SOCAN NORTH CAROLINA STAKEHOLDER WORKSHOP

10/27/17

Workshop Report

Ocean Conservancy®

SOCAN
Southeast Ocean and Coastal Acidification Network

Sea Grant North Carolina

SOCAN NORTH CAROLINA STAKEHOLDER WORKSHOP

SUMMARY

The Southeast Ocean and Coastal Acidification Network (SOCAN), in conjunction with North Carolina Sea Grant and the Ocean Conservancy, held a one-day acidification stakeholder workshop in Morehead City, NC on October 27, 2017. Ocean and coastal acidification are changing the chemistry of seawater with potential effects for economically important marine life and coastal communities. Land-use change, runoff pollution and a vibrant shellfish industry render North Carolina among the most socioeconomically vulnerable states to future acidification impacts. An understanding of these factors can lead to the development of the tools necessary for coastal industries and ecosystems to mitigate and adapt to these changes. The objectives of the workshop were to:

- Introduce coastal and ocean acidification and discuss potential impacts with stakeholders;
- Gauge stakeholder concern over the prospect of worsening acidification as it relates to other water quality issues;
- Understand how stakeholders adapt to and mitigate other issues of water quality, including co-occurring acidification;
- Discuss opportunities and strategies for political engagement;
- and form partnerships to move acidification monitoring efforts forward.

The workshop aimed to consider acidification with concurrent water quality issues, such as hypoxic events and eutrophication, to understand how existing regulations or mitigation of these issues could address acidification (See *Agenda*, Appendix I*)*. Diffuse and inland sources of eutrophication and runoff create an inherent problem in organizing management of coastal water quality. However, relative to regulations of global anthropogenic CO_2, land-based sources of acidification create an opportunity for state and local level mitigation.

The stakeholder workshop stimulated significant discussion of the heterogeneity of acidification in the coastal North Carolina region and it's impact on translating available scientific information to an actionable response for stakeholders. The differences in coastal ocean (e.g. Pivers Island Coastal Observatory) versus semi-enclosed basin (e.g. Pamlico Sound) ocean acidification dynamics highlighted the difficulty in scaling regional information to operations for end-users.

According to stakeholders, NC Sea Grant Aquaculture and the UNCW Shellfish Research Hatchery, there are unexplained mass mortality events for shellfish in North Carolina. These events are typically not reported in a timely manner to a centralized database and the lack of water quality measurements at shellfisheries

limits identification of causal agents of mortality. A centralized database and means of reporting, ultimately one that includes acidification parameters, would significantly enhance efforts to understand these mortality events.

ACTIONABLE ITEMS FOR NEXT STEPS

1. In the absence of significant funding for monitoring efforts, utilize existing and small funding sources to begin monitoring efforts in collaboration with oyster farms and university students
2. Incorporate carbonate chemistry measurements at the UNCW Hatchery
3. Collaborate with NC Sea Grant to develop enhanced reporting of mortality events in conjunction with water quality measurements
4. Identify NC Department of Environmental Quality (NCDEQ) divisions and roles as they relate to acidification, including those involved in regulations of impervious surfaces and agriculture point source runoff. Strategize opportunities for a unified approach to link acidification monitoring and mitigation with existing NCDEQ efforts.
5. Create a larger network of shellfish acidification monitoring resources to correlate how existing scientific monitoring efforts (e.g. NERRs, Duke University) can translate to stakeholder needs

PROCEEDINGS

Approximately 16 stakeholders, including natural resource managers, shellfish growers, scientists and non-profit representatives gathered for the SOCAN NC Stakeholder Workshop (*Attendee List*, Appendix II). The workshop began with an introduction of SOCAN followed by a general overview of ocean and coastal acidification. While discussing how SOCAN can provide support to stakeholders, the group reviewed ideas for a data portal that is currently in development (*Data Portal Discussion*, Appendix III). Zackary Johnson, Hans Paerl and Beth Darrow presented on "Setting the Local Context," a review of the state of the knowledge of acidification chemistry and biological impacts in North Carolina. To gain insights on how to build momentum from another state's perspective, Aaron Strong presented on the Maine Ocean and Coastal Acidification (MOCA) Partnership. The second half of the workshop was discussion-based, targeting dialogue to evaluate changes stakeholders have seen over time, how they manage risk related to changing conditions and what they need in order to adapt to or mitigate changing conditions. The workshop concluded with a presentation by Ryan Ono on strategies and opportunities for political engagement.

SETTING THE LOCAL CONTEXT

CHEMISTRY

Coastal Ocean Carbonate Chemistry (Presentation: Zackary Johnson)
Pivers Island Coastal Observatory (PICO) is a near-shore site tightly linked to coastal ocean dynamics. PICO utilizes a nested sampling design that includes weekly discrete sampling since 2010, daily sampling for one-month intervals, and hourly sampling for 4-day intervals. Measured parameters for acidification include spectrophotometric pH and DIC. Like many coastal systems, PICO experiences high variability in DIC and pH, with annual cycles that far exceed those expected from near-term acidification (i.e. ~0.3 pH units, 300 µM DIC; Johnson et al. 2013). Changes in pH are correlated with temperature, while changes in DIC are correlated with salinity, with summer peaks of each offset by about one month. Furthermore, episodic events serve as an additional and unique source of variability (see below). Monitoring efforts have not existed long enough to detect long-term trends in carbonate chemistry; statistical trends are strongly affected by episodic events.

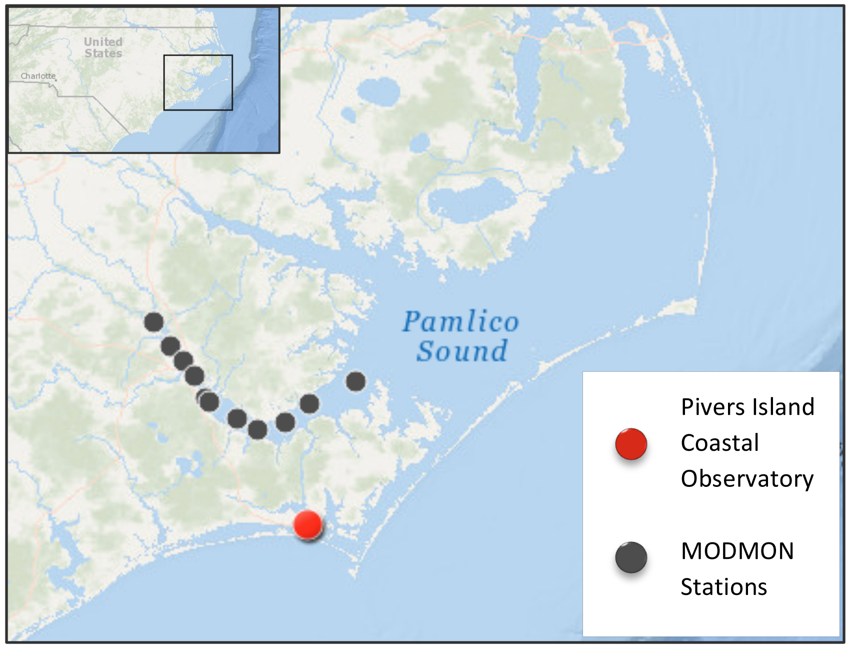

Figure 1. Locations of monitoring stations discussed in presentations of North Carolina carbonate chemistry

Pamlico Sound Carbonate Chemistry (Presentation: Hans Paerl)

The Pamlico Sound is a semi-enclosed basin with considerably different carbonate chemistry dynamics from open coastal shores, particularly with respect to eutrophication. Hans Paerl explained that eutrophication creates larger swings in pH, but in a closed basin could theoretically increase pH based on algal draw down of CO_2 and subsequent burial or export rather than remineralization. Time series in the Pamlico Sound from ModMon (www.unc.edu/ims/neuse/modmon) do not show significant changes in pH in surface or near shore waters over the past ~20 years. It was proposed that this lack of change despite anthropogenic CO_2 atmospheric increases could be due to aforementioned eutrophication or changes to alkalinity from land-based inputs.

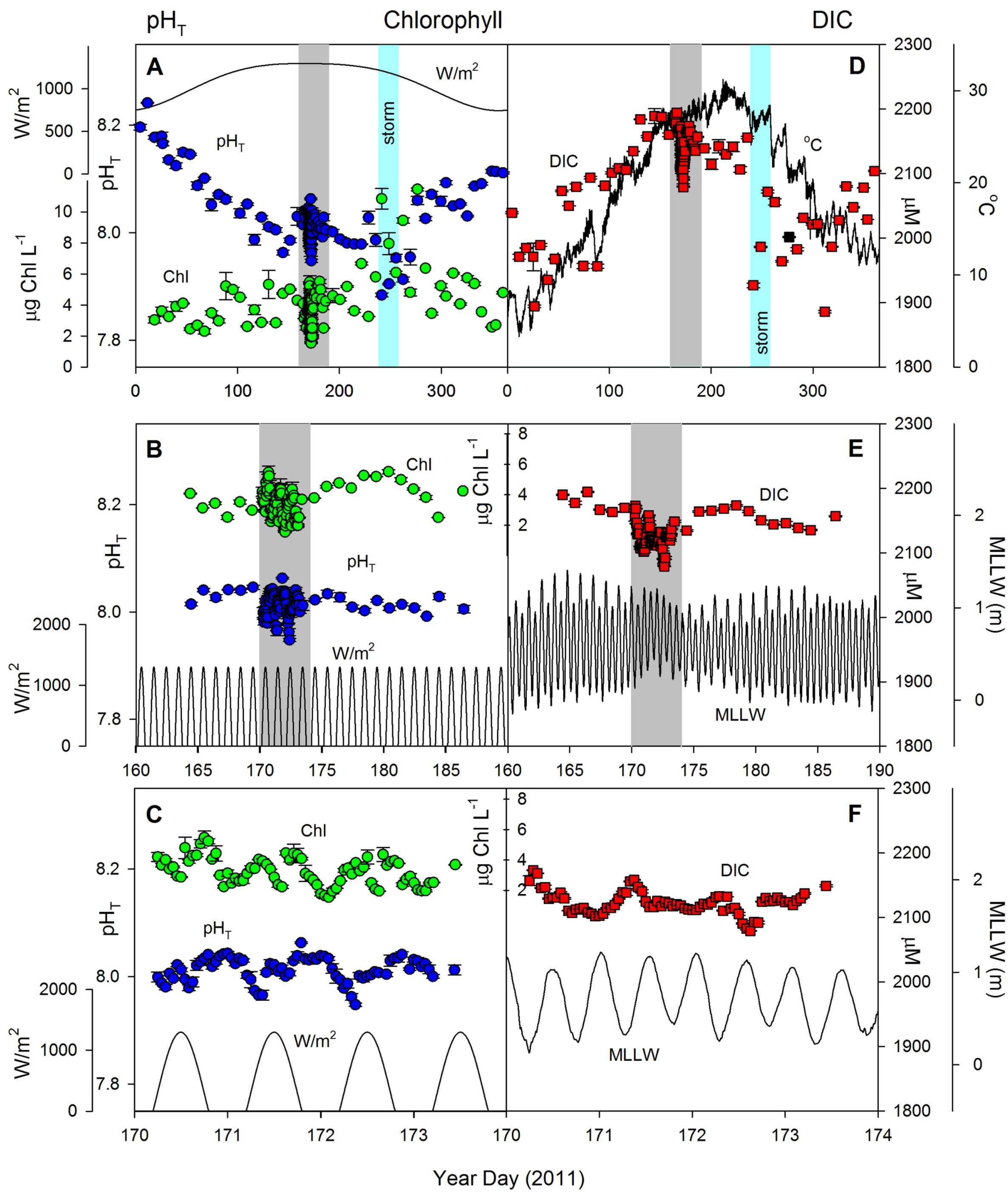

Figure 2. From Johnson et al. 2013. Variability at the PICO Site. Note effects of Hurricane Irene highlighted by the blue bar. *"Plots depict pH_T (in situ: A-C), chlorophyll ($\mu g\ L^{-1}$: A-C), DIC (μM: D-F) and associated physical variables including incoming no-sky solar radiation ($W\ m^{-2}$: A-C), water temperature (°C: D), or tidal height (MLLW, m: E-F). Data are shown depicting the nested sampling design with weekly measurements over the course of the year (A, D), daily measurements over a 3 week period (B, E) and hourly measurements over 3 days (C, F) Gray bars indicate periods of more intense sampling, shown in the panel immediately below. Cyan bars indicate periods influenced by major storm events. For clarity, only the maximum daily $W\ m^{-2}$ is plotted in top row."*

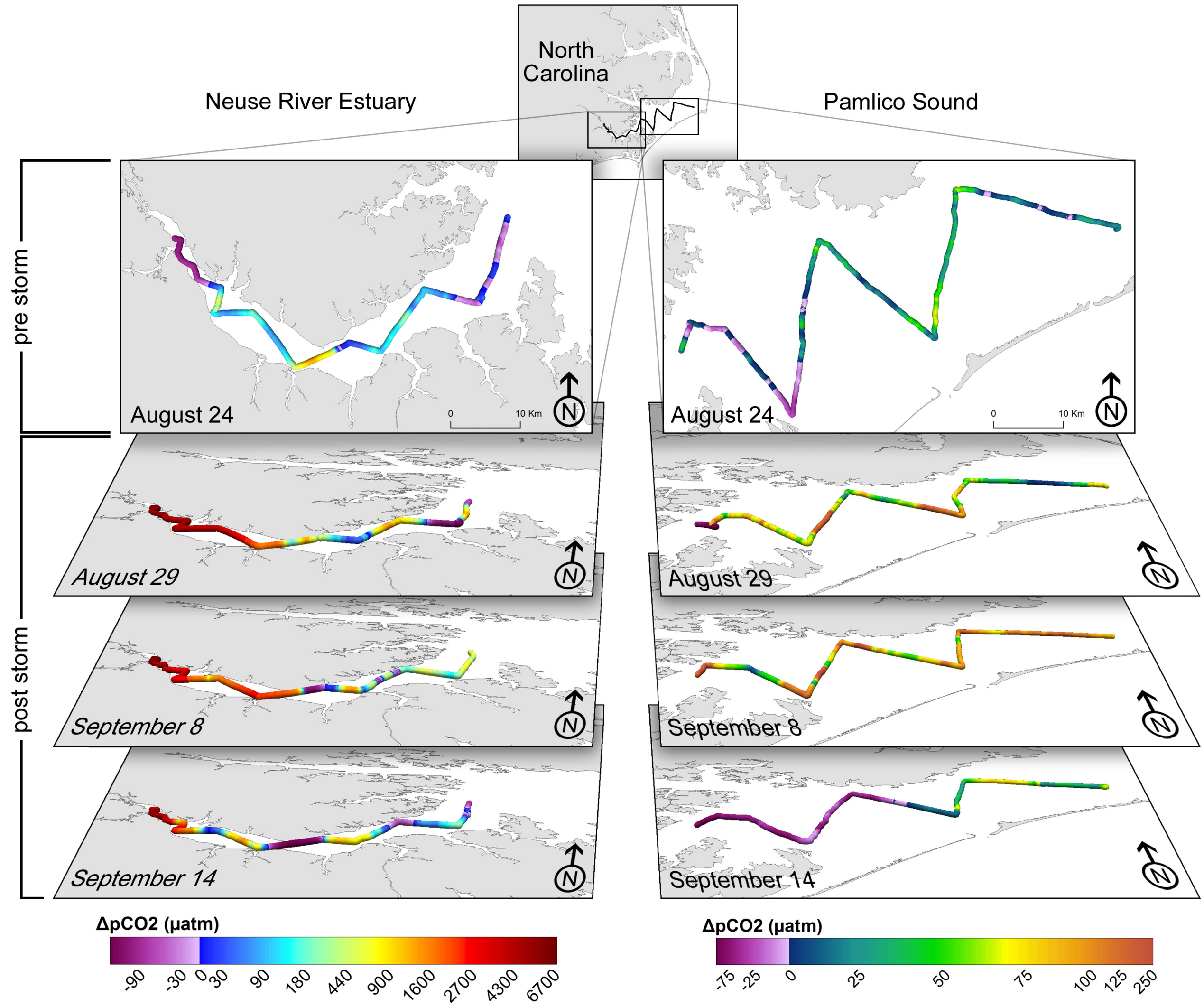

Figure 3. From Crosswell et al 2014. *"ΔPCO₂ in the Neuse River Estuary and Pamlico Sound 3 d before and 1, 12, and 17 d after Hurricane Irene. Negative values indicate an atmospheric CO_2 sink, while positive values indicate an atmospheric CO_2 source."*

Unique Episodic Variability

North Carolina typically experiences multiple high intensity storms a year (2-3 2σ/year) that can have both short and long term consequences for carbonate chemistry. In 2011 Hurricane Irene resulted in a 0.15 unit drop in pH and 200 µM drop in dissolved inorganic carbon (DIC) that lasted several weeks at the PICO site (Johnson et al 2013). The storm decoupled pH from DIC and showed the relative importance of acidic compounds and an influx of organic carbon that is ultimately converted to pCO2. Furthermore, the Neuse River-Pamlico Sound region vented as much pCO_2 during this storm system than is typically fixed biologically throughout one year (Crosswell et al. 2014). These episodic events can have dramatic and long-lasting effects on carbonate chemistry, particularly in semi-enclosed basins with long residence times.

BIOLOGY (Presentation: Beth Darrow)

Beth Darrow presented on the biological impacts of acidification in NC, focusing on the Eastern Oyster, *Crassostrea virginica*. The oyster harvest in 2016 equated to approximately $4.0 million in revenue. North Carolina has a notable potential to expand the industry with state interest to do so.

In the highly productive estuaries of NC, there is question as to whether organisms can account for energetic demands from acidification by increasing feeding rates. Recent research (Clements & Darrow, *in review*) suggests molluscs are more sensitive than arthropods to reduced feeding rates with acidification, with mulluscan larvae most affected. Experiments of juvenile oysters showed decreased feeding rates in acidified conditions (pH 7.1) with significantly lower feeding rates continuing after one week of recovery. After the second and third weeks, oysters returned to feeding rates similar to control oysters.

Newly published research indicates significant effects of acidification on reproduction, with oogenesis more sensitive than spermatogenesis (Boulais et al. 2017). Consequentially, the compounding effects of anthropogenic CO_2 on seasonal acidification could represent a bottleneck for oyster reproduction. Furthermore, low pH conditions coincide with oyster reproductive periods during summer months.

Suggested research and future directions include combining bioenergetics and genetic experiments to understand the role of genotypes and capacity to breed resistance oysters.

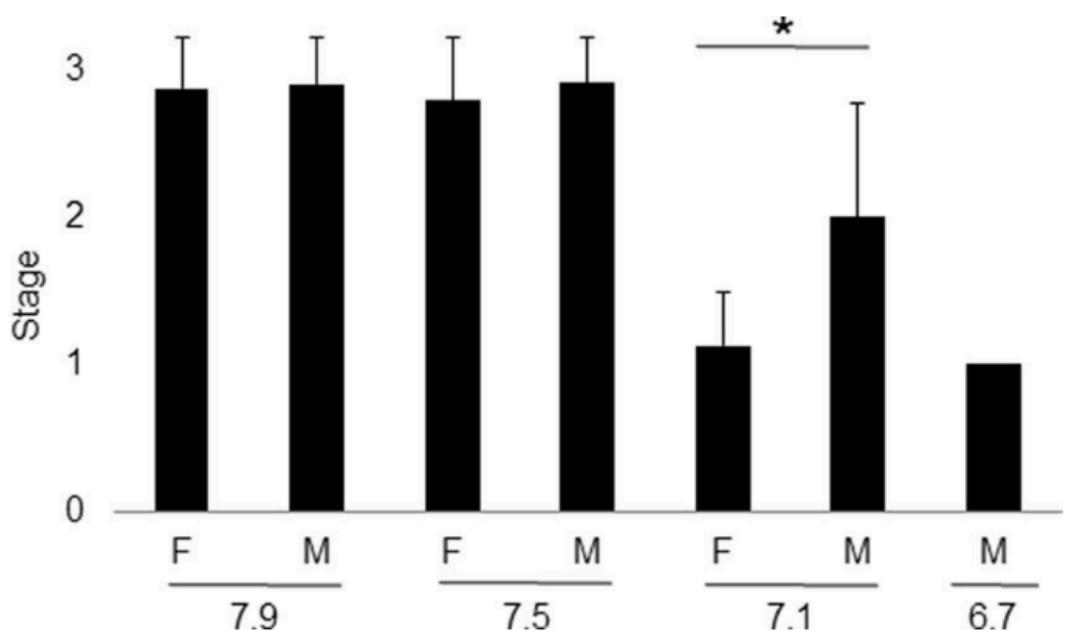

Figure 4. From Boulais et al. 2017. *"Mean gametogenesis stages of female and male oysters after 5-week conditioning at four pH levels. F: female, M: male, stage I: early development, stage II: late development, stage III: ripe gonad. Asterisk above bars indicates significant difference in gametogenesis stages between gender"*

CASE STUDY: THE MAINE OCEAN AND COASTAL ACIDIFICATION PARTNERSHIP

In an effort to gain insight on developing partnerships to increase state momentum to address acidification research and response, Aaron Strong presented on the Maine Ocean and Coastal Acidification Partnership (MOCA). Maine is one of seven states to have formal legislation to address acidification. The 126th legislature authorized an Ocean Acidification Study Commission that, following the release of the 2015 commissioned report, ultimately led to the volunteer MOCA partnership. The partnership leads coordination of acidification research and outreach efforts in Maine. As an advisory committee, rather than a legal entity, the partnership has more flexibility and it was suggested that this potentially increases its effectiveness.

DISCUSSION

Anecdotally there are accounts of sudden and significant losses at shellfish farms in NC that have not been accounted for by disease or other commonly measured water parameters (e.g. temperature, salinity). Two of these events occurred in Jarrett Bay in 2017. Given the prevalent use of floating cages, dissolved oxygen is presumably not the issue, but monitoring has not eliminated it as a potential causative factor. If and when these die offs are reported, reports are often made days after the event, limiting identification of the cause of mortality. SOCAN, along with other North Carolina entities, could benefit from a streamlined system for reporting mortality events and capturing co-occurring water quality parameters to deduce the causative agent.

Conversations continued to highlight the need for more monitoring to understand these mass mortality events. In an effort to identify “lowest hanging fruit” for monitoring it was suggested that student projects enhance collaborative and affordable efforts to engage shellfish farms with monitoring of water chemistry. Since the workshop, Zackary Johnson has proposed one such student project at Duke University. Given the predicted increase in the frequency of extreme weather with climate change, and the relative importance of episodic events for carbonate chemistry, monitoring plans must strategize to capture these events along with baseline monitoring.

Stakeholders stressed the importance of tying acidification to issues of eutrophication and pollution, though it was recognized the linkage between the two varies greatly by region. The group suggested removing the “ocean” terminology from “ocean acidification” to garner North Carolina support. Coastal issues are removed from ocean dynamics and including the anthropogenic CO_2 component could politically impair support of research and response.

Resource managers noted many regulatory agencies operate upstream of coastal areas with difficulties in managing linkages between inland county actions with coastal county consequences and operations of the Division of Coastal Management. For example, logging along the Cape Fear River could have significant consequences downstream, but linking it to changes in water quality is difficult based on current regulatory structure. In an effort to un-tease the various North Carolina Department of Environmental Quality divisions that could relate to acidification regulations and response, the following divisions were identified:

- Department of Marine Fisheries (DMF): Shellfish Sanitation & Recreational Water Quality Program does water quality testing & issues closures for shellfish and swimming, as necessary.
- The Division of Soil & Water Conservation has a number of voluntary programs promoting water quality best management practices (BMPs) for agriculture & other private lands.
- Division of Water Resources has many permitting and certification programs
- The Division of Coastal Management (DCM) handles permitting for development within designated Areas of Environmental Concern. DCM relies on Division of Energy, Mineral and Land Resources and Division of Water Resources for impervious limits and buffer requirements. DCM does not have jurisdiction over agricultural or forestry operations.
- The Coastal Resources Commission, Environmental Management Commission, Marine Fisheries Commission, and Wildlife Resources Commission have a formal agreement called the Coastal Habitat Protection Plan (CHPP) to protect fisheries habitats from degradation. Each commission agrees to take a set of voluntary actions: CHPP documents, including biennial implementation plans.

Additional ideas in moving forward:

- A better understanding of acidification would be required to lobby for direct legislation, but there may be opportunities to establish monitoring requirements through advocacy from the NC Coastal Federation and lobbying from the Coastal Conservation Association
- The UNC Coastal Ocean Research and Monitoring Program (CORMP) has conductivity-temperature-depth (CTD) equipment that could potentially be loaned to shellfish farms if funding can provide the required probes and insurance
- Align NC Coastal Federation restoration sites with efforts to monitor acidification
- Additional potential partners to leverage resources (suggested by attendees): Basic Observation Buoy (BOB) network, Phytoplankton Monitoring Network, Duke University Pratt School of Engineering

STRATEGIES AND OPPORTUNITIES FOR POLITICAL ENGAGEMENT

RYAN ONO, OCEAN ACIDIFICATION PROGRAM, OCEAN CONSERVANCY

Coastal businesses and residents are usually the first to notice the impacts of coastal acidification and its associated stressors, making them among the best advocates for federal and state action. In fact, stakeholders-turned-advocates have produced many acidification champions in Congress and in state legislatures in recent years.

Strategies for Engagement

Decision-makers respond positively when ocean and coastal acidification is characterized as a tangible threat to coastal economies. A focus on community jobs and business revenues tends to remove any political stigma associated with environmental issues caused by carbon dioxide and eases the way for bipartisan support. As the science discussed earlier suggests, runoff pollution may be a source of acidification in coastal embayments, and may be more familiar and actionable for decision-makers. In addition, broader community economic implications and stories of coastal residents' personal lives make the stakes much more real for decision-makers to care about and act on the issue.

Partnering with a diverse group strengthens the case for action. Stakeholder groups comprised of shellfish growers, scientists, fishermen, environmental advocates, natural resource managers, and local officials excludes few parties with direct interests at stake. Garnering broad support also reduces the possibility of this issue and corresponding action being seen as partisan.

Framing the message is also critical when discussing the science of acidification with policymakers. As mentioned previously, an economic lens can be used to help define the issue. A heavy carbonate chemistry or broad science lens on the other hand might cloud the issue. For instance, the ocean acidification story stems from carbon dioxide pollution, and comparisons to climate change can be easy to make. However, linking acidification to climate change can politicize, and therefore distract from, understanding acidification. This may turn off decision-makers, stunting action.

By describing acidification as a marine issue, communicating the personal concerns and stories of coastal residents and businesses while contextualizing it with the local economies at stake, ocean acidification communicators have earned bipartisan support at federal level and in several states in the form of durable legislative actions on acidification.

Opportunities for Engagement

Most of the legislation surrounding acidification can be characterized as foundational. Because of the novelty of the acidification issue to decision-makers outside of the Pacific Northwest region and perhaps the state of Maine, most legislative bills focus on two things: characterization of the issue on the community level, and funding for scientific research and monitoring. A number of states and legislatures around the country, such as Washington State, Oregon, Maine, Maryland and New York have commissioned ocean acidification task forces to better capture the science on a more local scale and have offered policy recommendations. Currently these states are in various stages of implementing these recommendations. Additional states have pending legislation to form commissions, including Rhode Island and Massachusetts.

On the national level, ocean acidification legislation follows a similar path. Ever since the Federal Ocean Acidification Research and Monitoring Act of 2009 was passed, most bills focused on ocean acidification have sought to expand understanding in small steps such as setting up prize competitions for research and monitoring advancements, or scientific research partnerships with industry members, or conducting socioeconomic vulnerability studies. Because of the narrow focus of these bills, many have received bipartisan backing with a significant amount of conservative support, especially from Florida Members of Congress.

Funding for the science and water chemistry monitoring that underpins these decisions offers another avenue to engage policymakers on acidification. Many of these funds flow from the NOAA Ocean Acidification Program (OAP), which since 2014 has seen a 75% increase up to its most recent $10.5 million 2017 budget as approved by Congress. Despite a difficult fiscal and political environment, NOAA OAP has been supported by a number of constituents, especially members of the shellfish growing industry.

Whether engaging on state or federal legislation and policy, stakeholders with direct ties to at-risk coastal resources have multiple options to voice their credible opinions on acidification to powerful effect. These can be coordinated with advocacy organizations for the highest impact. Strategic, individual actions targeting decision makers can include writing letters, making phone calls, and visiting legislative offices. Actions that raise awareness and create urgency by reaching broader audiences include writing editorial articles and providing quotes in local media outlets, generating publicity over acidification research findings, producing films on ocean acidification, and even posting messages on social media. All of these actions help to continue the acidification conversation and spotlight the need for answers to scientific unknowns.

The regional Coastal Acidification Networks established across the United States, like SOCAN, are diverse stakeholder groups organized with a focus on information-sharing. These groups provide a feedback loop for scientists to present recent research findings to marine users, and elicit a response while the users who are on-the-water interacting with the marine organisms, can suggest research questions and express concerns for the scientists and managers in the audience. These discussions and worries can be funneled to decision-makers or natural resource administrators for a change in legislation or policy.

APPENDIX I: AGENDA

9:15-9:30	**Check In**
9:30 – 9:45 Speaker: Leslie Wickes & Ryan Ono	**1. Welcome, Overview of Meeting Objectives, and Introductions** <u>Objective:</u> Welcome everyone, review agenda and objectives. Gather additional thoughts from attendees about objectives.
9:45-10:00 Speaker(s): Leslie Wickes	**2. SOCAN Vision & Strategy** <u>Objective:</u> Introduce SOCAN- past, present and future <u>Activities/Interactions</u>: ● Leslie gives short presentation on SOCAN ● Discuss how other regional networks work with stakeholders ● Discuss tools SOCAN can provide to stakeholders
10:00-10:20 Speaker(s): Leslie Wickes	**3. A Primer on Coastal and Ocean Acidification** <u>Objective:</u> Introduce ocean and coastal acidification
10:20-10:35	**Coffee Break**
10:35-12:00 <u>Panel:</u> Zackary Johnson (Chemistry) Beth Darrow (Biology) Hans Paerl (Nutrient Dynamics)	**4. Setting the Local Context** <u>Objective</u>: Discussion of local acidification and how COA fits into the matrix of other environmental issues ● (1) Presentation and discussion with Zackary Johnson on local chemistry dynamics ● (2) Presentation and discussion with Beth Darrow on biological impacts ● (3) Presentation and discussion with Hans Paerl on eutrophication, land use changes and expected changes to chemistry
12:00-12:30 Call in speaker: Aaron Strong	**5. Case Study: Acidification & Shellfish** <u>Objective:</u> Review Northeast shellfish story and how partnerships were formed
12:30-12:45	**Break and gather lunch**
12:45-15:00	**6. Open Discussion** (*originally breakout groups, but changed based on group size and dynamics*). See discussion framing and ideas below.
15:00-15:15	**Coffee Break**
15:15-15:45 Speaker: Ryan Ono	**7. Strategies and Opportunities for Political Engagement** <u>Objective</u>: Discuss tools and mechanisms for political engagement, highlighting the importance of doing so
15:45-16:15	**8. Final Discussion & Next Steps**

APPENDIX II: PARTICIPANT LIST

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APPENDIX III: DATA PORTAL DISCUSSION

SOCAN hoped to gain insight from North Carolina (NC) stakeholders on identifying the audience for the portal and how to best display and utilize the portal with reference to IPACOA as an example.

Points of discussion for the monitoring portal included:

- Identifying the audience is an essential first step to building the portal. While the intent in the long run may be serving stakeholders as the primary audience, such as shellfish growers, the reality is that there are very few monitoring stations that can be used to inform operations.
- The disconnect from the data portal to operational use is because seawater chemistry is extremely heterogeneous in NC. Real-time monitoring that could affect operations would have to be conducted in extreme proximity to the hatchery/farm.
- As opposed to the West Coast, where offshore buoys can inform stakeholders of impending changes from upwelling, the Southeast would need inshore buoys, as the mechanisms of acidification are land based.
- Ultimately, the portal should be seen as a starting point on which to build and add additional monitoring locations, but with a vision that can be applied to stakeholders at a later time.

APPENDIX IV: DISCUSSION QUESTIONS AND FRAMING IDEAS

DISCUSSION QUESTIONS AND FRAMING

Note time constraints did not allow full discussion of each of these items.

Ultimately, these questions are used to answer two of our objectives:

- Gauge stakeholder concern over the prospect of worsening acidification as it relates to other water quality issues;
- Understand how stakeholders adapt to and mitigate other issues of water quality, including co-occurring acidification;

1. What environmental changes have you observed over time?

- With change, uncertainties can emerge. Can you describe what uncertainties really impact your business/job decisions?
- How have other environmental changes been handled in the past? What can we learn from those experiences?
- Even if there are no changes that you have observed, what are the environmental threats that you face today?
- What water quality issue keeps you up at night? What water quality issues hinder your work?
- Outside of this SOCAN meeting, how is information about acidification incorporated into your work and decision-making process?

2. What would help you to better understand the impact of acidification and other water quality issues on your line of work?

- In order to address any negative impacts to environmental change, monitoring data of water quality and analysis will be needed. How could acidification be monitored?
    - How would monitoring for acidification parameters fit into the existing monitoring efforts?
    - What acidification monitoring would be sufficient? What is possible?
    - How would conclusions be drawn from the data? How would users (natural resource managers, hatchery folks, etc) on the water use this information?
    - Would a public-private monitoring or research partnership be helpful? What might one look like?
- How does the issue of acidification impact any local, state or federal water quality regulations? Other regulatory measures?
- What nagging research questions still remain?
- Even if the threat of coastal and ocean acidification in North Carolina was completely known, what amount of impact to you and your line of work is acceptable?

3. How would you like this effort to address coastal and ocean acidification in North Carolina to proceed?

- Where do you want to see the coastal and estuary resources of North Carolina in 10-20 years? What characteristics do you envision?
- How do you see yourself playing a role in making that happen with others?
- What recommendations do you have moving forward for either scientists, policy-makers, resource managers, industry or advocacy groups?
- How would you like to stay updated on this issue?

APPENDIX V: REFERENCES

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