WORKSHOP SUMMARY: SUPPORTING OA ACTION PLANNING AND IMPLEMENTATION IN THE MID-ATLANTIC

October 26, 2021
Virtual

EXECUTIVE SUMMARY & BACKGROUND

The Mid-Atlantic Coastal Acidification Network (MACAN)[1] is a nexus of scientists, tribal, federal, and state agency representatives, resource managers, and affected industry partners who seek to coordinate and guide regional observing, research, and modeling of estuarine, coastal, and ocean acidification in the Mid-Atlantic. Co-led by the Mid-Atlantic Regional Association Coastal Ocean Observing System (MARACOOS)[2] and the Mid-Atlantic Regional Council on the Ocean (MARCO)[3], MACAN works to develop a better understanding of the processes associated with estuarine, coastal, and ocean acidification, predict the consequences for marine resources, and devise local adaptation strategies that enable communities and industries to better prepare and adapt. MACAN is guided by a Steering Committee composed of individuals from a wide range of expertise, affiliation, and location within the Mid-Atlantic region.

The OA Alliance[4], or the International Alliance to Combat Ocean Acidification, brings together governments and organizations dedicated to taking urgent action to protect coastal communities and livelihoods. Launched in 2016 in response to West Coast oyster hatchery production failures, the OA Alliance partners with states and regional government entities to develop Ocean Action plans aimed at reducing carbon dioxide emissions, advancing scientific understanding of climate-ocean impacts, reducing local sources of pollution that exacerbate OA, protecting coastal communities from climate-ocean impacts, and expanding public awareness.

MACAN and the OA Alliance leveraged their complementary missions to plan and deliver this workshop, which looked at OA Action Planning in the Mid-Atlantic region and identified opportunities and next-steps for supporting state implementation of those plans.

The outcomes from the workshop informed MACAN's 2022-2024 work plan, including the development of a regional Ocean and Coastal Acidification Monitoring Inventory. In a post-workshop survey, several

[1] http://midacan.org/about-us
[2] https://maracoos.org/
[3] http://midatlanticocean.org/
[4] https://www.oaalliance.org/about

participants also noted how the workshop will help advance their efforts around OA and are leading to new partnerships with MACAN:

"I will be leveraging some of the regional data hubs and information about State OA plans for a project involving vulnerability of the Sea Scallop industry."

"We are looking into ways to incorporate OA monitoring into existing monitoring networks in the Chesapeake Bay and how we can connect this with biological impacts."

"I'm interested in learning if my facility can become one of the monitoring stations for our region. We're also very interested in showcasing the findings of this body of effort in our gallery exhibitions."

OVERVIEW & MEETING OBJECTIVES

On October 26, 2021 MACAN and the OA Alliance convened a half-day workshop to discuss Ocean Acidification (OA) action planning and implementation in the Mid-Atlantic. The majority of the Mid-Atlantic coastal states are pursuing OA Action Planning either as stand-alone efforts or as part of broader coastal/ocean planning efforts. This workshop was designed to help connect researchers, state agencies, and representatives from state legislatures from across the Mid-Atlantic region to help inform OA Action planning with an emphasis on identifying associated data/ information needs for management and coordinating monitoring where appropriate.

- Share OA Action Planning progress, lessons-learned and next steps regarding state OA Action Planning efforts.
- Deepen understanding about the science relevant for implementing OA Action Plans.
    - Where are the gaps?
    - Are there targeted research projects that would help fill those gaps?
- Identify opportunities for Mid-Atlantic states to coordinate on monitoring and/or data sharing at the regional (or water body) scale.
- Discuss pathways for setting up a regional OA observation network, beginning with a regional asset inventory.

WELCOME AND AGENDA OVERVIEW
AVALON BRISTOW, MACAN CO-COORDINATOR AND MARCO PROGRAM DIRECTOR

WORKSHOP GOALS

Avalon Bristow, MACAN Co-Coordinator, discussed the workshop objectives (listed above) that would be used to inform future MACAN planning and reviewed the meeting agenda.

ACKNOWLEDGEMENTS

Thank you to our sponsors:
Mid-Atlantic Coastal Acidification Network (MACAN)
Ocean Acidification Alliance (OA Alliance)
Mid-Atlantic Regional Council on the Ocean (MARCO)
Mid-Atlantic Regional Association Coastal Ocean Observing Network (MARACOOS)

Thank you to our Planning Committee:
Avalon Bristow and Judy Tucker, Mid-Atlantic Regional Council on the Ocean

Jessie Turner, Cascadia Policy Solutions and OA Alliance
Halle Berger, Knauss Fellow, NOAA OAP and NCCOS
Mary Ford and Kirstin Wakefield, MARACOOS

OPENING REMARKS
DWIGHT GLEDHILL, NOAA OCEAN ACIDIFICATION PROGRAM

Dr. Dwight Gledhill, Deputy Director of NOAA's Ocean Acidification Program, provided opening remarks for the workshop. Dr. Gledhill gave an overview of the research priorities outlined in NOAA's 10 year OA Research Plan for the Oceans, Coasts and Great Lakes and emphasized the importance of coordinating Mid-Atlantic regional OA Action Planning with this Research Plan. Focus areas of the Research Plan include: improving daily to decadal forecasting through informed observing systems with the addition of vertical dynamics; addressing OA in the context of multi-stressors and species response; and understanding the social and economic costs and benefits to mitigation and management. Dr. Gledhill set the stage for further discussion regarding OA monitoring, emphasizing that monitoring should be viewed as a means to a desired outcome, not the outcome itself. When making decisions to deploy an observing asset, consider what research and data are needed to inform decision-making.

PART 1. UPDATES FROM MID-ATLANTIC STATES' OA ACTION PLANNING EFFORTS

Most of the Mid-Atlantic states are either in the process of developing or have already completed state OA action plans. Primarily led by agency mandate or from a Governor's Executive Order, the planning efforts often build on or are tied into existing state efforts, e.g. NJ Climate Resilience Plan, NY Long Island Nitrogen Action plan, MD Greenhouse Gas Reductions 2030 plan and WHIP restoration plans. Representatives from New Jersey, New York and Maryland shared lessons learned from their state planning processes.

The importance of partnerships to identify knowledge gaps and opportunities for coordination was a common theme expressed by all three states in their OA Action Planning processes.

NEW JERSEY - MEGAN RUTKOWSKI, NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION

New Jersey's OA action planning efforts began with Executive Order 89, which authorized development of NJ DEP's Statewide Climate Resilience Strategy. Along with that strategy, the 2020 Scientific Report on Climate Change noted the economic impact of OA on NJ's shellfish industry and the counties dependent upon that industry. NJDEP and Rutgers University teamed together on a report, "Opportunities to Address OA Impacts in NJ," and continue to work with other state agencies to develop an OA Action Plan in coordination with the OA Alliance. The team hosted an OA monitoring workshop in November to build out their statewide OA Monitoring Network. Drawing from their repository of OA cruise and location-specific data, NJ aims to fill their monitoring gaps by adding carbonate chemistry parameters to existing monitoring stations; enhancing nearshore monitoring with gliders and partnering with industry groups to address species of economic interest, especially scallops and surf clams.
Lessons learned:

- To fill knowledge and research gaps, the NJ team has conducted interviews with other states about their OA Action Plans, and to identify opportunities to share existing monitoring data..
- Study approaches should be focused on local conditions.
- Seek funding and approvals for a comprehensive statewide monitoring network

NEW YORK - DR. HENRY BOKUNIEWICZ, PRINCIPLE INVESTIGATOR FOR THE NY OCEAN ACIDIFICATION TASK FORCE

New York's OA Task Force was initiated by the Governor in 2016. They're beginning to integrate OA action planning into the state's environmental plan and anticipate publication of a final report in 2022. The report focuses on coastal acidification, including the synergistic effects between nitrogen, low dissolved oxygen, and water quality. The sections of the report include mitigation, education for awareness and political will, identifying gaps in information, monitoring, and engagement, engaging in partnerships with business and industry, and recommendations for legislation. Focus areas include: investing in coastal ocean monitoring and coordinating across partners; mitigation tools, e.g. reducing sources of CO2 and nutrients and salt marsh and ribbed mussel restoration programs, and evaluating socioeconomic impacts to commercially important and sensitive species.

Lessons learned:

- Coordinate with others: NY is coordinating with EPA National Estuary Programs in the Hudson River and Long Island Sound, and the State of Connecticut.
- More research is needed on the chemistry and effectiveness of potential mitigation measures before the Task Force will be able to get policy action or funding.

MARYLAND - RACHEL LAMB, MARYLAND DEPARTMENT OF THE ENVIRONMENT

The development of Maryland's 2020 OA Action Plan was led by the MD Department of Energy Climate Change Program. Building on the 2015 MD OA task force report, the 2020 OA Action Plan includes three priority areas: 1) improve scientific understanding, 2) expand public awareness and partnerships, 3) reduce causes of OA and increase resilience. As a state, they're working on crafting greenhouse gas emissions reduction goals and protecting natural and working lands, especially to prevent eutrophication from nutrient runoff. They are also engaging with the Maryland Commission on Climate Change and expanding public connections around Chesapeake Bay. Gaining a better scientific understanding of aquaculture, OA & SAV (submerged aquatic vegetation) and the interactions between different stressors, and monitoring for key indicators to inform OA adaptive management are also key areas of focus.

Maryland is working to create consistent communication of drivers and impacts across different communities of practice, strategically investing in science and infrastructure for sustained data collection and access to understand changes over time, integrating data analysis into existing frameworks, supporting innovative research at landscape-scale, and adding OA to work already in progress with neighboring states on climate action and nutrient reduction. Dr. Lamb emphasized that OA action planning is part of climate change action planning and can be institutionalized in Maryland's work plan.

PART 2. OCEAN & COASTAL ACIDIFICATION MONITORING METHODS & REGIONAL DATA SHARING IN THE MID-ATLANTIC

This section of the workshop took a closer look at what OA monitoring actually means, where the data is currently being stored, how it can be accessed, and what types of data products might be helpful for informing policy and decision makers.

OVERVIEW OF OCEAN AND COASTAL ACIDIFICATION MONITORING

"WHAT ARE THE DIFFERENT WAYS OF COLLECTING DATA, AND WHAT IS THE UTILITY OF EACH?"

JEREMY TESTA, MACAN SCIENCE WORK GROUP, CHESAPEAKE BIOLOGICAL LABORATORY, UNIVERSITY OF MARYLAND

Water quality monitoring has a long history in the Mid-Atlantic and remains a high priority in many states. Many programs are already collecting at least one parameter related to OA through these programs; for example, 3-4 decades of pH data have been collected in DE, MD, and VA by a variety of partners. There is an opportunity to collaborate, leveraging the existing infrastructure and resources in order to add at least one more parameter related to carbonate chemistry[5,6]. Total alkalinity, for example, could be an easy and affordable variable to add to existing monitoring programs. States can also use existing monitoring data to prioritize locations for analyzing long-term trends. As we look to leverage monitoring capacity in support of a regional monitoring network, it's important to keep in mind that data must be comparable across the region. We also need to engage stakeholders and policymakers, plan for additional staffing costs, and provide a process to translate data to answers to inform state actions.

Considerations for building an expanded OA monitoring network include:

- Leveraging existing monitoring and infrastructure.
- Building new partnerships and incorporating new technologies.
- Packaging coastal and ocean acidification monitoring as water quality monitoring. For example, "hypoxia and acidification", may help communication with stakeholders resonate more strongly. as they are already familiar with the impacts of low dissolved oxygen on habitats and species in Chesapeake Bay and Mid-Atlantic waters.
- Engaging policy makers in planning for enhanced monitoring.
- Establishing the goals for monitoring ahead of time, and perhaps regionally embracing them, to ensure value is added for states with different priorities.

Goals for Regional OA Monitoring could include:

- Establishing a baseline to examine long-term trends
- Measuring/monitoring biological response - why monitor and how to collocate with existing water quality measurements
- Monitoring in targeted habitats
- Capturing most extreme (harmful) conditions
- Understanding land-water connections, eg. role of eutrophication in acidification and impacts of poorly buffered riverine water inputs
- Mapping hotspots for vulnerability

REGIONAL DATA SHARING AND MAPPING TOOLS IN THE MID-ATLANTIC

MARACOOS OCEANSMAP - MARY FORD, (DIRECTOR OF ENGAGEMENT AND EXTERNAL RELATIONS, MARACOOS)

MARCO DATA PORTAL - KARL VILACOBA (MID-ATLANTIC PORTAL PROJECT MANAGER) AND NICK NAPOLI (MARCO SENIOR ADVISOR)

[5] A workshop participant recommended a journal article in *Frontiers in Marine Science* on the National Estuary Program's continuous monitoring program: https://www.frontiersin.org/articles/10.3389/fmars.2021.679913/full

[6] Goldsmith, K.A., Lau, S., Poach, M.E., Sakowicz, G.P., Trice, T.M., Ono, R.C., Nye, J., Shadwick, E.H., St.Laurent, K.A., Saba, G.K. 2019. Scientific Considerations for Acidification Monitoring in the U.S. Mid-Atlantic Region. Estuarine, Coastal and Shelf Science 225: 106189,

Data visualization and storage is an important consideration of a regional OA monitoring network. In the Mid-Atlantic, MARACOOS OceansMap and the MARCO Data Portal are complementary regional spatial tools that can provide opportunities for sharing and mapping regional OA data. Live demonstrations of the MARACOOS OceansMap and the MARCO Mid-Atlantic Ocean Data Portal were presented and can be viewed on the workshop recording.

MARACOOS OceansMap is a dynamic data visualization tool integrating near real-time observational assets and model forecasts that contribute to ocean monitoring in the Mid-Atlantic region. User themes include winds, waves, currents, water level, water temperature, salinity, active tropical cyclones, fishing, and offshore wind. Data layers include Observation Stations, Gliders, Drifters, Coastal Flooding, Spatial Observations, Wind Predictions, GIS Layers, Active Tropical Cyclones, Wave Predictions, Water Level Predictions, Current Prediction, Water Temperature Predictions, Salinity Predictions, Air Temperature Predictions, Channels. Data trends can also be visualized using the time slider. While data for the Chesapeake Bay are available on OceansMap, the forecast system from the Chesapeake Bay portal has not been incorporated due to variance in time frames and the parameters being monitored. For those interested in observations with the regional carbonate chemistry data integrated, refer to Marjy Friedrichs' Chesapeake Bay Environmental Forecasting System.

The MARCO Mid-Atlantic Ocean Data Portal was created to focus on human uses of the region and for decision making purposes. In contrast to OceansMap, it does not provide ocean conditions and forecasts. However, it does provide static maps showing locations where acidification monitoring occurs. The Data Portal's data layers include Administrative, Fishing. Fishing - Communities at Sea (by Port), Marine Life, Marine Life, Library (Species Specific), Maritime, Oceanography, Recreation, Renewable Energy. Seafloor Habitat, Security, Socioeconomic, and Water Quality. Within the Water Quality layer, acidification monitoring locations are mapped with pop up legends listing the name of the buoy, who manages it, what parameters are monitored, as well as links to more information about the site or organization conducting the monitoring. Several acidification monitoring map products were also created in 2017 using data from continuous monitoring stations, cruise transect data, glider transect data, ongoing fixed stations, and former fixed stations. Users can pull data only for currently sampled sites. The Portal managers would like to know what additional OA data would be useful to include in the Water Quality layer and visual products..

A note in the chat box from Dwight Gledhill: *This is really great to see these mapping products. I wanted to alert you all to an upcoming NOAA research cruise, East Coast Ocean Acidification (ECOA) cruise, due to set sail this coming summer. This is a regional biogeochemical survey sponsored by NOAA OAP which is repeated every four years. The cruise runs from the Scotian Shelf to Bahamas running transects from the coast to the shelf break. We're eager to coordinate. Please reach out to me if you are interested to learn more.*

INTRODUCE AND ENCOURAGE PARTICIPATION IN THE ASSETS INVENTORY SURVEY

KARI ST. LAURENT, DELAWARE DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL

The information presented in the earlier sessions aimed to familiarize participants with the past and current state of OA monitoring in the Mid-Atlantic. The next step toward improving monitoring in the region is to update the inventory of monitoring assets currently deployed and how the data are being used by the research community, stakeholders, and decisionmakers. MACAN envisions the monitoring assets inventory to be a resource to help inform sensor choice based on the measurements and environment they are best suited for, to help create consistency between methods to allow for data comparison; and to identify what, where and how data is being distributed and used. Participants in Breakout Session Group

#4 can help MACAN refine the asset inventory goals, identify key participants for the survey, and discuss ways in which the information from the survey can be developed into useful products for stakeholders.

PART 3. CASE STUDY FROM THE WEST COAST: REGIONAL MONITORING INVENTORY

ESTABLISHING A COAST-WIDE OA MONITORING INVENTORY TO SUPPORT MANAGEMENT DECISIONS
CAREN BRABY, OREGON DEPARTMENT OF FISH AND WILDLIFE

Lessons learned from other regions can help MACAN be more successful in its inventory planning efforts and outcomes. Caren Braby, Marine Resources Program Manager for Oregon Department of Fish and Wildlife, joined us to discuss how the West coast approached a regional OA monitoring network, and to describe some of the lessons learned from that effort. Key takeaways included:

- *"Decision makers are motivated by local measurements of places and species that are priorities to them."* Tying the impacts on species to their constituents can help make connections to OA on a personal level. On the West coast, the local connection has been a good communication tool to help people understand the importance of addressing higher-order issues like OA. Once those connections are made, then the conversations can be held about how to mitigate the effects and adapt.
- OA monitoring can be expensive. Therefore, OA data must be strategically selected so that it will support the needs of decision makers and gain strong political support for funding.

The West Coast monitoring asset inventory stemmed from the West Coast Ocean Acidification and Hypoxia (OAH) Action Plan, which was based on recommendations from the West Coast OAH Science Panel. Monitoring is a central theme in the plan, and as a result, an interagency Inventory Task Force was formed. The rationale behind the monitoring assets inventory was to know what existed and then to fill gaps intentionally based on the needs of decision makers. We found that having science and policy leadership on board was really important; the Task Force utilized Sea Grant and Knauss fellows to drive this process forward. Figuring out where to house the inventory was challenging because regional data portals like the ones in the Mid-Atlantic did not exist on the West Coast at the time. (Currently, the OAH assets inventory is housed on the NANOOS data portal.) Governance jurisdictional boundaries also added complexity to the inventory. The OAH monitoring network on the West Coast is not an official entity, but after completing the inventory process, we now have an idea of all the players in the region and what they're contributing.

Data inclusion criteria for the West Coast inventory:

- At least one metric of OA or hypoxia
- Long time-series
- OAH and biological response in situ

Inventory pitfalls:

- Data submission template is too detailed, time-intensive
- Inventory maintenance is difficult
- Regional gaps are hard to identify, e.g. sensor location and staff capacity don't always correlate with areas of high sampling need.

Lessons learned from the Regional Inventory:

- Be inclusive in geographic scope with jurisdiction-based definitions, but have lead "authors" in most jurisdictions.
- Be strategic with metrics. What is likely to inspire action from decisionmakers?
- Build the portal/homepage first.
- Collect a catalog of projects, not of data.
- Always keep the audience in mind (awareness, funding, behavior change, policy, science collaboration.

ESTABLISHING LESSONS LEARNED CONDUCTING OA MONITORING GAPS ANALYSIS WITH AN EMPHASIS ON DECISION-MAKER RELEVANT INFORMATION AND RECOMMENDATIONS JUSTINE KIMBALL, CALIFORNIA OCEAN PROTECTION COUNCIL, CALIFORNIA OAH TASK FORCE

The Ocean Protection Council is the Natural Resources Agency of California and has a long history of involvement in West Coast OA efforts. The California OA Action Plan was released in 2018. Since OA and hypoxia monitoring is taxpayer funded, monitoring must focus on California, but the monitoring could be applied coast-wide.

High-level recommendations from the California OA and Hypoxia Science Task Force "Enhancing California's Ocean Acidification and Hypoxia Monitoring Network" report[7] :

- Better connect chemical and biological monitoring. Leverage the scientific community which is already doing the work
- Continuously improve OAH models as decision-support tools via the collection of additional monitoring data
- Strengthen continuity of OAH monitoring programs across CA's coastal environments

Additional Points to Consider:

- Standardize monitoring protocols
- Continue to collect biologically important indicators
- Expect to engage a lot of people!

PART 4. ACIDIFICATION MONITORING AND INTERFACE WITH REGIONAL DATA HUBS

FACILITATED DISCUSSION WITH ATTENDEES CAREN BRABY, OREGON DEPARTMENT OF FISH AND WILDLIFE

During this discussion, Caren Braby first shared her perspective on how the West Coast leverages the data from their OAH monitoring inventory and then turned to the information needs and audience for an inventory effort in the Mid-Atlantic.

On the West Coast, a broad range of decision-makers are interested in a specific place or species, e.g., oysterman, municipal regulator. There could be collaboration on the vulnerability of a regional set of species, but the more the set is narrowed, the less people will get excited addressing the issue. People near different water bodies are more concerned about their iconic species than other species. The concern might be environmental or economically driven. Comparing the economic value of different species is

[7] http://westcoastoah.org/taskforce/products/monitoring/

tricky. California's approach was not to monitor the most charismatic species or species with the greatest economic value, but to monitor the more sensitive species to be the canary in the coal mine. In their case, it helped to increase the geographic scope. A focus on the ecosystem services provided would shift the focus from individual species like scallops or oysters to enhancing water quality to benefit recreational fishing and engage more people. *A focus on multiple benefits is the key to driving forward the restoration, conservation, management, and research around OA* (coupling with other existing pipelines, e.g., SAV)

Existing state mandates can be used to leverage information which is relevant for many reasons. OA could be brought into existing structures, such as nutrient management and climate action, to levy the resources toward action on OA. Perhaps regional OA chemistry and physical monitoring could meet the needs for local biological themed needs.

Lessons learned from the West coast effort:

- Determine the level of detail that is desired.
- Find a theme that will appeal broadly.
- Leverage existing monitoring.

DISCUSSION:

The facilitated discussion then turned to a more local focus, beginning with the questions:

- Why even monitor for OA in the Mid-Atlantic region? What information are we trying to collect? For whom? To do what?
- What type of detail is required for "management" of different resources across different scales?
- Are we trying to collect more data vs. knowledge vs. insight?

Workshop attendees participated in the facilitated discussion orally, via chat or via JamBoard during the session and for several days afterward. The questions and responses from the JamBoard feedback are shown below. Responses shown are exactly what was received and have not been altered by MACAN or OA Alliance, and do not represent the perspectives of either organization.

Question: Why even monitor for OA in the region? What information are we trying to collect? For whom? To do what?

Why Monitor for OA in the Region?

- Capture region-wide OA impacts & make targeted local recommendations for action
- To quantify differences in OA exposure risk among locations. To quantify OA exposure risk for locations of interest.
- To document past and present change in water (habitat) conditions and to inform more accurate predictions/projections of how those conditions may change in the future
- Process interrogation of key process to improve forecast models
- Monitor species thresholds (tipping points) related to optimal habitat
- Inform/collaborate with aquaculture and shellfish farmers; shellfish perform ecological services, farmers often possess a wealth of knowledge not necessarily captured by the science community, so working with them and exchanging information would benefit both parties.
- Resolve cold pool carbonate dynamics to inform Atlantic Sea Scallop habitat suitability maps.
- Identify areas of natural buffering, related to oyster reef restoration efforts
- Awareness of how restoration or other conservation investments will succeed/fail

What Information are We Trying to Collect?

- Need data on fishing communities and human dimensions. How are different communities and user groups vulnerable to OA and what adaptive strategies can be employed to build resilience?

For Whom Should We Collect Data?

- Oyster hatcheries that support large-scale oyster restoration efforts in Chesapeake Bay
- Oyster Reef Restoration Efforts
- Oyster aquaculture
- Scallop Fisheries
- Help shellfish aquaculture and restoration projects get sited properly and successfully operate.
- Help fisheries management programs to manage fisheries around change in habitat from coastal acidification
- Academic researchers, to develop new hypotheses to test. Inform design of laboratory experiments.
- Need to make sure data is collected in jurisdiction of your audience (can be independent of oceanographic features of interest)
- Need to consider who has authority for regulatory action to effect change from the data being collected
- Different audiences across scale: decision-makers, funding agencies, fishers, constituents/the general public. How do we make people care?

Question: What type of detail is required for "management" of different resources across different scales?

- Really hard to answer! For local scales, I think a finer level of detail is ok, but regional/state-wide scales can have broader level of detail (more general trends, less specifics)

Question: Are we trying to collect more data vs. knowledge vs. insight?

- Need to translate the data to impacts to ecosystems and impacts to habitats and living resources. Is existing data enough? If not, what are the gaps?
- Maximize the data already being collected, interpret what is already known, and act on it. Then identify gaps.
- All 3 - collecting more data to gain insight and knowledge on what is happening across estuaries and the region. Are they comparable?

Question: How can OA monitoring data best interact with existing regional data hubs to be most useful and accessible to decision-makers?

- Have one master landing page/dashboard describing the kind of data in the different hubs, the contact information associated with them, and links to examples of how decision-makers have used the data

Question: What is needed to get real-time OA monitoring data to MARACOOS OceansMap?

- Technical assistance! We transmit via cellular telemetry to our office in near-real time, but don't know how to send it to MARACOOS.
- Funding
- Funding, training, and capacity support to maintain. Decrease staff turnover. Train next generation. Also, detailed records about metadata, methods, software, hardware, etc. used to make the map, and to update it.
- Support (and pipeline?) for personnel. We need not only the equipment infrastructure but the capacity to maintain the instruments and to turn the data into usable and useful products.

Question: What kinds of mapping products would be useful to decision-makers (MARCO Data Portal)?

- Summary maps and interpretation of the key trends/threats to their jurisdiction. They don't have time to play around with the tool, so they need brief summaries of the recent trends so they can act on them.

Question: What are the capacity and sensor needs for adding OA parameters to water quality monitoring efforts?

- Discrete sample analysis for validation. It is one thing to calibrate and run sensors, but without a proper lab it is tough to run the DIC analysis.
- Need education and funding support at all stages in this pipeline: training community scientists/people to collect data, resources to analyze the data, resources to interpret the data, and to keep it going for multiple years.
- Increase engagement with high schools, community colleges, NGOs, after school groups, etc.

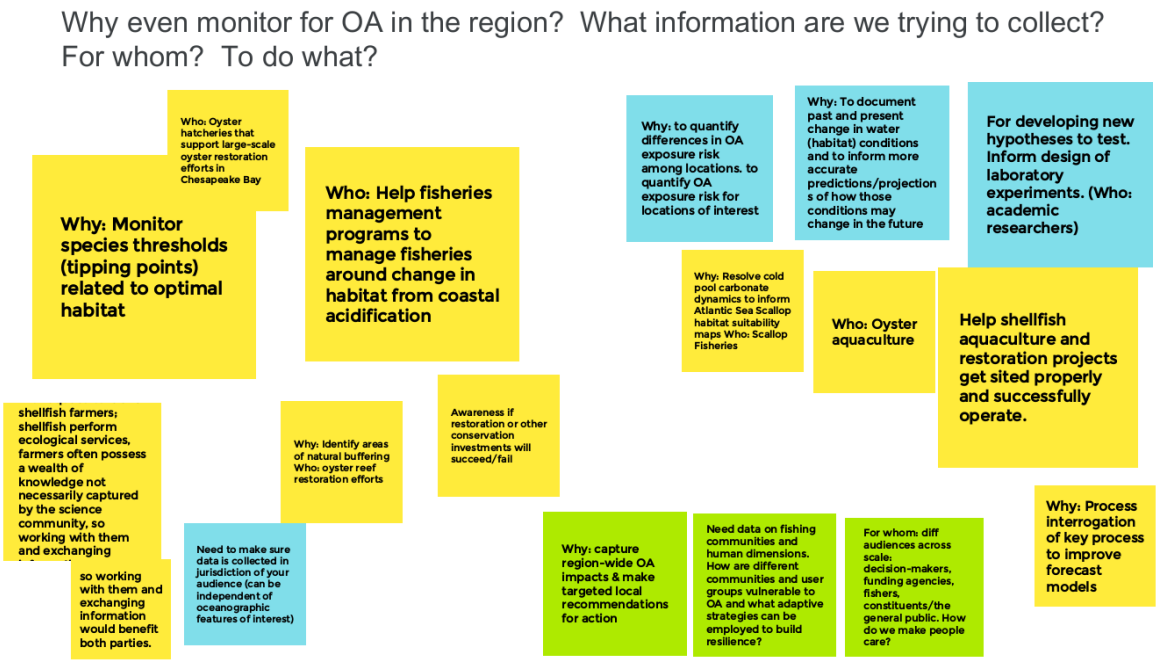
Question: How do we determine information gaps and what research is needed to fill them?

- A regional OA conference or symposium (annual) for region-specific discussions would be useful
- Need more capacity to do the research -- summarize at regional levels, scale up to national, and then see what work is being done internationally.
- Increase funds for trainees in the sciences to do this work; create jobs at the regional coastal acidification networks for people to do this work

Question: How best to integrate data across state boundaries?

- Incentivize and support data-sharing agreements between state governments. Invest in infrastructure (i.e., servers, IT support, computers, etc.) to support this work.

JamBoard illustration



PART 5. BREAKOUT SESSION SUMMARIES

Full notes for each breakout session are available upon request .

GROUP 1. ACTION PLANNING, INFORMATION NEEDS AND SYNTHESIS PRODUCTS FOR DECISION MAKERS
FACILITATOR: JEANNE HERB, RUTGERS UNIVERSITY

The Action Planning breakout session focused on identifying information needs and data products that MACAN could develop to more effectively engage decision makers in future OA Action planning. Main discussion points included the need for better communication about what ocean acidification is, what are the local drivers and impacts, what are early warning signals that can be acted upon by decision makers, and where successful actions have already occurred. In a region where OA is not as visible as eutrophication and other environmental changes stemming from anthropogenic climate change, communicating how OA interacts with those changes and how mitigation efforts for one can benefit the other was identified as a critical communication need. To help illustrate these connections, participants discussed how collocating monitoring and restoration efforts can maximize available resources, while also highlighting the benefits of addressing OA. For example, restoration of seagrass beds can help to buffer the pH of water around oyster aquaculture sites, illustrating the positive benefits of OA mitigation strategies. Participants also noted the importance of focusing synthesis materials to a regional scale not only so that decision makers could clearly see the negative effects of OA in their local waters, but also the benefits that restoration or mitigation strategies could have on resources and industries important to their region.

GROUP 2. GOAL AND APPLICATION POTENTIAL OF REGIONAL VULNERABILITY ASSESSMENTS FOR STATE PRIORITIES AND RESOURCE MANAGEMENT STRATEGIES
FACILITATORS: ERICA OMBRES AND COURTNEY COCHRAN, NOAA OAP

In this breakout session, NOAA's OAP staff sought feedback on how the upcoming national Coastal Climate Vulnerability report and future regional assessments could be used to advance or inform state OA action planning priorities. While national in scope, the report will have a Mid-Atlantic chapter. The two focus areas for vulnerability are: 1) Assessing gaps in OA monitoring and research needed to better characterize the exposure of regions to OA and the biological response; 2) Characterizing social vulnerabilities to communities, and the sensitivity and adaptive capacity of social and economic systems. In the Mid-Atlantic, there is currently only one Regional Vulnerability Assessment in progress, "Vulnerability of oyster aquaculture and restoration to OA and other co-stressors in the Chesapeake Bay". In order to help future assessments better reflect each state's needs, the importance of community discussions and stakeholder engagement were discussed. By engaging stakeholders in the early planning stages of regional vulnerability projects, future assessments can ensure issues are addressed from all sides while also making progress that addresses state priorities. The discussion also centered around what MACAN members would like to see in the national vulnerability report. Ideas included connections to state monitoring and research priorities, determination of vulnerability hot spots, and qualitative and quantitative assessments to help direct resources in the future.

Group 3. The importance of biological monitoring/research and application for management strategies
Facilitator: Emily Rivest, Virginia Institute of Marine Science, William and Mary

The goal of this breakout session was to discuss biological monitoring for OA and what should be considered when implementing new biological monitoring in the Mid-Atlantic to make it most impactful. The need for monitoring a broader range of species than shellfish was discussed, although methods for studying impacts of behavioral effects on fishes, for example, would need to be standardized before they could be implemented on a larger scale. Determining how to identify ideal locations for new biological monitoring sites was also an important topic of discussion. There was a consensus among participants that biological monitoring should be added to existing monitoring efforts, but it would need to be coupled with robust water quality data to establish linkages between biological metrics and OA. One suggestion for this was to couple biological monitoring to NERRs sites where widespread water quality monitoring is routinely conducted. Another idea was to co-locate oyster restoration efforts in the Chesapeake Bay or other regions with water quality monitoring to generate more information on biological impacts from OA. Reviewing water quality maps in conjunction with stakeholder engagement on what biological resources are of most concern could also help ensure that biological monitoring data is valuable. Lastly, participants emphasized the need to standardize and include metadata for any biological monitoring to ensure it is useful to managers in a broader context, as well as the need to establish relevant time scales for biological monitoring, which should be in line with stakeholder needs and concerns.

Group 4. Building a Mid-Atlantic Regional Monitoring Inventory
Facilitator: Kari St Laurent, Delaware Department of Natural Resources and Environmental Control

MACAN is planning to conduct a Mid-Atlantic regional monitoring inventory to learn more about what resources are currently in use in the region and identify strategic locations where monitoring can be leveraged to provide additional parameters to assess current and future OA conditions. In this breakout session, we sought feedback to refine the asset inventory goals, identify key participants for the survey, and discuss ways in which the information from the survey can be developed into useful products for stakeholders. Data on location (coastal vs. ocean), chemical and biological parameters collected, and duration of sampling effort were discussed. Participants highlighted the need to include methodologies for data collection and for QA/QC of data sets to ensure accuracy and precision of both current and future efforts. They also noted that collecting comprehensive metadata for each monitoring station would make the data more robust for decision maker use.

APPENDIX 1: WORKSHOP PARTICIPANT AFFILIATIONS

Americorps
Applied Research in Environmental Sciences Nonprofit, Inc.
Barnegat Bay Partnership
Boston College
California Ocean Protection Council
California State
Calvert County Public Schools
Cedar Crest College
Centre for Marine Applied Research
Chesapeake Research Consortium
Chesapeake Bay Program
Coastal Coordination Program
NOAA Office for Coastal Management
Department of Commerce/NOAA
Department of Conservation and Recreation
DNREC/DE NERR
DOI BOEM
EPA Region 3
Farmer
Freelance
Gaiergy
George Mason University
HarborLAB
International Alliance to Combat Ocean Acidification
Jacques Cousteau NERR
MARACOOS
MARAD
Maryland Department of Environment
Maryland Department of Natural Resources
Maryland Historical Trust/State Historic Preservation Office
Maryland Sea Grant
MEOPAR OA Community of Practice
Mid-Atlantic Regional Council on the Ocean
Monmouth University
Monmouth University Urban Coast Institute
National Center for Coastal Observing Systems (NCCOS)
New Jersey Department of Environmental Protection
NJ DEP Bureau of Climate Resilience Planning
New Jersey Sea Grant Consortium
NOAA
NOAA Fisheries
NOAA Ocean Acidification Program
National Research Council (NRC)
NRDC
NWF Northeast Regional Center
NYSDEC
NYSDOS
NYDOS Office of Planning, Development, and Community Infrastructure
NYSERDA
Ocean Conservancy
Oregon Department of Fish and Wildlife
Oyster Recovery Partnership
REEF
Responsible Offshore Development Alliance (RODA)
Rutgers University
SOCAN
Stony Brook University
The Pew Charitable Trusts
U.S. EPA, Coastal Environmental Sciences Division
U.S. EPA Region 1 and 3
UMCES
University at Albany SUNY
University of Delaware
University of Guyana
University of New England
University of Virginia
USGS
USNA
VA DWR
VIMS
Virginia Aquarium
Virginia Coastal Policy Center
Virginia Institute of Marine Science
VMRC
VMRC/FMAC
Wildlife Conservation Society
William and Mary Law School, VCPC
Woods Hole Oceanographic Institution