consumption of locally sourced products). Work with seafood certification and rating programs to integrate carbon footprint information into rating systems and public education products. (California OA Action Plan)

6. Reduce Causes - Launch a statewide and/or regional marine carbon dioxide removal (CDR) initiative to serve as a coordination vehicle for public-private funded research activities and to facilitate the creation of new marine CDR demonstration sites with the goal of delineating marine CDR benefits. (White House OCAP)

7. Reduce Causes - Evaluate the environmental and social impacts of marine carbon dioxide removal (CDR) (White House OCAP)

8. Reduce Causes - Include OA and its impacts in discussions of potential geoengineering approaches of carbon sequestration (CA OA Action Plan)

9. Reduce Causes (Nutrient Pollution) - Assess the need for water quality criteria under the Clean Water Act relevant to OA. (Washington State Strategic Response to OA)

10. Reduce Causes (Nutrient Pollution) - Impose stringent controls to reduce and limit nutrients and organic carbon from sources that are contributing to acidification of coastal marine waters if determined necessary based on scientific data. (New York OA Action Plan)

11. Reduce Causes (Air Pollution) - Assess whether local sources of airborne emissions (*e.g.*, nitrogen oxides, sulfur oxides) that contribute to acidification are affecting the rate of OA in select regions of the coast. Identify and implement options for reducing these airborne pollutants (CA OA Action Plan)

12. Reduce Causes (Stormwater Management) - Establish a Blue Communities Program to incentivize communities to implement cost-effective green infrastructure projects and incorporate conservation principles

(like stormwater management) into local ordinance and zoning laws. (Massachusetts Report on the State OA Crisis)

6. Build Adaptation/Resilience

Please rank the goals below based on their importance to you.

For your top "Build Adaptation/Resilience" choice, please provide a brief explanation below as to why that goal rose to the top of your list. What did you like about that goal? What would you change about that goal?

List of Goals:

1. **Build Adaptation/Resilience -** By 2025, complete all "near-term actions" identified in the "Maryland OA Research and Monitoring Action Plan" developed as part of the state's OA Action Plan. (Maryland OA Action Plan)

2. **Build Adaptation/Resilience -** Conduct ecosystem monitoring and modeling to examine the complex relationships between species impacted by acidification and overall health and resilience of the marine and estuarine systems. (Maryland OA Action Plan)

3. **Build Adaptation/Resilience –** Within the next 5 years, evaluate the potential for increased susceptibility of shellfish and crustaceans to predation, pathogens, and disease due to synergistic effects of OA and other human induced stressors (New York Ocean Action Plan)

4. **Build Adaptation/Resilience –** Require that State agencies develop Best Management Practices to ensure actions they regulate minimize additional stress on state estuaries, nearshore, and fishing grounds to build a buffering capacity against OA. (Oregon OA Action Plan)

5. **Build Adaptation/Resilience -** Consider establishing marine protected areas (MPA) in a way that does not negatively impact state fisheries or fishermen livelihoods. MPAs would provide waters with a buffering capacity against the impacts of OA. (White House OCAP)

6. **Build Adaptation/Resilience -** Identify, protect, and restore ocean and coastal habitats essential to climate-ready fisheries, protected species, and fishing communities. This includes identifying and incentivizing land uses via specific species plantings, superior retention basin design, wetlands design,

etc. to mitigate OA in NJ.

7. Build Adaptation/Resilience - Set water quality standards in marine state waters that are protective of aquatic/marine life (*e.g.*, a pH within the range of 7.2-8.5 with a human-caused variation within the range of less than 0.2 units.)

8. Build Adaptation/Resilience - Use shells in targeted marine areas to remediate impacts of local acidification on shellfish (WA Strategic Response to OA)

9. Build Adaptation/Resilience - Build on efforts to develop, test, and apply coupled aquaculture production systems that enhance shellfish production by integrating seagrasses to ameliorate OA (CA Ocean Action Plan)

10. Build Adaptation/Resilience - Advance capacities of members of the fishing community to identify and respond to shifts in the relative abundances of different target species. (California OA Action Plan)

11. Build Adaptation/Resilience - Develop science-based practices for how OA can best be integrated into the state's evolving tools for flexibly managing changing fishery resources, such as scenario-based models to explore alternative management options and science-based triggers and thresholds for decision-making. (CA OA Action Plan)

12. Build Adaptation/Resilience - Work with NJ Artificial Reef Program to examine the use and effectiveness of obsolete offshore infrastructure for artificial reefs to create climate resilient habitat

13. Build Adaptation/Resilience - Encourage the Mid-Atlantic Fisheries Management Council to continue to take steps to better understand the implications of OA for East Coast fisheries and to integrate this understanding into fisheries management science and decisions. (CA OA Action Plan)

14. Build Adaptation/Resilience - Build capabilities for short-term forecasting and long-term prediction of OA conditions (*e.g.*, make short-term forecasts of corrosive conditions for application to shellfish hatcheries, growing areas, and other coastal regions for finfish nurseries; make long-term models to project ecological responses to predicted OA conditions) (Washington State Strategic Response to OA)

15. Build Adaptation/Resilience - Invest in technical training and greater support of extension to the aquaculture/finfish industry regarding OA impacts and resilience opportunities (California OA Action Plan)

16. Build Adaptation/Resilience - Provide fishermen, ocean users, and resource decision makers with information they need to assess risks and take action to adapt to the changing ocean (WHOCAP)

17. Build Adaptation/Resilience - Co-produce tools, services, and assistance with fishing and aquaculture communities (WHOCAP)

7. Expand Public Awareness

Please rank the goals below based on their importance to you.

For your top "Expand Public Awareness" choice, please provide a brief explanation below as to why that goal rose to the top of your list. What did you like about that goal? What would you change about that goal?

List of Goals:

1. Public Awareness - Develop communication tools for OA with a focus on potentially impacted stakeholders, decision makers, and influencers. Engage relevant state communications programs and interested stakeholders in development process. (Maryland OA Action Plan)

2. Public Awareness - Build a communications plan and outreach materials to communicate OA science, impacts, and solutions; and evaluate the effectiveness of OA communication tools in filling information needs (Oregon OA and Hypoxia Action Plan)

3. Public Awareness - Create a forum for agricultural, business, and other stakeholders to engage with coastal resource users and managers in developing and implementing solutions (California OA Action Plan)

4. Public Awareness - Establish guidance and extension-type technical support to speed integration of OA into planning and operations of potentially affected communities and industries (*e.g.*, coastal cities and towns; tribes; ports and harbors; aquaculture, fisheries, coastal tourism industries). (CA OA Action Plan)

8. Build Support

Please rank the goals below based on their importance to you.

For your top "Build Support" choice, please provide a brief explanation below as to why that goal rose to the top of your list. What did you like about that goal? What would you change about that goal?

List of Goals:

1. **Build Support -** Expand partnerships with organizations to build understand about, and take action on, OA including the Mid-Atlantic Coastal Acidification Network (MACAN): a regional platform aimed to develop research and adaptation strategies. (Maryland OA Action Plan)

2. **Build Support -** Provide dedicated capacity and staff time to Implement the OA Action Plan, evaluate progress, and periodically update and revise the plan at least every 5-years. (California OA Action Plan)

3. **Build Support -** Identify and target funding to implement the OA Action Plan, including the priority science research needs. Identify and pursue public funding, public/private partnerships, leveraged investments, and identify priorities for other funders (science, federal, private philanthropy) (CA OA Action Plan)

4. **Build Support -** Participate in national-level forums and teams, such as the Ocean Acidification Information Exchange, that facilitate knowledge sharing and collaborative problem solving among different regions of the United States. (CA OA Action Plan)

5. **Build Support -** Enlist key leaders and policymakers to act as ambassadors advocating for greenhouse gas emission reductions and protection of NJ's marine resources from acidification (WA Strategic Response to OA)

9. Where there any goals that you were not able to add to your rankings above? For any additional goals you would like to see in a NJ OA Action Plan, please add them in the space below:

10. Is there anything else you'd like us to know at this stage of development for the state's OA Action Plan?

Survey 3 Questions

1. Who are you? Please include your first and last name below.

2. What stakeholder group do you represent?

- ❍ Front-Line Communities (commercial shellfish/finfish, charter boat, etc.)
- ❍ Environmental NGO
- ❍ Academia/Research Scientist
- ❍ Shellfish/Fisheries Manager
- ❍ Secondary Impact Communities (restaurant/food distribution)
- ❍ Outreach/Education
- ❍ State/National Expert
- ❍ Other (please specify):

3. The following goals were identified as critical to incorporate into a future NJ Ocean Acidification Action Plan. Some of the goals listed below have been modified to be broader and encompass other related goals that were a top priority for stakeholders. Please rank these 10 goals based on their importance to you.

1. Establish an expanded and sustained OA monitoring network to measure trends in local acidification conditions and related biological responses by 2030 per the recommendations of the 2021 NJ OA Monitoring Network Workshop.

2. Identify “near-term actions” that are most important to complete to build OA resilience for most at risk communities and industries and include those in the state OA Action Plan. By 2025, complete those “near-term actions.”

3. Identify funding to provide dedicated capacity and staff time to Implement the OA Action Plan, evaluate progress, and periodically update and revise the plan at least every 5-years.

4. Support and achieve ongoing State goals including those related to: reducing nutrient pollution in coastal waterbodies, carbon sequestration in the ocean, and overall climate goals (*e.g.*, reducing emissions).

5. Use data to predict future responses of commercially important shellfish and crustacean species to increased OA and develop OA indicators/thresholds to guide adaptive action for species and ecosystems.

6. Impose stringent controls to reduce and limit nutrients and organic carbon from sources that are contributing to acidification of coastal marine waters if determined necessary based on scientific data.

7. Build a communications plan and outreach materials to communicate OA science, impacts, and solutions; and evaluate the effectiveness of OA communication tools in filling information needs; engage interested stakeholders in development process.

8. Within the next 5 years, evaluate the potential for increased susceptibility of shellfish/finfish/crustaceans to predation, pathogens, and disease due to synergistic effects of OA and other human induced stressors.

9. Restore 79,800 submerged aquatic vegetation (SAV) acres by 2025. SAVs are natural carbon sinks and include vegetation like underwater grasses (*e.g.*, eelgrass). SAVs reduce the acidity of water by taking up carbon dioxide through photosynthesis.

10. Identify, evaluate, and implement, as warranted, additional opportunities to reduce GHG emissions by coastal and ocean uses and related industries (*e.g.*, tourism, recreation, restaurants) through voluntary, incentive-based, and/or regulatory measures and to secure carbon storage.

4. Provide a brief reflection on these top 10 goals. Please address the following:

(A) Is there something missing from this list that you thought would rise to the top of the pile?

(B) For your top ranked goal, what possible barriers to implementation are there in achieving this goal?

Power Point Presentation Workshop Meeting #1

Ocean Acidification Stakeholder Workshop Series

– Meeting 1 of 3 –

June 1, 2023

1

Agenda

- Introduction
  - 11:00am – Housekeeping and Setting the Stage
- Ocean Acidification Background
  - 11:20am – Presentation on Ocean Acidification
  - 11:30am – Group Exercise #1
- Ocean Acidification Action Plans
  - 11:50am – Presentation on Ocean Acidification Action Plans
  - 12:00pm – Group Exercise #2
- Wrap-up
  - 12:25pm – Closing Thoughts

Introduction | Part 1 – OA Background | Part 2 – OA Action Plans

2

Zoom Basics/Community Norms

- We will…
  - Start and end on time.
  - Have our videos on if we are able.
  - Have access to the chat and be ready to type.
  - Mute ourselves when we are not speaking.
  - Be at a screen, rather than on the phone.

Introduction | OA Background | OA Action Plans

3

Introductions

- NJDEP
  - Megan Rutkowski
- Rutgers University
  - Dr. Grace Saba
  - Jeanne Herb
  - Janine Barr
- Mid-Atlantic Coastal Acidification Network
  - Kirstin Wakefield
- Stakeholders
  - Name, where you work, and your favorite marine animal.

Introduction | OA Background | OA Action Plans

4

Goals of Stakeholder Engagement Process

1. For Rutgers and NJDEP to better understand stakeholder concerns and priorities regarding OA
2. Use stakeholder input to inform the content and elements of a future statewide OA Action Plan

Introduction | OA Background | OA Action Plans

5

History of OA Action in New Jersey

- 2020
  - NJDEP published the "Scientific Report on Climate Change"
  - Rutgers published a report on "Opportunities to Address OA Impacts in NJ"
- 2021
  - April - NJ joins the Ocean Acidification Alliance
  - October – NJDEP published the "NJ Climate Change Resilience Strategy"
  - November - Rutgers and NJDEP host a virtual workshop of OA monitoring experts focused on the development of a statewide OA monitoring network and published a report with recommendations
- 2023
  - Stakeholder engagement to inform the elements of a NJ OA Action Plan

Introduction | OA Background | OA Action Plans

6

Workshop Themes

- Workshop Meeting #1
  - Identifying your concerns regarding OA impacts and your goals regarding OA adaptation/mitigation.
- Workshop Meeting #2
  - Having robust discussions regarding draft elements/content of a future NJ OA Action Plan
- Workshop Meeting #3
  - Final thoughts and reflections on recommendations.

Introduction | OA Background | OA Action Plans

7

Ocean Acidification Background

What is OA and what do we know about OA in New Jersey waters?

Introduction | OA Background | OA Action Plans

8

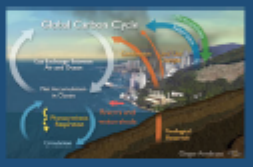
Ocean Acidification in New Jersey

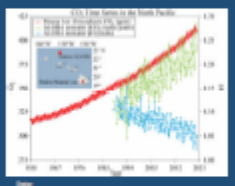
Grace Saba, Rutgers University
saba@marine.Rutgers.edu

9

Ocean Acidification

Driven by the ocean's absorption of increasing atmospheric carbon dioxide (CO_2)



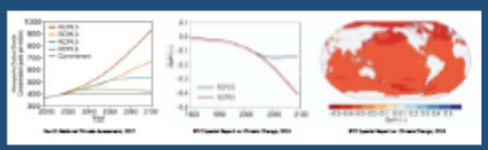


Atmospheric CO_2 increased 40% since 1800s

- Drop of 0.1 pH unit
- 28% increase in ocean acidity

10

Projections of Ocean Acidification: pH

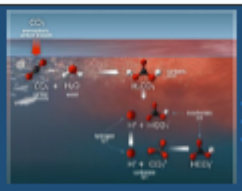


CO_2 is projected to double by 2100 (IPCC)

- Additional drop of 0.2-0.3 pH units
- Equivalent to 100-150% increase in ocean acidity

11

The chemistry of OA: carbonate chemistry

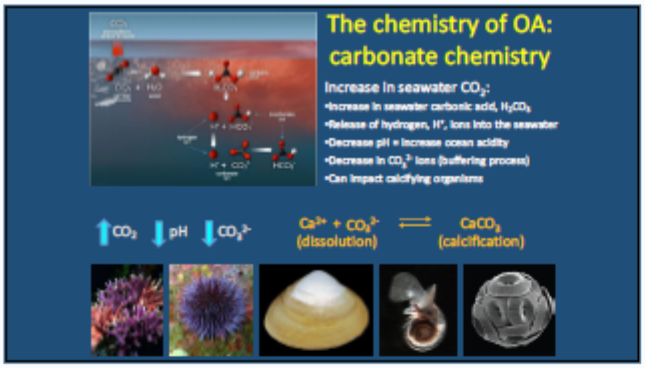


Increase in seawater CO_2:

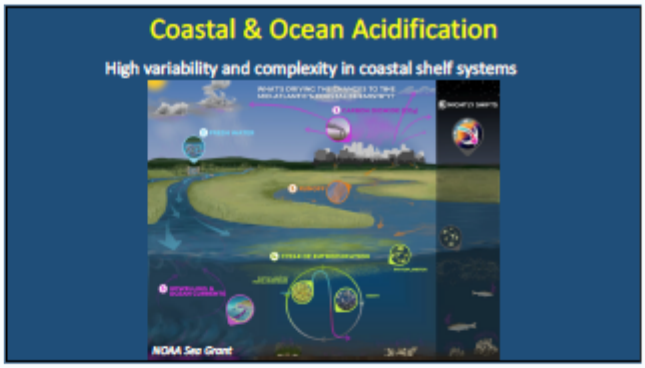
- Increase in seawater carbonic acid, H_2CO_3
- Release of hydrogen, H^+, ions into the seawater
- Decrease pH = increase ocean acidity

$\uparrow CO_2$ $\downarrow pH$

12

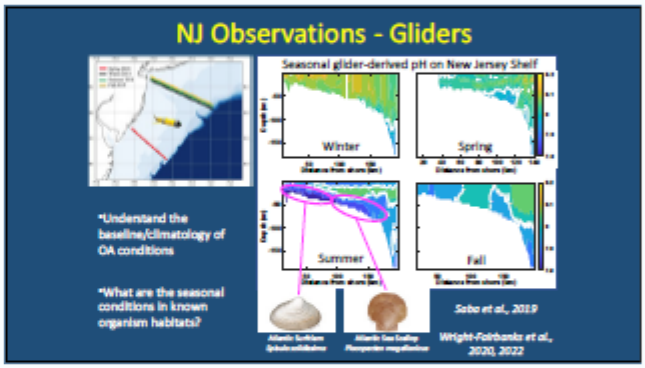


13

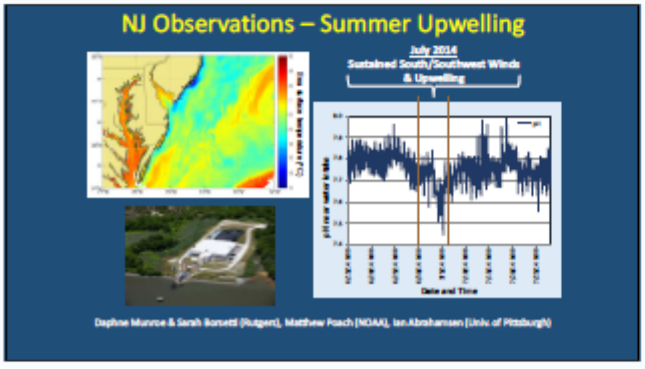


14

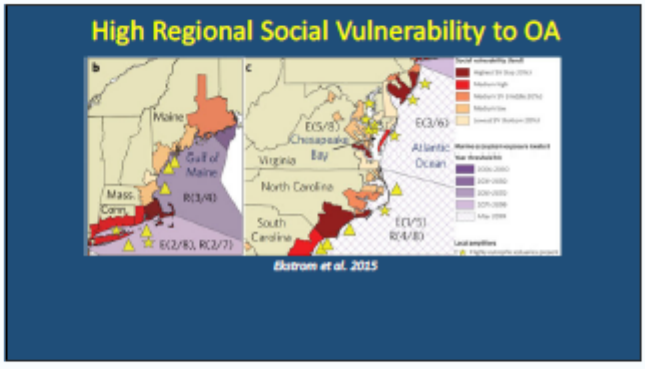
15



16

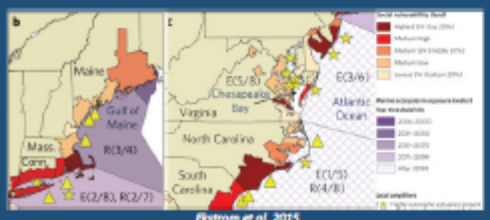


17



18

High Regional Social Vulnerability to OA



Ekstrom et al. 2015

- NJ is predicted to be at high risk of economic harm from OA conditions.
- Southern NJ counties rank 2nd in the U.S. in economic dependence on shellfish, which could suffer from increasing ocean acidity.

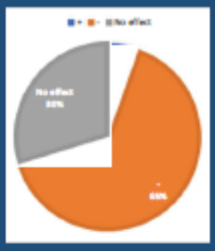
19

Potential Impacts on Mid-Atlantic Species

Saba et al., 2019: Estuarine, Coastal and Shelf Science

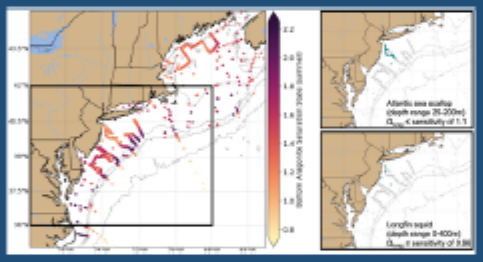
Data compiled from a review of acidification and multi-stressor studies conducted on economically important groups and species in the Mid-Atlantic:

- 18 species comprising of crustaceans, mollusks, finfish and elasmobranchs (from 59 studies)
- Species managed by MAFMC, ASMFC, NEFMC, NOAA and/or States
- Wide range of response variables



20

We are already seeing potentially impacted habitats



NOAA State of the Ecosystem 2023: Mid-Atlantic (report for MAFMC)

21

Thanks!

saba@marine.rutgers.edu

RUTGERS | NJ Climate Change Research Center

https://njclimateresourcecenter.rutgers.edu

(Research, Opportunities to address ocean acidification impacts in New Jersey)

NJCMP OA Team:
Megan Rutkowski
Russell Babb
Helaine Barr
Lauren Drumm
Heather Gerlevich
Karl Hartkopf
Kevin Hassell
Megan Kelly
Elizabeth Lange
Bob Schuster
Katherine Todoroff

Partners/other collaborators:
Jeanne Herb
Janine Barr
Brooke Schwartzman
Kirstin Wakefield

22

Group Exercise #1

https://rutgers.ca1.qualtrics.com/jfe/form/SV_cTqFiOzlaoMG4oS

Introduction | OA Background | OA Action Plans

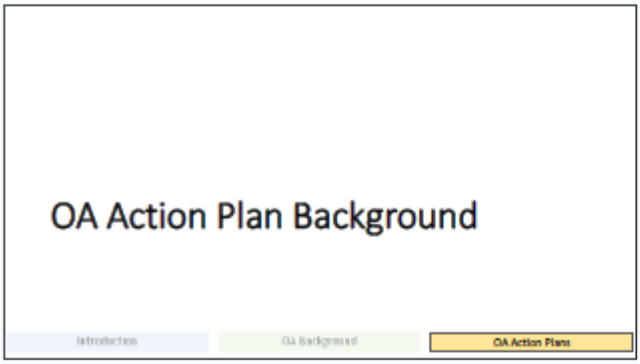
23

Snapshot of Responses

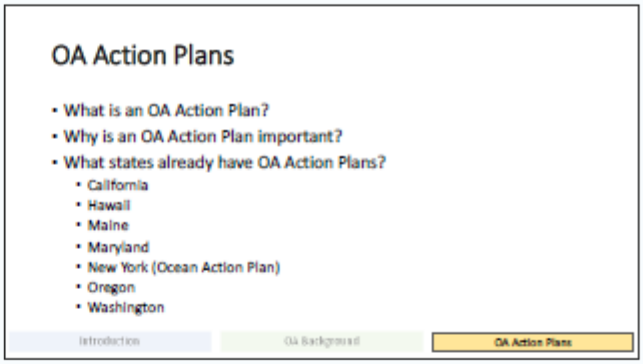
- While OA is a global problem there are some local solutions that can help with adaptation and mitigation. Doing those in concert with reducing CO2 emissions is the key to adapting and mitigating for OA
- How will OA interact with multiple stressors? How will/can various mCDR strategies impact OA?

Introduction | OA Background | OA Action Plans

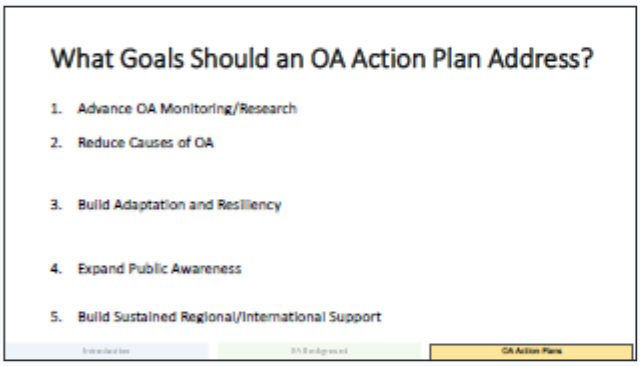
24



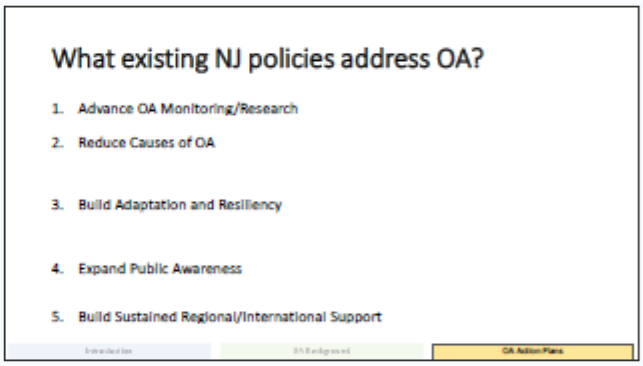
25



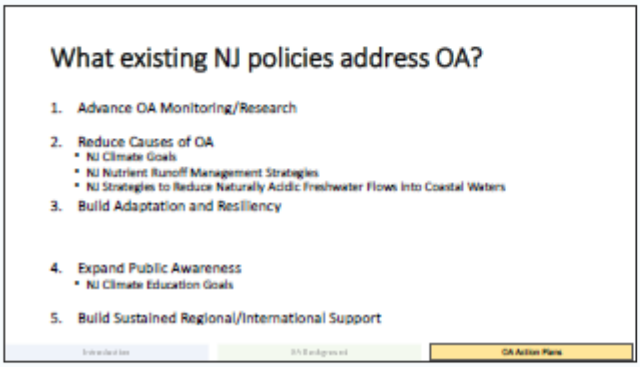
26



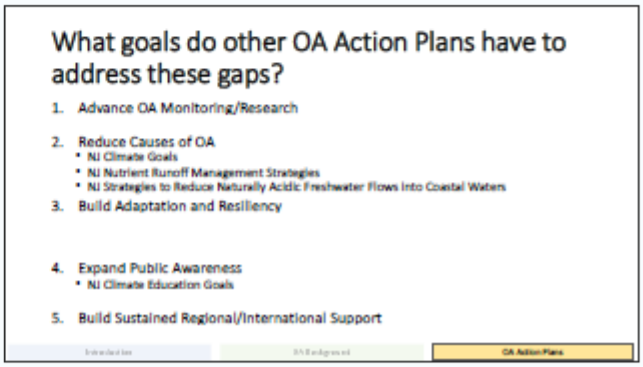
27



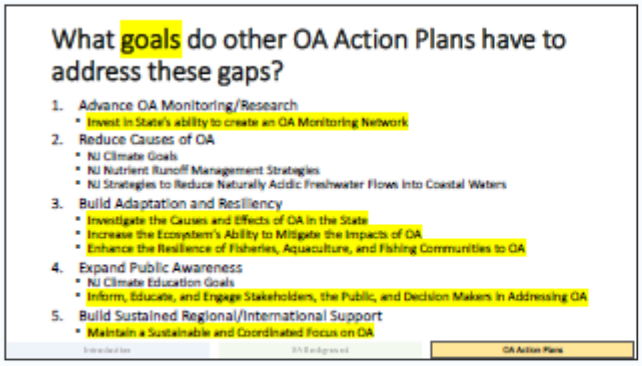
28



29



30


What goals do other OA Action Plans have to address these gaps?
1. Advance OA Monitoring/Research
• Invest in State's ability to create an OA Monitoring Network
2. Reduce Causes of OA
• NJ Climate Goals
• NJ Nutrient Runoff Management Strategies
• NJ Strategies to Reduce Naturally Acidic Freshwater Flows into Coastal Waters
3. Build Adaptation and Resiliency
• Investigate the Causes and Effects of OA in the State
• Increase the Ecosystem's Ability to Mitigate the Impacts of OA
• Enhance the Resilience of Fisheries, Aquaculture, and Fishing Communities to OA
4. Expand Public Awareness
• NJ Climate Education Goals
• Inform, Educate, and Engage Stakeholders, the Public, and Decision Makers in Addressing OA
5. Build Sustained Regional/International Support
• Maintain a Sustainable and Coordinated Focus on OA
OA Action Plans

31


Group Exercise #2
https://rutgers.ca1.qualtrics.com/jfe/form/SV_d6U7I3YuomGvnLk
OA Action Plans

32

Power Point Presentation
Workshop Meeting #2

Ocean Acidification Stakeholder Workshop Series

– Meeting 2 of 3 –

June 28, 2023

1

Workshop Themes

- Workshop Meeting #1
  - Identifying your concerns regarding OA impacts and your goals regarding OA adaptation/mitigation.
- Workshop Meeting #2
  - Having robust discussions regarding draft elements/content of a future NJ OA Action Plan
- Workshop Meeting #3
  - Final thoughts and reflections on recommendations.

2

Introductions

- NJDEP
  - Megan Rutkowski
- Rutgers University
  - Dr. Grace Saba
  - Jeanne Herb
  - Janine Barr
- Mid-Atlantic Coastal Acidification Network
  - Kirstin Wakefield
- Stakeholders
  - Name and where you work

3

Agenda

- Opening Exercise
  - 12:35pm – Rank the critical ocean acidification goals
- Survey Responses: A Deep Dive
  - 12:45pm – Monitoring/Data Collection
  - 1:00pm – Reducing the Causes of Ocean Acidification
  - 1:15pm – Building Adaptation/Resilience
- Framing an Ocean Acidification Action Plan
  - 1:30pm – Discuss overarching themes
- Wrap-up
  - 1:55pm – Closing Thoughts

Opening Exercise | Survey Responses | Framing OA Action Plan

4

Opening Exercise

https://rutgers.ca1.qualtrics.com/jfe/form/SV_eG12PIH6I54cmi6

Opening Exercise | Survey Responses | Framing OA Action Plan

5

Summary of Ranking

Opening Exercise | Survey Responses | Framing OA Action Plan

6

Survey Responses: A Deep Dive

Opening Exercise | Survey Responses | Framing OA Action Plan

7

Survey Result Themes - in Brief

- Data Organization and Expansion
  - "Collecting more data is necessary, but assessing impacts with existing data is vital to gaining public support by making a strong case for mitigating OA."
- Support Vulnerable Communities
  - "Working with the most at risk/vulnerable communities to help them adapt and respond to change and developing the predictive models to support that work is critical for future success."
- Meaningful OA Education and Outreach
  - "The general public or even the broader research community (those not necessarily working on OA) have a good comprehension of the problem and potential impacts."

Opening Exercise | Survey Responses | Framing OA Action Plan

8

Survey Results – Deep Dive

Three Deep Dives:

- Monitoring/Data Collection
- Reducing the Causes of Ocean Acidification
- Building Adaptation/Resilience

Opening Exercise | Survey Responses | Framing OA Action Plan

9

Monitoring/Data Collection

- **Top 3 Goals**
  1. Establish an expanded and sustained OA monitoring network to measure trends in local acidification conditions and related biological responses by 2030 per the recommendations of the 2021 NJ OA Monitoring Network Workshop.
  2. Use data to predict future responses of commercially important shellfish and crustacean species to increased OA and develop OA indicators/thresholds to guide adaptive action for species and ecosystems.
  3. Collaborate with other East Coast states to speak with one voice in identifying priority needs and partnering opportunities with the Federal government, including those related to ocean resources management and science.

- **Possible Additions?**
  1. Investigate and develop commercial-scale water treatment methods or hatchery designs to protect larvae and young fish from OA.
  2. Investigate genetic mechanisms and selective breeding approaches for acidification tolerance in shellfish and other vulnerable marine species.

Opening Exercise | Survey Responses | Framing OA Action Plan

10

Reducing the Causes of OA

- **Top 3 Goals**
  1. Impose stringent controls to reduce and limit nutrients and organic carbon from sources that are contributing to acidification of coastal marine waters if determined necessary based on scientific data.
  2. Identify, evaluate, and implement, as warranted, additional opportunities to reduce GHG emissions by coastal and ocean uses and related industries (e.g., tourism, recreation, restaurants) through voluntary, incentive-based, and/or regulatory measures and to secure carbon storage.
  3. Restore 79,800 submerged aquatic vegetation (SAV) acres by 2025.

- **Possible Additions?**
  1. Work on restorative activities to rebuild benthic inshore and offshore environs such as SUV, oyster beds, coral reefs.
  2. Establish a Blue Communities Program to incentivize communities to implement cost-effective green infrastructure projects and incorporate conservation principles (like stormwater management) into local ordinance and zoning laws.

Opening Exercise | Survey Responses | Framing OA Action Plan

11

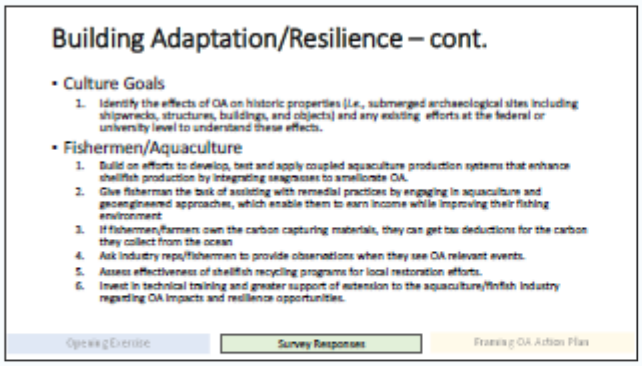
Building Adaptation/Resilience

- **Top 3 Goals**
  1. Identify **"near-term actions"** that are most important to complete to build OA resilience for most at risk communities and industries and include those in the state OA Action Plan. By 2025, complete those "near-term actions."
  2. Within the next 5 years, evaluate the potential for increased **susceptibility of shellfish/finfish/crustaceans** to predation, pathogens, and disease due to synergistic effects of OA and other human induced stressors
  3. Require that State agencies develop **Best Management Practices** to ensure actions they regulate minimize additional stress on state estuaries, nearshore, and fishing grounds to build a buffering capacity against OA.

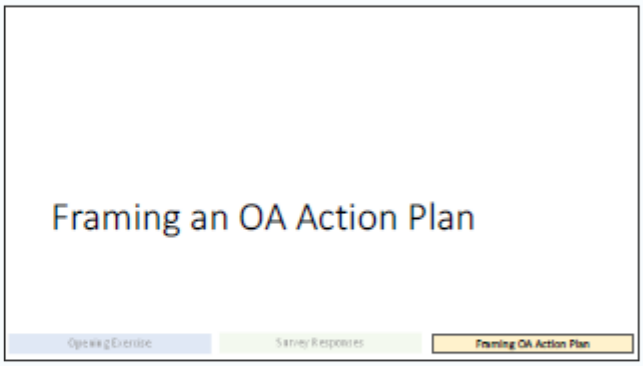
- **Possible Additions?**
  1. See next slide.

Opening Exercise | Survey Responses | Framing OA Action Plan

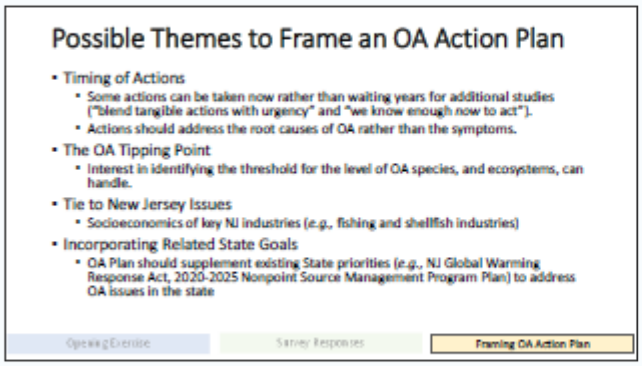
12


Building Adaptation/Resilience – cont.
• Culture Goals
1. Identify the effects of OA on historic properties (i.e., submerged archaeological sites including shipwrecks, structures, buildings, and objects) and any existing efforts at the federal or university level to understand these effects.
• Fishermen/Aquaculture
1. Build on efforts to develop, test and apply coupled aquaculture production systems that enhance shellfish production by integrating seagrasses to ameliorate OA.
2. Give fisherman the task of assisting with remedial practices by engaging in aquaculture and geoengineered approaches, which enable them to earn income while improving their fishing environment
3. If fishermen/farmers own the carbon capturing materials, they can get tax deductions for the carbon they collect from the ocean
4. Ask industry reps/fishermen to provide observations when they see OA relevant events.
5. Assess effectiveness of shellfish recycling programs for local restoration efforts.
6. Invest in technical training and greater support of extension to the aquaculture/finfish industry regarding OA impacts and resilience opportunities.
Opening Exercise
Survey Responses
Framing OA Action Plan

13


Framing an OA Action Plan
Opening Exercise
Survey Responses
Framing OA Action Plan

14


Possible Themes to Frame an OA Action Plan
• Timing of Actions
• Some actions can be taken now rather than waiting years for additional studies ("blend tangible actions with urgency" and "we know enough now to act").
• Actions should address the root causes of OA rather than the symptoms.
• The OA Tipping Point
• Interest in identifying the threshold for the level of OA species, and ecosystems, can handle.
• Tie to New Jersey Issues
• Socioeconomics of key NJ industries (e.g., fishing and shellfish industries)
• Incorporating Related State Goals
• OA Plan should supplement existing State priorities (e.g., NJ Global Warming Response Act, 2020-2025 Nonpoint Source Management Program Plan) to address OA issues in the state
Opening Exercise
Survey Responses
Framing OA Action Plan

15

83

Power Point Presentation
Workshop Meeting #3

Ocean Acidification Stakeholder Workshop Series

– Meeting 3 of 3 –

July 25, 2023

1

Workshop Themes

- Workshop Meeting #1
  - Identifying your concerns regarding OA impacts and your goals regarding OA adaptation/mitigation.
- Workshop Meeting #2
  - Having robust discussions regarding draft elements/content of a future NJ OA Action Plan
- Workshop Meeting #3
  - Final thoughts and reflections on recommendations.

2

Introductions

- NJDEP
  - Megan Rutkowski
- Rutgers University
  - Dr. Grace Saba
  - Jeanne Herb
  - Janine Barr
- Mid-Atlantic Coastal Acidification Network
  - Kirstin Wakefield
- Stakeholders
  - Name and where you work

3

Agenda

- Preview of Recommendations to DEP
  - 6:10pm – Interests, Challenges, and Opportunities
  - 6:30pm – Discussion of 12- and 36-Month Horizons
  - 6:45pm – Top Three Themes
- Next Steps
  - 7:05pm – Stakeholder Involvement Moving Forward Discussion
- Wrap-up
  - 7:25pm – Closing Thoughts

Preview of Recommendations | Next Steps

4

Preview of Recommendations

Preview of Recommendations | Next Steps

5

Summary of Stakeholder Interests

An OA Action Plan should...

1. Build on existing climate goals and other State goals
2. Address the root causes of OA and the symptoms (*i.e.*, incorporate mitigation and adaptation actions)
3. Advocate for building an OA monitoring network and conducting OA research with the goal of (1) identifying "tipping points" for species, population, and ecosystem health and (2) creating tools and implementing solutions that will build resilience to the fishing and aquaculture industries.
4. Communicate the importance of using existing data to take action now on OA rather than waiting years for additional studies to be completed.
5. Prioritize local action and regional coordination/collaboration on OA issues.
6. Underscore that all tools, services, and assistance efforts should be co-produced with fishing, aquaculture communities, and other impacted industries.
7. Emphasize the importance of educating stakeholders on OA issues to galvanize partnerships and political will to address OA.

Preview of Recommendations | Next Steps

6

Challenges

1. **Global Emissions** – local actions to reduce GHG emissions and mitigating other sources of OA may not be sufficient to counter the global rise in CO_2 in the atmosphere.
2. **Funding** – how to access and sustain funding.
3. **Politics** –
   - Shifting political landscape caused by a change in state leadership.
   - Alignment among State agencies (*e.g.*, how engaged will applicable programs be in developing and enforcing BMPs)
4. **Education** - Public buy-in on OA issues
5. **Goal Fatigue** –when *everything* is a priority, nothing is a priority.
6. **Planning Fatigue** – don't let too much planning stifle actions.

Preview of Recommendations | Next Steps

7

Opportunities

1. Insights about OA Education
   - "What do you wish you knew about OA?" responses
   - Build from existing MACAN resources and materials used in other States
   - Education leading to action
2. Suggested State Policy Changes
   - Identifying areas of improvement based on your experiences
3. How to do the Most Good with Limited Resources
   - Prioritize local mitigation actions that also benefit the fishing/aquaculture industries (*e.g.*, "For hire" monitoring)
   - Select OA projects that provide early success stories and provide co-benefits (galvanize support)
   - Coordinate with neighboring States

Preview of Recommendations | Next Steps

8

Discussion 1 – Time Horizons

Preview of Recommendations | Next Steps

9

12-Month Goals

1. Identify funding opportunities to provide dedicated capacity and staff time to implement the Plan
2. Identify members of an OA Task Force and have first meeting
3. Building on MACAN's monitoring inventory efforts, review priority locations and identify 5-10 sites to establish/enhance monitoring capacity

36-Month Goals

1. Implement three policy changes that incorporate OA risk into decision making process (*e.g.*, living shoreline requirements, habitat conservation, engaging industry in "for hire" activities)
2. Complete three OA research projects on species of concern
   A. Quantify potential impacts of the loss of shellfish/finfish industry to coastal communities and the physical resources
   B. Collect local knowledge from stakeholders on fish stocks and stressors
   C. Invest in research on OA impacts to specific species or geographic areas of interest
3. Disseminate education materials on OA to key stakeholder groups

Preview of Recommendations | Next Steps

10

Remaining Question

- Species of Concern
  - Shellfish: oysters, hard clams, scallops, surf clam, whelk
  - Finfish: mackerel, bluefish, sea trout, summer flounder, striped bass, black sea bass, black drum, menhaden, sand lance, tuna (various species)
  - Other: SAV, crustaceans (general), marine mammals (turtles), deep sea corals
- Geographic Areas of Concern
  - Hudson Shelf Valley (stronger bottom pH signature)
  - Delaware Bay (because of oyster population)
  - Areas with socioeconomic value

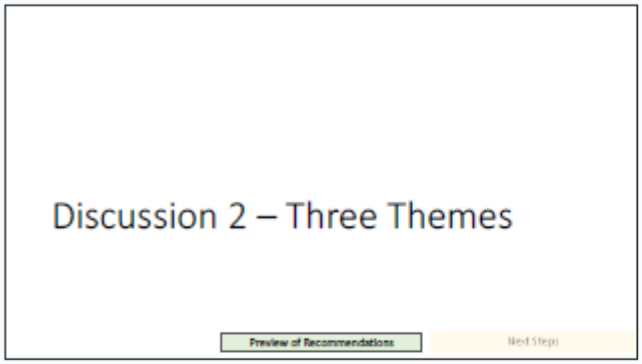
Preview of Recommendations | Next Steps

11

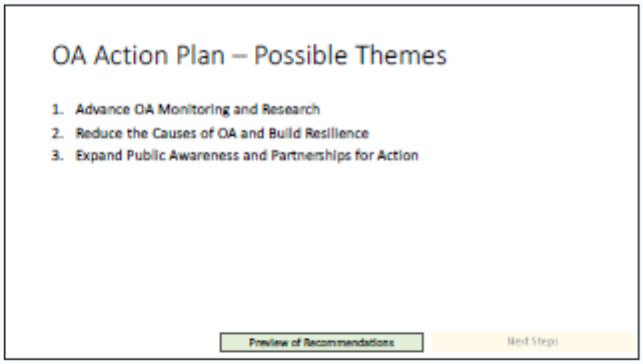
Ideas for "Coordination Council" Members

- NJDEP Experts
  - (1) member of the DEP OA Team
  - (1) NJFWS
  - (1) NJDA
  - (1) Cultural focused
- (2) representatives of the aquaculture industry
- (2) commercial fisherman
- (1) charter boat owner
- (4) NGOs (one from NJ Sea Grant)
- (2) Academic researchers (one from Rutgers)
- (X) Anyone working for the State Legislature or Governor's Office?

12


Discussion 2 – Three Themes
Preview of Recommendations
Next Steps

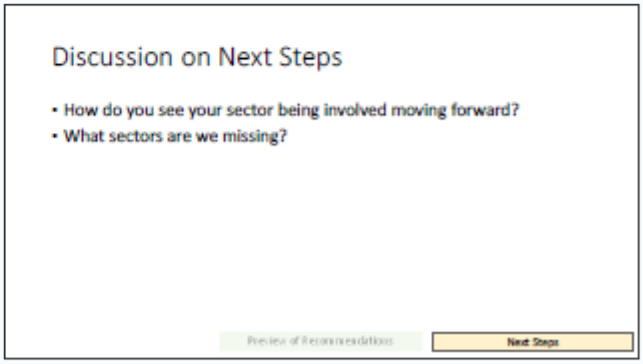
13


OA Action Plan – Possible Themes
1. Advance OA Monitoring and Research
2. Reduce the Causes of OA and Build Resilience
3. Expand Public Awareness and Partnerships for Action
Preview of Recommendations
Next Steps

14


Next Steps
Preview of Recommendations
Next Steps

15


Discussion on Next Steps
• How do you see your sector being involved moving forward?
• What sectors are we missing?
Preview of Recommendations
Next Steps

16

Appendix C – List of Possible Goals/Elements to Include in an OA Action Plan

Stakeholders and subject matter experts identified the following goal as a top goal to include in a New Jersey OA Action Plan: "identify 'near-term actions' that are most important to complete in order to build OA resilience for most at risk communities and industries." In various conversations, the participants have expanded on what those near-term actions could be and when, ideally, those actions could be completed.

For the purposes of this Appendix, goals have been binned into three categories: near-term, short-term, and long-term goals. Short term goals are those that would be achieved in the five years after an OA Action Plan is published, near-term goals would be achieved within 10 years of the Plan's publication, and long-term goals would be achieved beyond that 10-year threshold. It is important to note that while some goals are identified as "long-term" goals, actions should be taken in the near- and short- term to ensure preliminary steps are taken to ensure long-term goals are achieved.

In the event NJDEP is not prepared to use this structure in the final OA Action Plan, the list below could serve as a springboard for discussions among NJDEP and the OA Coordinating Committee.

A. Short Term (<5 Years)

1. **Funding**

   a. ***Allocate State Funds***

      i. Identify funding to provide dedicated capacity and staff time to Implement the OA Action Plan, evaluate progress, and periodically update and revise the plan at least every 5-years.

   b. ***Identify and Apply for Funding Sources to Support this Work***

      i. RGGI Strategic Funding after 2023-2025 Strategic Plan is Published

      ii. Compendium of Federal Nature-Based Resources for Coastal Communities, States, Tribes, and Territories" – has a more extensive list of grants

iii. Refer to resources available through "Opportunities for Accelerating Nature-Based Solutions: A Roadmap for Climate Progress, Thriving Nature, Equity, and Prosperity" document.

iv. The National Coastal Resilience Fund (pre-applications due ~early-April every year). Since 2018, NCRF has awarded 358 projects for a total investment of $733 million

2. Data Collection/Research

a. OA Monitoring Network - Establish an expanded and sustained OA monitoring network to measure trends in local acidification conditions and related biological responses per the recommendations of the 2021 New Jersey OA Monitoring Network Workshop. This may also include:

i. Pay for Service (sometimes referred to as "for hire" services) – Engage private boaters, charter boats, commercial shellfish/finfish/aquaculture individuals to conduct OA Monitoring. This may include engaging with individuals who already: conduct acoustic monitoring, sampling for BOEM sand mining projects, tag summer flounder, and citizens who populate the "Go Fish" app.

ii. Citizen Science – Develop QAQC protocols for OA data collection and train engaged stakeholders to collect OA data in the nearshore and offshore environment (*e.g.*, work with the Barnegat Bay Partnership to work with the commercial shellfish and aquaculture industry that have reported periodic upwellings to the Partnership).

iii. Coordinate with Existing Water Quality Monitoring Programs - There is extensive monitoring and networks of citizen scientists that could be tapped into to support an OA Monitoring Network. Additional funding may be needed to support the expanded effort.

b. Local Knowledge Collection

i. Coordinate Among State Agencies – NJDEP may benefit from coordinating with other state agencies to identify existing resources (*e.g.*, the Marine Resource Administration within Fish and Wildlife). Identify what information others are collecting and what information would be useful to collect.

ii. Establish Protocols – Develop QAQC protocols for collecting and utilizing local knowledge to inform management decisions.

iii. Collect Data – Work with local stakeholders (*e.g.*, commercial shellfish/finfish/aquaculture, charter boats, local/regional groups like MACAN) to catalogue local knowledge of fish stocks and stressors (like this account by MacKenzie 1990).

c. Biological/Ecological Research

i. Map and quantify the temporal and spatial variability in acidification parameters in the New Jersey habitats including current status, past baseline information (if enough data exist), and future predictions. In this process, identify drivers of acidification locally including aragonite/calcite saturation states to model/predict conditions and direct response appropriately. If possible, this effort should also (1) identify OA drivers between local and regional (*e.g.*, global GHG emissions, particulate matter deposition from Ohio Valley coal plants) causes and (2) quantify how sea-level rise may impact OA.

> ***More on air deposition:*** Assess whether local sources of airborne emissions (*e.g.*, nitrogen oxides, sulfur oxides) that contribute to acidification are affecting the rate of OA in select regions of the coast. Identify and implement options for reducing these airborne pollutants under state law, as appropriate, which may also yield public health benefits.

ii. Evaluate the potential for increased susceptibility of shellfish, finfish, crustaceans, and SAV to predation, pathogens, and disease due to synergistic effects of OA and other human induced stressors. Evaluate ecosystem susceptibility where sufficient data exists (otherwise, refer to “near term” goals below).

iii. Develop (or make sure) genetic libraries that include all relevant species that will be studied for the impacts of OA.

iv. Species of Concern (listed in no particular order):

1. Shellfish: oyster, hard clam, scallop, surf clam, whelk
2. Finfish: mackerel, bluefish, weakfish, striped bass, Atlantic sturgeon, summer flounder, striped bass, black sea bass, black drum, menhaden, sand lance, tuna (various species)
3. Vegetation: SAV, primarily eelgrass (*Zostera marina*) and widgeon grass (*Ruppia maritima*)

v. Geographic Areas of Concern:

1. New Jersey coastal bays, nearshore habitats, and offshore habitats that have ecosystem and economic value.
2. Hudson Shelf Valley (because it has a stronger bottom pH signature in waters by the NJ/NY Bay region)
3. Delaware Bay

d. Social Science

i. Quantify potential impacts of the loss of shellfish/finfish industry to (1) coastal communities and (2) the physical resources that make up those communities.

ii. Examine impacts of OA to coastal and submerged cultural resources as the increasing acidification likely causes increased deterioration of resources like shipwrecks.

3. Education/Outreach

a. Create an education working group that will:

i. Build a communications plan to communicate OA science, impacts, and solutions; and evaluate the effectiveness of OA communication tools in filling information needs.

ii. Identify proven education and outreach strategies to raise awareness of ocean acidification and encourage action at the community level, potentially using Community Based Social Marketing campaigns.

iii. Develop formal and informal education tools, products, and lesson plans to create a literate citizenry from K to Gray.

iv. Develop materials consistent with 2020 NJ Student Learning Standards

b. Education Material Needs Noted by Stakeholders

i. Audience: members of the public, recreational fisheries, commercial fisheries, shellfish industry, offshore wind industry, policy/decision makers.

ii. Topics: the impacts of OA on fish/shellfish landings and food security; impacts of OA to water quality, fish kills, human health, the economy;

how OA dovetails with other climate change issues (*e.g.*, runoff events); impacts of OA to macro-organisms; cultural impacts (*e.g.*, shipwrecks, submerged archaeological sites).

iii. ***Recommended Elements to Incorporate into Education Materials:*** Real numbers that allow readers to understand the impact of OA and the role OA mitigation efforts can have; describe OA as an urgent issue even if you can't see or feel OA happening like you do air temperature changes; and identify what can be done – locally, regionally, nationally (readers need to understand what their role is and what they can do to support change).

4. Policy

a. ***Support and achieve ongoing State goals including those related to:*** reducing nutrient pollution in coastal waterbodies, carbon sequestration in the ocean, and overall climate goals (*e.g.*, reducing emissions).

b. ***Establish a forum*** for agricultural, business, and other stakeholders to engage with coastal resource users and managers in developing and implementing solutions to OA.

c. ***GHG Emissions of Coastal Industries***

i. ***General:*** Identify, evaluate, and implement the most cost-effective opportunities that reduce GHG emissions by coastal and ocean uses and related industries (*e.g.*, tourism, recreation, restaurants) through voluntary, incentive-based, and/or regulatory measures to secure carbon storage.

ii. ***Seafood Specific:*** Reduce the carbon footprint of seafood production and consumption in the state (after evaluating the potential for and the environmental, economic, and social costs and benefits of incentivizing consumption of locally sourced products). Work with seafood certification and rating programs to integrate carbon footprint information into rating systems and public education products.

d. ***Develop BMPs and/or update State policies with State agencies and regulated industries*** to ensure actions of the State minimize additional stress on estuaries, nearshore, and fishing grounds to build a buffering capacity against OA. Some BMPs/policy updates may require regulatory

changes at the State level. Possible BMPs and/or updated policies include:

i. Supporting Fishing and Aquaculture Industries

1. Give fisherman the task of assisting with remedial practices by engaging in aquaculture and geoengineered approaches, which enable them to earn income while improving their fishing environment.
2. If fishermen/farmers own carbon capturing materials, consider allowing them to receive tax deductions for the carbon they collect from the ocean.
3. Invest in technical training and greater support of extension to the aquaculture/finfish industry regarding OA impacts and resilience opportunities.
4. Provide funds/grant to support investment in testing carbon neutral fishing practices and/or use of carbon capturing materials.
5. Dovetail with existing NRCS-funded COASTAL project to improve shellfish BMPs (more information available here).

ii. Habitat Conservation

1. Conserve wetlands during offshore wind development – OSW Permitting at this point allows for the removal of wetlands, consider tightening restrictions to protect these vulnerable ecosystems that may mitigate the impacts of OA by reducing runoff to coastal environments.
2. TATRAT – Consider implementing a take a ton, replace a ton re: beach replenishment.
3. Restore our benthic marine environment and reduce human activities and practices that are destructive (see subsection IV.G.2).
4. Consider establishing marine protected areas (MPA) in a way that does not negatively impact state fisheries or fishermen livelihoods. MPAs would provide waters with a buffering capacity against the impacts of OA.

iii. Shellfish

1. Update Living Shoreline Requirements – Enhance nutrient removal from coastlines by expanding living shoreline infrastructure in the state. Currently, it is challenging to create living shorelines in urban

areas, areas with CSOs, or areas with underserved communities due to shellfish contamination and consumption issues.

2. Consider Adjusting SAV/Aquaculture Regs – if there is substantial interest in pairing SAV with shellfish to ameliorate OA impacts to shellfish, that would require a regulatory change.
3. Streamline Process for Coupled Aquaculture – Allow seaweed to grow with shellfish aquaculture.

iv. Nutrient Reduction

1. Build on MS4 Permit Requirements to educate permit writers on the threat of OA and incorporate OA considerations into Watershed Improvement Plan Reports.
2. Assess the need for additional stringent controls to reduce and limit nutrients and organic carbon from sources that are contributing to acidification of coastal marine waters if determined necessary based on scientific data. It may be beneficial for any additional controls to consider what industry, user, and source of OA stress would be regulated and if those controls would cost the State more than the projected benefits.

v. BMP Reflections

1. Incentives – BMPs could be paired with incentives to encourage/require individuals to take action. This could include reduced permit costs if certain BMPs are implemented. Also, this could include items like identifying and incentivizing OA improving land uses via specific species plantings, superior retention basin design, wetlands design, etc.
2. Metrics to Quantify Impacts – Consider establishing metrics to determine how BMPs mitigate OA impacts and to determine how restoration and resilience projects may be impacted by OA long-term.

Near Term (5-10 Years)

1. Data Collection/Research

a. Sustained OA water parameter monitoring.

b. Biological/Ecological Research

i. Species

i. Establish across-taxa summary of (1) sensitivity to OA and (2) sensitivity to OA exacerbated by local conditions/stressors (*e.g.*, pathogens, salinity, temperature) including information on species specific thresholds across the full life cycle and sublethal effects.

ii. Species Specific Research

1. SAV – Expand on NJDEP/FWS SAV mapping efforts (2023 surveys conducted in Little Egg Harbor/Barnegat Bay Region, 2024 surveys to be conducted in Northern Rivers) to determine percent cover of SAV.

2. Shellfish/Finfish General Research

    a. Investigate genetic mechanisms and selective breeding approaches for acidification tolerance in shellfish and other vulnerable marine species

3. Oysters

    a. Investigate and develop commercial-scale water treatment methods or hatchery designs to protect larvae from corrosive seawater.

    b. Determine the association between water and sediment chemistry and shellfish production in hatcheries and in the natural environment

    c. Assess the upwelling conditions that bring in coastal OA near New Jersey and regional hatchery facilities. This research will answer the question: how far ahead can we know those winds are coming so shellfish hatcheries can respond (*e.g.*, turn off natural water source feeding hatchery and use alternative source of water).

    d. Dedicate more research on shellfish farming and reefs to solidify the role that they play as carbon sinks.

ii. Populations

i. Create summary of population sensitivity to OA from the scientific literature.

iii. Ecosystems

i. Quantify the effect of OA conditions on food webs/ecosystems (*e.g.*, existing SAV, coastal wetlands, future enhancement projects, community composition).

ii. Assess impacts of OA to ecosystem services (in estuarine, nearshore, and offshore environments).

iii. Quantify the benefits (environmental) and co-benefits (economic, etc.) of mCDR strategies and how those strategies will impact OA.

c. Supporting Fishing and Aquaculture Industries (including but not limited to: finfish, crustaceans, and benthic organisms)

i. Predictive Models

i. Establish the ability to make short-term forecasts of corrosive conditions for application to shellfish hatcheries, growing areas, and other coastal regions for finfish nurseries

ii. Enhance the ability to predict the long-term future status of carbon chemistry and pH in New Jersey waters and create models to project ecological responses to predicted OA conditions

d. Habitat Restoration

i. SAV – Establish an SAV conservation and restoration goal for the entire State (in tandem with NJDEP/FWS Natural and Working Lands Strategy) that covers all of New Jersey's coastal habitats, including Delaware Bay where less SAV work has been conducted.

ii. Oyster Shell Recycling – Build on the success of the Delaware Bay shell planting program and other shell recycling efforts in the state, including the New Jersey Fish and Wildlife Service Bureau of Marine Habitat and Shellfisheries' Shell Recycling Program in Atlantic City, New Jersey. Use shells in targeted marine areas to remediate impacts of local acidification on shellfish. Assess effectiveness of shellfish recycling programs for local restoration efforts.

iii. Coral communities - Rebuild deep sea coral communities to create ocean substrate and also serve as buffer against OA. (Stakeholder note: this item was not a top priority and was considered to have

little value added, but the authors are including this idea here for completeness.)

e. Social Science

*i. **Understand how/why people make decisions:*** this will be important in order to change behavior/elicit action on mitigating OA. (A stakeholder noted that, this is an "aspirational goal that has proven elusive across many fields.")

2. Education/Outreach

a. Continue to support outreach/education subcommittee activities and missions.

3. Policy

a. Create Mechanisms to Spur Positive "Boots-On-The-Ground" Changes

*i. **Launch a statewide and/or regional marine carbon dioxide removal (CDR) initiative*** to (1) serve as a coordination vehicle for public-private funded research activities and (2) to facilitate the creation of new marine CDR demonstration sites with the goal of elucidating marine CDR benefits. Dovetail this effort with the NJDEP Natural and Working Lands Strategy.

*ii. **Establish a Blue Communities Program*** to incentivize communities to implement cost-effective green infrastructure projects and incorporate conservation principles (like stormwater management) into local ordinance and zoning laws.

b. Science Informed Management Decisions

*i. **Incorporate OA into natural resource management decisions.***

1. For example, it would be beneficial for ocean chemistry to be part of the discussion on fish stocks. Moreover, fishery managers need to know what the population level impacts of OA are and how those impacts are manifesting within a population (*e.g.*, lower reproduction, changes in meet/product quality, broader changes to fisheries habitat etc.) to know what sort of action they should/shouldn't take.

ii. Update Standards

1. Assess the need for water quality criteria under the Clean Water Act relevant to OA and update those criteria accordingly.

c. Generate Guidance

*i. **Produce a guidance document*** that identifies the best "bank-for-your-buck" actions for communities, NGOs, and others to implement to mitigate OA.

*ii. **Identify best practices*** for people in waterfront communities and people who use the coastline to ensure their actions aren't contributing to lower pH levels.

Long Term (>10 Years)

1. Provide fishermen, ocean users, and resource decision makers with information they need to assess risks and take action to adapt to the changing ocean

2. Identify, protect, and restore ocean and coastal habitats essential to climate-ready fisheries, protected species, and fishing communities. This includes identifying and incentivizing land uses via specific species plantings, superior retention basin design, wetlands design, TMDLs, etc. to mitigate OA in New Jersey.

Appendix D – OA Action Plan Draft Outline

The recommended elements discussed in subsection IV.F of this report are referenced below in ***bold italicized font***.

1. Introduction
   a. New Jersey's Ocean Economy
      i. New Jersey's Connection to Coastal Waters
      ii. New Jersey's Fisheries and Coastal Economy
      iii. New Jersey's Investments in the Environment (***include an extensive list of existing, OA relevant state goals and policies***)
   b. What is at Stake for New Jersey
      i. Summary of Current Scientific Understanding of Causes/ Consequences of OA (***describe the drivers of OA***)
      ii. Existing OA Concerns in New Jersey
   c. Policy Framework for OA Action Plan
      i. Origin of New Jersey's OA Action Plan
      ii. Stakeholder Engagement Process
      iii. New Jersey Ocean Acidification Action Plan Framework/Scope (***include a funding mechanism***)
2. Vision and Strategies for Action on OA
   a. Priority Action Areas (***establish an OA workgroup/coordinating committee and identify tasks for the committee to complete***)
      i. Advance OA Monitoring and Research (***incorporate existing expert recommendations for a New Jersey OA Monitoring Network; identify broad research goals***)
      ii. Reduce the Causes of OA and Build Resilience (***identify broad policy goals***)
      iii. Expand Public Awareness and Partnerships for Action
   b. Strategies and Measures of Success
   i. Project team note: in this section, DEP could identify specific actions and timelines to achieve goals in each Priority Action Area above (***continued: establish an OA workgroup/coordinating committee and identify tasks for the committee to complete***)
   c. How Does the New Jersey OA Action Plan Support the State's Existing International and Domestic Climate Commitments? (***include an extensive list of existing, OA relevant goals and policies***)
3. Conclusions

RUTGERS

Edward J. Bloustein School
of Planning and Public Policy

Edward J. Bloustein School of Planning and Public Policy
Rutgers, The State University of New Jersey
33 Livingston Avenue
New Brunswick, N.J. 08901

p. 848-932-2725 eac@ejb.rutgers.edu
cupr.rutgers.edu/eac/