MidAtlanticRPB,
BOEM **boemmidatlanticrpb@boem.gov**

1:00 PM (3 hours ago)

to Alison, MidAtlanticRPB, maureen.bornho., gschultz, wabush1

Thank you for providing these recommendations on behalf of your organizations and their members.

We are forwarding your letter to the members of the MidA RPB for consideration as we prepare for the upcoming webinar and listening sessions.

We will also post your letter to the written public comments section on the MidA RPB webpage.

Please continue to contact us with any additional ideas or questions you may have.

On Wed, Feb 12, 2014 at 11:24 AM, Chase, Alison <achase@nrdc.org> wrote:

Below and attached please find a letter from several organizations regarding the Mid-Atlantic Regional Planning Body's work. Please feel free to contact me with any questions on these documents at 212.727.4551.

Sincerely,

Ali Chase

Citizens Campaign for the Environment • Clean Ocean Action • Maryland Coastal Bays Program • Miami2Maine • The National Aquarium • Natural Resources Defense Council • Ocean Conservancy • Surfrider Foundation • Wildlife Conservation Society

February 12, 2014

Mid-Atlantic Regional Planning Body Co-Leads:

Ms. Maureen Bornholdt
Renewable Energy Program Manager
Bureau of Ocean Energy Management
U.S. Department of the Interior
1849 C Street, NW
Washington, D.C. 20240

Ms. Gwynne Schultz
Senior Coastal and Ocean Policy Advisor
Maryland Department of Natural Resources
580 Taylor Avenue, E2
Annapolis, Maryland 21401

Mr. Gerrod Smith
Chief Financial Officer
Shinnecock Indian Nation
P.O. Box 5006
Southampton, New York 11969

Submitted electronically

Re: <u>The Mid-Atlantic Regional Planning Body's Upcoming Webinar and Listening Sessions on the Draft Framework</u>

Dear Ms. Bornholdt, Ms. Schultz, and Mr. Smith:

Thank you and the other Mid-Atlantic Regional Planning Body (MidA RPB or RPB) representatives for initiating a public outreach process to seek comment on the *Draft Mid-Atlantic Regional Ocean Planning Framework* (Framework).[1] Many of us will be attending the webinar and the listening sessions, and we look forward to sharing our feedback on the document with you at this time. In advance of the webinar, we want to share some recommendations for making the webinar and listening sessions even more successful and note a few additional topics beyond the Framework itself that we hope you will address.

As we have previously communicated, we recommend that for all official public meetings – in-person and webinars – a participant list that includes names and organizations be provided.[2] This document should be available upon arrival at the in-person meetings, such as the listening sessions, based on RSVPs and updated and posted online after the meetings and webinars. For webinars, participant names should be shown on screen. We further recommend that, in addition to continuing to allow participants the option to call in and voice questions in their own words, all questions posed by webinar participants be visible on screen so that everyone in attendance can see what issues are being raised and by whom. Allowing for a shared understanding of the individuals and organizations present at these meetings will help advance your efforts to ensure transparency and improve stakeholder communication.

We urge you to compile the comments from the webinar and those raised at the listening sessions into a summary document to be released before the Spring in-person MidA RPB meeting. If the Framework is revised prior to the meeting, we recommend that the summary document also describe the MidA RPB's process and rationale for making each substantive change. (If the Framework is not revised until later, the rationale for changes made should still be provided.) As a guide, we suggest the Washington Department of Ecology's summary of scoping on the Pacific Coast Marine Spatial Plan.[3] This document not only provides a rationale for changes that were made, but also includes an appendix which responds to each comment given. This kind of feedback on how changes are incorporated will result in greater stakeholder and public support, as it is made clear the impacts that individuals' time and efforts have made and allows for a greater understanding the reasoning behind decisions.

As the final Framework is intended to be a "blueprint for a more detailed, strategic MidA RPB work plan" and provides a "starting point" for coordinated ocean planning work, it is critical that participants view the listening sessions as the beginnings of a dialogue on what the MidA RPB's final work plan should contain.[4] It is important to have robust engagement from the state RPB members at the meetings so that the sessions are less about formal public comment and more about discussion. We urge you to answer questions to the extent possible at the upcoming sessions, so that the public has a better grasp of how you see this work unfolding and the directions it might go in.

We also recommend that the MidA RPB address several fundamental questions beyond the scope of the Framework on the webinar, in particular an update on the RPB's charter. Many of us attended the September 2013 RPB meeting and commented on the RPB's charter; we followed up with the attached letter, which addressed several points,[5] including:

- The mission and member commitments sections of the RPB's charter[6] should indicate a desire on behalf of all parties to use the ocean planning vehicle to advance shared priorities and produce a coordinated ocean plan by 2016.[7]

- We recommend adding the following sentence to the charter's mission: "The RPB commits to working together to help ensure healthy ocean and coastal resources and encourage sustainable use in order to promote the well-being, prosperity and security of present and future generations."

- The importance of conducting the Regional Ocean Assessment should be stated in the charter's mission, and upfront commitments should be made to use the best available data in planning and develop an iterative, adaptive process to ensure that the Regional Ocean Assessment and the coastal and marine spatial plan itself remain living documents.

- The role of stakeholders and the public in planning should be identified in the RPB's charter, and the RPB charter should note that any additional stakeholder engagement mechanisms be added as an appendix to the document.

We recommend that a summary document of comments submitted regarding the charter and RPB responses also be prepared, for the same reasoning as provided earlier.

We appreciate the Mid-Atlantic Regional Council on the Ocean's (MARCO) efforts to establish the new Stakeholder Liaison Committee (SLC) and are looking forward to learning more regarding the makeup and role of this body at the March 10, 2014 meeting. As previously noted, we recommend that this meeting and all SLC meetings be open to the public.[8] The SLC meetings and those of the RPB should be included in the work plan and announced at the listening sessions, so that stakeholders and members of the public can plan ahead to continue their engagement. We also recommend that the roles of MARCO and the RPB relative to each other be described at the listening sessions, and that any efforts to establish a MidA RPB science advisory panel – to advise this body on technical matters and to provide regular and meaningful advice at all stages of the planning process – be addressed.

On behalf of our organizations and their members, we appreciate your work and the opportunity to comment and engage in the Mid-Atlantic's coordinated ocean planning process to develop a plan that protects, maintains and restores the health of the Mid-Atlantic's valuable ocean and coastal resources for now and for the future. We look forward to seeing you at the upcoming listening sessions.

Sincerely,

Ali Chase
Policy Analyst
Natural Resources Defense Council

Matt Gove
Mid-Atlantic Policy Manager
Surfrider Foundation

Adrienne Esposito
Executive Director
Citizens Campaign for the Environment

Eric Schwaab
Senior VP/ Chief Conservation Officer
The National Aquarium

Cindy Zipf
Executive Director
Clean Ocean Action

Anne Merwin
CMSP Program Director

Ocean Conservancy

Dave Wilson
Executive Director
Maryland Coastal Bays Program

Margo Pellegrino
Founder
Miami2Maine

Merry Camhi
Director, New York Seascape
Wildlife Conservation Society

Alison Chase
Policy Analyst
Natural Resources Defense Council
40 West 20th Street
New York, NY 10011
Phone: 212.727.4551
Fax: 212.727.1773
achase@nrdc.org

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[1] *Available at* http://www.boem.gov/Draft-Mid-Atlantic-Regional-Ocean-Planning-Framework/.

[2] NRDC, et al. Letter re: Discussion Points from the Mid-Atlantic Regional Planning Body's August 1st Webinar to: Maureen Bornholdt, Gwynne Schultz, and Gerrod Smith. 4 September 2013.

[3] Washington Department of Ecology. *Marine Spatial Plan for Washington's Pacific Coast: Summary of SEPA Scoping and Response to Comments*. January 2013. *Available at* http://www.msp.wa.gov/wp-content/uploads/2014/01/MSP_scoping_summary_2014.pdf.

[4] Frequently Asked Questions about the *Draft Mid-Atlantic Regional Ocean Planning Framework* at 2. *Available at* http://www.boem.gov/Environmental-Stewardship/Mid-Atlantic-Regional-Planning-Body/FAQs-about-MidA-RPB-Draft-Framework-2014.aspx.

[5] NRDC, et al. Letter re: The Mid-Atlantic Regional Planning Body's Inaugural Meeting and Draft Documents to: Maureen Bornholdt, Gwynne Schultz, and Gerrod Smith. 8 October 2013.

[6] DRAFT Charter for the Mid-Atlantic Regional Planning Body at 2 and 5. *Available at*http://www.boem.gov/Environmental-Stewardship/Mid-Atlantic-Regional-Planning-Body/MidA-RPB-Materials.aspx.

[7] Additionally, the draft RPB charter's member commitment statement that "The Members agree, to the extent *practicable* and consistent with their underlying authorities, to participate in the process for marine planning…" (p. 5, emphasis added) falls short of Executive Order 13547's call for members of the federal family to develop and comply with plans "to the fullest extent consistent with applicable law" and, accordingly, the statement should be revised by inserting "fullest" before "extent" and removing the word "practicable." All National Ocean Policy documents should be used in developing a coastal and marine spatial plan.

[8] NRDC, et al. Letter re: Public and Stakeholder Engagement in the Mid-Atlantic Regional Planning Body Process to: Maureen Bornholdt, Sarah Cooksey, and Gerrod Smith. 30 May 2013.

Re: "Mid-Atlantic Regional Planning Body"--comments from Green Delaware

1 message

MidAtlanticRPB, BOEM <boemmidatlanticrpb@boem.gov> Wed, Feb 19, 2014 at 12:32 PM

To: Alan Muller--Green Delaware <greendel@dca.net>
Cc: BOEM MidAtlanticRPB <MidAtlanticRPB@boem.gov>, Maureen Bornholdt <maureen.bornholdt@boem.gov>, brent.greenfield@oceanpolicy.org, "Amy Roe (Delaware Sierra Club)" <amywroe@gmail.com>, "Mark Martell (Delaware Audubon)" <mmartell@icg.com>, John.Kowalko@state.de.us

Dear Mr. Muller,

Thank you for providing these comments to the Mid-Atlantic Regional Planning Body (MidA RPB) co-leads on behalf of your organizations.

We are forwarding your message to the members of the MidA RPB for consideration as we prepare for the upcoming listening sessions, which we encourage you to attend.

We will also post your letter to the written public comments section on the MidA RPB webpage.

Please continue to contact us with any additional ideas or questions you may have.

Sincerely,

Maureen A. Bornholdt

on behalf of the

Mid-Atlantic Regional Planning Body Co-Leads

On Tue, Feb 18, 2014 at 12:12 PM, Alan Muller--Green Delaware <greendel@dca.net> wrote:

February 13, 2014

Ms. Maureen Bornholdt
Mid-Atlantic Regional Planning Body Federal Co-Lead
Renewable Energy Program Manager
Bureau of Ocean Energy Management
1849 C Street, NW
Washington, D.C. 20240

Ms. Gwynne Schultz
Mid-Atlantic Regional Planning Body State Co-Lead
Senior Coastal and Ocean Policy Advisor
Maryland Department of Natural Resources
580 Taylor Avenue
Annapolis, MD 21401

Mr. Gerrod Smith
Mid-Atlantic Regional Planning Body Tribal Co-Lead
Chief Financial Officer/Natural Resource Advisor
Shinnecock Indian Nation
PO Box 5006
Southampton, NY 11969
Submitted Electronically via

Dear Ms. Bornholdt, Ms. Schultz, and Mr. Smith:

We have been receiving emails in connection with the "Mid-Atlantic Regional Planning Body" for some time, to which, I admit, we have not paid a great deal of attention. This is because it has not been obvious to us what the real significance of this is.

The language in your documents seems, for the most part, vague, generic, and hypothetical.

The transcript of the August 1, 2013 "Webinar" contains this:

"Good morning and thank you for joining us today to learn more about the progress and next steps of the Mid-Atlantic Regional Planning Body. I believe we're all joining together today because of our deep love of and connection to the ocean. This connection may stem from our appreciation the fish and wildlife and other natural resources that the ocean supports, the cultural treasures that are important to understanding our past and that many of our livelihoods depend on the resources that are in, above or below the ocean. I also believe that we all joined today's webinar because we know there are better ways to manage the ocean. There are more opportunities to streamline government decision making and improve efficiency. We also want to make sure that this ocean planning process does not in some way negatively impact us, our constituents or the businesses in the regions that depend on the ocean."

Later follows a--not very convincing--discussion of why the United States Government lacks the resources to establish a "stakeholder" advisory committee.

What is all this really about, in plain language, and why should the public be interested? (My inference is that this is about establishing an industry-friendly regulatory framework for offshore energy development, including wind turbines, transmission infrastructure, and hydrocarbon exploration and production. Is this correct?)

Looking at the "Mid-Atlantic Regional Planning Body Roster of Members and Alternates, January 2014" I do not see strong representation of "environmental" concerns or "user" concerns.

It appears from documents posted that various NGOs interested in "ocean policy" have requested repeatedly that advisory bodies be established and given a substantive role, yet the responses to these requests have been, up to this point, insubstantial.

The history of the Minerals Management Service (now doing business as BOEM) does not offer confidence that offshore industrial activities would be conducted with adequate care. We would, of course, like to see this change and hope the situation is improving. Yet, expansion of offshore extraction should come <u>after</u>, not <u>before</u>, such improvements have been demonstrated.

Many of the activities BOEM is about promoting, if not carried out with extreme care, have potential to do great harm to Mid-Atlantic coastal resources. Some are so fundamentally dangerous that they should be excluded categorically. Continuing spills, leaks, collisions, explosions, large-scale flaring and venting of gaseous and liquid hydrocarbon, and so on, suggest that acceptable industry practices and effective regulatory regimes are not yet in place. Addressing these fundamental shortcomings would be an appropriate activity.

Up to this point, I do not see that the various "outreach" and "public engagement" activities you are carrying out reflect a substantive commitment to transparency in policy making or implementation, or to addressing substantive concerns. Therefore, encouraging the public to participate in them is questionable from our point of view.

Yours very truly,

Alan Muller

From: **MidAtlanticRPB, BOEM** <boemmidatlanticrpb@boem.gov>
Date: Fri, Jun 6, 2014 at 2:29 PM
Subject: Re: Mid-Atlantic planning framework
To: Ben Furimsky <ben@flyfishingshow.com>

Thank you for your message about regional ocean planning and recreational fishing. The Mid-Atlantic RPB will consider all comments received, and will post them on the website.

During the Mid-Atlantic RPB meeting in May, the RPB discussed a strategy to further engage all Mid-Atlantic stakeholders in regional ocean planning, identified next steps and a timeline for regional ocean planning products and processes, and shared information about activities underway by RPB member institutions that are relevant for regional ocean planning. Meeting materials are posted on the website: http://www.boem.gov/Mid-Atlantic-Regional-Planning-Body/. The draft stakeholder engagement strategy outline is available on the website for public comment until July 15. Please check the website for additional information and updates, and please continue to share any comments you might have.

On Fri, Jun 6, 2014 at 11:19 AM, Ben Furimsky <ben@flyfishingshow.com> wrote:

Hi,
I was reading about the planning framework for the Mid-Atlantic ocean waters that is being set up. I believe this is a great step forward and consistency throughout the region is very important, especially in the case of many of our fish that are migratory. I also believe it is very important to include states to the north and south of our region because there are states that wipe out fish populations due to poor regulations before the migratory fish enter our region. I am writing to make sure you consider recreational fishing separate from any commercial fishing. Recreational anglers bring in many more dollars to the area. It is also important to note that a growing number of anglers are only out for sport and release all fish. While we can’t deny there is some mortality in catch and release, it still helps to preserve the quality of a fishery in a non-consumptive way. I look forward to the results.

Thanks,
Ben Furimsky
Co-Director
Fly Fishing Show
ben@flyfishingshow.com

From: **MidAtlanticRPB, BOEM** <boemmidatlanticrpb@boem.gov>
Date: Tue, Jun 24, 2014 at 3:42 PM
Subject: Re: Letter to the Mid-Atlantic Regional Planning Body re: the May 20-21 Meeting
To: "Chase, Alison" <achase@nrdc.org>
Cc: "MidAtlanticRPB@boem.gov" <MidAtlanticRPB@boem.gov>, "maureen.bornholdt@boem.gov" <maureen.bornholdt@boem.gov>, "gschultz@dnr.state.md.us" <gschultz@dnr.state.md.us>, "treyleonard@gmail.com" <treyleonard@gmail.com>

Dear Ms. Chase,

Thank you for the June 23, 2014, letter to the Mid-Atlantic Regional Planning Body Co-Leads on behalf of organizations interested in working with us as we continue our efforts on regional ocean planning.

Your letter is very thoughtful and it raises many important issues. We will forward your letter to the members of the MidA RPB for consideration as we discuss our next steps. In addition, we will post your letter to the written public comments section on the Mid-A RPB webpage.

We also appreciate the comments you made during our May meeting in Baltimore. Please continue to contact us with any additional ideas or questions you may have.

Sincerely,

Maureen A. Bornholdt

Gwynne Schultz

Kelsey Leonard

On Mon, Jun 23, 2014 at 3:10 PM, Chase, Alison <achase@nrdc.org> wrote:
Hi Everyone –

My apologies, but one organization was missing from the previous letter. Attached please find the final version with all signers. No other changes have been made to the letter. Many thanks – Ali

From: Chase, Alison
Sent: Monday, June 23, 2014 12:18 PM
To: 'MidAtlanticRPB@boem.gov'
Cc: 'maureen.bornholdt@boem.gov'; 'gschultz@dnr.state.md.us'; 'treyleonard@gmail.com'
Subject: Letter to the Mid-Atlantic Regional Planning Body re: the May 20-21 Meeting

Below and attached please find a letter from several organizations regarding the Mid-Atlantic Regional Planning Body's work. Please feel free to contact me with any questions on these documents at 212.727.4551.

Sincerely,

Ali Chase

American Littoral Society ● Anacostia Watershed Society ● Maryland Academy of Sciences at The Maryland Science Center ● Maryland Coastal Bays Program ● Miami2Maine ● National Aquarium ● Natural Resources Defense Council ● Ocean Conservancy ● Operation SPLASH ● Surfrider Foundation ● TerraScapes ● Wildlife Conservation Society

June 23, 2014

Mid-Atlantic Regional Planning Body Co-Leads:

Ms. Maureen Bornholdt
Renewable Energy Program Manager
Bureau of Ocean Energy Management
U.S. Department of the Interior
1849 C Street, NW
Washington, D.C. 20240

Ms. Gwynne Schultz
Senior Coastal and Ocean Policy Advisor
Maryland Department of Natural Resources
580 Taylor Avenue, E2
Annapolis, Maryland 21401

Ms. Kelsey Leonard
Shinnecock Indian Nation
P.O. Box 5006
Southampton, New York 11969

Submitted electronically

Re: The Mid-Atlantic Regional Planning Body's May 20-21 Meeting

Dear Ms. Bornholdt, Ms. Schultz, and Ms. Leonard:

On behalf of our organizations listed above and their millions of members and activists, we congratulate you and the other Mid-Atlantic Regional Planning Body (MidA RPB or RPB) representatives on a successful May meeting and, in particular, on approving a final *Mid-Atlantic Regional Ocean Planning Framework* (Framework).[1] We appreciated the opportunity to review a revised Framework draft, as well as the rest of the briefing book materials,[2] in advance of the meeting; it greatly helped those of us who were able to attend come prepared to contribute to the discussion.[3]

We offer the below recommendations on the other briefing book items, building on the ideas that many of our organizations shared at the meeting and look forward to a continued discussion with you on these recommendations.

I. The MidA RPB should develop its Regional Ocean Action Plan by 2016.

Thank you for committing to develop a Regional Ocean Action Plan (Plan) to achieve the Framework's healthy ocean and sustainable use goals and objectives. We were pleased to hear the announcement at Capitol Hill Ocean Week that the Administration supports finalization of a Mid-Atlantic Plan in 2016 and we urge all of you to help meet that commitment. Coordinated ocean plans are a key aspect of the new stewardship approach to ocean management that has taken shape under this Administration; please tighten up the Workplan's draft timeline[4] so that the Plan – which should include implementation actions – is submitted to the National Ocean Council (NOC) for its approval in 2016.

In addition, as many of us expressed at the May meeting, we want to see the Plan identify – based on the Regional Ocean Assessment (ROA) – ocean areas that are appropriate for different uses and those that need protection in order to ensure that the ecosystem is healthy.

To lay the proper groundwork for the Plan, the ROA should spatially show where important ecological areas are: for example, marine mammal migratory pathways and important fish habitat. It should also show where existing and future offshore uses occur/are likely to occur, for example, based on characteristics such as substrate and wind speed. The document should also identify the impacts of various uses, from shipping to offshore renewables, on the environment and recommend where and when activities should occur to avoid or minimize impacts. Based on an understanding of where uses are occurring or anticipated and the interactions, the ROA should analyze how well different spatial configurations of uses would meet the Framework's goals and objectives, analyze cumulative impacts, and note where activities would be able to coexist.

The *Final Recommendations of the Interagency Ocean Policy Task Force* (Final Recommendations) offers important guidance. The Final Recommendations state, "The regional assessment would include: relevant biological, chemical, ecological, physical, cultural, and historical characteristics of the planning area; ecologically important or sensitive species/habitats/ecosystems; and areas of human activities. The assessment would also include an analysis of ecological condition or health and of cumulative risks as well as forecasts and models of cumulative impacts."[5] The Final Recommendations also call for the RPB to "… identify a range of alternative future spatial management scenarios based upon the information gathered on current, emerging, and proposed human uses, ecosystem conditions, and ecosystem services. Comparative analyses would assess, forecast, and analyze the tradeoffs and cumulative effects and benefits among multiple human use alternatives. The alternatives and the supporting analyses would provide the basis for a draft … Plan."[6]

The Plan should build from the ROA and select an optimal scenario for the region's development that maximizes the benefits of where and when things occur and identifies actions that each of the agencies can take – using existing authorities – to ensure this. The Final Recommendations state the Plan should "… describe the spatial determinations for conservation and uses, at the appropriate scale, and include any necessary visual representations. The … Plan would describe the strategies, methods, and mechanisms for integrated or coordinated decision-making, including addressing use conflicts. [It] would further describe the continuing processes by which implementation would proceed, including mechanisms to ensure that individual partner and collaborative decision-making are reviewed for consistency with plan priorities and objectives."[7]

The Plan needs to also identify performance measures, benchmarks and indicators to evaluate the Plan's effectiveness in achieving its goals and objectives. This work includes development of a series of ecological indictors to assess regularly the natural system's baseline health in order to better understand the changing environmental conditions and the impacts from increased human activities. Specifically, the Final Recommendations call for "Performance measures [that] would assess both conservation and socio-economic objectives of the [regional ocean plan]. Measures of conservation may include, but are not limited to, indicators of ecosystem health such as the status of native species diversity and abundance, habitat diversity and connectivity, and key species (*i.e.,*species known to drive the structure and function of ecosystems)."[8] This concept is also expressed in the new Framework's principle regarding adaptability: "The MidA RPB will embrace a flexible and adaptive approach in accommodating changing environmental and economic conditions, advances in science and technology, and new or revised laws and policies. The MidA RPB will track progress towards meeting established planning objectives and use the information gained to modify and adapt MidA RPB actions."[9]

II. The final Plan should identify and protect important ecological areas.

One key component to Plan development is identifying a network of areas important for spawning, breeding, feeding and migrating ocean fish and wildlife to ensure that the ecosystems continue to function and are resilient in the face of new challenges like increasing ocean uses, ocean acidification and climate change. The Final Recommendations state:

> With assistance from scientific and technical experts, the regional planning body would investigate, assess, forecast, and analyze the following:
>
> - Important physical and ecological patterns and processes (*e.g.*, basic habitat distributions and critical habitat functions) that occur in the planning area, including their response to changing conditions;
>
> - The ecological condition and relative ecological importance or values of areas within the planning area, *including identification of areas of particular ecological importance*, using regionally-developed evaluation and prioritization schemes that are consistent with national guidance provided by the NOC;
>
> - The economic and environmental benefits and impacts of ocean, coastal, and Great Lakes uses in the region;
>
> - *The relationships and linkages within and among regional ecosystems, including neighboring regions both within and outside the planning area, and the impacts of anticipated human uses on those connections*;
>
> - The spatial distribution of, and conflicts and compatibilities among, current and emerging ocean uses in the area;
>
> - Important ecosystem services in the planning area and their vulnerability or resilience to the effects of human uses, natural hazards, and global climate change;
>
> - The contributions of existing placed-based management measures and authorities; and
>
> - Future requirements of existing and emerging ocean, coastal, and Great Lakes uses.[10]

In the final Plan, the RPB should steer project siting to less sensitive areas. The Final Recommendations note: "[Spatial planning] ultimately is intended to result in protection of areas that are essential for the resiliency and maintenance of healthy ecosystem services and biological diversity, and to maximize the ability of marine resources to continue to support a wide variety of human uses."[11] Currently, despite the extent of ecologically and economically valuable offshore habitat within the region, there are virtually no habitat areas designated for year-round protection.[12] The RPB has an opportunity to rectify this situation by identifying in the Plan various actions that agencies will take under existing authorities to protect these special ecological places.

We look forward to working with the newly-established Regional Ocean Action Plan Workgroup to flesh out further the Plan's "nature and purpose … what additional information and actions are needed to develop it".[13]

III. The MidA RPB should finalize the Workplan and Charter in 2014.

The Workplan should be completed this year to clarify and direct the RPB's activities – many of which are already ongoing, such as the ROA. Our organizations understand that the Workplan may need to be modified throughout the process to incorporate revisions to planning products; however, we hope that the primary actions, timelines and capacities to advance the Framework's goals of healthy ocean ecosystems and sustainable use, and their associated objectives, will be finalized in 2014. *Moreover, forward movement on the ROA and the Plan development should not await nor be slowed down pending finalizing of the Workplan*.

As the RPB develops the Workplan, we recommend adding in specific tasks, noting which agencies are doing what work, and the planned-for results, similar to what the Northeast Regional Planning Body has done.[14] We hope to review a draft of the Workplan in advance of the next meeting this Fall and to see it finalized at the meeting, after opportunity for comment.

We appreciated the update on the Charter's status at the RPB meeting and share your hope that the document will be finalized soon. While the RPB has done much to engage the public and seek feedback, the Charter is one category where we believe that outreach has fallen seriously short. We appreciate the RPB's assurances that many of our recommendations on Charter edits have been incorporated, but would appreciate an update on which changes have been adopted and, if not, why, when the final Charter is made available.[15] We recommend that future opportunities for document feedback follow the most recent example of the Framework revision process instead.

IV. To review and advise the MidA RPB's products, the RPB should develop a science engagement strategy.

Our organizations appreciate the RPB's stakeholder outreach efforts to date, in particular the public outreach that the RPB conducted with listening sessions and through sharing various iterations of the draft Framework. We recommend that the RPB continue to reach out to all parties and look forward to commenting on the *Mid-Atlantic Regional Ocean Planning Stakeholder Engagement Strategy Draft Outline* (Strategy Draft Outline).[16]

One particular community that should be expeditiously engaged further in this process is the science community. We recommend holding a webinar for this community in the coming months and identifying components of the RPB's work where they might be able to engage. As previously noted, our organizations believe that a science advisory panel comprised of academics and subject matter experts should be established to provide feedback on the ROA and other work products.[17] The Final Recommendations envision the science community's engagement: "The regional planning body would consult scientists, technical experts, and those with traditional knowledge of or expertise in coastal and marine sciences and other relevant disciplines throughout the process to ensure that [planning] is based on sound science and the best available information. To this end, the regional planning body would establish regional scientific participation and consultation mechanisms to ensure that the regional planning body obtains relevant information."[18] As it currently stands, despite the fact that the Framework notes a need to "Consult scientists, technical, and other experts in conducting regional ocean planning and developing ocean planning products", the Strategy Draft Outline does not mention this particular stakeholder subset.[19] We recommend moving quickly to establish an outreach effort to the science community and an advisory panel to assist the RPB's work so that they can be ready to review drafts of the ROA and other products.

Conclusion

As the RPB well knows, only a healthy ocean can continue to provide the food, jobs and recreation we want and need. The Mid-Atlantic's ocean resources support more than 670,000 jobs, with the tourism and recreation sector representing almost three-quarters of these.[20] In 2012, 2.3 million recreational anglers took 14 million fishing trips in the Mid-Atlantic region.[21] These jobs rely on clean coastal waters and beaches and healthy and abundant fish and wildlife.

We are at a unique historical juncture where the plans we set in place now will determine how well the Mid-Atlantic's ocean waters and wildlife – already under stress from pollution, destruction of productive marine habitats, climate change and ocean acidification – continue to function and provide for us as increased shipping, offshore wind, sand mining and other uses escalate. The sooner we have a final Plan, the sooner agencies can refine their ways of doing business to better align with the region's shared goals, including advancing our ocean ecosystem health. If we fail to plan, we are essentially planning to fail.

We appreciate the RPB's efforts and look forward to working with you as you continue your deeply important work to develop a final Plan to guide the region's ocean protection and sustainable use.

Sincerely,

Ali Chase

Policy Analyst

Natural Resources Defense Council

Matt Gove

Mid-Atlantic Policy Manager

Surfrider Foundation

Eric Schwaab
Senior VP/Chief Conservation Officer

National Aquarium

Van R. Reiner
President and CEO
Maryland Academy of Sciences at The Maryland Science Center

Tim Dillingham
Executive Director
American Littoral Society

Anne Merwin
Director
Coastal & Marine Spatial Planning
Ocean Conservancy

Dave Wilson

Executive Director

Maryland Coastal Bays Program

James Foster

President

Anacostia Watershed Society

Merry Camhi, PhD
Director
New York Seascape
Wildlife Conservation Society

Terra Pascarosa Duff
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TerraScapes

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achase@nrdc.org

[1] *Available at* http://www.boem.gov/Mid-Atlantic-Regional-Ocean-Planning-Framework/.

[2] *Available at* http://www.boem.gov/MidA-RPB-May-20-21-2014-Meeting-Materials/.

[3] The *Executive Summary of the Mid-Atlantic Regional Planning Body's Public Listening Sessions on the Draft Framework* was helpful for those of us unable to attend all of the coastal meetings andwe recommend that future outreach efforts include both a similar summary document and the MidA RPB's process and rationale for making each substantive change, based on this feedback. Knowing why RPB members decided for or against recommended changes would allow our comments to be more substantive and directed.

[4] The *Process Recommendations for Mid-Atlantic RPB Consideration* calls for development of a Plan by mid-2017, with work on an implementation/ adaptation plan for the Plan to begin only after.*Available at* http://www.boem.gov/MidA-RPB-May-20-21-2014-Meeting-Materials/.

[5] Final Recommendations at 59, *available at* http://www.whitehouse.gov/files/documents/OPTF_FinalRecs.pdf.

[6] Final Recommendations at 57, *available at* http://www.whitehouse.gov/files/documents/OPTF_FinalRecs.pdf.

[7] Final Recommendations at 59, *available at* http://www.whitehouse.gov/files/documents/OPTF_FinalRecs.pdf.

[8] Final Recommendations at 64, *available at* http://www.whitehouse.gov/files/documents/OPTF_FinalRecs.pdf. Also, at 59, "As part of monitoring and evaluation, regional planning bodies would define a clear set of regional performance measures to be used to assess whether or not the region is meeting national and regional objectives and goals."

[9] Framework at 5. *Available at* http://www.boem.gov/Mid-Atlantic-Regional-Ocean-Planning-Framework/.

[10] Final Recommendations at 57, *available at* http://www.whitehouse.gov/files/documents/OPTF_FinalRecs.pdf. Emphasis added.

[11] Final Recommendations at 44, *available at* http://www.whitehouse.gov/files/documents/OPTF_FinalRecs.pdf.

[12] Chasis, S. and C. Bower. 2013. Legal Mechanisms and Opportunities to Advance Ocean Habitat Protection in the Mid-Atlantic. *Sea Grant Law and Policy Journal*, *6* (1), 147-164. *Available at* http://nsglc.olemiss.edu/sglpj/vol6no1/7-Chasis.pdf.

[13] *Process Recommendations for Mid-Atlantic RPB Consideration*, *available at*http://www.boem.gov/MidA-RPB-May-20-21-2014-Meeting-Materials/.

[14] Northeast Regional Planning Body. *Framework for Ocean Planning in the Northeast United States*, *available at* http://neoceanplanning.org/wp-content/uploads/2014/02/NE-Regional-Ocean-Planning-Framework-February-2014.pdf.

[15] *See*, for example, the letters several of our organizations submitted to the MidA RPB on November 4, 2013 and February 12, 2014.

[16] *Available at* http://www.boem.gov/MidA-RPB-May-20-21-2014-Meeting-Materials/.

[17] *See*, for example, the letters several of our organizations submitted to the MidA RPB on September 4, 2013, November 4, 2013 and February 12, 2014.

[18] Final Recommendations at 56, *available at* http://www.whitehouse.gov/files/documents/OPTF_FinalRecs.pdf.

[19] Framework at 2. *Available at* http://www.boem.gov/Mid-Atlantic-Regional-Ocean-Planning-Framework/.

[20] National Oceanic and Atmospheric Administration, ENOW Data Wizard. Mid-Atlantic, 2011.*Available at* http://www.csc.noaa.gov/ENOWDataWizard/index.jsp?RegionList=-4&vYears=2011.

[21] National Marine Fisheries Service. 2014. *Fisheries Economics of the United States, 2012*. U.S. Department of Commerce, NOAA. *Available at* http://www.st.nmfs.noaa.gov/economics/publications/feus/fisheries_economics_2012. Please note that the results from this survey cannot be directly compared to the ENOW data; the analyses use different data and models. Please note that the NMFS report includes self-employed fishermen.

From: **MidAtlanticRPB, BOEM** <boemmidatlanticrpb@boem.gov>
Date: Thu, Sep 4, 2014 at 8:05 AM
Subject: Re: OA, OA Data, & Climate Change
To: MARY FALL WADE <mfwade_99@hotmail.com>

Thank you for submitting suggestions concerning important ocean issues. The MidA RPB will consider all comments received as we discuss our next steps. In addition, we will post your message on the written public comments section on the MidA RPB webpage.

One of the MidA RPB's objectives is to "Facilitate enhanced understanding of current and anticipated ocean ecosystem changes in the Mid-Atlantic. These include ocean-related risks and vulnerabilities associated with ocean warming (including sea level rise, coastal flooding/inundation), ocean acidification (including effects on living marine resources), and changes in ocean wildlife migration and habitat use." There are a number of federal agencies represented on the MidA RPB (NOAA, BOEM, and EPA) that will help inform the development of actions under this objective. You might be aware that NOAA is a partner with the OA-ICC, and NOAA, BOEM and EPA are part of an interagency work group on ocean acidification. These federal partners have mandates for research and/or management of resources likely to be impacted by ocean acidification.

Please continue to contact us with any additional ideas you may have. As a reminder, the MidA RPB is working on draft products that will be shared for public review and input later this fall. Please check the website (http://www.boem.gov/Mid-Atlantic-Regional-Planning-Body/) for updates and additional information.

On Tue, Sep 2, 2014 at 10:08 PM, MARY FALL WADE <mfwade_99@hotmail.com> wrote:
Dear Mid-Atlantic RPB:

I am curious why you aren't partnering with GOA-OA or the OA-ICC for ocean acidification? Are policy makers taking OA into account when planning for aquaculture and MPAs?

In addition to using some of the IAEA's OA-ICC's data on OA, it seems some of their research on climate change could potentially be pertinent?

- OA-ICC: http://www.iaea.org/ocean-acidification/page.php?page=2181
- Coping with Climate Change: http://www.iaea.org/newscenter/focus/climatechange/
- Isotopes in Hydrology, Marine Ecosystems, and Climate Change Studies : http://www-naweb.iaea.org/na/about-na/na-ddgs-symposium-isotopes.html
- Isotopic Tools for Protecting the Seas: http://www-naweb.iaea.org/na/resources-na/factsheets/Environment/Isotopic%20Tools%20for%20Protecting%20the%20Seas.pdf
- Protecting the Marine Environment: http://issuu.com/iaea_bulletin/docs/oceans
- Policy Brief on Ensuring Survival: Oceans, Climate, and security: http://issuu.com/christinadianparmionova/docs/policy_brief_on_oceans_and_climate

MARY FALL WADE
mfwade_99@hotmail.com
https://www.linkedin.com/pub/mary-fall-wade/48/117/561

From: **MidAtlanticRPB, BOEM** <boemmidatlanticrpb@boem.gov>
Date: Fri, Sep 5, 2014 at 9:08 AM
Subject: Re: Resources for People Who Want to Learn More About OA
To: MARY FALL WADE <maryfallwade@gmail.com>

Thank you for providing information about ocean acidification as it relates to ocean planning. We appreciate the information and will post your message containing all of the resources onto the MidA RPB's webpage under Written Public Comments. The MidA RPB will consider all input received as we discuss our next steps, and will consider posting additional information to the website in a future revision.

Please continue to contact us with any additional ideas you may have. As a reminder, the MidA RPB is working on draft products that will be shared for public review and input later this fall. Please check the website (http://www.boem.gov/Mid-Atlantic-Regional-Planning-Body/) for updates and additional information.

On Thu, Sep 4, 2014 at 10:54 AM, MARY FALL WADE <maryfallwade@gmail.com> wrote:
Hello Mid-Atlantic RPB:

For members of the general public and policy makers who want to learn more about ocean acidification and its role in MSP, I would like to highlight the OA-ICC news stream from the OA-ICC which I find particularly useful. The news stream also lists upcoming meetings and such. As an example, I would like to highlight the following articles:

- Ocean Acidification from Domestic to International: This discusses the US Inter-Agency Work Group on OA composed of NOAA, NASA, the US Navy, US Fish and Wildlife Service, and BOEM: http://news-oceanacidification-icc.org/2014/09/04/ocean-acidification-from-domestic-to-international/
- Clownfish that Inspired Finding Nemo Closer to Endangered Species Act Protection: This discusses a few of the threats from ocean acidification, including threats to the orange clownfish, which galvanized public support as the species was popularized in the Finding Nemo movie: http://news-oceanacidification-icc.org/2014/09/04/clownfish-that-inspired-finding-nemo-closer-to-endangered-species-act-protection/

Also of note is the OA-ICC's Communication Resources which includes OA resources for a variety of audiences:

- Resources for Policy Makers: http://www.iaea.org/ocean-acidification/page.php?page=2232
- Resources for the General Public: http://www.iaea.org/ocean-acidification/page.php?page=2231

In addition, the NOAA OA Story Map is rather informative:

- http://weather.maps.arcgis.com/apps/MapTour/index.html?appid=0ac58c426e6749bfb3b3314ba7d6a646&webmap=a390999867714bed9127456ef50e9f68

Finally, the GOA-ON webpage explains the international OA framework:

- GOA-ON Homepage: http://www.goa-on.org/GOA-ON.html
- Global Ocean Acidification Observation Network: Requirements and Governance Plan (attached)

It took me awhile to locate these resources, so I thought I would provide them for others so they do not have to dig around on the web to find them. Perhaps some of these resources could be included on the BOEM Related Resources page, in MarineCadastre, or perhaps NOAA's CMSP Data Registry could give OA a nod and indicate that OA is a CMSP consideration and OA data consolidation is in the works? Eventually, guidance on modeling OA to inform adaptive MSP would be very useful. It would better help people like me understand the CMSP-OA nexus (Washington State's efforts with regard to the CMPS-OA nexus are discussed briefly here: http://news-oceanacidification-icc.org/2013/01/18/coastal-legislators-top-jan-25-marine-advisory-council-agenda/#more-12092), OA and aquaculture, as well as OA and climate change.

Thank you,

Mary Fall

MARY FALL WADE
maryfallwade@gmail.com
https://www.linkedin.com/pub/mary-fall-wade/48/117/561

Begin forwarded message:

From: Ocean acidification <oaiccproject@gmail.com>
Subject: Ocean acidification
Date: September 4, 2014 at 9:13:52 AM EDT
To: maryfallwade@gmail.com

Ocean acidification

- Ocean acidification: state-of-the science considerations for Small Island Developing States
- Clownfish that inspired Finding Nemo closer to Endangered Species Act Protection
- Ocean acidification from domestic to international
- Space-time variability of alkalinity in the Mediterranean Sea
- Life in the slow lane

Ocean acidification: state-of-the science considerations for Small Island Developing States

Posted: 04 Sep 2014 02:05 AM PDT

The United States of America and New Zealand, in partnership with the Secretariat of the Pacific Regional Environment Programme, hosted a two-day International Workshop on Ocean Acidification: State-of-the-Science Considerations for Small Island Developing States (SIDS) on August 28 and 29, 2014, in Apia, Samoa. The workshop was an official parallel event to the Third International [...]

Email this

Clownfish that inspired Finding Nemo closer to Endangered Species Act Protection

Posted: 04 Sep 2014 01:56 AM PDT

Species threatened by global warming, ocean acidification, aquarium trade SAN FRANCISCO— The National Marine Fisheries Service announced today that the orange clownfish — a species popularized for a generation of children by the movie Finding Nemo — may warrant protection under the U.S. Endangered Species Act because of threats from global warming and ocean acidification. […]

Email this

Ocean acidification from domestic to international

Posted: 04 Sep 2014 01:46 AM PDT

Since the industrial revolution began, we have released 2 trillion tons of carbon dioxide (CO2) into the atmosphere, and about one-third of it went into the ocean. We initially thought that the ocean taking up CO2 was a good thing – because it took it out of the atmosphere. Unfortunately, we were wrong. There has […]

Email this

Space-time variability of alkalinity in the Mediterranean Sea

Posted: 04 Sep 2014 01:37 AM PDT

The results indicate that the Mediterranean Sea shows alkalinity values that are much higher than those observed in the Atlantic Ocean on a basin-wide scale. A marked west-to-east surface gradient of alkalinity is reproduced as a response to the terrestrial discharges, the mixing effect with the Atlantic water entering from the Gibraltar Strait and the […]

Email this

Life in the slow lane

Posted: 04 Sep 2014 01:29 AM PDT

The paper: Cornwall C. E. et al., 2014. “Diffusion boundary layers ameliorate the negative effects of ocean acidification on the temperate coralline macroalga Arthrocardia corymbosa”. PLOS ONE 9:e97235. The speed of water flowing around coralline algae, a critical member of coral reef and coastal seaweed communities, affects their response to ocean acidification. Anthropogenic ocean acidification […]

Email this

Global Ocean Acidification Observing Network: Requirements and Governance Plan

First Edition

JA Newton, RA Feely, EB Jewett, P Williamson, J Mathis

EXECUTIVE SUMMARY

The scientific and policy needs for coordinated, worldwide information-gathering on ocean acidification and its ecological impacts are now widely recognized. The importance of obtaining such measurements has been endorsed by the UN General Assembly[1], and by many governmental and non-governmental bodies who have recently assisted the scientific community in developing the Global Ocean Acidification Observing Network (GOA-ON). The design and foundation of the Network comes from two international workshops held at the University of Washington, Seattle, USA, in June 2012 and at the University of St. Andrews, UK, in July 2013 involving over a hundred participants and over 30 nations.

The policy need relates to the requirement for robust evidence on ocean acidification and its worldwide impacts, to inform appropriate management action at both national and international levels. The scientific need is for large-scale, long-term data, to improve understanding of relevant chemical and biological processes; assist in the design and interpretation of experimental studies; and thereby improve predictive skills.

Three high level goals of the Network aim to provide measurements for management while also delivering scientific knowledge: to improve our understanding of global ocean acidification conditions (Goal 1); to improve our understanding of ecosystem response to ocean acidification (Goal 2); and to acquire and exchange the data and knowledge necessary to optimize the modeling of ocean acidification and its impacts (Goal 3).

This GOA-ON Requirements and Governance Plan provides both broad concepts and key critical details on how to meet these goals. In particular, it defines: the Network design strategy; ecosystem and goal-specific variables; spatial and temporal coverage needs; observing platform-specific recommendations; data quality objectives and requirements; initial GOA-ON products, outcomes, and applications; GOA-ON's proposed governance structure; and Network support requirements.

International OA data sharing arrangements are proposed based on defined data and metadata standards and open access to observing data. While the ocean carbon

[1] Paragraph 153 of Resolution 68/70, passed 9 December 2013: "… encouraged States and competent international organizations and other relevant institutions, individually and in cooperation, to urgently pursue further research on ocean acidification, especially programmes of observation and measurement…"

community has a relatively mature data-sharing process, it is recognized that the addition of coastal sites, as well as biological and ecological data to this framework will take time and effort to structure.

The effort of GOA-ON to develop the optimal observing system to detect ecosystem impacts of ocean acidification on various types of ecosystem (including tropical, temperate, and polar regional seas; warm and cold-water corals; and nearshore, intertidal and estuarine habitats), and in the context of other stressors, has only started recently. Further work will be needed to refine detailed protocols for relevant biological observations on a habitat- or regionally-specific basis. The potential scope for such observations is extremely wide; it is therefore essential that GOA-ON builds on, and is conceptually part of, the Framework for Ocean Observation developed by the Global Ocean Observing System (GOOS) and the International Ocean Carbon Coordination Project (IOCCP), while also working closely with the Intergovernmental Oceanographic Commission (IOC of UNESCO), the Ocean Acidification International Coordination Center (OA-ICC of IAEA), and other relevant bodies.

The GOA-ON website, http://www.goa-on.org/, has been developed to include the latest version of the interactive map of global ocean acidification observing activities. This map represents the best information available on the current inventory of GOA-ON observing assets, and provides a tangible means for increasing awareness and coordination between network partners and others with interests as well as access to ocean acidification data being collected around the globe.

Future actions of the Network include facilitating additional measurement efforts in geographic areas of high concern, together with associated capacity-building; strengthening of linkages with experimental and theoretical studies; maintaining and extending communications with the ocean observing community; establishing effective and quality-controlled international data management and data sharing, through distributed data centers; and encouraging the development of synthesis products based on GOA-ON measurements. All this will require that the Network secure the necessary level of support and resources to achieve these actions.

1. Background and Introduction

The two main needs for worldwide information-gathering on ocean acidification[2] and its ecological impacts have been articulated by several bodies and organizations in the past five years. This includes the United Nations General Assembly who noted the work of the Intergovernmental Panel on Climate Change and "encouraged States and competent international organizations and other relevant institutions, individually and in cooperation, to urgently pursue further research on ocean acidification, especially programmes of observation and measurement.[3]" Firstly, a well-coordinated, multidisciplinary and multi-national approach for ocean acidification observations and modeling would provide authoritative evidence to policy-makers on fundamental changes to marine ecosystems occurring from pole to equator, and from estuaries to ocean depths. Second, the collation and analysis of global-scale datasets documenting these chemical changes and associated biological responses would greatly increase understanding of the processes involved, allowing us to firmly establish impacts attributable to ocean acidification, assess the importance of associated climate change feedbacks, and improve the reliability of projections of future biogeochemical and ecological conditions, and their societal consequences.

National observational programs and activities to address such issues now exist or are under development in several countries. Their value, however, is greatly enhanced when they are brought together at global and regional levels, and explicitly linked with other field studies, manipulative experiments, and modeling

This report, based on two international workshops, provides a consensus vision and strategy for such coordination through the Global Ocean Acidification Observing Network (GOA-ON). The first workshop, held at the University of Washington in Seattle, USA (during 26-28 June 2012), defined the goals and requirements of a global observing network for both carbon and ocean acidification in the context of an overall framework for ocean observing responding to societal needs. This Seattle workshop was supported by the NOAA Ocean Acidification Program, the International Ocean Carbon Coordination Project (IOCCP), the Global Ocean Observing System, including the U.S. Integrated Ocean Observing System (IOOS), and the University of Washington.

Building on that effort, a second GOA-ON workshop was held at the University of St. Andrews, UK (during 24-26 July 2013). The overarching goal of the second meeting was to refine the vision for the structure of GOA-ON, with emphasis on standardizing the monitoring of ecosystem impacts of OA in shelf and coastal seas.

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[2] The International Panel on Climate Change (IPCC) Workshop on Impacts of Ocean Acidification on Marine Biology and Ecosystems (2011, p. 37) defines Ocean Acidification (OA) as "*a reduction in the pH of the ocean over an extended period, typically decades or longer, which is caused primarily by uptake of carbon dioxide from the atmosphere, but can also be caused by other chemical additions or subtractions from the ocean.*" The interests of GOA-ON focus on the changes in ocean chemistry and biology driven by anthropogenic increases of atmospheric CO_2 in the context of their future societal implications and their interactions with other perturbations.
[3] Extracted from Resolution 68/70 of the United Nations General Assembly (passed on 9 December 2013)

Support for this workshop was provided by the UK Ocean Acidification research programme (UKOA, co-funded by Natural Environment Research Council, Defra and DECC); the International Ocean Carbon Coordination Project; the Ocean Acidification International Coordination Centre of the International Atomic Energy Agency; the UK Science & Innovation Network (co-funded by BIS and FCO); the NOAA Ocean Acidification Program, the Global Ocean Observing System, the Intergovernmental Oceanographic Commission of UNESCO, and the University of Washington. This report is expected to be a "living" document to be refined and updated periodically as the GOA-ON matures over the next several decades. The revisions to the document will be based on community input and consensus based recommendations of future GOA-ON workshops.

Participants in both workshops designed GOA-ON to monitor biogeochemical changes at sufficient detail to discern trends in acidification and determine relative attribution of the primary physical and chemical processes governing such changes. The consensus was that GOA-ON must also include a means of tracking changes in large-scale biological processes (changes in productivity, species distributions, etc.), which may be affected by ocean acidification, as well as other factors. GOA-ON will build on the existing global oceanic carbon observatory network of repeat hydrographic surveys, time-series stations, floats and glider observations, and volunteer observing ships in the Atlantic, Pacific, Arctic, Southern, and Indian Oceans.

Recognition of the importance of the continuity and quality of these foundational observations will help to assure their future support, while also providing the basis for a more comprehensive, multidisciplinary ocean acidification observing network. The further development of GOA-ON will require the adoption of advanced new technologies that will reliably provide the community with the requisite biogeochemical measures necessary to track ocean acidification synoptically (e.g. new carbon chemistry sensors developed and adapted for moorings, volunteer observing ships, floats and gliders, with close linkage to satellite-based remote sensing). Such technologies provide critically important information on the changing conditions in both open-ocean and coastal environments that are presently under-sampled.

As indicated above, GOA-ON is not just a pH monitoring program. A fully-realized network needs to have the capability to not only track changes in other chemical parameters, such as $CaCO_3$ saturation states and chemical speciation in the ocean, but also biological production rates and species functional group distributions. These additional measurements are needed to improve confidence in projected future ocean acidification, and better discern ecosystem responses. New technologies for monitoring dissolved inorganic carbon, total alkalinity and pH would be beneficial for tracking changes in the marine inorganic carbon system, including those resulting from non-CO_2 sources of acidification.

The biological measurements are admittedly more difficult and complex to measure repeatedly or remotely. However, measurements of net primary production and community metabolism, either directly or from carbon, nutrient or oxygen inventories, along with an understanding of hydrodynamics are important in order to identify biological impacts and adaptations to ocean acidification, especially in coastal zones where globally-driven changes in ocean acidification are augmented by local processes.

Implementation of GOA-ON requires coordination and integration both internally, within the network, and externally, through linkage to existing international research and observational programs. Leveraging existing infrastructure and monitoring (for carbon-related work and broader ecological activities) will improve efficiency; however, new infrastructure will be necessary given that considerable observational gaps remain. In addition to helping to sustain existing infrastructure and its capabilities, we must also identify and prioritize new time series stations, repeat surveys and underway measurements that are urgently needed in under-sampled marine environments. No single nation can address all these issues on a truly global basis: GOA-ON must therefore be developed as a collaborative international enterprise, stimulating additional effort and sharing expertise between nations to advance infrastructure development.

Capacity building and training of new scientists is essential to the GOA-ON effort. Guidance and workshops on methods and techniques for those new to OA observing must also be developed. The GOA-ON website will provide access to such products (e.g., guidance documents, training manuals). Such information will be incorporated into future versions of this document.

2. Paths to Creation of the Global OA Observing Network

The international efforts which led to the first GOA-ON workshop in Seattle are pictured in Figure 1. A Working Group on Ocean Acidification (with broad international representation) was jointly established in 2009 by the non-governmental Surface Ocean Lower Atmosphere Study (SOLAS) and the Integrated Marine Biogeochemistry and Ecosystem Research project (IMBER). This Working Group produced the initial proposal for the Ocean Acidification International Coordination Centre (OA-ICC) and associated activities, including a global observing initiative. The OA-ICC was announced at the Rio +20 United Nations Conference on Sustainable Development held in Rio de Janeiro, June 2012, and began its work in early 2013 under the auspices of the International Atomic Energy Agency (IAEA).

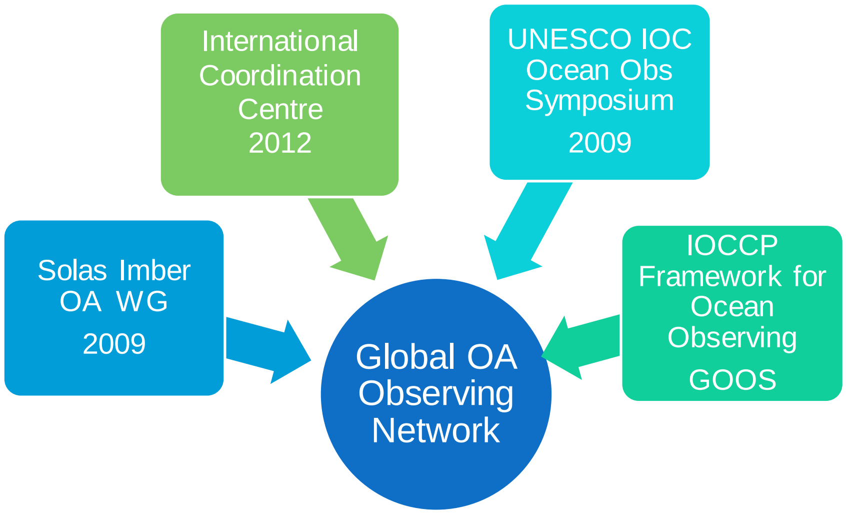

Figure 1. Schematic diagram of the international drivers that contributed to the development of a global observing network for ocean acidification and the first GOA-ON workshop.

An additional key factor in the genesis of GOA-ON was the OceanObs '09 Conference (Venice, September 2009; Hall, Harrison & Stamer, 2010), involving a very wide range of sponsors and endorsers, and resulting in the publication of several plenary papers, community white papers and other contributions relating to the observing requirements for ocean acidification; these included Feely et al. (2010) and Iglesias-Rodriguez et al. (2010), providing a solid structural framework for the GOA-ON described in this document.

In a closely-linked initiative, the International Ocean Carbon Coordination Project (IOCCP) developed a cooperative agreement with the Global Ocean Observing System (GOOS), and released the Framework for Ocean Observing, led by the Intergovernmental Oceanographic Commission of UNESCO (Lindstrom et al., 2012). All of the entities referenced above continue to provide the basic foundation for the network. Other regional-scale activities contribute to and complement GOA-ON activities, e.g., OSPAR/ICES (ICES, 2013; Hydes et al., 2013).

3. Workshop Goals and Community Input

The common goals of the international workshops at Seattle and St. Andrews were to:

1. Provide the rationale and design of the components and locations of a global network for ocean acidification observations that includes repeat hydrographic surveys, underway measurements on ships of opportunity (SOOP), moorings, floats and gliders and leverages existing networks and programs wherever possible;

2. Identify a minimum suite of measurement parameters and performance metrics, with guidance on measurement quality goals, for each major component of the observing network;
3. Develop a strategy for data quality assurance and data reporting; and
4. Discuss requirements for international program integration and governance.

At both workshops, participants included ocean carbon chemists, oceanographers, biologists, data managers, and numerical modelers. See Appendix 1 for participant lists and Appendix 2 for the workshop agendas.

At the **Seattle workshop** there were 62 participants from 22 countries and 1 international body. Countries represented were: Australia, Bermuda, Canada, Chile, China PR, France, Germany, Iceland, India, Israel, Italy, Japan, Rep Korea, Mexico, New Zealand, Norway, South Africa, Sweden, Taiwan, United Kingdom, United States, and Venezuela.

At the **St. Andrews workshop** there were 87 participants from 26 countries and 4 international bodies. Countries represented were: Australia, Bermuda, Brazil, Canada, Chile, China PR, France, Germany, Iceland, India, Ireland, Israel, Italy, Japan, Rep Korea, Malaysia, New Zealand, Norway, Philippines, South Africa, Spain, Sweden, Taiwan, Thailand, United Kingdom, and United States.

Prior to each workshop, participants and their colleagues were requested to identify existing (red) and planned (green) OA observing assets, as shown in Figure 1, to provide the basis for the Network. As addressed later in this document (section 14), this map will be a resource on the GOA-ON portal, updated as current information changes and to incorporate new information from additional GOA-ON members. This resource will be highlighted in workshops and conferences to increase awareness of this information and to encourage wide participation.

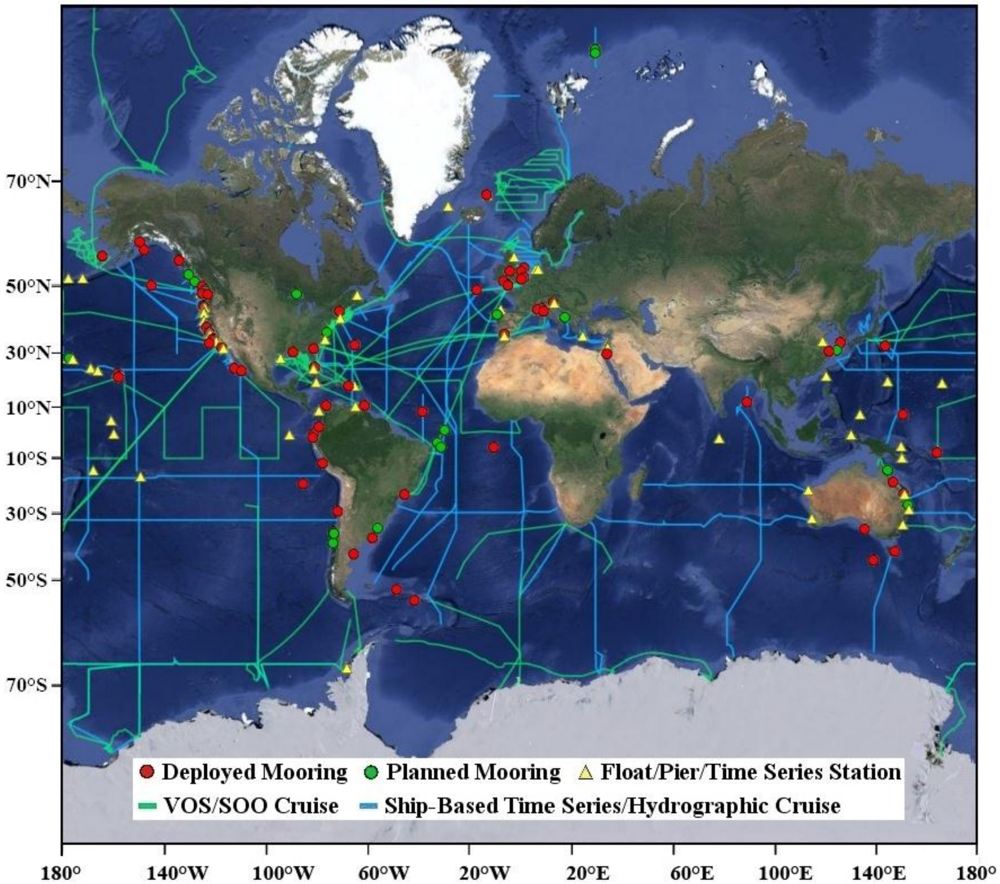

Figure 2. Map of current and planned Global Ocean Acidification Observing Network (GOA-ON) components (weekly updated; last updated December 2013; http://www.goa-on.org/).

4. Global OA Observing Network Justification and Goals

There was strong consensus in both workshops on why an ocean acidification observing system was needed, why it must be global in scale, why it should be integrated across physical, chemical, and biological observations and the goals of the GOA-ON.

4.1 Why is a Global OA Observing Network needed?

- We need information and data products that can inform policy and the public with respect to ocean acidification and implications for the overall ecosystem health (status) of the planet.
- Ocean acidification processes are occurring at global scales; therefore, we need to go beyond local measurements and observe ocean acidification on global scales in order to understand its drivers correctly.
- Insufficient observations and understanding exists to develop robust predictive skills regarding ocean acidification and impacts. While we need enhanced coverage at local scales, successful international coordination of

these observations will allow for nesting of these local observations within a global context.

4.2 What does the Global OA Observing Network need to provide?

The goals of the GOA-ON are established to:

- **Goal 1:** Improve our understanding of **global ocean acidification** conditions.
    - Determine status of and spatial and temporal patterns in carbon chemistry, assessing the generality of response to ocean acidification;
    - Document and evaluate variation in carbon chemistry to infer mechanisms (including biological mechanisms) driving ocean acidification;
    - Quantify rates of change, trends, and identify areas of heightened vulnerability or resilience.

- **Goal 2:** Improve our understanding of **ecosystem response to ocean acidification**.
    - Track biological responses to OA, commensurate with physical and chemical measurements and in synergy with relevant experimental studies and theoretical frameworks;
    - Quantify rates of change and identify areas as well as species of heighted vulnerability or resilience.

- **Goal 3:** Acquire and exchange data and knowledge necessary to **optimize modeling of ocean acidification and its impacts**.
    - Provide spatially and temporally-resolved chemical and biological data to be used in developing models for societally-relevant analyses and projections;
    - Use improved knowledge gained through models to guide Goals 1 and 2 in an iterative fashion.

5. System Design of the Global OA Observing Network: Conceptual

Conceptually, GOA-ON addresses each of these three goals through the use of a nested design encompassing observations from a very wide range of marine environments (from open ocean to coastal waters, including estuaries and coral reefs), and using a variety of integrated and interdisciplinary observing strategies appropriate to the environment of interest.

5.1. Global OA Observing Network Nested System Design

To address the goals, a **nested design** is proposed for measurements at stations:

- *Level 1:* critical minimum measurements; measurements applied to *document* ocean acidification dynamics.
- *Level 2:* an enhanced suite of measurements that promote understanding of the primary mechanisms (including biologically mediated mechanisms) that

govern ocean acidification dynamics; measurements applied towards *understanding* those dynamic processes.

- <u>Level 3</u>*:* Opportunistic or experimental measurements that may offer enhanced insights into ocean acidification dynamics and impacts; measurements under *development* that may be later adapted to Level 2.

The system design of the Network is further nested because observing investments designed to address Goal 2 should be implemented at a subset of the Goal 1 stations.

5.2 Global OA Observing Network Design Attributes

- GOA-ON will comprise observing assets within multiple ecosystem domains, including the ***open ocean, shelf seas, coasts (including the nearshore and estuaries), and warm and cold-water coral habitats****.* The open ocean, shelf seas, and coasts can also be subcategorized into polar, temperate and tropical regions with their associated ecosystem types.
- The Network will make use of a variety of observing platforms, classified here into three categories that share similar capabilities. These are: *1)* ***ship-based sampling*** *including survey cruises, the Ship of Opportunity Program (SOOP), [also called the Voluntary Observing Ship (VOS) program]; 2)* ***fixed platforms****, including moorings and piers; and 3)* ***mobile platforms****, including marine gliders (both profiling and wave) and floats (possibly others, such as animals).*
- Use will be made of existing platforms wherever possible and appropriate.
- The Network will be interdisciplinary in approach, including in particular: *carbon chemistry, meteorology, oceanography, biogeochemistry, ecology, and biology.* Such integration will be much more effective from a system design standpoint if carried out from the start. For instance, while typically ocean chemistry is measured to assess effects on biology, an equally critical question is "How is biology affecting ocean chemistry?" and the design of the Network must reflect such needs.

6. System Design of the Global OA Observing Network: Data Quality

The measurement quality goals of the GOA-ON may differ from site to site depending on the intended use of the observations, with differing intended uses requiring different measurement uncertainties (Box 1).

Box 1. MEASUREMENT UNCERTAINTY AND GOA-ON

A key goal for any observing network is to ensure that the measurements made are of appropriate quality for their intended purpose, and that they are comparable one with another- even though such measurements are made at different times, in different places, and in many cases by different instruments, maintained by different groups. It is thus as important to communicate the uncertainty related to a specific measurement, as it is to report the measurement itself. Without knowing the uncertainty, it is impossible for the users of the result to know what confidence can be placed in it; it is also impossible to assess the comparability of different measurements of the same parameter (de Bièvre & Günzler, 2003).

The term *uncertainty* (of measurement) has a particular technical meaning (ISO, 1993; Ellison & Williams 2012). It is a parameter associated with the result of a measurement that permits a statement of the dispersion (interval) of reasonable values of the quantity measured, together with a statement of the confidence that the (true) value lies within the stated interval. It is important not to confuse the terms *error* and *uncertainty*. Error refers to the difference between a measured value and the *true* value of a specific quantity being measured. Whenever possible we try to correct for any known errors; for example, by applying calibration corrections. But any error whose value we do **not** know is a source of uncertainty.

It is therefore essential to ascertain (and report) the *uncertainty* of measurements made as part of GOA-ON, and to characterize GOA-ON measurement quality goals in terms of such uncertainties. Hence GOA-ON must establish clear guidelines for estimating this uncertainty for each of the separate measurement procedures to be used in the Network, and ultimately must also emphasize the need for formal quality assurance procedures in the various participating laboratories responsible for the instruments comprising GOA-ON to ensure that the various measurements quality goals are met.

Throughout this document, the term "uncertainty" should be taken to mean the standard uncertainty of measurement; that is with the associated confidence interval equivalent to that for a standard deviation.

6.1 Data Quality Objectives

Conventionally, long-term sustained carbon observations have been the purview of carbon inventory and flux studies focused on documenting small changes within 'blue water', oligotrophic oceanographic settings over decadal time-scales. Such measurements demand an exacting quality necessary for identifying small changes over decadal time-scales. However, participants recognized that differing measurement quality goals are appropriate for the observations proposed here for observing ocean acidification depending on the intended application, the relative 'signal-to-noise' with respect to the environment and the processes being examined. For example, the uncertainty of measurement required for observations intended to track multi-decadal changes at a long-term time-series open ocean station is inherently different from the needs of data collected for determining the relative contributions of the acidification components within an estuary or to inform assessments of biological response. Each application has associated measurement quality goals that need to be met. Analogous to terminology adopted in atmospheric sciences, it was agreed at the Seattle workshop that the Network would provide separate measurement quality goals specific to "climate" and "weather", defined here (Box 2) both in general and in the context of ocean acidification.

Box 2. MEASUREMENT QUALITY GOALS FOR GOA-ON

"Climate"

- Defined as measurements of quality sufficient to assess long term trends with a defined level of confidence
- With respect to ocean acidification, this is to support detection of the long-term anthropogenically-driven changes in hydrographic conditions and carbon chemistry over multi-decadal timescales

"Weather"

- Defined as measurements of quality sufficient to identify relative spatial patterns and short-term variation
- With respect to ocean acidification, this is to support mechanistic interpretation of the ecosystem response to and impact on local, immediate OA dynamics

6.2 Data Quality Requirements

For GOA-ON to succeed at delivering its goals, observations must be of a verifiable quality and consistency. Three critical data quality requirements must be followed:

- Observations provided to the Network (whether measured, estimated, or calculated) will be accompanied by a statement of their uncertainty

- Observations will be calibrated to a community-accepted set of reference materials, when available
- All constants applied in the derivation of calculated parameters will be documented and reported, along with the units and scale. The uncertainties of such constants will need to be incorporated into the estimate of the uncertainty of each derived parameter.

7. System Design of the Global OA Observing Network: Measurements

7.1 Measurements for GOAL 1: understanding global OA conditions

Contributors to the GOA-ON will provide the hydrographic conditions and carbon chemistry data necessary to provide for:

i. At a minimum, a basic understanding of the local, immediate spatial and temporal OA dynamics (weather).
ii. Optimally, detection of the long-term anthropogenically-driven changes in hydrographic conditions and carbon chemistry over multi-decadal timescales (climate).

At each GOA-ON measuring site, a complete description of the seawater carbonate system will be needed. Such a description can be achieved in a variety of ways, involving alternate combinations of measurable parameters together with values for various equilibrium constants. Measurement quality goals are given below in terms of constraining the measurement uncertainty for the observed parameters used for calculating the saturation state of aragonite (a form of calcium carbonate).

7.1.1 GOAL 1 Level 1 Measurements

The following five parameters were considered to be the minimum suite of Goal 1 Level 1 measurement, applicable to all marine environments:

- Temperature
- Salinity
- Pressure(water depth at which measurement is made)
- Oxygen concentration
- Carbon-system constraint, achievable in a number of ways, including combinations of direct measurements and estimates of other parameters, such as nutrients (see further discussion below).

In addition, two further parameters were considered necessary, except where the platform is not appropriate or available for such measurements:

- Fluorescence
- Irradiance

The **weather** objective requires the carbonate ion concentration (used to calculate saturation state) to have a relative standard uncertainty of 10%. This implies an uncertainty of approximately 0.02 in pH; of 10 $\mu mol\ kg^{-1}$ in measurements of total alkalinity and total dissolved inorganic carbon; and a relative uncertainty of about 2.5% in the partial pressure of carbon dioxide. Such precision should be achievable in competent laboratories, and is also achievable with the best autonomous sensors.

The **climate** objective requires that a change in the carbonate ion concentration be estimated at a particular site with a relative standard uncertainty of 1%. This is smaller than the uncertainty in the carbonate ion concentration itself, since uncertainties in the various equilibrium constants largely cancel out when estimating the uncertainty of the difference between two values.

It implies an uncertainty of approximately 0.003 in pH; of 2 $\mu mol\ kg^{-1}$ in measurements of total alkalinity and total dissolved inorganic carbon; and a relative uncertainty of about 0.5% in the partial pressure of carbon dioxide. Such precision is only currently achievable by a very limited number of laboratories and is not typically achievable for all parameters by even the best autonomous sensors..

As noted above, observations provided by the Network will report corresponding values for the uncertainty in measured, estimated, and calculated parameters, regardless of quality objective. Observations will be calibrated using a community-accepted set of reference materials.

The addition of fluorescence and irradiance is because biological processes (primarily photosynthesis) may affect the chemical status of OA and its attribution to underlying mechanism. However, as noted above, not all platforms (such as underwater gliders) can accommodate these measurements. Thus, while these remain highly desirable Level 1 measurements, it is understood that in some cases, they will not be made.

Coral habitats: For habitats dominated by photosynthetic calcifiers (warm-water corals, coralline algae), in addition to the above 'generic' Goal 1 Level 1 measurements, the following additional measurements are considered necessary:

- Biomass of biota
  - Corals or coralline algae, other photosynthesizers (macro-algae, seagrasses)
- Changes in net ecosystem processes
  - Calcification/dissolution (NEC: net ecosystem calcification)
  - Production/respiration (NEP: net ecosystem production).

For non-photosynthetic cold-water corals, typically occurring at depths of 200-2000 m, it is highly desirable that biomass and changes in net ecosystem processes are also measured in a standardized way.

7.1.2 GOAL 1 Level 2 Measurements

The optimal suite of Goal 1 Level 2 measurements is conditional on site location, season, and hydrographic conditions; they are also question-dependent. Recommended measurements include:

- Nutrients
- Bio-optical parameters (beam C, backscatter, turbidity, absorption)
- Currents
- Meteorology
- Net community metabolism (NCM)
- Trace metals
- ^{18}O and ^{13}C
- Export production
- Particulate inorganic carbon (PIC) and particulate organic carbon (POC)
- Atmospheric pCO_2
- Phytoplankton species

In reality, some of these measurements are currently more likely Level 3 measurements (see definition, above), and that distinction may actually vary in different systems.

For warm-water coral habitats, the following measurements were specified as necessary in some areas or instances:

- Processes
  - Freshwater input
  - Nutrient input (especially for inshore reefs)
  - Sediment input
- Wind (for oxygen-derived NPP)

7.2 Measurements for GOAL 2: understanding ecosystem response to OA

There are two aspects when considering the interface of biology and ocean acidification:

i. What are biological responses to ocean acidification (i.e. how will ecosystems respond to OA with regard to metabolic rates, morphology, and community composition)?

ii. What effect does biology have on ocean acidification (i.e. how do species, communities and ecosystems affect local carbon chemistry)?

The second question needs to be considered in the context of both Goals 1 and 2. This question notes the biological contribution to pH and other aspects of carbonate chemistry. As reflected in the Goal 1 sections above, some biologically relevant measurements are required. Thus, fluorescence and light are defined as generic Goal 1 Level 1 measurements to help assess photosynthesis and respiration, along with the other Goal 1 Level 1 measures, including oxygen (for hypoxia) and salinity (for freshwater input). While the remainder of the discussion in this section is focused on the first question only (Goal 2: the biological/ecosystem responses to OA), there is inherent coupling of these two questions.

In the context of Goal 2, a conceptual structure for the effects of OA on ecosystems is depicted in Figure 3 that illustrates direct effects of CO_2 and pH on organisms, as well as indirect effects of OA on ecosystems and ecosystem services.

GOA-ON will focus on specific measurements within this conceptual structure to resolve thresholds of response to ocean acidification in relation to site-specific baselines. Experimental work on biology plays an important role in determining which aspects of the marine ecosystem will likely be vulnerable to changing chemical conditions. While experiments are not explicitly part of GOA-ON since we are establishing an "observing" network, the role for experimental work is important to recognize. The Network will help inform experimental site selection, experimental laboratory treatment levels (identify conditions the species studied are already encountering in their natural environments) and rapidly changing eco-regions where more intensive, experimental study is needed. On the other hand, results from experimental work will be used to inform and update core observational parameters (e.g., identify aspects of the biological system that are most sensitive to OA, and aspects of the changing carbon chemistry (bicarbonate, saturation state, protons) that have greatest effect on biology) and may be used in combination with the chemical observing data to generate global biological vulnerability maps.

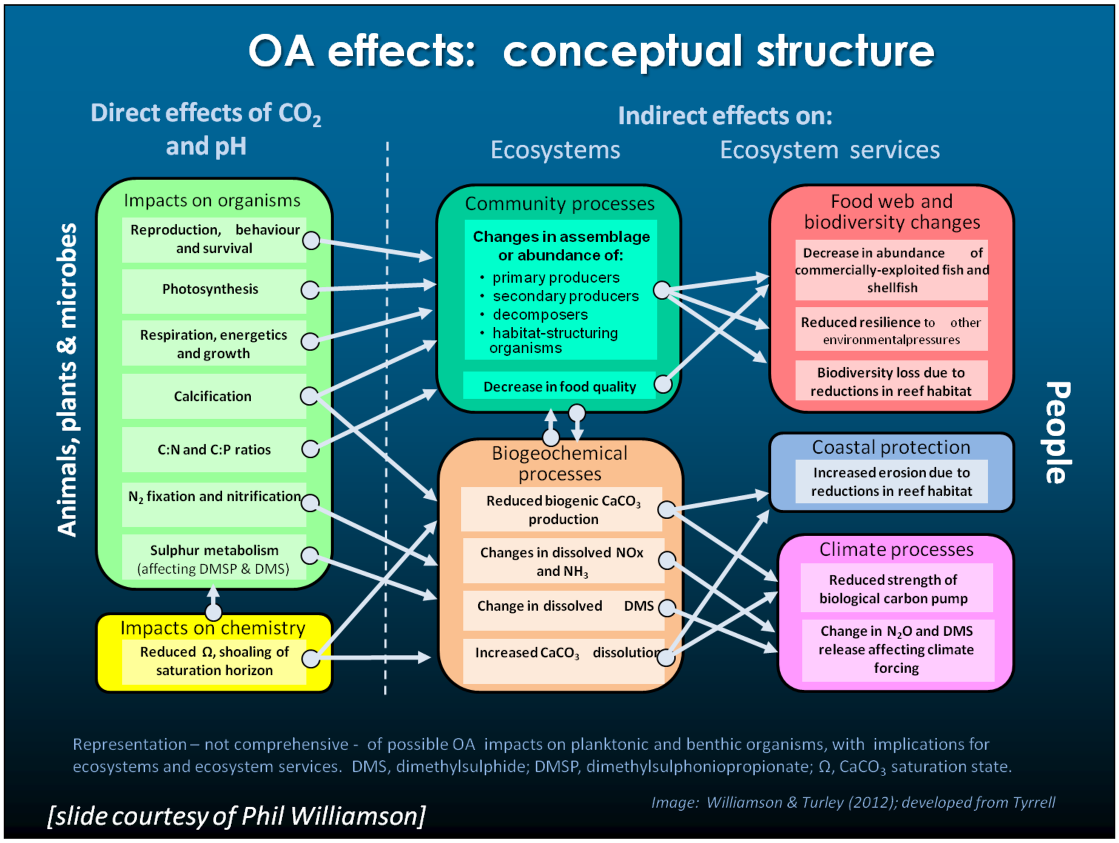

Figure 3. Conceptual model of the effects of ocean acidification on ecosystems illustrating direct effects of CO_2 and pH on organisms, as well as indirect effects of OA on ecosystems and ecosystem services (adapted from Williamson & Turley, 2012).

7.2.1 GOAL 2 Level 1 measurements

Addressing Goal 2 at the broadest scale requires the measurement of biomass or abundance of functional groups, listed below, contemporaneous with the physical and chemical measurements for Goal 1 that achieve at least 'weather' data quality.

- Biomass/abundance of:
  - Phytoplankton
  - Zooplankton
  - Benthic producers and consumers (shelf seas and nearshore)

Biomass of calcified versus non-calcified species is desired, as is measuring the timing of changes in abundance, e.g., blooms, community shifts, pigment changes. Zooplankton should include both micro- (e.g., protists) and meso- (i.e., multicellular) plankton as well as meroplankton, where applicable.

Recommendations for Goal 2 Level 1 measurements for broad climatic regions and specific ecosystem types are as follows:

Polar: Phytoplankton and zooplankton biomass/abundance; phytoplankton functional types; particulate inorganic carbon (PIC); sunlight (PAR)

Temperate: Phytoplankton and zooplankton biomass/abundance; calcified to non-calcified plankton abundance; phytoplankton functional types; PIC; sunlight (PAR)

Tropical: Phytoplankton and zooplankton biomass/abundance; size fractionated chlorophyll; sunlight (PAR); turbidity; colored dissolved organic material (CDOM)

Nearshore: Phytoplankton, zooplankton, and benthic producers and consumers abundance/biomass; calcified to non-calcified plankton and benthos abundance; chlorophyll; TSS/turbidity; CDOM (remote sensing); nutrients; sunlight (PAR).

Coral habitats: For Goal 2 Level 1, most of the necessary measurements for warm- and cold-water coral habitats have already been specified above under Goal 1 Level 1; i.e. biota biomass and distribution; net ecosystem calcification/dissolution; net primary production (if applicable), net production, and respiration rates. Additionally for Goal 2 Level 1, it is recommended to obtain information on:

- Biota: The population structure of corals; the population structure of macroalgae; the biomass, population and trophic structure of cryptobiota; population structure of urchins; and architectural complexity
- Processes: The NEP:NEC ratio, food supply rate and quality and bioerosion rates at specific sites.
- Habitat: Further characterization of the chemical habitat through sediment mineralogy/composition; organism mineral content; alkalinity anomalies; and the vertical profiles of saturation state over time (for cold-water corals)

7.2.2 GOAL 2 Level 2 measurements

Goal 2 Level 2 measurements primarily add measurements to help elucidate more information about the biota functional groups and responses to OA including:

- Processes and rates (e.g., production and export)
- Chemical speciation (e.g., C, N, P and phase)
- Species distributions (e.g., key species or groups)

For specific regions and ecosystem types, Goal 2 Level 2 recommendations are:

Polar: Primary production; export flux rate; net community production (NCP); net community calcification (NCC); nutrient uptake rates; taxonomy; sea algae

Temperate: Primary production; export flux rate; NCP; calcification rates; remineralization; dissolution; POC/DOC (size fractionated); PON/DON (size fractionated); TEP; POP; fatty acid measurements; benthic processes: burial deposition, benthic respiration, calcification, and production

Tropical: Primary production; export flux rate; NCP; DOC; DOM; N/P ratios; Nitrate/Phosphate; satellite imagery; algal pigments (HPLC); currents (ADCP); zooplankton vertical/spatial and temporal variation; zooplankton grazing rates

Nearshore: Phytoplankton primary production; pelagic and benthic NCP; community structure; trophic interactions/del O18; disease; phytoplankton species (for HABS include species and toxicity)

7.3 Measurements for GOAL 3: data to optimize modeling for OA

7.3.1 Global/Basin and Climate Scales

To improve the capacity of existing models to yield widespread information on global/basin scale ocean acidification status and trends, the following recommendations are made.

- Large scale surveys – a snapshot of ocean acidification conditions – are needed to constrain models; need to coordinate information at basin-scale, repeat hydrography, Voluntary Observing Ships, historical sections.
- Better spatial coverage of moorings with OA-relevant physical, chemical, and optical measurements; targeted process studies (rate measurements, budget, community structure) at time series stations and key locations to improve biogeochemical model structures and parameters.
- More Argo floats with bio-optical and chemical sensors (NPZD-O_2 floats) with temporal sampling frequencies appropriate to establishing interconnections of water masses.
- Extended spatial coverage of gliders, based on modeling simulations and experiments to establish new glider and survey sections.
- Connect global/basin ocean acidification conditions with shelf seas and coastal processes; use coastal OA observing networks and modeling capabilities to examine impact of coastal seas on the open ocean.

7.3.2 Shelf Seas/Coastal – Weather and Climate Scales

To improve our capability to use coastal models for physical, chemical, and biological applications relevant to OA and to optimize a coupled monitoring-modeling network for the coastal and shelf seas, the following recommendations are made.

- Make better use of regional and coastal physical modeling capabilities, especially near-real time and short-term (weather) forecasting information;

coastal OA observations provide necessary information to establish and improve physical-biogeochemical models.

- Evaluate and constrain model performance at ocean acidification observing locations (moorings, glider and survey sections); produce near-real time and short-term forecasts of OA conditions; extract and simplify model results to develop a set of usable OA indicators for the key locations.
- Based on physical-biogeochemical model results and numerical experiments, including observing system simulation experiments (OSSE), identify new ocean acidification observing locations and modify existing OA monitoring networks.
- Integrate ocean acidification measurements with water quality information (oxygen, nutrients/loading, turbidity, etc.) and plankton community structures (survey data, bio-optical and remote sensing measurements); incorporate this information into physical-biogeochemical models to produce 3D distribution on dominated temporal scales.
- Develop models for pelagic and benthic organisms with connections to the habitat and ocean acidification conditions; contribute to the development of ecosystem models to link with living marine resource management (integrated ecosystem assessment).

7.3.3 Warm-water Coral Systems – Weather and Climate Scales

To provide for the capability to assess ocean acidification impacts on coral reef systems the following recommendations are made.

- Very high spatial resolution (100 meters scale) circulation models for coral reef ecosystems need to be developed; these models will need to address connectivity related issues, linking with basin/regional models.
- Wave models should be incorporated into circulation models, which will address impact of extreme weather events.
- OA observing information is needed that constrains initial and boundary conditions for targeted reef systems (smaller spatial domain and shorter temporal simulations).
- There will need to be multiple model simulations and future projections of OA conditions and key physical processes (temperature, sea level, light, frequency and intensity of extreme events) for coral reef systems.
- Models must capture habitat conditions and ecosystems connections.

8. Global OA Observing Network Design: Spatial and Temporal Coverage

The current and proposed spatial and temporal coverage of GOA-ON is considered below with regard to three broad ecosystem domains: the open ocean, shelf seas and coasts (including estuaries and the nearshore), and warm-water coral reefs. Issues discussed include: the desired spatial and temporal resolution of the measurements; identification of gaps and high vulnerability areas; and priorities for filling gaps or building capacity for new measurements.

8.1 Current status

8.1.1 Current status: Open ocean

On a global scale, the main building blocks of a network for assessment of ocean acidification in the open ocean are well established and quality-controlled by the ocean community (e.g., CLIVAR/CO_2 Repeat Hydrography Program (GO-SHIP) , OceanSITES, SOOP, SOCAT), but there is need for filling-in certain areas, some components lack sustained funds, and some components need enhancements.

8.1.2 Current status: Shelf seas and coasts

For these environments, a global network for assessment of ocean acidification needs construction. At the regional level, there are some systems in place with some ability to leverage OA observations on existing infrastructure (e.g., World Association of Marine Stations, International Long-Term Ecological Research Network), but also many gaps. These elements need a globally consistent design which must also be coordinated and implemented on a regional scale. In some areas, there is a need for significant infusion of resources and infrastructure to build the necessary capacity.

8.1.3 Current status: Coral reefs

For assessment of ocean acidification and its impacts on warm-water coral reefs, a globally consistent coral reef OA observing network needs construction. On a regional scale, there is some observing capacity in some regions but observing assets may not cover the extent of variability that organisms observe and should be supplemented by site-specific studies. The U.S. National Coral Reef Monitoring Program for Atlantic and Pacific coral reefs can serve as a model.

8.2 Recommendations for Spatial-Temporal Network Design

8.2.1 Network design recommendations: Open ocean

A framework for GOA-ON in the open ocean largely exists but components need further attention in order to bring this to full realization.

i. Utilize the **GO-SHIP** global plan (Figure 4) and similar research cruises for critical OA components of the Network. The existing repeat hydrography program provides essential foundation to establish OA conditions at global scale. Expansions include a sampling density sufficient to map aragonite saturation horizon and addition of bio-optical measurements for calibrating Argo floats.

ii. Participate in **VOS/SOOP** global plan (Figure 5; bimonthly temporal resolution at roughly 10-15° latitude spacing at some locations) and enhance its coverage, especially to the southern hemisphere, Indian Ocean, Arctic, and other locations to be scoped.

iii. Contribute to **OceanSITES** deepwater reference stations (Figure 6; roughly half have OA sensors now) and enhance this plan to address gaps (e.g., high latitudes, Labrador Sea, South Pacific gyre, BATS, etc.) or keep operational (e.g., Japanese site at 60° S). High vulnerability sites with insufficient coverage include the Arctic, Southern Ocean, Coral Triangle, off Peru.

- To optimize this for the GOA-ON, the OA community could add/share funding, operational effort/cost/ship time/people, sensors, data processing/management, or in a few cases take ownership of complete moorings.

iv. Participate in ongoing developments to collect OA relevant data with sufficient quality from **floats,** such as Argo floats (Figure 7)**.**

- Comparison with ship-based measurements is essential to the success of this effort. Utilize a smaller number of additional biogeochemistry-ecosystem Argo floats (Figure 8) that would have shorter profile intervals (e.g. 6 hours) more relevant to biological processes (e.g. NPZD floats)

v. Contribute to development of **glider** technology for deployment, especially to target high vulnerability areas. Will need attention to address biofouling and depth restrictions for the subsurface gliders.

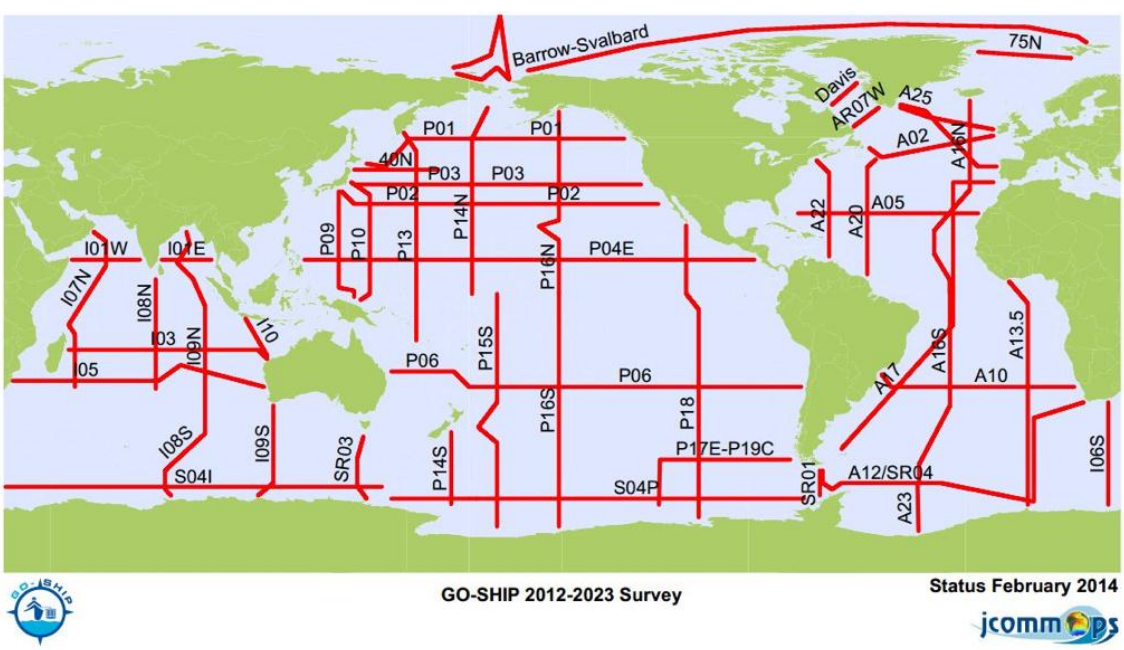

Figure 4. Map of GO-SHIP Repeat Hydrographic Surveys; current status as of February 2014 (from: www.go-ship.org).

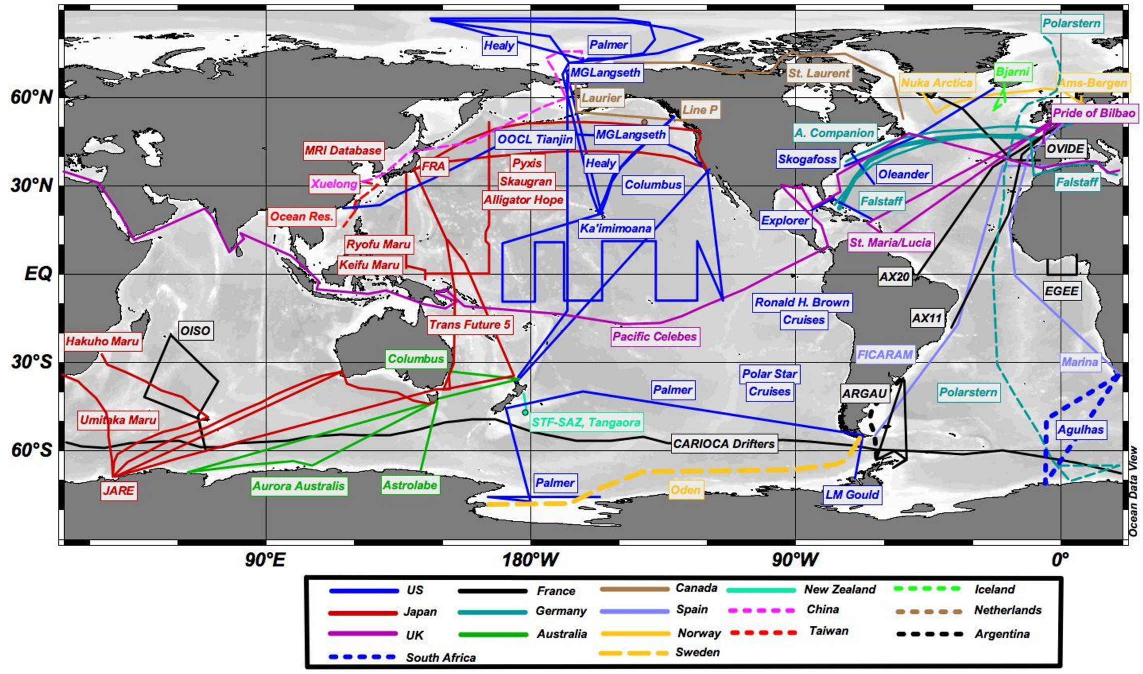

Figure 5. Map of global Ships of Opportunity/CO_2 cruise tracks for underway measurements, current status as of 2013.

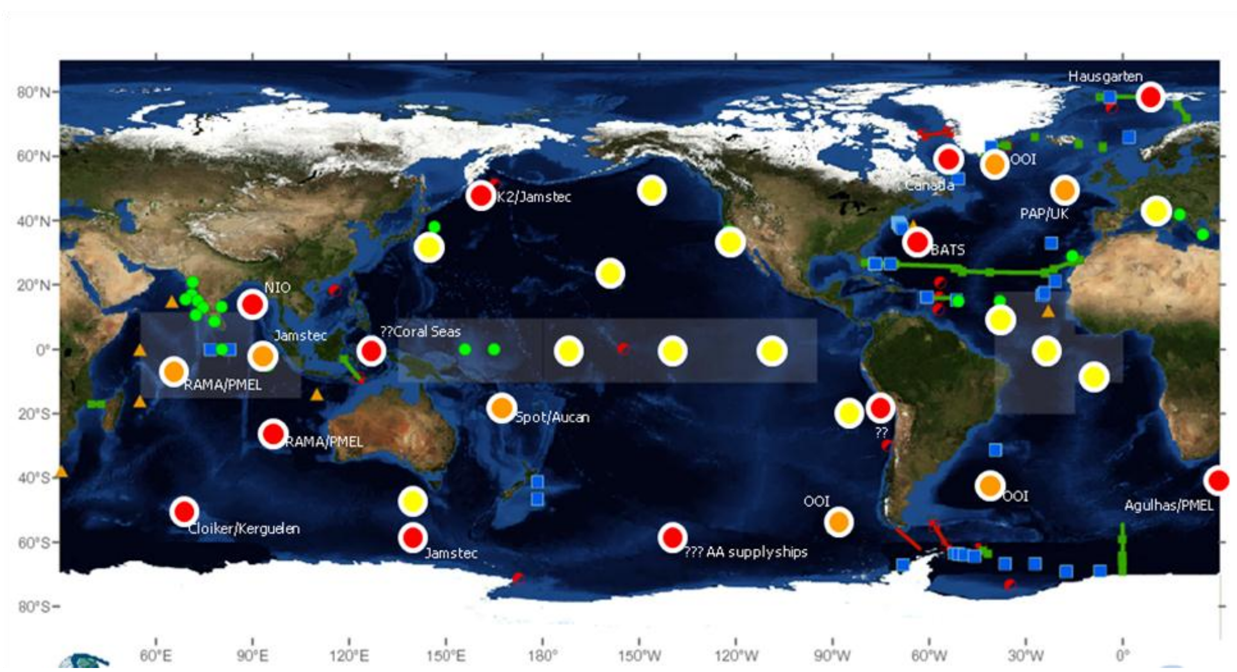

Figure 6. Map of OceanSites mooring locations for time-series measurements. Color coding: Yellow = collecting some OA parameters in 2012; Orange = likely to happen in next year; Red = unlikely to happen without strong push from OA community.

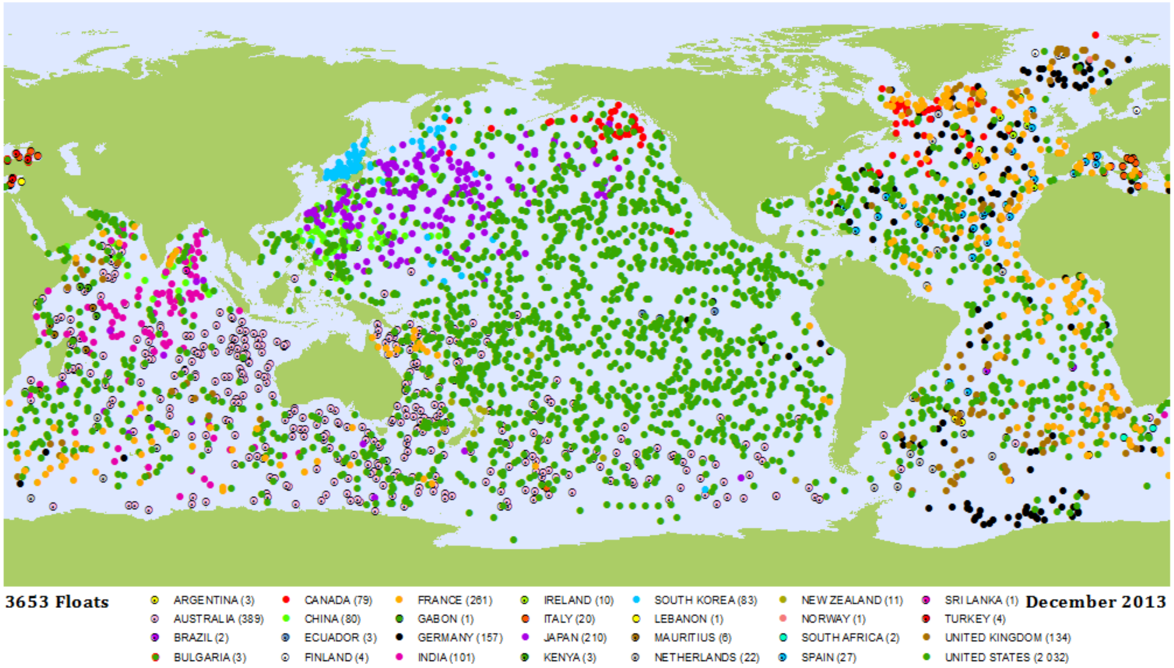

Figure 7. Map of ARGO Float locations, current status as of December 2013. Some of the floats are equipped with biogeochemical sensors, as shown in Figure 8.

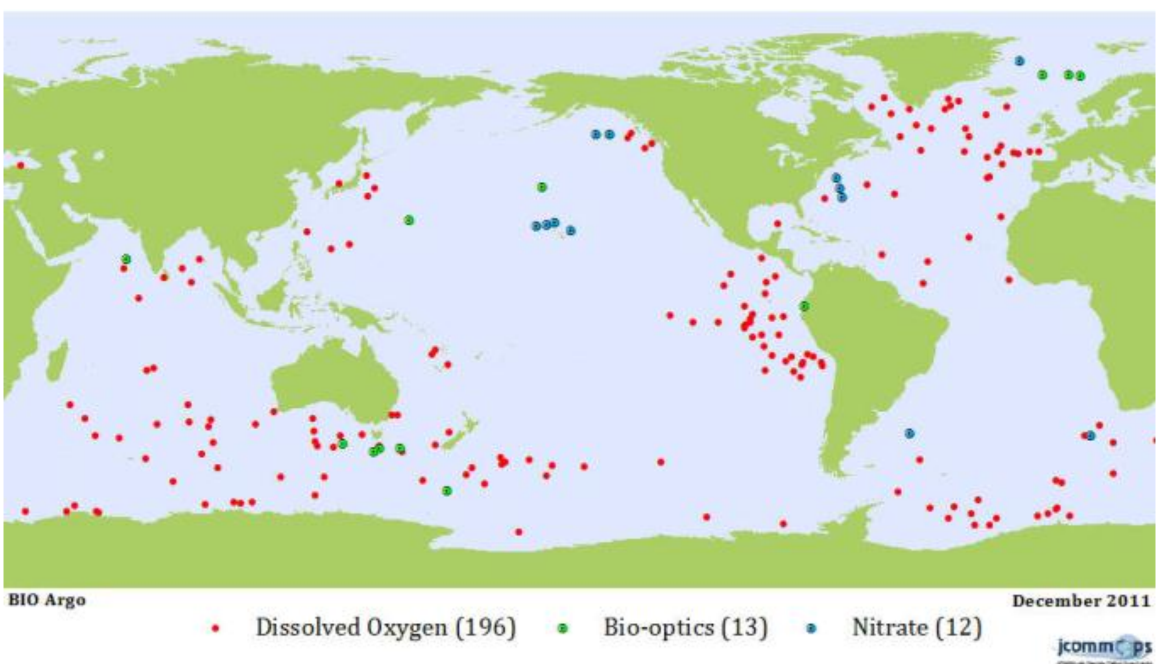

Figure 8. Map of ARGO floats with biogeochemical sensors, current status as of December 2011.

8.2.2 Network design recommendations: Shelf seas and coasts

The status of a Global OA Observing Network in the coastal area is much less developed than that for the open ocean. There is no existing framework for most regions and no global framework for coastal areas, so the Network's design needs a more fundamental approach.

i. Create OA capacity:
   - Make an inventory of current observing capacity and expand subset to include OA observations (building on existing OA or other related observing, where available)
   - Prioritize adding OA measurements on existing biological time-series, where variability is documented
   - Be proactive in treatment of geographic gaps (e.g., Africa, etc). Use statistical/quantitative analyses to target new assets to optimal locations, also to provide a means of filling gaps (data extrapolation in a resource-limited world)

ii. Aim for balanced representation:
   - Represent the full range of natural variability (and presumably ecosystem resilience); include high vulnerability areas and areas with important economic resources. For example, upwelling zones versus stable water column areas should both be captured. While the former may see lower pH in surface waters, organisms may be better adapted to variation, thus more resilient.

iii. Work within regions to optimize capacity and relevance.
   - Encourage use of coastal observational nodes as ideal locations to conduct explanatory process studies
   - Improve upwelling indices for nearshore areas (to indicate upward transport of deep waters, thus useful in creating proxy methods for extrapolating sparse observations across complex coastal zones)

8.2.3 Network design recommendations: Coral reefs

Capacity is adequate in some areas, but non-existent in others; a balance is needed for GOA-ON to be truly global.

i. Utilize current observing assets including moorings/buoys in:

   Hawaii (Kaneohe Bay), Bermuda (Hog Reef, Crescent), GBR (Heron Island) and Ningaloo (W Australia), Chuuk, Florida Keys (Cheeca Rocks), and Puerto Rico (La Parguera). However, these do not cover the extent of variability that organisms observe, nor do they provide any coverage of the Coral Triangle region or non-U.S. Caribbean, and thus should be supplemented.

ii. Aim for balanced representation, monitoring across gradients of latitude, biodiversity, warm vs. deep coldwater systems, relatively pristine vs. impacted.

iii. The observing system should also give us insight as to what reefs may look like in 50-60 yrs., so include natural-CO_2 seeps.

8.2.4 Network design recommendations: system wide

There are several items that the Network system design needs to address that are not specific to any one of the above ecosystem categories:

- Data coverage gaps – a global network cannot be global if not adequately distributed to all sectors of the globe. The current status is not adequate. To enforce the global character of the Network, spatial gaps have to be filled.
- 'Threatened' ecosystems – either due to proximity to perceived thresholds, rate of change in carbonate chemistry conditions, or socio-economic vulnerability of ecosystem, these systems should be observed via the Network. It is likely that the global OA community, perhaps under the auspices of the IOCCP and the OA-ICC, can focus attention on identifying those hot spots through a dedicated research effort.
- Ecosystem function – because OA is an environmental condition with implications for biota, the ecosystem function must be a focal point for observations. This calls for integration of physical, chemical, and biological sensing.
- Data and information access – data from the Network should be available to and linked with the broad community including those sectors of society that benefit from the data in making business and management decisions. The Reference User Group of the Ocean Acidification International Coordination Centre will become a focal point for bringing messages to industry, governments and the public.

9. Data Quality Objectives in the context of Goals and Sampling Platforms

The various sampling platforms currently available to the community are differentially suited to the first two GOA-ON goals and its two data quality levels.

- Data satisfying Goal 1 'climate' data quality criteria currently can only be obtained from direct analysis of water samples, typically necessitating sampling from <u>cruises or SOOP</u>. Thus, cruise and SOOP sampling, analyzed appropriately, more likely assures 'climate' quality data as well as offers sporadic validation of 'weather' quality measurements.
- Data of Goal 1 'weather' quality are often collected on <u>moorings or fixed platforms</u>, but must be calibrated, as noted above, by validation samples of 'climate' quality. The added benefit of mooring/fixed platforms is that these

platforms can be used to obtain high temporal resolution data that is useful for elucidating mechanisms of variation. Such high temporal resolution measurements are also valuable in the ‘climate’ context to verify means in highly dynamic systems i.e. to increase knowledge on representativeness of spot sampling from cruises.

- Goal 1 is also aided by ‘weather’ quality data obtained from gliders or floats yielding high spatial resolution data that is useful for assessing vertical variation (shoaling of saturation horizons) and elucidating mechanisms. The same caveats as for moorings/fixed platforms apply, that these should be calibrated.
- Data for Goal 2 currently requires cruise-based sampling for all variables, except for some indicators relevant to phytoplankton and production, e.g., fluorescence and Photosynthetically Active Radiation (PAR).

Needs: In order to accurately satisfy goals in all environmental regimes, the applicability of method to environment is key and having documentation thereof. Important examples mentioned are the:

- Need to prepare certified reference materials (CRMs) for other environments (low salinity).
- Assure capacity for CRMs matches demand as Network increases in size.
- Need to establish carbon system dissociation constants for lower salinity waters.
- Need for standard operating procedures (SOPs) for autonomous sensors and and clear guidelines as to appropriate quality control for such sensors.
- Need for detailed documentation of what people are doing, including validation, SOPs, metadata. It is the intent of GOA-ON to build access to these items via the GOA-ON map server.

10. Global OA Observing Network Products

An important output of the GOA-ON is informational products on OA status that can inform scientists, managers, policy makers, educators, other stakeholders and the public at large.

10.1 GOAL 1 priority products:

- Open ocean
  - Seasonally resolved global and regional surface maps of pH, DIC, total alkalinity, saturation states, pCO_2
  - Time series data from stations (e.g. interactive maps)
  - Decadal changes in pH, DIC, total alkalinity, saturation states, and pCO_2 from repeat hydrography
  - Export production (PIC, POC) below the winter mixed layer
  - Subsurface saturation maps

- Shelf seas and coastal
    - Seasonally resolved surface maps of pH, DIC, total alkalinity, saturation states, pCO_2
    - Time series data from stations (e.g. interactive maps)
    - Near-Real-Time data access
    - Alkalinity anomaly
    - Subsurface maps of pH, total alkalinity, saturation states, pCO_2

- Coral reefs
    - DIC/Alkalinity relationships for different sites
    - Biogeochemical model output at coral reef sites
    - Time series of alkalinity deviation from salinity

10.2 GOAL 2 priority products

These are desired ecosystem products from the GOA-ON, but recognizing that not all will be possible with Level 1 measurements only. Products would be spatially resolved and analyzed in relation to carbonate system variability.

- Benthic recruitment and recruitment variability
- Planktonic calcifiers (phyto- and zooplankton) abundance and variability
- PIC:POC (calcifiers:non-calcifiers) in planktonic and benthic organisms
- Phytoplankton biomass, primary production, and assemblage shifts
- Habitat compression/expansion of pelagic & benthic organisms
- Comparative resilience of managed vs. unmanaged ecosystems
- Susceptibility to phase shifts

11. GOA-ON Data Management

11.1 Data Sharing: Consensus vision and solutions to roadblocks

GOA-ON data sharing is essential to achieving the payoff of the Network. The consensus statement regarding sharing of ocean domain GOA-ON data approved by participants of both GOA-ON workshops is:

> "The participants in the Global OA Observing Network agree to support in principle the construction of a web portal that
> – builds on current capacity and capabilities,
> – accepts data streams from relevant data centers,
> – provides visual and data link capabilities, and
> – exhibits synthesis products for the ocean scale."

Recommended metrics for data sharing for ocean data from the GOA-ON were to:

- Provide the quality controlled data for synthesis products
  - 6 months (desired) – 2 years (longest possible) after collection
  - Work to accelerate the quality control (QC) process of these data
- Post on-line the near-real-time (NRT) data
  - Visual graphic of data (realistically possible)
  - Download of data (desired)
  - Work to accelerate the QC process of these data
- Provide the data via public web portal

It is recognized this is sometimes problematic in shelf seas and coastal waters, due to national policies. Additional roadblocks to data sharing were identified by the workshop; however, solutions were also identified (Box 3).

Box 3: ROADBLOCKS AND SOLUTIONS TO DATA SHARING

1. Data Quality Assurance/Quality Control: it takes time; there are no standardized procedures; capacity lacking
- Solution: On the GOA-ON portal
  - Advertise Data Managers, e.g., CDIAC, better
  - Create standardized procedures for the Network
  - Engender trusting relationship between data providers and data managers
  - Post information on benefits of data sharing

2. Institutional boundaries or national regulations
- Solution:
  - Develop terms of reference for Global OA Network
  - Network provides contacts for EEZ paperwork

3. There is no consistent data portal
- Solution:
  - Develop a GOA-ON data portal

4. Scientists' reluctance to share data
- Solution:
  - Publication, acknowledgement
  - Highlight examples of benefits on portal
  - Provide version control
  - Provide DOI for datasets

5. Funding insufficient
- Solution:
  - Outreach to scientists regarding data expectations
  - Provide relevant products to users that are highly valued

11.2 Data Management Plan

There is opportunity for the GOA-ON Data Management Plan to build on an existing data management plan for ocean acidification that NOAA has developed with other U.S. agencies (including DOE, NASA, NSF, and USGS) and with academic representatives. An "Interagency Ocean Acidification Data Management Plan: Draft One," has been developed and published on-line (NODC, 2012). The essence of that plan (also known as the "Declaration of Interdependence") was shared with the Seattle workshop participants, who welcomed it. The declaration is appended to this report (Appendix 3). There is ongoing activity led by the U.S. National Oceanographic Data Center (NODC) to begin implementing that plan.

The data management vision for GOA-ON, building on recommendations from both GOA-ON workshops, would provide effective long-term scientific data management using interoperable online data services allowing for human- and machine-to-machine data discovery and access. This vision includes specific considerations for:

- Providing data sharing time limits for coastal, shelf sea, and open ocean data.
- Deployment of a web data portal allowing optimal data discovery, access, integration, and data visualization from collection- to granular- level OA data and data products using common inter-operable web data services. This web portal would build on current capacity and capabilities, accepts data streams from relevant data centers, provides visual and data link capabilities, and synthesis data products for the ocean scale.
- A coordinated scientific data management and data flow framework that builds on existing infra-structure and scientific requirements over the long-term in coordination with the OA-ICC.
- Adoption of best practice metadata procedures/protocols following international standards (e.g., ISO) to facilitate data discovery, use of DOIs or similar identifiers to provide clear data provenance and attribution.
- Adopt international OA long-term archival centers for OA observational, biological, model data, and data products. These centers would provide data integration where possible using interoperable online data services consistent with the proposed web data portal.

12. GOA-ON Governance

A preliminary governance structure was established at the St Andrews workshop (Figure 9). It was decided that, until more formal arrangements are made, the organizing committee of the 2nd workshop would provide the basis for the GOA-ON Executive Council (see Appendix 4 for members). The main national and international entities directly represented on the Executive Council are expected to continue to provide both in-kind and direct support for GOA-ON organizational activities, including future meetings and staff involvement, with additional support potentially available for training, technological infrastructure and other forms of capacity building.

The roles for the core entities of GOA-ON included in the diagram below and as outlined in the St Andrews workshop include:

i. **OA observing activities, data, expertise and assets of global research community:** these components collectively represent the central and most important piece of the network which encompasses all the actual assets in the water, the data collected and, most importantly, the scientists who oversee their operation and interpret the data.

ii. **National and Regional Funders:** will provide the human, technical and financial resources for the actual implementation of the observing assets around the globe. Several, such as US/NOAA and University of Washington, Aus/CSIRO and UK/NERC, are represented on the Executive Council. Staffing for the GOA-ON website and for management of the network will likely be provided by national funders but may also be supported by the ICC.

iii. **OA- International Coordination Centre:** will coordinate across international scientific efforts from sharing of scientists and expertise across national observing efforts, development of standardized data management approaches and capacity building for developing countries. The global observing network is a primary task in the ICC project.

iv. **International Atomic Energy Agency:** will support the OA-ICC project as its parent body but will also support development of new scientific observing capacity in under-observed regions through its global capacity building networks.

v. **Blue Planet task of the Group on Earth Observations**: includes an activity focused on the GOA-ON and provides access to: 1) novel international audiences (Departments of Environment, for instance) and 2) their scientific networks in developing regions.

vi. **Global Ocean Observing System**: is current developing the Framework on Ocean Observing which will also guide the GOA-ON requirements. GOA-ON scientists are participating in the biogeochemical panels for the FOO.

vii. **Intergovernmental Oceanographic Commission**: will support the GOOS as its parent body but also has its own Ocean Acidification project which will, in near term, work on organizing the next GOA-ON scientific meeting. Further it will connect other international initiatives on biogeochemical ocean observation with the GOA-ON.

viii. **International Ocean Carbon Coordination Projects**: will, through its Ocean Acidification task, coordinate: the development of the requirements for the biogeochemical essential ocean variables for GOOS (see above) and with other international carbon observing efforts.

The Executive Council is charged with ensuring the core functioning of the Network. Its responsibilities include:

- Finishing the Plan including soliciting input from the broader membership (by May 2014)
- Overseeing the process for further refinement of Plan
- Maintaining the Network membership
- Networking with other relevant international bodies
- Developing resources for certain geographic areas of high concern

- Ensuring international data management, to provide centralized access to distributed data centers
- Keeping the map (currently supported by NOAA PMEL and NOAA OAP) of OA observing assets robust, current, and useful
- Encouraging development of synthesis products based on data from GOA-ON
- Providing transboundary (across national boundaries) scientific sharing to ensure high quality observing

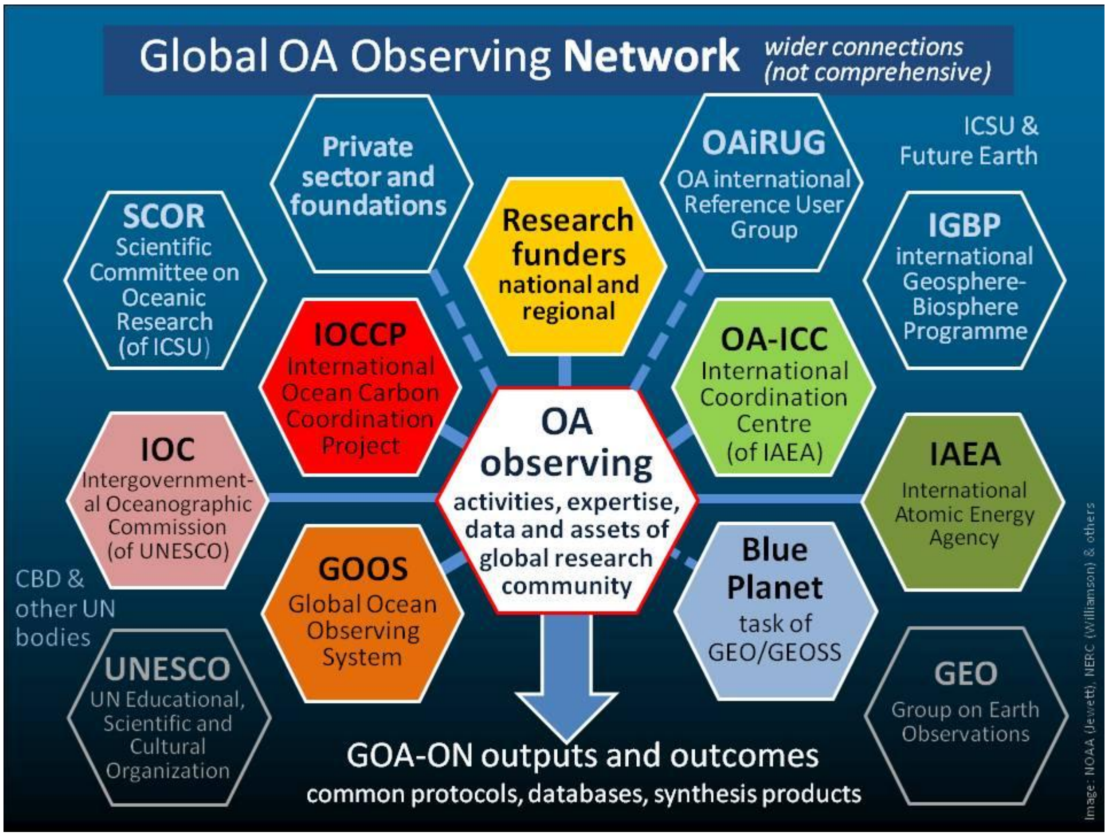

Figure 9. Representation of the basic matrix constituting GOA-ON and the primary entities responsible. The entities represented by colored shapes are represented on the Executive Council and have committed to providing either direct or in-kind support to core organizing activities. The outlined shapes are parent bodies.

13. GOA-ON Support Requirements

GOA-ON needs to support, or facilitate the support of, a functional Network in its entirety. The Network is not just sensors in water; it also requires support for all of the following capacities:

- Physical infrastructure, i.e., the platforms and sensors
- Operations and maintenance, i.e., the humans to run the network and keep it functioning

- Data Quality Assurance/Quality Control (QA/QC), i.e., the standards and application thereof to keep the data quality suitable to the intended use.
- Analytical and synthesis activities, i.e., the humans and models to analyze the data, synthesize it into useful data products, and interpret and publish its significance to a variety of audiences
- Capacity, i.e., the new infrastructure and job force that will have to be built and provided for in order to bring GOA-ON to a global reality.

It is recognized that individual countries are likely most interested in what is happening within their respective national waters and may provide financial resources to support the network when systems are located locally. However, deployment of observing assets **needs to be preceded** by identification of local or regional scientific expertise to support the deployment.

14. GOA-ON Web Portal

Participants in the Network have agreed to support the GOA-ON web portal (http://www.goa-on.org/), currently maintained by US NOAA PMEL, which provides:

- A detailed overview of the GOA-ON goals, elements, governance, and network members, with relevant links to each of the components
- A visual and interactive map representation of the platforms in the network, building upon current capacity and capabilities; the interactive component for each platform will include:
    - a detailed summary of the project
    - a direct link to the project website(s)
    - a list of the parameters being measured
    - direct links to original data at data centers and/or project websites
    - direct links to data synthesis products
- Visual and data link capabilities to process studies, manipulative experiments, field studies, and modeling activities
- Clear links to existing data centers and data management plans
- Access to graphics, data, and GOA-ON data synthesis products for a variety of users with specific OA information needs
- Links to workshops, references, and other relevant GOA-ON activities
- A means for new participants to join the GOA-ON

Forthcoming links from the web portal will provide information on agreed upon data QC protocols, and access to future GOA-ON data synthesis products

15. GOA-ON Outcomes and Applications

The outcomes from GOA-ON are globally distributed quality-assured data, near-real-time data, and data synthesis products that:

- Facilitate research (new knowledge) on OA and its drivers

- Communicate status of OA and biological response
- Enable forecasting/prediction of OA conditions

These OA data can be used to provide relevant products to variety of users. Specific applications with information needs relevant to OA are:

- Scientific inquiries;
- International policy especially carbon emission policies;
- Education and outreach as related to forecasts;
- Socio-economic impact forecasts;
- Potential fisheries impacts;
- Cultural impacts
- Insurance on fisheries yields
- Coral reefs and livelihood, especially developing countries
- Regulatory needs
- International food and economic security
- Shellfish aquaculture (widespread globally) adaptation strategies;
- Shore protection, tsunami protection as related to implications for coral reefs
- Tourism as related to coral reef and marine habitat degradation

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Appendix 1. Global OA Observing Network workshop participants

[1]Seattle, WA; [2] St Andrews, UK; [a]Organizing Committee; [b]Steering Committee

Rebecca Albright[1] - Australian Institute of Marine Science

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Gernot Friederich[1] - Monterey Bay Aquarium Research Institute, USA
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Jian Ma[1,2] - State Key Laboratory of Marine Environmental Science, Xiamen University, China
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Wendy Watson-Wright[2] - Intergovernmental Oceanographic Commission - UNESCO

Sieglinde Weigelt-Krenz[2] - BSH Hamburg, Germany

Steve Weisberg[1b] - Seattle Workshop Facilitator

Steve Widdicombe[1, 2] - Plymouth Marine Lab, UK

Phil Williamson[1, 2a,b] - Natural Environment Research Council/University of East Anglia, UK

Alette Yniguez[2] - University of the Philippines, The Philipines

Appendix 2. Schedules of the Seattle and St. Andrews GOA-ON workshops

Appendix 2.1 Seattle Workshop Agenda

Day 1: 26 June 2012

08:15 - 09:00: Workshop Introduction: Welcome, Logistics, and Opening Remarks:
Jan Newton (UW-NANOOS, Workshop Leader) and Steve Weisberg (SCCWRP, Workshop Facilitator); Dean Lisa Graumlich, College of the Environment, University of Washington; Clark Mather on behalf of Congressman Norm Dicks, U.S. House of Representatives

09:00 - 10:15: Session A: What is a Global Ocean Acidification Observing Network and why do we need one?

The purpose of this session is to address and discuss the following questions:

1. What has been the activity to date regarding a global ocean acidification observing network and why is one needed?
2. What are the likely benefits to the various stakeholders (academic, governmental, and commercial) that could be provided by global ocean acidification observing network?
3. What kind of ocean acidification observing network is needed to provide such benefits?
4. How can it be coordinated at the international level?

Overview talk: "What are the benefits of a Global Ocean Acidification Observing Network?" by Libby Jewett, NOAA OA Program Director, (9:00 – 9:20) followed by Plenary Discussion (9:20 – 10:15).

10:30 - 12:00 Session B: Network Design: Building from existing programs and assessing strategic needs for new locations

The purpose of this session is to address and discuss the following questions:

1. What are the existing global carbon observing efforts?
2. How do we define Tier 1 and Tier 2 measurements?
3. What are the obvious gaps in existing efforts when viewed as a global ocean acidification observing network?
4. What should a global ocean acidification observing network consist of (survey cruises, moorings, floats, gliders, etc) and where should assets be located?

Overview talk: "What are the possible components of an ocean acidification network based on existing resources?" by Richard Feely, NOAA PMEL, (10:30 – 11:15) followed by Plenary Discussion (11:15 – 12:00).

13:00 - 17:00 Session C: Global Ocean Acidification Observing Network System Design: *1. Definition*

The purpose of this session is to define attributes of the observing network system design.

13:00 Charge to Breakout Groups – Jan Newton/Steve Weisberg

13:30 - 15:00 **Breakout Session I: Defining the Global Ocean Acidification Observing Network's System Design**

Breakout Group 1: Time Series Measurements and Platform Location Network Design: This group will focus from a temporal and spatial perspective, what scales need to be accounted for in the system design. They will focus on questions 2 & 3. They will also focus on the rationale for the observations in various regions.

Uwe Send, Simone Alin, Maciej Telszewski

Breakout Group 2: Physical/Chemical Measurements Network Design: This group will focus from a physical/chemical disciplinary perspective, what measurements need to be accounted for in the system design. They will focus on question 1, but also 2 and 3.

Andrew Dickson, Burke Hales, Kitack Lee

Breakout Group 3: Biological Measurements Network Design: This group will focus from a physical/chemical disciplinary perspective, what measurements need to be accounted for in the system design. They will focus on question 1, but also 2 and 3.

Bruce Menge, Rebecca Albright, Joe Salisbury

Questions to be addressed by each group:

1. What minimum physical, chemical and biological parameters (Tier 1 and Tier 2) should be measured for each platform? Where? At what depths?

2. What is the desired spatial and temporal resolution of these measurements?

3. Where are the gaps in present observing systems? Where are the areas of high vulnerability? Where do we need new measurements?

15:30 - 17:00 **Continue Breakout Session C**

Day 2: 27 June 2012

08:30 - 11:30 Session C: Global Ocean Acidification Observing Network System Design: *2. Group Consensus* - Steve Weisberg, Facilitator

The purpose of this session is to hear back from breakout groups re the observing network system design and to reach consensus and/or identify unresolved issues.

08:30 - 10:00 **Breakout Group Reports** (30 min per group)

10:30 - 11:30 **Plenary Discussion** to reach consensus on Observing System Design and/or identify unresolved issues

11:30 - 12:00 Session D: Data Quality Control and Validation for the Global OA Observing Network in the context of International Coordination: *1. Current International Network Coordination*

The purpose of this session is to introduce the current level of international OA network coordination.

Presentation by Richard Feely for Jean-Pierre Gattuso, Chair, SOLAS-IMBER Ocean Acidification Working Group

13:30 - 17:00 <u>Session D</u>: Data Quality Control and Validation for the Global OA Observing Network in the context of International Coordination: *<u>2. Data Quality Control and Validation</u>*

The purpose of this session is to address and discuss the following questions:

1. What are appropriate data quality goals for the proposed measurements?
2. What activities are required to achieve these goals?
3. What should be the network system requirements for data availability and data management? (e.g., data delivery schedule, metadata, data archival centers)
5. What data synthesis efforts are essential to achieve the benefits of the observing system?

Overview talk: "What are the possible guidelines for data quality control and validation?" by Hernan Garcia, NODC, and Emilio Mayorga, NANOOS-IOOS, (13:30 – 14:00) followed by Plenary Discussion (14:00 – 14:30).

14:30 - 15:30 **Breakout Session II. Defining Data Quality Control and Validation for the Global OA Observing Network in the Context of International Coordination**

The purpose of this session is to define data QC and validation attributes of the observing network system design.

14:30 Charge to Breakout Groups – Jan Newton/Steve Weisberg

<u>Breakout Group 1</u>: Cruises and Ships of Opportunity
Benjamin Pfeil, Hernan Garcia, Cathy Cosca

<u>Breakout Group 2</u>: Fixed Platforms (e.g., Moorings & Piers)
Mark Ohman, Adrienne Sutton, Simone Alin

<u>Breakout Group 3</u>: Floats and Gliders
Jeremy Mathis, Libby Jewett, Jenn Bennett

Questions to be addressed by each platform-defined group:

1. What are appropriate data quality goals for the proposed Tier 1 and Tier 2 measurements on each platform?
2. What data quality requirement system is needed to achieve goal?
3. What should be the network system requirements for data availability and data management? (e.g., data delivery schedule, metadata, data archival centers)
4. What are potential data products and strategies for the required data synthesis needed to make the products?

16:00 - 17:00 **Continue Breakout Group Discussions**

Day 3: 28 June 2012

08:00 - 10:15 Session D: Data Quality Control and Validation in context of International Coordination: *3. Group Consensus*

The purpose of this session is to hear back from breakout groups re the data QC and validation needs for the network and to reach consensus and/or identify unresolved issues.

08:00 - 09:30 Breakout Group Reports (30 min per group)

09:30 - 10:15 Plenary Discussion to reach consensus on Data QC/V in context of International Coordination and/or identify unresolved issues

10:45 - 12:00 Session E: International Data Integration and Network Coordination

Plenary Discussion on the International Coordination for Data and Network Integration – Steve Weisberg, Facilitator

The purpose of this session is to identify if we have consensus on data sharing and what roadblocks inhibit data integration and network coordination.

Presentation by Jan Newton of the “Declaration of Interdependence” from the Consortium for the Integrated Management of Ocean Acidification Data (CIMOAD)

Group poll: Do we have consensus to share data?

Identify roadblocks inhibiting data integration and network coordination on an international scale (take individual participant contributions)

1. What are ideas to overcome identified roadblocks?
2. How will we ensure that the discrete observing efforts become a network?
3. Should there be an official structure or a more organic collective?
4. What actions are needed to better integrate and coordinate the observation network?
5. What actions are needed to better integrate and coordinate data access?

13:00 - 15:30 Session F. Future Planning

The purpose of this session is to identify if we have consensus on vision for network and what next steps are.

1. Looking at the current/planned observing system vs. the vision for the system we have identified here to address gaps, do we a consensus view?
2. What tasks should be done first to move this effort forward?
3. What infrastructure will be needed to achieve this?
4. What has not been resolved and how shall this be addressed?
5. What is an appropriate timeline, with milestone steps, for implementation of the network?
6. How should we define the network association and what is the most efficient way to integrate efforts in the future? (e.g., regular meetings, website, steering committee, etc.)

16:00 - 17:00 Workshop Summary: Recap Action Items and Identify Points of Contact for follow-up

Appendix 2.2 St. Andrews Workshop Agenda

Day 1: 24 July, 2013 **Joint session of UKOA ASM and GOA-ON workshop**

13.30 **Ocean acidification research in a wider context**

Chair: Carol Turley

1. From national to international, from science to policy (*Phil Williamson*)
2. Awareness and action on ocean acidification (*Jane Lubchenco*)
3. Environmental protection in the North Atlantic (*Darius Campbell, Executive Secretary, OSPAR Commission*)
4. Framework for ocean observing and ship-based time series aiding the design of a global OA observing network (*Maciej Telszewski*)
5. Update on the OA International Coordination Center (*Lina Hansson*)
6. Promoting technological advances: the X-Prize (*Paul Bunge*)

Discussion

15.20 **The development of a global ocean acidification observing network**

Chair: Bronte Tilbrook

1. Why we need a global OA network (*Wendy Watson-Wright, Executive Secretary IOC/UNESCO*)
2. Where we are now: outcomes from Seattle 2012 *(Jan Newton)*
3. An introduction to the global OA observing asset map (*Cathy Cosca)*

Discussion: where we want to be

16.30 **Global observing of ocean acidification and ecological response**

Chair: Arthur Chen

1. Observing OA in regional seas: a modeller's perspective (*Jerry Blackford*)
2. OA processes and impacts in US coastal waters (*Richard Feely*)
3. Observing OA in upwelling regions off South America (*Rodrigo Torres & Nelson Lagos*)
4. Observing OA and its impacts in the Pacific-Arctic (*Jeremy Mathis*)
5. Observing OA and its impacts in the Southern Ocean (*Pedro Monteiro*)

Discussion

18.00 Session ends

Day 2: 25 July 2013 **GOA-ON Workshop**

08.40 **Aims and objectives of the workshop – and the network**

Chair: Libby Jewett

1. Goals for the meeting (*Jeremy Mathis and Phil Williamson*)
   Discussion: Defining how the network will operate – and what it will

deliver

09.30 **Best practice for analytical chemistry** (Goal 1, Level 1)

1. Review best practices for OA chemistry ('weather' v 'climate') as decided at Seattle (*Andrew Dickson*)
2. Comparison of carbonate chemistry software packages – and implications for GOA-ON (*Jim Orr*)

Discussion

10.00 **Short presentations on physico-chemical variability (and how it may be affected by biology) in specific environments**

Chair: Maciej Telszewski

What are the key science issues relevant to establishing long-term observing programmes?

- Shelf seas: from sea surface to sediment (*Kim Currie)*
- Riverine influences on coastal systems (*Joe Salisbury*)
- Polar-specific issues (*Liqi Chen*)
- Tropical-specific issues (*Moacyr Araujo*)

Discussion

Short presentations on ecosystem response to OA in specific habitats and environments

Chair: Mark Ohman

11.15 What are the key science issues relevant to establishing long-term observing programmes?

- Pelagic ecosystems in shelf seas (*Ulf Riebesell*)
- Warm water corals (*Rusty Brainard*)
- Cold water corals (*Murray Roberts*)
- Other coastal benthic and intertidal habitats (*Steve Widdicombe*)

Discussion

12:15 **Charge to the breakout groups** *(Libby Jewett)*

12.20 **Breakout session #1**

Discussion on how to observe relevant variability for different ecosystems and habitats, distinguishing signal from noise and including under- observed oceanic and coastal regions. Overall goal: to fine-tune the recommendations for the Ecosystem Response part of the network, taking account of regionally-specific considerations. Issues to include:

- How can we best match chemical, biogeochemical and biological observing to track/predict quantifiable OA impacts of ecological and socio-economic importance?
- What are the (regionally-specific) "essential ocean variables" for biogeochemistry and biology?
- Are there 'indicator species' that may be especially vulnerable to OA impacts?

Tropical regional seas (excl coral reef habitats)	Temperate regional seas (excl cold-water coral habitats)	Polar regional seas	Warm and cold -water corals	Nearshore, intertidal & estuarine habitats
Leaders: Eric de Carlo Rodrigo Kerr	***Leaders: Bruce Menge Kirsten Isensee***	***Leaders: Richard Bellerby Jeremy Mathis***	***Leaders: Dwight Gledhill Andreas Andersson***	***Leaders: Sam Dupont Terrie Klinger***

14.00 **Breakout session #2**

Discussion on how to observe relevant variability – continued, with same breakout groups (but opportunity for some individuals to change groups). Overall goal: to fine-tune the recommendations for the Ecosystem Response part of the network, developing the optimal observing system for the various ecosystem types, with variables appropriate for model testing and development. Issues requiring attention include:

- What suite of chemical and biological measurements comprise the essential (Level 1) and desirable (Level 2) at the regional level (maximising congruence with Seattle report)?
- What spatial and temporal coverage is essential/desirable for these measurements?
- Are there regionally-specific 'hot spots' (high rate of change or potential for high impacts) for prioritising national and international effort?

Break-out leaders as identified above

Tropical regional seas (excl coral reef habitats)	Temperate regional seas (excl cold-water coral habitats)	Polar regional seas	Warm and cold -water corals	Nearshore, intertidal & estuarine habitats

15.15 Time for breakout leaders to put together their reports. Opportunity for poster-viewing and other informal discussions.

15.45 **Data sharing and management**

Chair: Jim Orr

Introductory presentation: "The vision for GOA-ON data management" (*Hernan Garcia & Alex Kozyr*). Discussions on:

1. Specific issues for shelf seas/coastal regions, and integrating chemistry and biology – building on decisions at Seattle
2. Use of the GOA-ON map as a starting point – scope for including links to databases and datasets

3. Importance of metadata
4. Lessons learnt from SOCAT, ICES and EPOCA *(to include inputs from Dorothee Bakker, Evin McGovern and Lina Hansson*)
5. Linkages to other relevant data management activities , via IOCCP and GOOS

17:30 – POSTER SESSION

Day 3: 26 July, 2013 **GOA-ON workshop**

09:00 **Summary of workshop progress and outcomes. Consensus on how to observe chemistry and biology in shelf seas and coastal regions, across full climatic range**

Chair: Jan Newton

Two slides from each of yesterday's break out groups (summarizing main outcomes), presented by breakout leaders.

Discussion

10.45 **Consensus on how to observe chemistry and biology in shelf seas and coastal regions – continued**

Chair: Jeremy Mathis

1. What measurements
2. How frequently
3. Spatial distribution
4. How precise do we need the data to be, given the high level of variability
5. What technology advancements need to be made? For example, how can gliders contribute and how can we promote that?

13.00 **Discussion on what do we mean by a "network"? Are there examples of observing networks that we can use as a model? What are the optimal governance arrangements?**

Chair: Libby Jewett

Contributions by Maciej Telszewski and Phil Williamson – plus wide input from participants

13.45 **Regional coverage and capacity building. Can we identify specific regions (currently under-observed but potentially subject to rapid change) which this global OA community will target for improved coverage in the next**
2-3 years? How will additional partnerships be created, expertise developed and national funding secured to help fill gaps in the map?

Chair: Phil Williamson

Contributions by Jim Orr (re role of OA-ICC and iOA-RUG), plus wide input from participants

14.30 **Next steps/ synthesis products:** Jeremy Mathis and Phil Williamson

15.15- ~16.40	***Workshop Organizing Committee meeting:*** *implementing the agreed actions*

Appendix 3. An excerpt from the "Interagency Ocean Acidification Data Management Plan" produced by NOAA, US IOOS, and NODC.

"**Declaration of Interdependence of Ocean Acidification Data Management Activities in the U.S.**"

Whereas Ocean Acidification (OA) is one of the most significant threats to the ocean ecosystem with strong implications for economic, cultural, and natural resources of the world;

Whereas our understanding of OA and our ability to: 1. inform decision makers of status, trends, and impacts, and 2. research mitigation/adaptation strategies, requires access to data from observations, experiments, and model results spanning physical, chemical and biological research;

Whereas the various agencies, research programs and Principal Investigators that collect the data essential to understanding OA often pursue disparate, uncoordinated data management strategies that collectively impede effective use of this data for synthesis maps and other data products;

Whereas an easily accessible and sustainable data management framework is required that:
i) provides unified access to OA data for humans and machines; ii) ensures data are version-controlled and citable through globally unique identifiers; iii) documents and communicates understood measures of data and metadata quality; iv) is easy to use for submission, discovery, retrieval, and access to the data through a small number of standardized programming interfaces;

Whereas urgency requires that short-term actions be taken to improve data integration, while building towards higher levels of success, and noting that immediate value can be found in the creation of a cross-agency data discovery catalog of past and present OA-related data sets of a defined quality, including lists of parameters, access to detailed documentation, and access to data via file transfer services and programming interfaces;

Whereas this integration will also benefit other users of data for a diverse array of investigations;

Therefore, be it resolved that the 31 participants of an OA Data Management workshop in Seattle, WA on 13-15 March 2012 established themselves as the Consortium for the Integrated Management of Ocean Acidification Data (CIMOAD) and identified three necessary steps forward to achieve this vision:

1. The endorsement of agency program directors and managers for collective use of machine-to-machine cataloging and data retrieval protocols (including THREDDS/OPeNDAP) by each agency data center to provide synergistic, consolidated mechanisms for scientists to locate and acquire oceanographic data;

2. The commitment of the scientific community to establish best practices for OA data collection and metadata production, and the leadership to provide a means of gaining this consensus; and

3. The endorsement of agency program directors and managers to direct data managers to collaborate to develop the system articulated above and contribute to a single national web portal to provide an access point and visualization products for OA.

We, the undersigned, request your attention to this matter and commitment to bringing this vision to reality in the next five years for the benefit of our nation and contribution to the global understanding.

Signatories to the Declaration of Interdependence of Ocean Acidification Data Management Activities:

1. Alexander Kozyr, Oak Ridge National Lab, CDIAC
2. Burke Hales, Oregon State U
3. Chris Sabine, NOAA PMEL
4. Cyndy Chandler, WHOI & NSF BCO-DMO
5. David Kline, UCSD
6. Emilio Mayorga, UW & NANOOS-IOOS
7. Hernan Garcia, NOAA NODC
8. Jan Newton, UW & NANOOS-IOOS
9. Jon Hare, NOAA NMFS NEFSC
10. Kevin O'Brien, NOAA PMEL
11. Kimberly Yates, USGS
12. Krisa Arzayus, NOAA OAR NODC
13. Libby Jewett, NOAA OAP
14. Libe Washburn, UCSB
15. Liqing Jiang, NOAA OAP
16. Michael Vardaro, OSU & OOI
17. Mike McCann, MBARI
18. Paul McElhany, NOAA NMFS NWFSC
19. Peter Griffith, NASA
20. Philip Goldstein, OBIS-USA
21. Richard Feely, NOAA PMEL
22. Roy Mendelssohn, NOAA SWFSC
23. Samantha Siedlecki, UW & JISAO
24. Sean Place, U South Carolina
25. Simone Alin, NOAA PMEL
26. Steve Hankin, NOAA PMEL
27. Tom Hurst, NOAA NMFS AFSC
28. Uwe Send, UCSD SIO
29. Sarah Cooley (via phone), WHOI and OCB
30. Derrick Snowden (via phone), NOAA IOOS
31. Jean-Pierre Gattuso (via phone) OAICC

Appendix 4. Global OA Observing Network Executive Council (as of May 2014)

Co-chairs:
Phillip Williamson (UK – UKOA/NERC)
Libby Jewett (US - NOAA)

Members:
Richard Bellerby (Norway - NIVA)
Chen-Tung Arthur Chen (Taiwan – National Sun Yet-Sen University)
Sam Dupont (Sweden – Gothenburg University)
Richard Feely (US – NOAA)
Albert Fischer (Global Ocean Observing System)
David Osborn (IAEA/OA International Coordination Centre)
Kitack Lee (Korea – Pohang University)
Jeremy Mathis (US – NOAA)
Pedro Monteiro (South Africa - CSIR)
Jan Newton (US – University of Washington/IOOS)
Yukihiro Nojiri (Japan – NIES)
Benjamin Pfiel (Norway – University of Bergen)
Maciej Telszewski (IOCCP)
Bronte Tilbrook (Australia – CSIRO)
Jorge Luis Valdes (IOC)

Technical Architect:
Cathy Cosca (NOAA PMEL)

Appendix 5. List of Abbreviations

To be crafted after Paris….

Also, add somewhere Acknowledgements for contributors, Andrew Dickson, Cathy Cosca, Hernan Garcia…maybe others I am forgetting.

From: **MidAtlanticRPB, BOEM** <boemmidatlanticrpb@boem.gov>
Date: Wed, Nov 19, 2014 at 1:35 PM
Subject: Re: Submarine cable / ocean planning meeting summary for MidA RPB review
To: Kris Ohleth <kohleth@atlanticwindconnection.com>
Cc: Gwynne Schultz <gwynne.schultz@maryland.gov>, Laura McKay <Laura.McKay@deq.virginia.gov>, "Sarah W. Cooksey" <Sarah.Cooksey@state.de.us>, Liz Semple <Elizabeth.Semple@dep.nj.gov>, Greg Capobianco <Gregory.Capobianco@dos.ny.gov>, Bob Wargo <rw1791@att.com>

Thank you for sharing this information about the submarine cable industry with the MidA RPB. The MidA RPB will consider all comments received. In addition, we will post your message on the written public comments section on the MidA RPB webpage.

Please continue to contact us with any additional information you may have. As a reminder, the MidA RPB shared draft products for public review and comment this fall. The MidA RPB will refine its ideas about an approach for the materials, informed by public input, and discuss these topics further during the RPB's next in-person meeting on January 21-22, 2015 in New York. Please check the website (http://www.boem.gov/Mid-Atlantic-Regional-Planning-Body/) for updates and additional information.

On Tue, Nov 18, 2014 at 2:17 PM, Kris Ohleth <kohleth@midatlanticocean.org> wrote:
Dear MidA RPB,

Please note that this document is appropriate for distribution, and no longer an internal draft. The reference to that from an older draft is updated in the attached.

Apologies for any confusion.

Kris

Kris Ohleth
Executive Director
Mid-Atlantic Regional Council on the Ocean (MARCO)
KOhleth@MidAtlanticOcean.org
(201) 850-3690

On Nov 18, 2014, at 1:38 PM, Kris Ohleth <kohleth@midatlanticocean.org> wrote:

Dear Members of the Mid-Atlantic Regional Planning Body,

The Mid-Atlantic Regional Council on the Ocean (MARCO) is pleased to submit the attached document that summarizes the major outcomes of the discussion of a group of representatives from the submarine cable industry at a sector-specific meeting convened by the Mid-Atlantic Council on the Ocean (MARCO) in Bedminster, NJ on July 15, 2014. We anticipate that you find this meeting summary helpful as you continue to enhance your understanding of the various communities using the ocean in the Mid-Atlantic.

In July, MARCO hosted a meeting for the members of this community through our submarine cable Stakeholder Liaison Committee (SLC) representative, Bob Wargo. Bob brought together several of his colleagues for this half-day meeting during which we listening and learned about the submarine cable sector, and then had an opportunity to share information about ocean planning in the Mid-Atlantic region.

Please note that this meeting summary does not substitute for specific comments on the RPB's draft documents that are available for review through November 20.

Best,
Kris

<Summary Submarine Cables 7 15 2014_FINAL.pdf>

Kris Ohleth
Executive Director
Mid-Atlantic Regional Council on the Ocean (MARCO)
KOhleth@MidAtlanticOcean.org
(201) 850-3690

Summary of MARCO Submarine Cable Industry Sector-Specific Meeting

This document summarizes the major outcomes of the discussion of a group of representatives from the submarine cable industry at a sector-specific meeting convened by the Mid-Atlantic Council on the Ocean (MARCO) in Bedminster, NJ on July 15, 2014.

Review of Ocean Planning

Kris Ohleth of MARCO offered brief comments about the history of ocean planning in the Mid-Atlantic region and the activities of MARCO and the Mid-Atlantic Regional Planning Body (MidA RPB). The primary points of discussion and clarifications offered include the following:

- MARCO is a regional ocean partnership consisting of five Mid-Atlantic States: New York, New Jersey, Delaware, Maryland, and Virginia who share four regional ocean priorities: climate change adaptation, protection of important marine habitats, offshore renewable energy development, and water quality improvement. In addition, it recognizes ocean planning as a mechanism for convening diverse interests, fostering productive dialogue, and collecting important ocean use information. MARCO works collaboratively with the MidA RPB where possible to advance regional ocean planning. The two groups have significant overlapping membership.
- The MidA RPB consists of Federal, State, Tribal, and Fishery Management Council representatives who analyze how a suite of ocean uses intersect and work to improve coordination among those entities responsible for managing different uses.
- The MidA RPB has no authority for decision-making beyond the individual authorities of member entities. Each individual member entity retains all current permitting and regulatory authorities (e.g., BOEM retains offshore wind leasing authority).
- The MidA RPB is currently developing a suite of products to inform a decision in January 2015 about the structure and content of a regional ocean action plan. This action plan will necessarily include both process and planning elements, and will be adaptable over time. Drafts of these products will be published for public comment in late October 2014. The first iteration of the regional ocean action plan will be released in 2016.
- Based upon MARCO member states' shared regional priorities, a primary purpose of forming MARCO's Stakeholder Liaison Committee and impetus for scheduling a series of sector-specific meetings like this one is to gather input about the interest and needs of different industries and transmit that information to the MidA RPB to inform its planning processes.

A list of Frequently Asked Questions about the MidA RPB may help provide additional context about the relationship between MARCO, the Mid-Atlantic Regional Planning Body, and each individual state and federal member entity. This list is available on the MidA RPB's website at http://www.boem.gov/MidA-RPB-FAQ/.

Overview of the Mid-Atlantic region submarine cables industry

Bob Wargo (telecommunications) & Bill Wall (energy) provided the background, connections, and differences between the telecommunications and power submarine cable industries. The submarine cable industry is interconnected, and is divided into a few sectors: cable owners, cable, amplifier and terminal manufacturers, installers and maintenance providers, consultants, and construction companies. For all sectors, the major difference in cabling is the size, requiring different shipboard equipment, although installation practices are similar.

Telecommunications Cables
History
The telecommunications submarine cable industry, which began in 1851, with a telegraph cable lain between England and France. Progress continued with inter-continental telephone cables and fiber optic cables, which are retired as technology changes and capacity needs increase. The current trend is 100 gigabits per second per wavelength, with higher density of wavelengths. As cables are taken out of service, they are generally not removed. More recently, states are including removal in the contracts. Some companies are setting up recovery and recycling processes, although new permits also affirm that the company won't do more environmental damage than good when recovering cable. Currently, 97-99% of international communications traffic is riding on these cables, and most companies have a restoration capability to route around outages.

Installation
Most cables since TAT-4/5 have been buried at a target burial depth of 1 – 2 meters to get below the sea bed. The standard depth in Asia is 3 meters. A typical telecommunications system (Network Management System) includes: 1. terminal equipment on shore in cable station, 2. Armored cable on shore, 3. Lightweight cable on ocean floor, and 4. Amplifiers are spliced in to amplify light. A typical installation requires a survey swath width of 2x the depth of the water, which allows room to go around ocean features, although cable is laid very accurately. Installation begins with a desktop study where many sources are investigated (NAVY, publicly available info, fisheries, and previous studies). Geomorphology of seabed and bathymetry is established. This is followed by a route survey. The seabed is surveyed and mapped so cables can be laid precisely on the ocean floor. During the permitting process, external agencies may express concern, which are often included as some form of mitigation measure in the permit to lay the cable.

Financing
Trans-oceanic cable can cost upwards of $200M to $500M, and a consortium (20-30) telecommunications companies will often jointly fund a new cable, each owning their proportionate share of the capacity.

Energy

Cables Installation

For energy cables, the GIS desktop study is very important, and they utilize a magnetometer for archeological information in national & international waters. Gravity cores and vibracores are used to determine seabed properties for cable burial, with a target burial depth of 4 - 6 ft. A jet plow is used to bury the cables to the desired depth. Armory on energy cables can cause problems due to weight.

Future

Wind energy will bring in multiple power cable systems laid offshore. In New Jersey, there could be up to 23 wind energy lines, and the grid will need to be adapted to manage additional energy. Wind farms will be in shallow waters, with current plans for NJ in less than 100 ft of water.

Energy and Telecommunications

Laws & Regulations

Acquiring a submarine cable permit can take several months to over a year, and some contingencies will come from the comments sought from NMFS, USCG, etc.
BOEM oversees permitting for oil and gas and wind energy, but not for submarine cables. While the FCC grants a landing license for telecommunications cables, the states, in partnership with the Army Corps of Engineers, will grant submerged land lease permits for up to 3 nautical miles off their coasts. Challenges arise as different states and ACE districts have different interpretations of how far out they have jurisdiction.

Cable breaks can be caused by various sources, including: commercial fishing, anchoring (illegal and improperly stowed), dredging, marine construction, and natural hazards such as typhoons or earthquakes/tsunamis. US laws protect cables for willful or negligent damage, but laws are old and fines are minimal, so the Coast Guard often won't pursue charges for low fines.

Cable Routes

Most routes are known, however, there is some talk about routes from South America to Asia to Australia and North America to Australia, as well as an Arctic route. To determine the routes, companies gather as much available data as possible from portal and past surveys, etc. In most cases, this information is not sufficient and hydrographic studies are needed. Surveys need to be completed prior to the installation of the cable. Telecommunications companies involved in undersea cables frequently use GIS and can superimpose their proposed routes to ID possible hazards for the route surveys.

Seismic surveys (airgun technology, used in oil and gas exploration) penetrate the seabed and are much stronger than what is used in the cables industry, which does not use air guns. Cable survey penetrates 6-10 feet, and is more localizes and high frequency.

Some information about cable routes must be selectively disclosed (e.g. fishermen, who need to know). Cable companies disclose information by request, such as sharing charts with fishermen and distributing to ports. Contact Bob if two industries need to share information.

Final Thoughts

Future changes for submarine cable industry will be centered around upgrades to existing systems, and won't add too much to the Atlantic Basin.

The industry's major concern regarding ocean planning is that they do not want the process to make it harder to do their jobs.

Mid-Atlantic Ocean Data Portal

Tony MacDonald of Monmouth University and the Mid-Atlantic Ocean Data Portal Team provided an overview of the MARCO Mid-Atlantic Ocean Data Portal (Portal) data and applications. All Portal data is available to the public, and they are working to add additional data such as Recreational and AIS data used for fisheries mapping. The information placed on the portal can be used to understand interactions in ocean uses, such as those between fishing, wind energy areas, and navigation. The overlap in use data identifies management hotspots.

NASCA and NOAA are working on non-disclosure agreement to map submarine cable data route position lines. They are working on guidelines to share datasets for the Marine Cadastre and the regional portals. Due to proprietary information concerns, only select Cadastre staff will have access to raw data. Data will be seen on Portals but will not be downloadable; line data will not be able to be extracted. Will also remove the data related to the near-shore landing sites. Attached attributes will include information about the (1) owner, (2) emergency contact, and (3) planning contact.

Al Lombana provided an overview of the Portal, showing participants how to Register for Data Portal, and sharing training course information with the Portal Tutorials. Using the interactive Marine Planner, you can save maps in bookmarks or request specific maps, which are all printable.

Next Steps

- The meeting summary will be distributed to the meeting participants for comment, and the commentary will be forwarded to the RPB.

- Set MARCO Portal to help researchers understand who to contact to retrieve information about submarine cables. "Call before you dig."
- Participants are encouraged to provide comments on the MidA RPB's public materials that will be released in late October 2014. They are also encouraged to attend a public listening session planned for early November in one of five Mid-Atlantic locations. These listening sessions are an opportunity to industry representatives and other stakeholders to convey the importance of the submarine cables industry and ask questions about the RPB's process in a productive forum. Information about the public listening sessions is available on the MidA RPB's website at http://www.boem.gov/MidA-RPB-Meetings/.

Resources

International Cable Protection Committee (ICPC): http://www.iscpc.org/

History Resources:

- Atlantic Cable – broad history of submarine telecomm history: http://atlantic-cable.com/
- http://www.history-magazine.com/cable.html
- Washington Post article: http://www.washingtonpost.com/blogs/the-switch/wp/2014/07/11/what-a-quarter-century-of-internet-growth-looks-like-underwater/

How to fix a damaged cable: http://www.washingtonpost.com/blogs/the-switch/files/2014/07/bote1.gif

From: **MidAtlanticRPB, BOEM** <boemmidatlanticrpb@boem.gov>
Date: Mon, Dec 8, 2014 at 8:01 AM
Subject: Re: Tug and barge / ocean planning meeting summary for MidA RPB review
To: Kris Ohleth <kohleth@midatlanticocean.org>
Cc: BOEM MidAtlanticRPB <MidAtlanticRPB@boem.gov>, Gwynne Schultz <gwynne.schultz@maryland.gov>, Laura McKay <Laura.McKay@deq.virginia.gov>, "Sarah W. Cooksey" <Sarah.Cooksey@state.de.us>, Liz Semple <Elizabeth.Semple@dep.nj.gov>, Greg Capobianco <Gregory.Capobianco@dos.ny.gov>, Michelle Lennox - MARCO <mlennox@midatlanticocean.org>, Kim Barber <kbarber@midatlanticocean.org>, Arlo Hemphill <ahemphill@midatlanticocean.org>, Tony MacDonald <amacdona@monmouth.edu>

Thank you for sharing this information about MARCO's tug and barge sector meeting with the MidA RPB. The MidA RPB will consider all comments received. In addition, we will post your message and this meeting summary on the written public comments section on the MidA RPB webpage.

Please continue to contact us with any additional information you may have.

On Sun, Dec 7, 2014 at 2:24 PM, Kris Ohleth <kohleth@midatlanticocean.org> wrote:
Dear Members of the Mid-Atlantic Regional Planning Body,

The Mid-Atlantic Regional Council on the Ocean (MARCO) is pleased to submit the attached document that summarizes the major outcomes of the discussion of representatives from the tug and barge industry at a sector-specific meeting convened by MARCO in Portsmouth, VA on September 22, 2014. We anticipate that you find this meeting summary helpful as you continue to enhance your understanding of the various communities using the ocean in the Mid-Atlantic.

In September, MARCO hosted a meeting for the members of this community through our tug and barge Stakeholder Liaison Committee (SLC) representative, Eric Johansson, who delegated the meeting planning and agenda development to John Harms of the American Waterways Operators. John brought together several of his colleagues for this half-day meeting during which we listening and learned about the tug and barge sector, and then had an opportunity to share information about ocean planning in the Mid-Atlantic region. We hope the information in this meeting summary document is helpful to the RPB as you continue your important work.

Sincerely,
Kris Ohleth

Kris Ohleth
Executive Director
Mid-Atlantic Regional Council on the Ocean (MARCO)
KOhleth@MidAtlanticOcean.org
(201) 850-3690

Summary of MARCO Tug and Barge Sector-Specific Meeting

This document summarizes the major outcomes of the discussion of a group of representatives from the tug and barge industry at a sector-specific meeting convened by the Mid-Atlantic Council on the Ocean (MARCO) in Portsmouth, VA on September 22, 2014.

Review of Ocean Planning

Kris Ohleth of MARCO and Laura McKay of the Virginia Coastal Zone Program offered brief comments about the history of ocean planning in the Mid-Atlantic region and the activities of MARCO and the Mid-Atlantic Regional Planning Body (MidA RPB). The primary points of discussion and clarifications offered include the following:

- MARCO is a regional ocean partnership consisting of five Mid-Atlantic States: New York, New Jersey, Delaware, Maryland, and Virginia which share four regional priorities: climate change adaptation, protection of important marine habitats, offshore renewable energy development, and water quality improvement. MARCO recognizes ocean planning as a mechanism for convening diverse interests, fostering productive dialogue, and collecting important ocean use information. MARCO works closely with the MidA RPB to advance regional ocean planning through stakeholder engagement and has significant overlapping membership.
- The MidA RPB consists of federal, state, tribal, and Fishery Management Council representatives that will analyze how a suite of ocean uses intersect and improve coordination among those entities responsible for managing different uses.
- The MidA RPB has no authority for decision-making beyond the individual authorities of member entities. Each individual member entity retains all current permitting and regulatory authorities (e.g., BOEM retains offshore wind leasing authority).
- The MidA RPB is currently developing a suite of products to inform a decision in January 2015 about the structure and content of a regional ocean action plan. This action plan will adapt over time and will provide non-binding guidance to the MidA RPB's federal agency members. Drafts of these products will be published for public comment in late October 2014.
- One of the primary purposes of forming MARCO's Stakeholder Liaison Committee and impetus for scheduling a series of sector-specific meetings like this one is to gather input about the interest and needs of different industries and share that information with the MidA RPB to inform its planning processes.

A list of Frequently Asked Questions about the MidA RPB may help provide additional context about the relationship between MARCO, the Mid-Atlantic Regional Planning Body, and each individual state and federal member entity. This list is available on the MidA RPB's website at http://www.boem.gov/MidA-RPB-FAQ/.

Overview of the Mid-Atlantic region tug and barge industry

John Harms of the American Waterways Operators (AWO) catalyzed a discussion among meeting participants to establish some basic facts about the tug and barge community and identify specific concerns related to ocean planning that may be helpful for the MidA RPB to consider. The group discussed the following baseline information:

- There are three primary types of tug and barge categories:
    - Barge on wire, in which tugboats tow barges using cables that can be up to 2600 feet long and can have a catenary (slack wire underwater) of up to 80 feet deep, depending on weather and the distance between tug and barge. Additionally, the tow can be blown by wind up to several hundred feet to either side of the tug's trajectory. A barge is rarely following directly behind the lead tugboat and may be up to sixty degrees off the stern of the vessel to either side.
    - Barges in the notch, in which tugs slip into a notch in the back of a barge and pushes from behind the barge. These vessels are able to operate in calm seas but must detach and place the barge on a wire during adverse weather conditions.
    - Articulated tug barge unit (ATB), in which there is a much larger notch and the tug is rigidly connected to the barge via metal pins. ATBs have a deeper draft, can travel at faster speeds, and can go farther offshore in worse weather than traditional tug and barge combinations.
- Tug routes are well established and have been used for decades. Route planning is crucial to safe tug operations. Routes selected will vary depending on what a tug is towing, the weather, and other vessels in the vicinity.
- Tug and barge vessel speed can vary between one and twelve knots, which is significantly slower than many cargo ships. Therefore, tug operators attempt to avoid waterways used by faster deep-draft vessels. While the typical operating speed is 8-10 knots, adverse weather can decrease speed to one or even zero knots. In these cases, operators are essentially holding position to wait-out a storm. Only certain ATBs are capable of travelling upwards of 12 knots.
- Adverse weather can significantly affect the planned route of a tug. Tug captains must retain the ability to significantly modify planned tug routes to avoid extreme weather by moving closer to shore, where the lee of shoreline can prevent damage to vessels and cargo. Clear and unfettered access to ports of refuge in the event of adverse weather is critical.
- Tugboat operators often take advantage of the gulfstream along the 100 fathom curve to speed travel, but water temperature changes there can cause weather systems and

abrupt changes to sea conditions. This, too, makes clear and unfettered access to ports of refuge critical to safe operations. Note that existing AIS data does not reflect this offshore navigation route because vessels are beyond the reach of shore-based AIS receivers.

- Tug and barge operators are specifically concerned about the effect of wind farm development in BOEM's established lease blocks up and down the Atlantic Coast on traditional vessel routes.
- The U.S. has significantly more tug and barge traffic than European countries that have installed offshore wind farms. Domestic marine spatial planning projects must take tug and barge operations into account and cannot rely purely on European planning models.
- The distance of proposed wind farms from shore will require tugs to choose between travelling closer to shore in already-congested waters or travelling farther offshore where rougher seas and faster, larger vessels can threaten the safety of vessel operations.
- The widening of the Panama Canal will increase vessel traffic along the Atlantic coast, including tug and barge traffic, and may lead to increased congestion in the near future.
- The industry is opposed to creating a designated fairway for tug and barge traffic. Such a designation would greatly restrict captains' flexibility in choosing the safest route and would increase unsafe congestion by funneling vessels into a confined waterway.

Industry representatives enumerated concerns about potential impacts of ocean planning activities on tug and barge operators into two major categories: safety concerns and economic concerns. Safety concerns included the following:

- If wind farms are developed in BOEM's identified lease areas, it could funnel tug and barge traffic either very close to the coast, which would further congest already busy waterways (e.g., mouths of the Chesapeake and Delaware bays), or further offshore, which could expose tugs and barges to faster moving deep vessel traffic. Existing visibility and radar issues could be exacerbated by this crowding.
- If wind farms were developed in BOEM's identified lease areas, it could also force tugs and barges to transit further offshore. In certain weather conditions, just one mile further offshore can change sea conditions drastically, putting towing vessels at greater risk and jeopardizing safe transit.
- Static energy generated from wind turbines might present a safety concern and interfere with electronic systems on tugboats.
- If routes shift, there may be a significant increase in risk profile and liability for tug operators.
- There are three primary principles important to ensuring tug and barge vessel safety in the waterways in which they travel:

  - Water needs to be of adequate depth to protect the towing wire catenary from dragging on the bottom of the ocean floor (preferably 90 feet or more).
  - There must be at least a half-mile (preferably one mile) buffer between vessels and fixed objects.
  - There must be a minimum distance of one mile between vessels to accommodate all vessels in all weather conditions.

Economic concerns listed included the following:

- Significant alteration of historical routes will require tug operators to increase distance traveled, which will increase fuel use and air emissions. Fuel costs account for approximately 50-60% of transit costs, and tugboats burn between 100 gallons and 300 gallons of fuel an hour, depending on the size of the tow.
- Different routes may increase the risk of groundings and collisions, which could increase both repair costs and insurance premiums.
- Altered routes may also delay delivery of goods within anticipated timeframes, which could result in penalties for operators and ultimately additional costs for consumers.
- There may be a need for some tugboats to hire additional crew if vessels are forced to navigate in shallower waters, where tow lines need to be adjusted often.

Mid-Atlantic Ocean Data Portal

Jay Odell of the Nature Conservancy and the Mid-Atlantic Ocean Data Portal Team provided an overview of the MARCO Mid-Atlantic Ocean Data Portal (Portal) data and applications. He specifically reviewed the shipping data available on the Portal and demonstrated how the Portal could be used for industry representatives to demarcate important locations and submit that information to MARCO to illustrate specific concerns or potential conflicts. John Walters of the U.S. Coast Guard provided an example of how the Portal team has helped the Coast Guard develop maps to show where marine traffic intersects with the New Jersey wind area in response to BOEM's proposed sale of that area.

One particular piece of feedback from the tug and barge industry representatives was that the Automatic Identification System (AIS) data captured in the Portal does not reflect the fact that often barges are not on the exact same path as the tug. A more appropriate way to convey these paths might be to build out wider swaths based on tugboat AIS data to account for lateral tow movement.

Next Steps

- Participants were encouraged to provide comments on the MidA RPB's public materials that will be released in late October 2014. They are also encouraged to attend the Virginia public listening session planned for November 6, 2014 in Virginia Beach. These listening sessions are an opportunity for industry representatives to convey the importance of the tug and barge industry and ask questions about the RPB's process in a productive forum. Information about the public listening sessions is available on the MidA RPB's website at http://www.boem.gov/MidA-RPB-Meetings/.
- Members of the Portal team will work with John Harms and others at AWO to connect to one or more members of the tug and barge community to feature on the Portal in order to help other stakeholders better understand the industry.