Meeting Report

A Florida Roundtable on Ocean Acidification

Mote Marine Laboratory, Sarasota, FL

September 2, 2015

Staghorn coral, Curaçao. Credit: Kim Ritchie/Mote
# Contents

Executive Summary ........................................................................................................................................... 3  
Overview ....................................................................................................................................................... 3  
Background .................................................................................................................................................... 3  
Roundtable proceedings ................................................................................................................................... 6  
  Welcome and Overview ................................................................................................................................... 6  
  Panel discussion: OA in the US and Florida ................................................................................................. 7  
  Panel Discussion: Florida Resources and Communities at Stake .............................................................. 10  
  Keynote remarks ........................................................................................................................................... 12  
  Afternoon breakouts ...................................................................................................................................... 12  
    Science ...................................................................................................................................................... 12  
    Aligning research with other communities and resources .................................................................. 13  
    Engaging others ....................................................................................................................................... 13  
  Plenary discussion ........................................................................................................................................ 13  
  References .................................................................................................................................................... 14  
  Appendix 1 .................................................................................................................................................. 17
Executive Summary

Although the Florida ocean science community has been studying ocean acidification (OA) for several years, public conversation and concern about OA are still just beginning. Ocean Conservancy and Mote Marine Laboratory recently held a roundtable on OA to discuss the state of the science, Florida resources and initiatives that could be affected, and ways to engage other groups beyond scientists on the issue. Key takeaways from the day include:

- OA is measurable, and it is happening now in Florida waters.
- It’s urgent that we understand what OA will do to key Florida systems like coral reefs, carbonate bedrock, and seagrass-rich bays.
- Some species will thrive in the new conditions while others will not. Understanding which ones is critical to knowing how to restore, maintain, and use ocean ecosystems effectively.
- OA is happening in tandem with other issues like warming, runoff, sea level rise and water cycle changes, which could impact marine life more substantially than any stressor alone.
- Information about OA’s potential impacts to Florida’s economy and human communities is critically needed to engage decision makers and inform smart policies.
- Strategic next steps could include forming a statewide consortium dedicated to synthesizing data on the issue and developing effective education and outreach messages on OA.
- There is a need for developing transdisciplinary partnerships to support synthesis, communications, and further science on OA within Florida.
- Taking advantage of best communications practices and building on regional partnerships to engage new user groups will help expand the conversation on OA outside the science community.

Overview

Ocean acidification (OA) has received a good deal of attention from Florida researchers over the past decade, but public conversation and concern about the issue are just beginning. In early September 2015, Ocean Conservancy and Mote Marine Laboratory partnered to host a roundtable on ocean acidification in Florida at Mote designed to accelerate the public discussion about OA in Florida by convening scientists, elected officials, journalists, industry and environmental organization representatives, and local resource managers to discuss knowns, unknowns, and necessary next steps.

Background

Ocean acidification is a progressive change in ocean chemistry occurring over decades to centuries, caused when seawater takes up excess carbon dioxide (CO₂) from the atmosphere. CO₂ reacts with water to create an acid, which lowers seawater pH (increases its acidity) and robs the water of naturally occurring carbonate ions. Long-term records collected at fixed ocean time-series study sites, such as the ones in Hawaii and Bermuda, show the ocean CO₂ content rising at the same rate as that of atmospheric CO₂ (Figure 1) and the ocean pH dropping as well. This process is happening nearer shore, too, but time
series measurements there are lacking and coastal processes, like upwelling and phytoplankton blooms and crashes, obscure the atmospheric signal that can be seen so clearly far offshore.

The net effect of these changes in seawater chemistry is to make certain physiological processes more difficult for many marine species. Organisms like corals and bivalve shellfish, whose hard parts are made of calcium carbonate minerals, have a difficult time making and maintaining these hard parts (Hofmann et al. 2010). Other organisms reproduce less abundantly and grow more slowly (Kroeker et al. 2013). Some finfish even show behavioral changes: clownfish are attracted to the scent of predators (Munday et al. 2009), and make risky choices; and dusky sharks have a difficult time tracking the smell of their prey (Dixson et al. 2015).

The total long-term effect of ocean acidification on marine populations and ecosystems is still a topic of intense study. It’s clear that OA and other stressors tend to enhance each other, leading to a greater stress response by individual organisms (Przeslawski, Byrne, and Mellin 2015). OA also tends to decrease seafloor community diversity and favor communities of macroalgae over reef-building organisms (Fabricius et al. 2011; Hall-Spencer et al. 2008). But how ocean food webs will change is still not well understood (Kaplan et al. 2010).

Ocean acidification is expected to affect human communities as well to different degrees, particularly via fisheries, coastal protection, and other ecosystem services provided directly by OA-sensitive marine species (Cooley, Kite-Powell, and Doney 2009). Impacts to human communities from OA are expected to vary substantially depending on other social and environmental factors, such as whether marine communities have employment alternatives, effective governance, or other environmental problems (Ekstrom et al. 2015). Economic losses from OA are difficult to forecast, and estimates range widely.
Economic revenues depend on a host of factors external to the marine ecosystem services in question that are difficult to predict. But because many human communities currently depend heavily on marine benefits, it is reasonable to expect that any changes in marine ecosystem services would strongly affect marine-dependent jobs and income in these communities.

Regions like Florida that depend heavily on healthy oceans to attract visitors, support fisheries, and protect shoreline have a lot to lose from ocean changes like OA. Based on data from NOAA, Ocean Conservancy estimates that saltwater recreational fishing in Florida supports about 110,000 jobs and coral reef tourism supports more than 70,000 jobs. In addition, economic impacts of recreational fishing, diving, and reef viewing total in the billions of dollars each year (Figure 2). Acknowledging how important healthy oceans are to Florida, three Florida U.S. House members (Buchanan, R-FL 16; Curbelo, R-FL-26; and Crenshaw, R-FL 4) have co-sponsored the bipartisan Coastal Communities Ocean Acidification Act of 2015 (HR 2553) this year, joined by eleven more Florida representatives (Castor, D-FL 14; Deutch, D-FL 21; Grayson, D-FL 9; Hastings, D-FL 20; Jolly, R-FL 13;
Murphy, D-FL 18; Nugent, R- FL 11; Rooney, R-FL 17; Ros-Lehtinen, R-FL 27; Ross, R-FL 15; and Wasserman Schultz, D-FL 23) in support. The act directs NOAA to study how ocean acidification could affect people in coastal communities through changing job opportunities, identify dangers to communities that rely on ocean-based economies, and find possible solutions to mitigate ocean acidification’s threats.

**Roundtable proceedings**

Approximately 63 attendees participated in this fruitful day of forward-looking discussions, creating many cross-links between communities of coastal users that may energize future OA activities in Florida. The attendee list and day’s agenda are included in Appendix 1. The meeting began with an overview of Mote’s involvement in OA and coral reef work, followed by two panels that focused on the state of knowledge about OA in Florida and the resources and activities that could be affected, respectively. Following a keynote presentation by Rep. Holly Raschein (R-FL 120) at lunch, attendees divided into three breakout groups that examined scientific needs, resources that could be affected by OA, and ways to engage other communities on the issue. Breakout leads then reported out to all attendees, who closed the day with a plenary-style discussion reviewing the day.

**Welcome and Overview**

*Michael Crosby, Mote Marine Laboratory*

Mote’s involvement in this roundtable aligns with its mission to advance marine science through research, education, and outreach, which lead to the pursuit of meaningful science and sustainable use of marine resources. Mote is mainly a research institution and maintains research partnerships around the world. Recently, Mote has begun a focused research program examining OA impacts on coral reefs, funded by federal and state research grants and philanthropy. In addition, Mote has begun building a research center in the Florida Keys dedicated to studying impacts of climate change and OA on coral, and it and has hosted several international convenings on OA.

Ocean acidification is an urgent issue for Florida, given the state’s heavy dependence on a healthy blue environment. The state has 1800 miles of coastline that supports billions of dollars of economic activity. Sarasota Bay alone supports $12 billion of activity that leads to regional economic impacts of $60 billion. The Gulf of Mexico is home to 1500 species of fish, and saltwater fishing supports $7 billion of activity within Florida. Florida’s coral reef is the only barrier reef in the continental United States and provides habitat for over 6000 species, as well as shields the state from storms and destructive waves. In all, the reef supports over 70,000 jobs in the state. Any impacts that OA has on Florida’s environment will also affect its economy and culture. Addressing OA in Florida is key for helping the state to move into the future.
Panel discussion: OA in the US and Florida

Shirley Pomponi, Florida Atlantic University; Erinn Muller, Mote Marine Laboratory; Chris Langdon, University of Miami; Kim Yates, United States Geological Survey

National priorities regarding ocean acidification were summarized in the recent National Research Council report (National Research Council 2015), and these will guide future funding initiatives for the National Science Foundation (NSF). Questions arising from these priorities that are relevant to ocean acidification are:

What are the consequences and impacts OA has on marine organisms?

- How does decreasing pH affect species, genetic, and functional biodiversities?
- How will adaptation and migration affect organisms and ecosystems?
- How will superimposed stressors, including OA, affect ecosystems?

This NRC report drew heavily on the recommendations and findings of the 2010 National Research Council report that specifically focused on OA (National Research Council 2010). That document acknowledged that the responses of many marine organisms, either by acclimation or adaptation to OA, are generally not well known. There are likely to be ecological winners and losers, as some species will be more resilient than others. The composition of many marine ecosystems could shift in response to changes in the abundance of particular species. Changes in ocean chemistry are expected to negatively affect organisms that secrete calcium carbonate skeletons or shells, but more information is needed to understand how this happens. At the same time, a global network to collect chemical and biological observations is needed to monitor OA. As part of this network, observational sites need to be added in vulnerable ecosystems, such as coral reefs and highly variable coastal areas, to monitor OA. In all, more information is needed on the processes that affect OA, the physiological mechanisms that are involved, the potential for acclimation and adaptation of organisms to OA, the responses of individuals, populations, communities, and ecosystems, the interactive effects of multiple stressors, the global scale biogeochemical implications of OA, socioeconomic impacts, and decision-relevant information needs.

One example of a marine relationship for which the response to OA is poorly understood is bioerosion. Some sponges create space to inhabit by using chemical processes to erode coral skeletons and mollusc shells. In an acidifying ocean, coral skeletons and mollusc shells may become less dense and, possibly, more easily bioeroded. Changes in temperature and pCO₂ may lead to an increase in rates of bioerosion by sponges (Wisshak et al. 2014). Moreover, some sponges that commonly occur on Florida coral reefs are more resilient than corals to increasing temperatures and decreasing pH (Duckworth et al. 2012), and may emerge as winners in competition for space in a warmer and more acidic ocean. This may influence the coral-sponge balance in Florida’s reefs in the future. Sponges on Florida reefs are not framework builders, so changing the coral-sponge balance could also alter the underwater topography around Florida.
Corals face other environmental threats, though, including disease. Coral disease can cause major losses when environmental stressors interact, and it is responsible for most sudden, mass coral die-offs. The most common abiotic coral disease is bleaching, typically caused when corals experience intense warming. The coral expel their symbiotic photosynthetic algae that are required for survival, leading to bleaching and often, death. Numerous biotic coral diseases exist (black band, white band, dark spot, white plague, white pox, yellow band, etc.), but they are not clearly associated with a disease mechanism or progression. OA is known to increase susceptibility to coral bleaching (Anthony et al. 2008), but the interaction of OA with biotic coral diseases is still poorly understood. In one study, the virulence of black band disease decreased as pH declined. In another study, decreased pH also decreased the rate of lesion creation (Williams et al. 2014). Although these early results suggest that OA may slow down biotic coral disease, we need to understand the relationship between stress, pH, temperature, bleaching, and disease. A stressed organism is less able to handle additional pathogens or pressures. Studies of this nature will accelerate restoration efforts by allowing scientists to select strains for culture and out-planting that may be more resistant to stressors anticipated in the future.

Ocean acidification is driven globally by carbon dioxide that has accumulated in the atmosphere (Figure 1). Combining this contemporary record with the historical record from ice cores provides the atmospheric CO\(_2\) record for nearly 1 million years (Figure 3). These figures show that the CO\(_2\) concentration in the Earth’s atmosphere has changed abruptly in a short time. Present-day organisms have become accustomed to CO\(_2\) concentrations over 200-300 ppm for generations, but industrial processes are changing this rapidly. Today’s CO\(_2\) levels and rates of change are thought to be stressful for marine organisms, but local studies are needed to determine how specific organisms and ecosystems will respond. In Florida, an OA monitoring buoy placed near Cheeca Rocks shows that CO\(_2\) levels in this area are highly seasonal, reflecting seagrass photosynthesis in summer and die-back in winter (Langdon, in prep.) The annual average CO\(_2\) value in water is quite close to that of the overlying air, suggesting that conditions monitored at Cheeca Rocks do indicate the integrated physical/biological effects on OA in the area. Water chemistry in winter suggests that corals are dissolving seasonally, but in the summer they are still accreting. There is a distinct north-south trend, also, which must be interpreted with caution as it may be related to geography or proximity to urbanized locations. Winter dissolution is happening sooner than expected, but these types of studies allow insight into the problem before conditions become dire.

Florida seems particularly vulnerable to OA because the state lies atop a carbonate rock platform that developed several million years ago when sea level was higher. Calcifying organisms like corals created this platform on a submerged coastal shelf. Now, the carbonate bedrock is exposed to fresh water and weathering, creating “karst” topography, which is a dissolvable carbonate platform full of holes and passages (Tihansky 1999). This forms Florida’s well-known aquifers and sinkholes. Florida’s ground water is stored in aquifers, which are being inundated by seawater as water demand increases. If OA can dissolve carbonate bedrock in addition to the carbonate shells and skeletons of present-day corals and shellfish, Florida has a unique and urgent need to understand the effects of OA. A key regional question is how OA can affect Florida’s karst architecture, possibly affecting drinking water, saltwater intrusion, sinkholes, coastline strength, and reefs. Other related questions focus on how other aquatic pollutants
will chemically interact with the karst and increased CO2 levels. A good deal of data exists from ongoing regional monitoring efforts by Florida departments as well as the U.S. Geological Survey, making data synthesis and coordination among Florida agencies a good first step. This may shed light on what is known already and what may be best choices for different areas of Florida, such as whether restoration of corals, seagrasses, or other regional efforts are indicated for different areas. Joining in regional synthesis and evaluation efforts, Florida scientists are part of the developing Southeast Ocean and Coastal Acidification Network (SO-CAN), organized by NOAA and the Southeast Coastal Ocean Observing Regional Association (SECOORA). This group seeks to facilitate collaboration and communication among natural and social scientists, industry, and citizens around OA research and action.

Monitoring water chemistry for OA in heterogeneous, highly variable environments like coral reefs and seagrass beds is challenging. Not only are there big differences at the surface and seafloor, but variability is high across time and horizontal space. Organisms contribute to the variability by respiring and producing CO₂, and by altering carbonate chemistry through calcification and dissolution of skeletal or shell material. Tracking and evaluating this variability will require that new methods be developed, including not only chemical and physical indicators or sensors, but also biological indicators (e.g., of metabolic processes likely to be affected). Nevertheless, even putting more monitoring in place by building on to existing local efforts could be useful (e.g., increasing the array of water quality variables being monitored by state entities, or linking into existing restoration efforts or Sea Grant outreach initiatives as citizen science opportunities become available) and could shed light on the interactive effects of changes that are co-occurring, like OA and ocean warming. An integrated science plan is desirable to ensure that the issues most important to Floridians are addressed, even as basic research advances our understanding of these processes and their ecological and societal impacts.
Panel Discussion: Florida Resources and Communities at Stake

Panelists: Billy Causey, NOAA National Marine Sanctuaries; David Vaughan, Mote Marine Laboratory; David Tomasko, Environmental Science Associates; Phil Purcell, Marine Industries Association of South Florida.

The Florida Keys National Marine Sanctuary (FKNMS) is one of 14 nationwide marine sanctuaries and monuments that together cover 150,000 square nautical miles. The FKNMS totally surrounds the Florida Keys, covering 29,000 square nautical miles. NOAA co-manages the FKNMS with the state of Florida. One of the top concerns for the sanctuary is threats to coral reefs, which are an indicator of ecosystem change. Climate change is the top threat affecting the sanctuary, followed by pollution from land, habitat loss, overfishing, and invasive species. The coral reefs in the sanctuary first began bleaching in 1983 in response to climate change impacts. Several subsequent major bleaching events have occurred since then, usually followed by coral disease. The major climate-related impacts until now have included ocean warming, sea level rise, and tropical storms. But ocean acidification is a new and emerging additional climate-related impact. Normally, bioerosion of corals is slightly less than calcification, leading to gradual growth (net calcification) of reefs. However, reefs in the FKNMS are now seeing a 20% reduction in calcification and more erosion. This might also affect other organisms that live on and among the coral reefs, starting with the bottom of the food chain. Moreover, the interactive effects of ocean acidification and temperature that have been observed suggest that reefs will be under even more stress in the future. In the Gulf and Caribbean, lower coral diversity (2 species of branching corals there, compared to 185 species in the Great Barrier Reef off Australia) may make Gulf reefs more vulnerable to environmental stress. But humans can lower their CO₂ emissions at the same time as we work to understand the effects of CO₂, changing pH, and other environmental variables on calcifiers that make up such a large part of the FKNMS.

Recent observational research has shown that OA is not a future problem; it’s a problem happening now. pH levels that used to be “ambient” aren’t ambient anymore, and we are seeing new average conditions. Change is happening now, and faster than predicted before. Coastal benthic communities are showing change faster and faster. Bleaching is happening every year. Coral reef restoration research at Mote has started to focus on temperature and pH-resilient species that can withstand rising sea level as well, but restoration is still a temporary solution. Challenges to restoration work include needing to support recruitment as well as growth and survival of individual polyps. Ocean conditions projected to occur in several decades in ocean basins are what are seen in coastal areas now, so coral restoration efforts need to select for species that can handle much greater extremes than originally anticipated.

 Restoration of seagrass meadows has been underway around Florida for years to clean up and restore coastal habitats. Local, regional, state and federal partners in Sarasota Bay, for example, spent $300 million on restoration of its water quality. In the first six years after implementing a widespread water quality improvement project, the bay gained 617 acres of seagrass meadows, which was tied to an estimated 13 million more fish in the bay. Between 1988 and 2014, Sarasota Bay added 3,815 acres of new seagrass meadows, a 44 percent increase. Carbon storage is associated with below ground portions of seagrass meadows, which can have photosynthetic carbon uptake rates as high as 2 gram of carbon per square meter per day. Therefore, seagrass restoration may take carbon dioxide out of the
water column and partially offset impacts of OA. Protection and restoration of seagrass meadows could thus be considered as part of a portfolio of activities that move the region reducing the impacts of OA. In Tampa Bay, long-term investments to restore the bay’s water quality, at a total cost in excess of $1 billion, has resulted in substantial improvements in water quality, and Tampa Bay has added almost 30 square miles of new seagrass coverage over the past 30 years. In response, the bay-wide average pH is increasing, which suggests that seagrass restoration is perhaps helping to offset the impact of ocean acidification. Surprisingly, pH trends are not increasing over time in Sarasota Bay, despite a similar seagrass trend as in Tampa Bay. Comparing Sarasota and Tampa Bay outcomes highlights how numerous processes affect coastal regions, which can be difficult to understand and unravel. However, preliminary findings in Tampa Bay (Yates et al., personal communication) support the conclusions of researchers such as Unsworth et al. (2012) and Hendriks et al. (2014) that seagrass meadows can help offset some of the impacts of ocean acidification, so that seagrass restoration and protection and restoration of coral reefs should be considered complimentary priorities.

There is a need to connect the research and observations under way with new communities. Despite Florida’s long engagement in OA science, most people outside of the research community are not aware of this work. A particular community that could be activated is wealthy philanthropists (e.g., from the tech, film, energy, logistics and entertainment industries), who often have large private vessels with oceanographic facilities on board that could be tasked to collaborate oceanographic research into solutions. At the 2016 Fort Lauderdale International Boat Show there will be a unique opportunity for highlighting science needs and reaching out to the community with resources to offer, but this is still in the planning stage. Furthermore, the Marine Trade Association may be another group to connect with, as they wish to offer solutions and a middle ground for collaboration. Connecting with these groups may offer opportunities to help bridge the science research community and the public simply for outreach and education purposes or to inspire new collaborations. The Florida research community may need to band together, possibly via the Florida Institutes of Oceanography (FIO) network that already exists, and self-advertise as a center of expertise (an oceanographic research hub) to attract these kinds of partnerships. Citizen science is very active in Florida, but measurement kits do not contain the proper equipment to monitor OA (this is also true worldwide). Engagement by citizens could dramatically increase the number of eyes looking at inshore water systems.

A recurring concern for managers and restoration experts is the notion of freshwater storage and release, and how it interacts with seagrass and organic carbon production and decay. Too much or too little terrestrial runoff could layer more challenges onto reefs in the FKNMS and other sensitive environments. Too much runoff brings poorly buffered water onto the reefs, driving CO₂ levels higher, and runoff often carries organic carbon that can add CO₂ when it decays. The net effect of seagrass in the region tends to be as a local short- to medium-term carbon sink, as carbon is stored above ground and below ground. Above-ground shoots also house epiphytes, which are key pieces of the local food web. Closer to low-pH zones (seen in an extreme in the Mediterranean, where volcanic CO₂ vents drive pH very low), epiphytes do not populate seagrass shoots heavily and diversity decreases. Prior long-term seagrass/epiphyte shifts in the Florida coastal ecosystem were not studied relative to acidification, but
it’s possible that acidification has influenced local seagrass/epiphyte communities more than previously considered.

**Keynote remarks**

*Holly Raschein, Florida House of Representatives (R-120)*

District 120 includes the southern part of Southern Miami Bay County and the Florida Keys. This district depends on healthy ocean ecosystems, as it contains some of the only barrier reef in the continental United States. Millions of dollars from tourist revenue come through this district each year. Healthy reefs support 71,000 jobs and add $6.3 billion to the state’s economy each year. But ocean acidification could change the ocean and affect these dependent communities. Raschein noted, "As a mother of a young son, it's important to me that our coral reefs are thriving for him and for future generations to come." Research and communication about OA will help underscore the importance of restoration and resiliency of Florida marine resources to the state’s economic well being. The OA community can help by producing attractive outreach materials that show the human side of what's at stake (in Florida, that could include divers and fishermen), always tying back environmental change to the economy. Messages of hope are also needed that highlight successes and positive improvement.

**Afternoon breakouts**

**Science**

There is a good deal of baseline data already collected by various agencies and researchers that characterizes Florida’s coastal environments, and some of this data may shed light on biological or water quality responses to OA and other stressors. Synthesizing this data could show how impacted Florida’s coastal ecosystems, economy, and reefs might already be. There is a need to understand carbonate chemistry at the resource and organism level, specifically in marine coastal ecosystems. These parameters are changing in space and time, and we do not have an adequate understanding of how these are changing at the seafloor, where corals and seagrass are growing. Regional differences are likely to become apparent among ecosystems when compared that way, leading to opportunities to explore how commercially or ecologically important ecosystems will be affected. The combination of regionally and species-specific information is likely to be effective in getting the attention of decision makers.

Strategic collection of additional data, such as characterization of keystone species and sentinel locations, may be warranted after data are synthesized to fill gaps and answer Florida-specific questions. For example, characterization of different environments (for example: coral reef, estuary, seagrass bed) as “end members” may offer insight into other local environments where ecosystems and species are mixed. With all of these investigations, examining OA in combination with other processes like warming and hypoxia is critical.

Finally, collaboration between natural scientists and social scientists that can help quantify the economic value of ecosystem changes is important. This translates the importance of OA into terms that non-scientists can understand, and may offer opportunities to attract new funders to this sort of
research. Interdisciplinary research like this may even point to solutions that can be implemented widely across the state that take into account terrestrial factors (like coastal pollution and development) as well as oceanic factors (like refugia). Florida has an opportunity to lead in developing and applying best practices for coastal resilience.

**Aligning research with other communities and resources**

OA needs to be considered while planning and designing restoration plans. A best practices or action plan on how to develop restoration plans would be useful to remind leaders of this every time, and this may also provide ideas on how to make sure each project is funded and survives the length of time it needs to, to be complete. Research and monitoring on OA can be piggybacked on top of existing monitoring and restoration activities, many of which have been occurring for decades. One of the major challenges to doing so, though, is the expense and specialization of doing OA monitoring. Certainly there is a need to engage citizen scientists in monitoring for OA, to the extent that appropriate monitoring equipment is available and affordable.

Citizen engagement on OA has much in common with citizen engagement on climate. There are many ways citizens can get involved, such as by helping communicate issues to different stakeholder groups. In that case, best practices for effective climate communications, which have been well established, must be used. For example, analogies are needed that are easy to understand by the public, as well as personal action steps instead of a doom-and-gloom message. Outreach messages that emphasize return on investment can also be effective. It’s also important to include a diverse group of voices that call on the expertise of experienced communicators. Extension agents or professional outreach experts may be critical for helping facilitate successful peer-to-peer communication.

**Engaging others**

To spread the word about OA, new communities must be educated and engaged as active spokespeople for the issue. As noted by the other discussion group, best practices in climate change communication are needed to also discuss OA. For instance, different strategies are needed to discuss OA, depending on who the audience is, who the messenger is, and what the message is. In Florida, a coalition to connect scientists with skilled communicators and thought leaders may be useful. But, as part of this coalition, a common language must be agreed upon at the beginning that is scientifically correct yet accessible to nonscientists. This coalition could also be part of efforts mentioned earlier to bring together scientific entities and brand Florida as a global marine science hub.

**Plenary discussion**

There is room to bring together all OA-interested parties in Florida again in a major convening that takes full advantage of existing partnerships, networks, and initiatives. Some of this convening could be
dedicated to exploring future science needs, such as developing a coordinated plan to screen organisms to assess responses to OA and warming, then use the selected organisms to inform restoration efforts. A center of excellence or effort is needed within Florida to bring together all partners; this idea was mentioned in several sessions throughout the day. There are funding opportunities oriented towards building these types of networks (e.g., National Science Foundation’s Research Coordination Network or Centers of Excellence calls for proposals), but leading these efforts represents a substantial effort by a handful of leaders.

Other outreach and coordination opportunities might include “Oceans Day” in February and annual Florida Institutes of Oceanography (FIO) convenings. Although the topic of Oceans Day is already set, a side meeting and press conference could be organized to discuss OA, the state’s needs in moving this research issue forward, and opportunities to join in. This might allow participation from more sectors (e.g., state resource management groups, NOAA, environmental engineering firms) as well as the classical academic science community that NSF proposals generally target. Bringing in industry may also provide leveraged monitoring opportunities: for example, Shell is putting up an observational buoy in the Northwest Gulf, and partnering with industry may allow the deployment of autonomous observing equipment needed in new areas.

Regional initiatives like the Southeast Coastal Acidification Network (SO-CAN) may also help provide structure for coordinating work happening within Florida. SO-CAN has been holding a series of webinars to discuss the state of science knowledge on OA in the Southeast U.S., which will culminate in a meeting next January to produce a synthesis document. After that, meetings will be held around the Southeast with stakeholder groups to engage the right people at the beginning. Synthesis of science for the Southeast that takes a strong societal perspective will necessitate including local organizations, which can help set priorities that will matter to decision makers and funders in the region. This kind of effort, tied tightly into the human dimension from the start, can help get people passionate about the issue and sustain long-term work.

References


Appendix 1

Agenda

8:30AM-9:00AM Check in and continental breakfast

9:00AM-9:30AM Welcome & Opening Remarks
- Dr. Sarah Cooley (Science Outreach Manager, Ocean Conservancy)
- Dr. Michael P. Crosby (President & CEO, Mote Marine Laboratory)

9:30AM-10:45AM Panel discussion: Ocean Acidification in the U.S. and Florida
- Dr. Shirley Pomponi (Executive Director, Cooperative Institute for Ocean Exploration Research, & Technology, Florida Atlantic University)
  Overview of National Research Council Decadal Survey of Ocean Sciences recommendations for Ocean Acidification Research, with comments on potential future scenarios for Florida's coral reef ecosystems.
- Dr. Erin Muller (Coral Disease and Health Research Program Manager, Mote Marine Laboratory)
  Ocean Acidification and Coral Disease
- Dr. Chris Langdon (Professor, Department of Marine Biology & Ecology, University of Miami)
  Ocean Acidification Impacts on Coral Reef Development
- Dr. Kim Yates (Research Oceanographer, United States Geological Survey)
  A state-wide ocean acidification monitoring network for Florida

10:45AM-11:15AM Coffee break

11:15AM-12:30PM Panel discussion: Florida Resources and Communities at stake
- Dr. Billy Causey (Director, Southeast Atlantic, Gulf of Mexico and Caribbean Region, NOAA Office of National Marine Sanctuaries)
  Marine protected Area Management Strategies relate to Ocean Acidification
- Dr. Dave Vaughan (Executive Director, Tropical Research Lab, Mote Marine Laboratory)
  Tailoring Coral Restoration for success despite Ocean Acidification
- Dr. Dave Tomasko (Principal Associate, Environmental Science Associates)
  Coastal Restoration and Carbon Sequestration’s Impacts on Acidification
- Phil Purcell (Executive Director Marine Industries Association of South Florida)
  Ocean Acidification, Business Impact & Collaboration

12:30PM-1:45PM Lunch
- Keynote Speaker: Representative Holly Raschein (Florida House of Representatives)

1:45PM-3:15PM Breakout discussions: What are the next steps?
• Florida-focused science priorities  
  (Facilitator – Dr. Kim Ritchie, Senior Scientist, Mote Marine Laboratory)
• Alignment with other local activities (e.g., water quality mgmt., restoration)  
  (Facilitator – Drs. David and Jennifer Shafer, Science & Environment Council)
• Engaging communities and elected officials  
  (Facilitator – Kelly Dowd, KD Logistics, Inc.)

3:15PM-3:45PM  Coffee break

3:45PM-4:45PM  Plenary discussion
  • Presentation of breakout conclusions
  • Assembly of main messages

4:45PM-5:00PM  Concluding remarks

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