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

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 (CO_2) from the atmosphere. CO_2 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 CO_2 content rising at the same rate as that of atmospheric CO_2 (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.

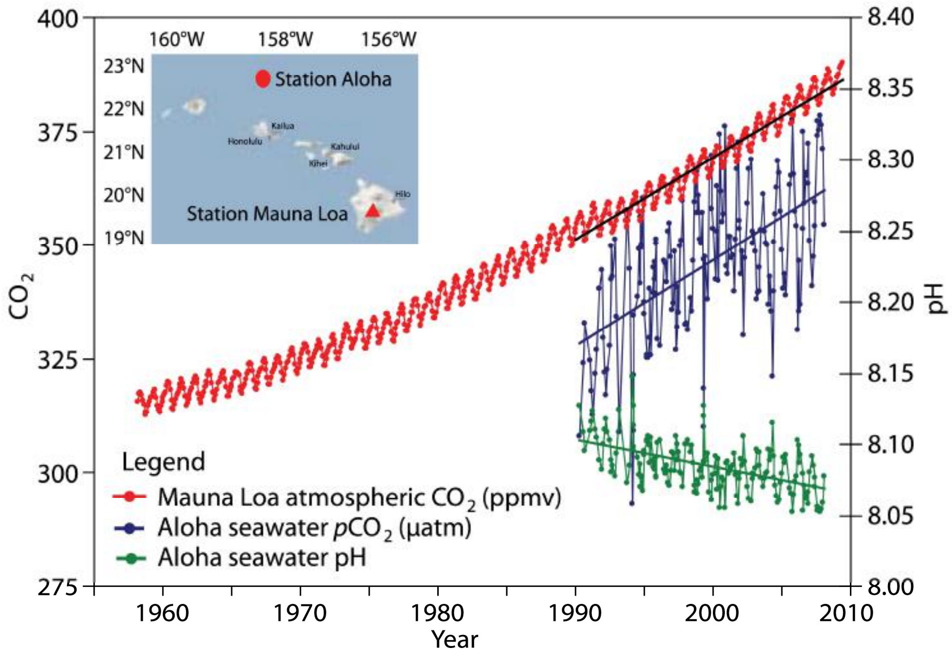

Figure 1: Atmospheric CO_2 (red) from station Mauna Loa with seawater pCO_2 (blue) and seawater pH (green) from station Aloha. (Doney et al. 2009)

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.

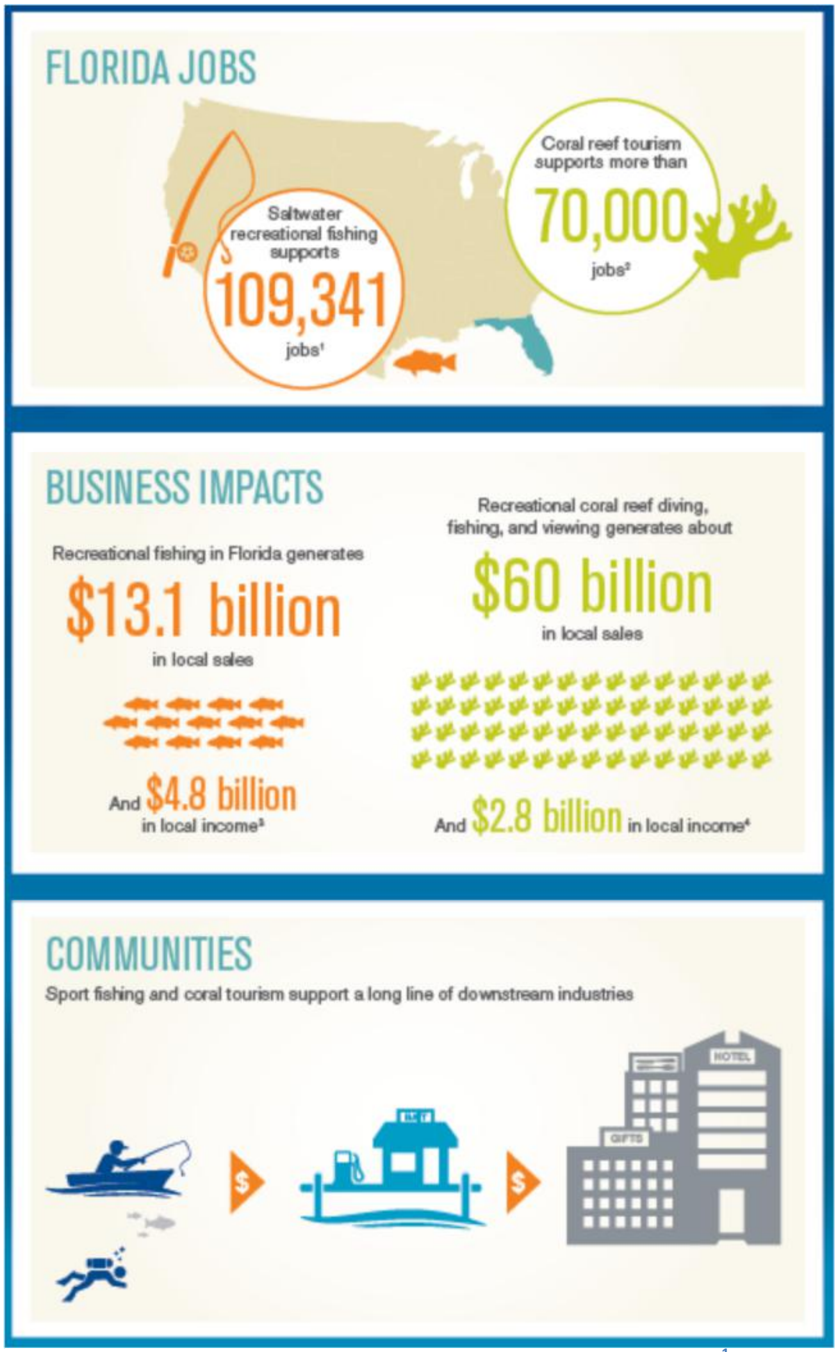

Figure 2: Ocean acidification could affect Florida jobs and the economy. [1] Fisheries economics of the United States 2012. [2] Johns, G.M., et al. 2001. Socioeconomic Study of Reefs in Southeast Florida. Hazen and Sawyer, Final report for Broward, Palm Beach, Miami-Dade and Monroe Counties, Florida Fish and Wildlife Conservation Commission and National Oceanic and Atmospheric Administration; Hazen and Sawyer, 2004. Socioeconomic Study of reefs in Martin County, Florida. Final Report. 120 pp. [3]Fisheries economics of the United States 2012. [4]Values from Johns et al. for 2000 and from Hazen and Sawyer for 2003 adjusted to 2014 dollars and summed.

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 pCO_2 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

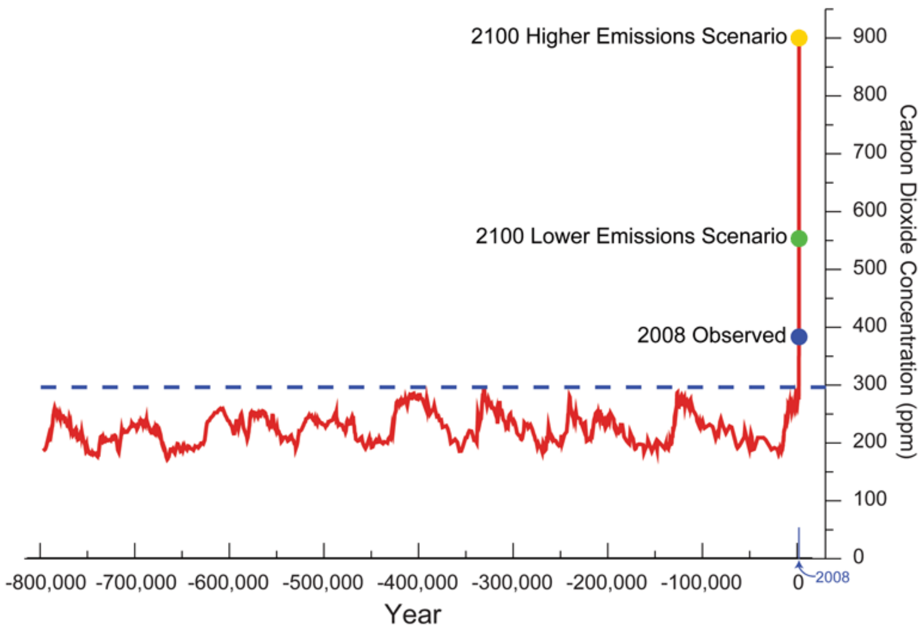

Figure 3: Geological record of atmospheric carbon dioxide concentrations. Courtesy Chris Langdon, RSMAS/U. Miami.

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 CO_2, 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 CO_2 emissions at the same time as we work to understand the effects of CO_2, 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 CO_2 levels higher, and runoff often carries organic carbon that can add CO_2 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 CO_2 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 calls 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

Anthony, K. R. N, D. I Kline, G. Diaz-Pulido, S. Dove, and O. Hoegh-Guldberg. 2008. "Ocean Acidification Causes Bleaching and Productivity Loss in Coral Reef Builders." *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA* 105 (45): 17442–46. doi:10.1073/pnas.0804478105.

Cooley, Sarah R., Hauke L. Kite-Powell, and Scott C. Doney. 2009. "Ocean Acidification's Potential to Alter Global Marine Ecosystem Services." *Oceanography* 22 (4): 172–81.

Dixson, Danielle L., Ashley R. Jennings, Jelle Atema, and Philip L. Munday. 2015. "Odor Tracking in Sharks Is Reduced under Future Ocean Acidification Conditions." *Global Change Biology* 21 (4): 1454–62. doi:10.1111/gcb.12678.

Doney, Scott C., William M. Balch, Victoria J. Fabry, and Richard A. Feely. 2009. "Ocean Acidification: A Critical Emerging Problem for the Ocean Sciences." *Oceanography* 22 (4): 36–47.

Duckworth, Alan R., Lyndon West, Tifanie Vansach, Amber Stubler, and Marah Hardt. 2012. "Effects of Water Temperature and pH on Growth and Metabolite Biosynthesis of Coral Reef Sponges." *Marine Ecology Progress Series* 462 (August): 67–77. doi:10.3354/meps09853.

Ekstrom, Julia A., Lisa Suatoni, Sarah R. Cooley, Linwood H. Pendleton, George G. Waldbusser, Josh E. Cinner, Jessica Ritter, et al. 2015. “Vulnerability and Adaptation of US Shellfisheries to Ocean Acidification.” *Nature Climate Change* 5 (3): 207–14. doi:10.1038/nclimate2508.

Fabricius, Katharina E., Chris Langdon, Sven Uthicke, Craig Humphrey, Sam Noonan, Glenn De’ath, Remy Okazaki, Nancy Muehllehner, Martin S. Glas, and Janice M. Lough. 2011. “Losers and Winners in Coral Reefs Acclimatized to Elevated Carbon Dioxide Concentrations.” *Nature Climate Change* 1 (3): 165–69. doi:10.1038/nclimate1122.

Hall-Spencer, Jason M, Riccardo Rodolfo-Metalpa, Sophie Martin, Emma Ransome, Maoz Fine, Suzanne M Turner, Sonia J Rowley, Dario Tedesco, and Maria-Cristina Buia. 2008. “Volcanic Carbon Dioxide Vents Show Ecosystem Effects of Ocean Acidification.” *NATURE* 454 (7200): 96–99. doi:10.1038/nature07051.

Hendriks, I. E., Y. S. Olsen, L. Ramajo, L. Basso, A. Steckbauer, T. S. Moore, J. Howard, and C. M. Duarte. 2014. “Photosynthetic Activity Buffers Ocean Acidification in Seagrass Meadows.” *Biogeosciences* 11 (2): 333–46. doi:10.5194/bg-11-333-2014.

Hofmann, Gretchen E., James P. Barry, Peter J. Edmunds, Ruth D. Gates, David A. Hutchins, Terrie Klinger, and Mary A. Sewell. 2010. “The Effect of Ocean Acidification on Calcifying Organisms in Marine Ecosystems: An Organism-to-Ecosystem Perspective.” *Annual Review of Ecology, Evolution, and Systematics* 41 (1): 127–47. doi:10.1146/annurev.ecolsys.110308.120227.

Kaplan, Isaac C., Phillip S. Levin, Merrick Burden, and Elizabeth A. Fulton. 2010. “Fishing Catch Shares in the Face of Global Change: A Framework for Integrating Cumulative Impacts and Single Species Management.” *Canadian Journal of Fisheries and Aquatic Sciences* 67 (12): 1968–82. doi:10.1139/F10-118.

Kroeker, Kristy J., Rebecca L. Kordas, Ryan Crim, Iris E. Hendriks, Laura Ramajo, Gerald S. Singh, Carlos M. Duarte, and Jean-Pierre Gattuso. 2013. “Impacts of Ocean Acidification on Marine Organisms: Quantifying Sensitivities and Interaction with Warming.” *Global Change Biology* 19 (6): 1884–96. doi:10.1111/gcb.12179.

Munday, Philip L, Danielle L Dixson, Jennifer M Donelson, Geoffrey P Jones, Morgan S Pratchett, Galina V Devitsina, and Kjell B Doving. 2009. “Ocean Acidification Impairs Olfactory Discrimination and Homing Ability of a Marine Fish.” *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA* 106 (6): 1848–52. doi:10.1073/pnas.0809996106.

National Research Council. 2010. *Ocean Acidification:A National Strategy to Meet the Challenges of a Changing Ocean*. Washington, D.C.: The National Academies Press. http://www.nap.edu/catalog.php?record_id=12904#toc.

National Research Council, Committee on Guidance for NSF on National Ocean Science Research Priorities: Decadal Survey of Ocean Sciences; Ocean Studies Board; Division on Earth and Life Studies. 2015. *Sea Change: 2015-2025 Decadal Survey of Ocean Sciences*. National Academies Press. http://www.nap.edu/catalog/21655/sea-change-2015-2025-decadal-survey-of-ocean-sciences.

Przeslawski, Rachel, Maria Byrne, and Camille Mellin. 2015. “A Review and Meta-Analysis of the Effects of Multiple Abiotic Stressors on Marine Embryos and Larvae.” *Global Change Biology* 21 (6): 2122–40. doi:10.1111/gcb.12833.

Tihansky, A.B. 1999. “Sinkholes, West-Central Florida.” In *Land Subsidence in the United States*, by D Galloway, D.R. Jones, and S.E. Ingebritsen, 121–40. USGS Circular 1182. United States Geological Survey.

Unsworth, Richard K F, Catherine J Collier, Gideon M Henderson, and Len J McKenzie. 2012. “Tropical Seagrass Meadows Modify Seawater Carbon Chemistry: Implications for Coral Reefs Impacted by Ocean Acidification.” *Environmental Research Letters* 7 (2): 024026. doi:10.1088/1748-9326/7/2/024026.

Williams, Gareth J., Nichole N. Price, Blake Ushijima, Greta S. Aeby, Sean Callahan, Simon K. Davy, Jamison M. Gove, et al. 2014. "Ocean Warming and Acidification Have Complex Interactive Effects on the Dynamics of a Marine Fungal Disease." *Proceedings of the Royal Society of London B: Biological Sciences* 281 (1778): 20133069. doi:10.1098/rspb.2013.3069.

Wisshak, M., C. H. L. Schönberg, A. Form, and A. Freiwald. 2014. "Sponge Bioerosion Accelerated by Ocean Acidification across Species and Latitudes?" *Helgoland Marine Research* 68 (2): 253–62. doi:10.1007/s10152-014-0385-4.

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

Meeting registrants

Mark Alderson
Executive Director
Sarasota Bay Estuary Program
111 S. Orange Ave., Suite 200W, Sarasota, FL 34236
Email: mark@sarasotabay.org
Phone: 941-955-8085
Twitter: N/A
URL: Sarasotabay.org

Leticia Barbero
Associate
AOML/NOAA-CIMAS/RSMAS
4301 Rickenbacker Causeway, Miami, FL 33134
Email: Leticia.Barbero@noaa.gov
Phone: (305) 361 4453
Twitter: N/A
URL: N/A

Kira Barrera
Physical Scientist
USGS
600 4th St. S., St. Petersburg Fl, 33701
Email: kbarrera@USGS.gov
Phone: 727-502-8044
Twitter: N/A
URL: coastal.er.usgs.gov/ocean-acidification/

Jay Butera
Senior Congressional Liaison
Citizens' Climate Lobby
420 Howard Road, Gladwyne, PA 19035
Email: JayButera@icloud.com
Phone: 610-724-7709
Twitter: N/A
URL: www.CitizensClimateLobby.org

Justin Campbell
Research Biologist
Smithsonian
701 Seaway Drive, Ft. Pierce, FL 34949
Email: campbellju@si.edu
Phone: 305-206-3575
Twitter:
URL: N/A

Billy D. Causey
Regional Director
NOAA Office of National Marine Sanctuaries:
Southeast Atlantic, Gulf of Mexico and Caribbean
Region
33 East Quay Road, Key West, Florida 33040
Email: Billy.Causey@noaa.gov
Phone: 305.809.4670 (ex 234)
Twitter: N/A
URL: N/A

Sarah Cooley
Science Outreach Manager
Ocean Conservancy
1301 19th St NW, Suite 8, Washington DC 20036
Email: scooley@oceanconservancy.org
Phone: 202.280.6231
Twitter: @co2ley
URL: oceanconservancy.org

Michael P. Crosby, Ph.D.
President and CEO
Mote Marine Lab
1600 Ken Thompson Parkway, Sarasota, FL 34236
Email: mcrosby@mote.org
Phone: 941-388-4441
Twitter: N/A
URL: https://mote.org/

John Darovec
Group Leader
Citizens' Climate Lobby, Bradenton Group
9202 68th Avenue East, Bradenton, FL 34202
Email: jsdarovec@verizon.net
Phone: (941) 752-1760
Twitter: N/A
URL: citizensclimatelobby.org

Susan Darovec
Group Leader
Citizens' Climate Lobby, Bradenton Group
9203 68th Avenue East, Bradenton, FL 34202
Email: jsdarovec@verizon.net
Phone: (941) 752-1761
Twitter: N/A
URL: citizensclimatelobby.org

Kelly Dowd
President
KD Logistics, Inc.
PO Box 2077, Sarasota, FL 34230
Email: Kelly@KDLogisticsInc.com
Phone: 941.312.1817
Twitter: N/A
URL: www.kdlogisticsinc.com

Ashley Dungan
Masters Student/Staff Chemist
Nova Southeastern University/Mote Marine Lab
24244 Overseas Highway, Summerland Key, FL 33042
Email: adungan@mote.org
Phone: (607) 684-3062
Twitter: N/A
URL: N/A

Terry Gibson
Principal
North Swell Media, LLC
2060 NE 23rd Terrace, Jensen Beach, Fl 34957
Email: Terry.Gibson@northswellmedia.com
Phone: 772-285-7683
Twitter: N/A
URL: www.northswellmedia.com

Sandra Gilchrist
Professor of Biology, Director, Pritzker Marine Biology Research Center
New College of Florida
5800 Bay Shore Road, Sarasota, Fl 34243
Email: gilchrist@ncf.edu
Phone: 941-487-4596
Twitter: N/A
URL: N/A

Karla Gore
Fishery Biologist
NOAA Fisheries Southeast Regional Office
263 13th Ave S St Petersburg, FL 33701
Email: karla.gore@noaa.gov
Phone: 727-551-5752
Twitter: N/A
URL: N/A

Philip Gravinese
PhD Candidate
Florida Institute of Technology
234 S. Wimbrow Dr. Sebastian, FL 32958
Email: pgravine@my.fit.edu
Phone: 610-724-4099
Twitter: @YouthRipples
URL: www.beneaththewavesfilmfest.org/youth-making-ripples/

Emily R. Hall
Staff Scientist and Manager of the Ocean Acidification Program
Mote Marine Lab
1600 Ken Thompson Parkway, Sarasota, FL 34236
Email: emily8@mote.org
Phone: 941-388-4441 x 327
Twitter: N/A
URL: N/A

Erin Handy
Climate and Energy Campaign Organizer, Florida
Oceana
940 17th Ave. N. Jacksonville Beach, FL 32250
Email: ehandy@oceana.org
Phone: 904-885-1348
Twitter:
URL: usa.oceana.org

Brian Hartz
Freelance Journalist
Southern Boating magazine
1900 52nd St. South, Gulfport, FL 33707
Email: bfhartz@gmail.com
Phone: 812-327-4770
Twitter: @BriWrites
URL: www.southernboating.com

Deborah Hilbert
Education Coordinator
Nature's Academy
3655 Cortez Rd, Suite 140, Bradenton, Fl 34210
Email: deborah@naturesacademy.org
Phone: 941-538-6829
Twitter: N/A
URL: naturesacademy.org

Andres Jimenez
Senior Manager, Government Relations
Ocean Conservancy
1302 19th St NW, Suite 8, Washington DC 20036
Email: ajimenez@oceanconservancy.org
Phone: 202.351.0453
Twitter: N/A
URL: oceanconservancy.org

Ray Judah
Coordinator
Florida Coastal Ocean Coalition
12664 Coconut Creek Court, Fort Myers, Florida 33908
Email: Ray.judah@icloud.com
Phone: (239) 218-7676
Twitter: N/A
URL: Flcoastalandocean.org

Dr. Barb Kirkpatrick
Executive Director
Gulf of Mexico Coastal Ocean Observing System Regional Association (GCOOS RA)
3146 TAMU, Department of Oceanography, College Station, TX 77843
Email: barb.kirkpatrick@gcoos.org
Phone: (941)724-4320
Twitter: N/A
URL: www.gcoos.org

Chris Langdon
Professor and Chair
Rosenstiel School of Marine and Atmospheric Science: Department fo Marine Biology and Ecology
3500 Coral Way Unit 1407, Miami, FL 33145
Email: clangdon@rsmas.miami.edu
Phone: 305-421-4614
Twitter:
URL: N/A

José H. Leal, PhD
Science Director / Curator
The Bailey-Matthews National Shell Museum
P.O. Box 1580 Bailey-Matthews National Shell Museum,3075 Sanibel-Captiva Road, Sanibel, Florida 33957 U.S.A.
Email: jleal@shellmuseum.org
Phone: 239-339-2233
Twitter: @josehleal52
URL: shellmuseum.org

Jay Leverone
Staff Scientist
Sarasota Bay Estuary Program
111 S. Orange Avenue, Suite 200W, Sarasota, FL 34236
Email: jay@sarasotabay.org
Phone: (941) 955-8085
Twitter: N/A
URL: www.sarasotabay.org

Jaclyn Lopez
Florida Director
Center for Biological Diversity
P.O. Box 2155, St. Petersburg, FL 33731
Email: jlopez@biologicaldiversity.org
Phone: 727-490-9190
Twitter:
URL: www.biologicaldiversity.org

Kathleen Lunz
Associate Research Scientist
Florida Fish and Wildlife Research Institute
100 8th Ave SE / Saint Petersburg Fl 33705
Email: kate.lunz@myfwc.com
Phone: 727-892-4123
Twitter: N/A
URL: N/A

Sage Melcer
Research Assistant
Ocean Conservancy
1300 19th St NW, Suite 8, Washington DC 20036
Email: smelcer@oceanconservancy.org
Phone: 202.280.6249
Twitter: @SageMelcer
URL: oceanconservancy.org

Ryan P. Moyer, Ph.D.
Associate Research Scientist
Florida Fish and Wildlife Research Institute
100 Eighth Ave SE, Saint Petersburg FL 33701
Email: ryan.moyer@myfwc.com
Phone: 1-727-892-4153
Twitter: N/A
URL: N/A

Erinn Muller, Ph.D.
Mote Marine Lab
1600 Ken Thompson Parkway, Sarasota, FL 34236
Email: emuller@mote.org
Phone: 941-388-4441
Twitter: N/A
URL: www.mote.org

Anton Oleinik
Associate Professor
Department of Geosciences, Florida Atlantic University
777 Glades Road, Boca Raton, FL 33431
Email: aoleinik@fau.edu
Phone: (561) 297-3297
Twitter: N/A
URL: www.geosciences.fau.edu

Holly Parker
Florida Regional Manager
Surfrider Foundation
1229 Mitchell Ave. Tallahassee, FL 32303
Email: hparker@surfrider.org
Phone: 850-567-3393
Twitter: @Surfrider
URL: surfrider.org

Valerie Paul
Director
Smithsonian Marine Station at Ft. Pierce
701 Seaway Drive, Ft. Pierce, FL 34949
Email: paul@si.edu
Phone: 772-462-0982
Twitter: N/A
URL: N/A

Shirley A. Pomponi
Research Professor & Executive Director
Cooperative Institute for Ocean Exploration, Research, and Technology
Harbor Branch Oceanographic Institute
Florida Atlantic University
5600 US 1 North, Fort Pierce, FL 34946
Email: spomponi@fau.eduPhone: 772-216-1631
Twitter: N/A
URL: www.fau.edu/hboi/mbbr/spongebio.php

Phil Purcell
Executive Director
Marine Industries Association
2312 South Andrews Ave., Fort Lauderdale, FL 33316
Email: phil@miasf.org
Phone: 954-524-2733
Twitter: N/A
URL: www.miasf.org

Pete Quasius
Advocacy Director
Audubon of the Western Everglades
4580 Little River Lane, Fort Myers, Fl, 33905
Email: pquasius@msn.com
Phone: 239.465.1556
Twitter: N/A
URL: N/A

Rep. Holly M. Raschein
FL Dist. 120 representative
Florida House of Representatives
99198 Overseas Highway Key Largo, FL 33037-2437
Email: Holly.Raschein@myfloridahouse.gov
Phone: (305) 453-1202
Twitter: @HollyRaschein
URL:
www.myfloridahouse.gov/Sections/Representatives/details.aspx?MemberId=4562

Kim B. Ritchie, Ph.D.
Senior Scientist and Coral Reef Ecology & Microbiology Program Manager
Mote Marine Lab
1600 Ken Thompson Parkway, Sarasota, FL 34236
Email: Ritchie@mote.org
Phone: 941-388-4441
Twitter: N/A
URL: mote.org

Cliff Ross
Chair/Associate Director
Dept. of Biology, University of North Florida
1 UNF Drive, Jacksonville, Fl 32224
Email: cliff.ross@unf.edu
Phone: (904) 620-1853
Twitter: N/A
URL: N/A

William Timothy Rumage

Coordinator, Environmental Studies
Ringling College of Art and Design
2700 N. Tamiami Trail, Sarasota FL 34234
Email: trumage@c.ringling.edu
Phone: 941 704 3051
Twitter: N/A
URL: planetaryethicist.com

John Scott
Group Chair
Sierra Club Calusa Group
6150 Bowling Rd., North Fort Myers, FL 33917
Email: John.scott@florida.sierraclub.org
Phone: 239-822-0048
Twitter: @sccalusagroup
URL: sierraclub.org/florida/calusa

Ruth Scott
Conservation Chair
Sierra Club Calusa Group
6151 Bowling Rd., North Fort Myers, FL 33917
Email: Ruth.scott@florida.sierraclub.org
Phone: 239-822-0048
Twitter: @sccalusagroup
URL: sierraclub.org/florida/calusa

Austin Seroka
Student
New College of Florida
1354 Grantham Dr. sarasota 34234
Email: austin.seroka12@ncf.edu
Phone: 281 727 8195
Twitter: N/A
URL: N/A

David Shafer
Shafer Consulting, LLC
1530 Dolphin Street, Suite 4
Sarasota, FL 34236
Email: david@shafer-consulting.org
Phone: 941-232-9952
Twitter: N/A
URL: www.shafer-consulting.org

Jennifer Shafer
Shafer Consulting, LLC
1530 Dolphin Street, Suite 4
Sarasota, FL 34236
Email: jennifer@shafer-consulting.org
Phone: 941-232-8222
Twitter: N/A
URL: www.shafer-consulting.org

Andrew N. Shepard
Director
Florida RESTORE Act Centers of Excellence Program
FIO, 830 First St. S, Saint Petersburg, FL 33701
Email: sheparda@usf.edu
Phone: 727-553-3374
Twitter: @FIOTweet
URL: www.fio.usf.edu/restore-act

Edward T. Sherwood
Senior Scientist
Tampa Bay Estuary Program
263 13th Ave. S., Suite 350, St. Petersburg, FL 33701
Email: esherwood@tbep.org
Phone: (727)893-2765
Twitter: N/A
URL: www.tbep.org

Brandon D. Shuler
Outreach Specialist
Ocean Conservancy
834 9th Ave S St Petersburg, Fl 33701
Email: bshuler@oceanconservancy.org
Phone: (832) 603-3787
Twitter: @brandonshuler
URL: oceanconservancy.org

Rodney Smith
President
Anglers for Conservation
265 South Robert Way Satellite Beach, FL 32937
Email: irlcoast@gmail.com
Phone: 321-750-3374
Twitter: @IrlcoastSmith
URL: rodneysmithmedia.com/

Mark J. Spalding
President
The Ocean Foundation
1320 19th St NW, 5th Floor
Email: mspalding@oceanfdn.org
Phone: 202-887-8996
Twitter: @oceanfdn
URL: www.oceanfdn.org

Brad Tanner
Senior School Programs Coordinator
Mote Marine Lab
1600 Ken Thompson Parkway Sarasota, FL 34236
Email: bradtanner@mote.org
Phone: 941.388.4441 x 351
Twitter: N/A
URL: N/A

Terry Tomalin
Outdoors editor
Tampa Bay Times
490 First Ave. South, St. Petersburg, FL 33701
Email: ttomalin@tampabay.com
Phone: (727) 709-3551
Twitter: N/A
URL: N/A

David Tomasko, Ph.D.
Pricipal Associate
ESA: Water Resources
7909 Hampton Lake Drive, Tampa, FL 33647
Email: dtomasko@esassoc.com
Phone: 813.207.7205
Twitter: N/A
URL: www.esassoc.com

David Vaughan
Executive Director TRL
Mote Marine Lab: Coral Reef Restoration
1600 Ken Thompson Parkway, Sarasota, FL 34236
Email: dvaughan@mote.org
Phone: 305-745-2729, ext202
Twitter: N/A
URL: www.mote.org

Abbey Wakely
Communications Specialist
SECOORA
209 9th Avenue N., St. Petersburg, FL 33701
Email: abbey@secoora.org
Phone: 863 838 4699
Twitter: @secoora
URL: www.secoora.org

Kimberly K. Yates, Ph.D.
USGS
600 Fourth Street South, St. Petersburg, Florida
33701
Email: kyates@usgs.gov
Phone: 727-502-8059
Twitter: N/A
URL: N/A