Report from NROC/NECAN Workshop: December 1, 2017

NROC/NECAN Partnership:

The Northeast Regional Ocean Council (NROC) is a state and federal partnership that facilitates the New England states, federal agencies, regional organizations, and other interested regional groups in addressing ocean and coastal issues that benefit from a regional response. It is NROC's mission to provide a voluntary forum for New England states and federal partners to coordinate and collaborate on regional approaches to support balanced uses and conservation of the Northeast region's ocean and coastal resources.

The Northeast Coastal Acidification Network (NECAN) represents a nexus of scientists, federal and state resource managers, and marine industry partners dedicated to coordinating and guiding regional observing, research, and modeling endeavors focused on ocean and coastal acidification (OCA). NECAN serves as an interface between research and industry interests and facilitates sharing of state-of-the-science information. The overarching goal is to better identify critical vulnerabilities to ocean and coastal acidification, particularly with respect to regionally important and economically significant marine resources.

As regional collaboration entities, NECAN and NROC partnered together to host a workshop to bring together OCA experts, coastal managers and industry members to address the OCA monitoring needs of the Northeast region. The goals of this workshop are listed below.

Goals of Workshop:

NROC and NECAN hosted a workshop to:

(1) identify what management and policy questions could be addressed by enhanced ocean and coastal acidification (OCA) monitoring;
(2) discuss collaborative opportunities to integrate, enhance and expand OCA and nutrient monitoring throughout the region to address these questions; and
(3) broaden the conversation about OCA and coastal resources to local resource managers who may be new to OCA, but are already dealing with other environmental issues that coincide with or worsen OCA.

The workshop began with presentations from different perspectives: state government, industry**,** and policy. It continued with breakout sessions to provide opportunity for discussions. The agenda is included in Appendix 1 of this report. A list of participants is provided in Appendix 2.

Presentations:

State needs and approaches for monitoring OA and water quality (Steve Couture, NH Department of Environmental Services):

Steve Couture presented and led a discussion on state needs and approaches for monitoring ocean acidification (OA) and water quality. He described the Great Bay (a tidal estuary and National Estuarine Research Reserve in New Hampshire) as a hyperactive system where the effects of OA are more influenced by freshwater input and hypoxia, making it difficult to detect effects caused by increased CO_2. The New Hampshire Coastal Marine Natural Resources and the Environment (CoMNaRE) Commission published a report in December 2017 that highlighted a

lack of available data for measurements of pCO_2, aragonite saturation state, and a lack of analysis on existing pH data. Drivers of OCA in the Great Bay include atmospheric loading, freshwater inputs, temperature, nutrients, and carbon storage. Various stressors such as temperature, nutrient load, and eelgrass cover, have been shown to fluctuate and impact pH level (both increasing and decreasing pH). At the time of this report there is no direct evidence that OA is impacting NH coastal resources, but the following recommendations were made by participants:

- Develop a monitoring plan to improve our understanding of Omega (saturation state) variability in NH waters and where these vulnerabilities overlap with biological processes related to ecosystem services such as oyster farming, oyster restoration, and fish biology.
- Develop a research agenda that will address gaps in knowledge relevant to NH vulnerabilities to the effects of OA. These recommendations are likely to include further research on all life history stages of vulnerable species in NH of high economic and ecosystem value.
- Explore potential mitigation strategies for OA relevant to NH waters.

The group also discussed the specific information needed by states to assess and address OCA:

- Nutrient and respiration rates are difficult to measure but are necessary for models and adaptive management. These data would enhance models, inform management strategies, and create links among multiple drivers and stressors.
- Biological assessments (e.g. eelgrass monitoring) are strong in freshwater, but not estuarine, environments. This is an important biological link to OCA that is currently missing from discussions.
- The CoMNaRE report is step one for legislation, but it will take time to do this state by state. There are multiple examples of organizations working across state lines, including: the NECAN Policy Working Group, the Ocean Conservatory, and the Conservation Law Foundation.
- Ecosystems are complex and regulatory agencies cannot control every factor but they can reduce factors such as nutrient loading to place some control on the system. Furthermore, a coordinated effort among agencies to standardize parameters, methodology, and data analysis will help make comparisons and streamline monitoring efforts.

Industry needs and capabilities for monitoring (Meredith White, Mook Sea Farm):

Meredith White represented the needs of industry and the capabilities within companies for OCA monitoring. Mook Sea Farm is an oyster farm and hatchery on the Damariscotta River, ME. The effects of OCA on bivalve larvae at Mook Sea Farm were seen as early as 2009, including major larval developmental delays that were eventually attributed to heavy rainfall events that caused a lower aragonite saturation state.

Starting in 2014, Mook Sea Farm established a seawater monitoring system to better understand the changes occurring in Maine's coastal waters. Measurements included pCO_2, temperature, salinity, dissolved oxygen, and total alkalinity and were used to guide planning as conditions changed seasonally and over time.

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Mook Sea Farm's key research priorities include:

- Understanding the relative importance of drivers of OCA in space and time along the coast of Maine;
- Understanding the influence of environmental variability on juvenile calcification when juveniles are transferred out of the hatchery; and
- Defining thresholds for juveniles and adults.

To mitigate the effects of OCA on industries such as Mook Sea Farm, the following strategies were suggested:

- Release buffer into the water from key points to mitigate effects of heavy rain or freshwater input events.
- Develop and grow a marketable warm water seaweed that can be cultivated during the oyster growing season.

The group discussed several gaps and questions that remain for shellfish industries:

- Growers can measure pH locally to understand total alkalinity (often measured using salinity), but equipment is needed to do so daily.
- Understanding the effects of OCA on shellfish market quality (e.g. taste, size) is currently a gap. One study has shown that OA affects the taste of shrimp.
- In recent years, there has been an increase in oyster growth in the Cape Cod region, while declining fisheries and souring of settlements is much more of a problem. Distinguishing regional effects, particularly declining stocks, is important for gaining traction on OCA as a threat to industries.
- Is buffering estuaries at large scales an option? Researchers at Bigelow are studying this, but there are huge legal barriers to modifying estuarine environments.
- Collaboration rather than competition within industry is key for sharing information and identifying industry-wide problems. West coast hatcheries have begun to come together, but the same level of collaboration has not yet occurred on the east coast.

Policy and management options (Aaron Strong, University of Maine):

Aaron Strong outlined the policy and management options for monitoring OCA. He identified anthropogenic CO_2 emissions as a global driver of OA, while local and coastal acidification are influenced more by nutrient runoff, freshwater input, and extreme storm events. Regionally, OCA could impact jobs and economic productivity of commercial fisheries & aquaculture (e.g. lobsters, clams and scallops), food webs in coastal ecosystems, and culturally significant industries (e.g. commercial and recreational fishing). He provided several types of management and policy options:

- **Mitigation**: Reducing global and local drivers through incentives or regulatory approaches
- **Adaptation**: Changing practices to minimize the negative effects of changing chemistry
- **Remediation**: "Improving" the carbonate chemistry environment through direct interventions

- **Suffering**: Loss of jobs and livelihoods

The Clean Water Act (CWA) is one tool that applies to mitigation, adaptation, and remediation of OCA. There is a lack of sufficient data to link changes and drivers in coastal ecosystems and to understand deviation from 'normal' pH, but the EPA has indicated that they are looking to states as a new source of standards and criteria for the CWA. Some states have already identified specific needs:

- **California:** need to verify local sources are meaningful contribution to OA to pursue mitigation
- **California:** need to establish baseline conditions
- **Oregon and Washington:** need to establish what the benefits would be of including OA in the CWA

Monitoring of OCA is a key for many regulatory options under the CWA and can help produce more effective adaptation information products. Monitoring is also needed to understand the possibilities for win-win remediation.

The group collectively agreed that ocean acidification should not be considered separate from other ocean changes, e.g. temperature change. Thinking about ocean changes collectively is difficult but they are all interacting components that should be considered in broad regulatory policies. The group also identified the following monitoring priorities:

- Understanding the factors that are decreasing saturation states
- Nearshore monitoring in key coastal areas
- Capitalizing on large precipitation events and freshwater inputs

Breakout Groups:

Workshop participants were assigned to one of four breakout groups to discuss sets of questions related to how nutrients are connected to OCA, how to assess potential impacts to coastal resources, and how existing management structures can be used to address OCA. Each breakout group contained a mix of academic, management and industry perspectives.

The Nutrient-OCA Connection:

Each group discussed several approaches on how to improve our understanding of how nutrients impact OCA:

- Quantify the effects of nutrient change within ecosystems, particularly how the degree of change (both increase and decrease) in nutrients corresponds with predicted and observed impacts.
- Investigate how microbes and their interactions influence nutrients in marine environments.
- Generate more holistic models and understanding of the role of nutrients in OCA. Analyzing the interactive effects of nutrients with other factors (e.g. sources, land-use, climate) may be more informative than measuring direct effects of a single factor.

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Despite ongoing monitoring efforts, there is a general lack of consistency and communication among monitoring groups. Coordination is needed regarding the frequency, methodology, and metrics (i.e. what variables are we measuring?) with clear channels for sharing information among sites. The group discussed the following strategies to approach nutrient monitoring and OCA management together:

- Assess current monitoring efforts.
- Establish tipping points and thresholds of species and ecosystems.
- Cultivate strong relationships between academia, management and industry.
- Encourage communities to engage with the topic of OCA through citizen science and communication of direct impacts of OCA.

Linking OCA parameters to impacts:

As new knowledge about OCA continually comes to light, there are still major gaps in our scientific understanding of OCA. The group identified biology (e.g. individual species thresholds, phytoplankton bloom shifts) and chemistry (e.g. nutrient inputs, acidity/alkalinity) as major areas of opportunity. Furthermore, a more holistic understanding of the drivers and indicators of OCA is needed. More inquiry in these areas is critical, and communicating both new and established scientific information to the public remains a major challenge.

Communicating the impacts and uncertainties of OCA is one step toward engaging the public with the topic. Articulating the difference between scientific uncertainty and the general public's definition of uncertainty is particularly important. The group identified specific formats that may help communicate these two things:

- Economic gain/loss ($, jobs)
- Ecological health (species habitat size, shellfish growth)
- Distinct physico-chemical changes in the water (pH, ocean conditions)
- Availability of seed for shellfish hatcheries
- Tolerance/risk of individual marine species
- Historical data to highlight past trends

Using current management structures to impact OCA:

A better understanding of OCA indicators is needed for scientific, industrial, and regulatory activities. The group identified several useful indicators that are currently used as well as others that could be useful for their work.

Indicators currently used:

- Total nitrogen
- Presence/absence of species
- Water optical properties (e.g. turbidity, attenuation, TSS, riverine influences)
- Shell fragility
- pH (using Clean Water Act guidelines)

Other indicators and information needed:

- Sediment characterization to identify areas of muck
- Indicator species assessment, such as:
    - salt marsh cover
    - eelgrass bed size
    - organic matter

Consensus and closing discussion:

- There are many opportunities to identify next steps, which can be made incrementally. A first step could be taking inventory of monitoring efforts, especially within the National Estuary Program and National Estuarine Research Reserve System.
- Sound communications strategies will help to illuminate points of intersection between nutrients and ocean acidification.
- There is consensus on the need to develop a plan for standardized monitoring. This report can serve as a touchstone to relate to grant funding and to build future work.
- With the wealth of data on OCA out there, there is a need to synthesize and bring information together, for example through the Maine Coastal and Ocean Acidification partnership (MOCA) and the regional Integrated Sentinel Monitoring Network (ISMN).
    - NERACOOS will be hosting a data integration workshop next year.
    - Finer scale resolution models are needed for OCA.
- How can we tell when we've reached an end point? This would be useful for the states to make the case for regulation.
- The upcoming OA Information Exchange hosted through NERACOOS will be used to facilitate discussions regionally, nationally, and internationally.

Recommendations to NECAN:

- Develop ways to share data for integration, analysis, and interpretation for management.
    - There's an intersection with the ISMN, and the group could consider leveraging that network: ISMN Science & Implementation Plan
- It might be interesting to do a case study of why nutrient standards haven't succeeded – many of the same people and interests will be affected.
    - Political concerns from agriculture industry
    - Federal/state tensions
    - Cheaper to litigate than to update sewage treatment plants
    - Impacts everyone who drives, heats their house, etc.
- Consider the ozone or acid rain campaigns as an example of acting before catastrophic impacts were seen.
- Create narrative standards with numerical interpretations.
- We need to have a better communications strategy with an emphasis on who is communicating to which audiences.
    - Utilize industry associations, shellfish constables, herring network as venues
    - Better communicate interactions of OCA and water quality, especially nutrients
    - Consider science and instrument challenge programs to address unknowns
    - Involve citizen science groups

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- Test strips for quick measurements?
- Settlement plates that could be related to water conditions?
- Oyster growth on coastal piers and docks?

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Appendix 1: Meeting agenda

NROC/NECAN Monitoring Workshop Agenda
Dec 1, 2017
10 AM - 4 PM

NHDES Portsmouth Regional Office
Pease International Tradeport
222 International Drive, Suite 175
Portsmouth, NH 03801

10:00	Welcome by Ru Morrison (NERACOOS) and Steve Couture (NH DES) Intros by all around the room
10:30	Presentation and discussion: State needs and approaches for monitoring OA and WQ *Steve Couture*, NH Department of Environmental Services
11:00	Presentation and discussion: Industry needs and capabilities for monitoring *Meredith White*, Mook Sea Farm
11:30	Presentation and discussion: Policy and management options *Aaron Strong*, University of Maine
12:00 - 12:50	LUNCH
12:50 - 1:00	Charge for breakouts
Breakout groups meet 1:00 – 3:00 to discuss 3 sets of questions	Breakout 1: The Nutrient - OA Connection *This set of questions will discuss how we might approach nutrient management and OCA management together. Can we better constrain how nutrients impact OCA? What are the gaps in monitoring of nutrients and OA?*
	Breakout 2: Impacts *This set of questions will discuss what monitoring data mean to managers and industry, i.e. how do we translate measures of pH or carbonate saturation into potential impacts to coastal resources?*
	Breakout 3: Indicators and Their Use

	This set of questions will discuss the avenues and possibilities for using existing management structures to address ocean and coastal acidification. The goal of the session is to identify opportunities, potential hang-ups and to chart a set of next steps for exploring these possibilities from the perspective of state managers.
3:00 - 4:00	Reports from breakouts, discuss next steps ● Workshop report ● Future engagement

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Appendix 2: Meeting participants

Breakout Group 1 (facilitated by Steve Couture and Jackie Ball Motyka)

Jim	O'Donnell	UCONN
Machie	Susan	Aquaculturist
Watters	David	NH State Senator
Laferriere	Alix	TNC
White	Meredith	Mook Sea Farms
Miller	Jeremy	Wells NERRS

Breakout Group 2 (facilitated by Beth Turner and Carolina Bastidas)

Tyrell	Megan	Waquoit Bay NERR
Gregory	Tom	UNH
Vella	Prassede	Massachusetts Bays Estuary Program
Sullivan	Sue	NEIWPCC
Reitsma	Joshua	WHOI
Edwardson	Kenneth	NH DES
Kuhns	Mick	Maine DEP

Breakout Group 3 (facilitated by Aaron Strong and Ivy Mlsna)

Williams	Chris	NH DES
Chapman	Erik	UNH Sea Grant/Oyster Grower
DeRosia-Banick	Kristin	CT Bureau of Aquaculture
Cushing	Renny	NH State Rep
Carlisle	Bruce	MA CZM
Priester	Anna	Island Creek Oysters

Breakout Group 4 (facilitated by Sarah Cooley and Ru Morrison

Barrett	Juliana	UConn
Brewer	Angie	Maine DEP
Callaghan	Todd	MA CZM
McGee	Sally	Sixpenny Oysters/TNC
Lyons	Regina	EPA