As summer draws to a close, it’s a great time to reflect upon the cutting edge, collaborative, and innovative research done by MOCA members. This newsletter provides a sample of our work. The June meeting at Bowdoin showcased current research on the impacts of ocean acidification on subadult lobsters. The panel presented:

- Forecasting tools that are being developed across different time scales that can be used to look at the impacts of OA across multigenerations.
- Indirect, direct and interactive effects of climate change on subadult lobsters. For example, copepods, which are important food for lobster larvae, contain 60% fat. When exposed to low pH in cold water, they become fatter. When exposed to low pH in warmer water, they are not as fat and thus are not as good a food source. This is an interactive effect between water temperature and acidity where temperature is the driver.
- A 61-day trial of 48 female subadult lobsters where half of the lobsters were exposed to water with a pH of 8.0 (control) and the other half were exposed to a pH of 7.6 showed a difference in cardiac performance when lobsters’ heart rates were measured for 2.5 hours over a temperature ramp of 12°C to 29°C. As temperature increases, heart rate also increases until a certain point, then decreases. The lobsters in the more acidic environment did not do as well in warmer temperatures.
- An update of DMR’s biological monitoring focusing on lobster reproduction, egg release, and diseases to support the 2020 Lobster Stock Assessment.

The winter meeting will shift gears from science updates to ACTION. On November 29, from 1-4 pm, we will meet at the State House with Maine legislators and select lawmakers from around New England to discuss creating an Action Plan. The plan will coordinate and advance our work to better understand OA and adopt policies to limit its harmful impacts. The meeting will be followed by a reception at The Maine House in Hallowell. I will send out a save-the-date with draft agenda soon, and we hope to see you all in November!

Ivy
Summer Transitions

As one who has recently retired from fishing, I find that some of what I’ve left behind, remembered as hard work, match up with what many others seek out as their summer pleasures. Long hours on the water, exposure to the sun’s rays, communing with nature, and all that. And almost as if seeking to complete an odd reversal, I have now filled my summer days with lectures at the Darling Marine Center, Bigelow Labs, our own MOCA Summer Meeting, workshops on water sampling, and even speaking on climate and fisheries at my local land trust. The lectures I attended at these institutions were great and also allowed me to revisit some of the people and places doing the OA and related research that I know we need.

What will stand out, however, as my best and lasting summer memory, is returning again for the SEA Fellow Symposium poster session at the DMC and Center for Research and Seafood Solutions student poster session and spoken presentations at Bigelow. What I found there truly cleansed and uplifted my psyche, which felt needy and downtrodden by those who wield power by denigrating science and even nature itself. It was bathed with the young researchers’ energies and intelligence bubbling up like springwater. Yes, I silently repeated, yes, there is hope.

Richard Nelson

Updates from MOCA members:

Downeast Institute

Dr. Brian Beal of the University of Maine at Machias (UMM) and the Downeast Institute (DEI) and Dr. William Otto of the University of Maine are investigating the combined effects of sediment acidity levels and predators on survival and growth rates of juvenile soft-shell clams. The research monitors pH and aragonite saturation levels in two different towns’ clam flats. The flats have been planted with soft-shell clams and either protected from predators or not protected from predators. It also measures clam recruitment by utilizing DEI’s “Beal Boxes” that protect just-settled clams from being eaten by predators and compares how wild seed is affected by both predators and sediment pH levels.

The research builds upon UMM’s and DEI’s three large-scale and five small-scale field experiments conducted in 2014, 2015, and 2016, in five different clam flats. The results from each of those eight experiments were that the addition of crushed shell did not result in an enhancement of soft-shell clam recruits. Instead, in 5 out of 8 field trials, significantly more recruits occurred in plots that were protected from predators versus those that were not. These findings will help clam managers combat the most critical threats and increase success rates for the commercial production of soft-shell clams. For more information contact Sara Randall, sara.randall1@maine.edu.
Environmental Protection Agency

The Handbook for Citizen Science Quality Assurance and Documentation will be released soon! It will provide citizen scientists and organizations with tools and procedures to help them properly collect and document quality OA related data. The Handbook includes common expectations for quality assurance and documentation, including best management practices to enable uniform training of volunteers in the collection of quality environmental data.

The Handbook should be used with two companion documents – the Templates and the Compendium of Examples. This Handbook explains the purpose of each of the templates. The Templates provide instructions, tables and questions that should be filled in or answered, and the Compendium provides specific examples of quality assurance documentation. Together, these documents will help organizations complete a QAPP and provide information for data users to evaluate the quality of data collected by citizen scientists. The Templates are recommended but not required (unless required by another organization). EPA regional offices and state environmental organizations may also be contacted for more specific assistance or guidance, or if other requirements must be met. For more information, contact Matthew Liebman, liebman.matt@epa.gov.

Ocean Conservancy

Ocean Conservancy (OC) and its constituents (including a delegation from Maine that worked with the OC) have worked to support funding the NOAA Ocean Acidification Program (OAP), which plays a significant role in coordinating and funding acidification scientific research and water chemistry monitoring around the US. In Congress, the House and Senate subcommittees have approved preliminary Fiscal Year 2019 budgets for OAP in the amount of $13 million and $11 million respectively. Current OAP funding is $11 million; Congress should settle on a final budget number this fall.

Other OA legislation pending before Congress includes the National Estuaries and Acidification Research Act (HR. 6270). If passed, HR 6270 will direct the National Academies of Science to evaluate acidification in estuaries and coasts, how other processes intensify it, and how researchers can close knowledge gaps so communities can prepare for acidification.

Ocean Conservancy will continue to garner Congressional support for, and advance, ocean acidification-related legislation in this and future Congressional sessions. Ocean Conservancy also works with Coastal Acidification Networks (CANs), including the Northeast CAN, to identify priorities and shape goals. OC experts currently are assisting the Mid-Atlantic CAN in drafting an acidification monitoring plan and a research priorities plan, due to be finalized later this year, and co-coordinating the South Atlantic CAN to conduct workshops in North Carolina and South Carolina/Georgia. For more information contact Ryan Ono, rono@oceanconservancy.org.
ECOA Cruise

Joe Salisbury and his crew joined the East Coast Ocean Acidification (ECOA) cruise this summer. This was the second ECOA cruise done with support from NOAA’s OAP (Ocean Acidification Program). The major goal was to monitor changes in inorganic carbon dynamics due mainly to anthropogenic carbon input. Researchers will use the data to establish a time series and to increase understanding of the controls of OA and how OA impacts ocean ecosystems.

Scientists and crew aboard NOAA’s Henry B. Bigelow embarked from Newport, RI, on June 25th. They spent two weeks collecting data in the Gulf of Maine from RI to Nova Scotia. Researchers then collected data in the Mid Atlantic Bight and South Atlantic Bight as the vessel headed to Miami, FL, where the cruise ended on July 29th. During this month at sea, scientists and crew worked hard, day and night, taking samples for various carbonate parameters in the water column, using a 24 bottle CTD rosette at depths ranging from 15 to 2500 meters. They also collected optical properties to help with understanding ocean acidification from space using satellite data. Researchers will use the data to help us better understand physical and biological processes such as freshwater inputs and phytoplankton productivity, to help improve current efforts on modeling ocean acidification. For more ECOA updates and stories about our adventures, follow us on Facebook at facebook.com/eastcoastOA.
Story credit: Tyler Mendez

Friends of Casco Bay

Friends of Casco Bay continues to build on a 25-year dataset by monitoring temperature, salinity, dissolved oxygen, pH, chlorophyll, and nutrient concentrations at twenty two sites around the bay. Monitoring occurs every three weeks from April to September, and includes both surface-only and water column profile sites.

In addition to this ongoing seasonal water quality monitoring, our Continuous Monitoring station on Cousins Island, Yarmouth, collects data hourly, year-round. This station includes the same parameters listed above, and also collects measurements of the partial pressure of carbon dioxide, which is paired with pH to calculate total alkalinity, dissolved inorganic carbon, and omega aragonite. Calibration, maintenance, and the seemingly endless scrubbing and cleaning of the equipment and structural cage occur biweekly.
The Shaw Institute, a non-profit scientific research organization based in Blue Hill, ME, piloted a study this summer on the potential link between declining blue mussel populations and changing ocean conditions in the Gulf of Maine. The goal of the study is to evaluate the effects of changes in water quality parameters that may be contributing to the more than 60% population declines seen throughout the Gulf in the past 40 years. As cold-water calcifying organisms, blue mussels could be especially susceptible to increases in water temperature and ocean acidification.

Water quality parameters, including temperature, pH, dissolved oxygen (DO), turbidity, flow velocity, and chlorophyll a, are being monitored at two sites. At one site there is a well-established, but declining mussel population. At the other near-by site, the mussels are almost completely gone. The project also utilizes anti-predator larval collection boxes designed and implemented by Dr. Brian Beal of U. Maine Machias for his work on Gulf of Maine clam flat populations. The application of these boxes for mussel collection is experimental, as are the initial study locations. Boxes were deployed in early June within the intertidal zone and will be retrieved at the beginning of October. Afterwards their contents will be analyzed for mussel spat survival and growth, population size, shell deterioration, and predation.

Marine research coordinator, Madelyn Woods, is leading the project with the help of her very dedicated intern, Mary Stack, who will help analyze the relationships across all 17 variables. The Gulf of Maine is one of the fastest-warming bodies of water on Earth. Understanding the scope of climate change impacts as well as developing mitigation and response strategies are essential to being prepared with globally beneficial solutions to a warming and acidifying ocean. The Shaw Institute, with the development of this project and others, will contribute to the multitude of research necessary to achieve this goal. For more information about this project please contact Madelyn Woods at mwoods@shawinstitute.org.
Spring OCA Monitoring Workshop
hosted by the Bowdoin Schiller Coastal Studies Center

In moving from regional vulnerability assessments for ocean and coastal acidification (OCA) to actionable steps towards mitigation and adaptation, it is important to delineate drivers of acidification, and to foster community outreach about OCA. Coordinating water monitoring can help individual stewardship organizations to advance understanding of local conditions, while monitoring collaborations can allow future data sets to be integrated into regional research and management. However, designing new monitoring programs, and synthesizing collective observations can only be successful with effective and comparable sampling approaches and a shared understanding of collaborators’ individual monitoring goals. Therefore, there exists a tremendous opportunity in Maine to build upon the existing networks of water quality monitoring programs to develop robust opportunities for community science to advance local understanding and preparedness for OCA.

In the spring of 2018, a webinar and workshop series helped to gather citizen science and stewardship organizations who are interested in monitoring ocean and coastal acidification. The training and discussion in the workshop aimed to assist attendees in pursuing coastal acidification monitoring and to identify the patterns and drivers of acidification in the nearshore environment.

Workshop Resources: http://necan.org/OCACitizenScienceWorkshops

Following the success of the Maine workshop, along with accompanying workshops conducted in Connecticut and Massachusetts, three primary projects have been initiated, based on participants input:

- There is an effort underway through the Connecticut Department of Energy and Environmental Protection to collate Northeast OCA monitoring locations into a Global Information Systems (GIS) Story Map. To add your monitoring sites to this Map, please contact parker.gassett@Maine.edu.
- NECAN Education and Outreach Working Group is further investigating options for OCA data storage and data sharing.
- MOCA and NECAN partners are vetting plans to orchestrate an OCA Monitoring Blitz event for the spring of 2019. In the proposed plan, water monitoring organizations from Long Island Sound to Down East Maine could join a single-day opportunity to simultaneously observe conditions of coastal acidification.

Our sincere thanks to all the workshop participants, local advisors, science advisors, and organizations supporting this work,
These three partners have completed a third season of monitoring carbonate chemistry inside and outside a kelp farm off Chebeague Island in Casco Bay. The goal was to determine if growing sugar kelp can locally remediate ocean acidification and improve growing conditions for co-located shellfish. Based on data from the first two seasons, the partners have identified a spatially and temporally variable “phytoremediation halo effect” around the kelp. Moored instrument data, underway mapping data for the planar extent of the halo, and depth profiles for the 2018 season are still being analyzed.

This season, the instruments were deployed from January through early August, making this the first season post-harvest data was collected in the field. NOAA-SK funding allowed us to add several components to the 2018 monitoring agenda, including a fluorometer, PAR sensors, and a MAVS 4 (Nobska) current meter. Additionally, the partners planted mussels inside the farm and at varying distances outside the farm during the spring, prior to the kelp harvest. Preliminary results suggests that shell strength and meat:shell is significantly higher within the ’halo’ region. A Bigelow REU Intern (Research Experience for Undergraduates), Bri Groves, generated these data and presented her findings at two events this summer.

In the lab at Bigelow, experiments are scheduled for August to determine mussel performance with and without kelp in both ambient and future temperature and CO2 conditions. For more information, contact Nichole Price (nprice@bigelow.org) or Susie Arnold (sarnold@islandinstitute.org)