NOAA Ocean Acidification Education Needs Assessment

Summary Report

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Executive Summary

Ocean acidification (OA) potentially threatens the health of marine life and the sustainability of food supplies, jobs, and economies in the U.S. and around the world. The broad impacts necessitate effective distribution of OA science, education and communication tools to raise awareness of and create the opportunity to adapt to OA. The NOAA Ocean Acidification Education Implementation Plan guides NOAA OA education and outreach collaborators to better communicate OA and its impacts by achieving four goals. The first goal is to develop and conduct a comprehensive needs assessment of education and outreach programming and potential audiences. Consistent with this goal, in Spring 2016, NOAA conducted an education needs assessment survey to obtain a snapshot of current OA education and outreach programming and to identify gaps and opportunities to strengthen OA education and communication. In addition to the survey, NOAA conducted a comprehensive review of existing OA education products and programming (Appendices A and B).

The needs assessment included separate surveys of five key segments of the OA education community: Non-governmental organizations, Collaboratives, Scientists and Research Institutes, Formal Educators and Informal Educators.

Seven central areas for improvement and action emerged from the needs assessment and comprehensive review.

- The primary audiences of current OA products and programs are students and the general public. Tools that simplify communication of OA while maintaining scientific integrity are needed for use in a variety of settings including schools and informal learning settings such as aquariums, science and nature centers.
- For formal and informal educators, hands-on materials, videos, graphics, and activities that make OA information more accessible and real for students is critical to effective teaching of OA. The current suite of products and curriculum available, while helpful, do not fully provide teachers with the tools to easily integrate OA in their teaching. Formal educators have limited planning time and would benefit from a toolkit designed with national science standards in mind. Overwhelmingly, however, educators want resources for lab and field experiments.
- A positive tone in OA communications is a commonly expressed sentiment across audience segments surveyed. An emphasis on progress that has been achieved and solutions (e.g., emission reduction, lifestyle changes, new technologies and policies that facilitate mitigation and adaption strategies, etc.) can strike a hopeful balance while also communicating the implications of OA.
- Many educators (informal and formal) are stressing local and regional impacts of OA in their work. Informal educators often receive questions about the local implications of

OA and climate changes. Educators would welcome more resources to support localized approaches to OA education and programming. Some ways this can be done is through partnerships with schools and/or classrooms as well as informal learning centers. Guest speakers are another vehicle that was identified as a way to help "bring the message home."

- Respondents are less likely to report that OA products have been developed for the media compared to other audiences (e.g., students, educators, scientists, policymakers). More content designed to educate the media on OA could help raise awareness and stimulate funding for more research.
- The need for more OA science was consistently expressed by respondents. Notably, respondents often linked the necessity of OA research to their ability to effectively explain OA.
- Collaboration on OA should be increased, especially to produce lesson plans and other teaching tools for teachers; however, many organizations and informal learning centers such as nature centers are collaborating with scientists. These collaborations occur regularly and aid in the development of tools and programming. More collaborations that produce tools that formal educators can use in the classroom and for experiments would fill an important gap in OA education.

Introduction

In Spring 2016, the NOAA Ocean Acidification Program, National Marine Sanctuaries, and Office of Education conducted a needs assessment to determine strengths, weaknesses and gaps within the landscape of ocean acidification (OA) education and outreach programs. Consistent with the first goal of the NOAA Ocean Acidification Education Implementation Plan, the aim of the needs assessment is to strengthen implementation of effective OA education and outreach programming.

Five key audiences were surveyed for the need assessment including informal educators at science and nature centers, formal educators, scientists, non-governmental organizations, and OA collaboratives. In addition to the survey, NOAA conducted a comprehensive review of existing OA education products and programming (Appendices A and B). This report summarizes the findings from all five surveys and examines the findings in relation to the existing suite of OA products identified in the comprehensive review. The findings reported here provide insight on current OA education and programming activities and summarize the needs of the OA education community. Although the sample size for the needs assessment limits broad generalizations about existing activities and priorities for the OA education community, the findings fill an important information gap by providing valuable insight for future planning and collaborations.

Methodology

The survey instruments and methodology were designed by Public Square Communications (PSC) and a team of representatives from various NOAA programs and offices engaged in OA research and education. Email invitations to participate in the survey were sent to a sample of professionals within governmental agencies (e.g., NOAA, EPA, NPS); informal educators at aquariums, nature and science centers; formal educators, researchers; and representatives from non-governmental organizations and collaboratives. No personally identifiable information was collected from survey respondents.

Calculation of Scores for Ranking Questions

The score is a weighted calculation. Items ranked first are given a higher value or "weight." The score, computed for each answer option/row header, is the sum of all the weighted values. The weighted values are determined by the number of columns, which is usually the same as the number of rows. For example, in the report below, because there are 6 options, the weighted sum for an option that was placed in the first position (1) would be worth 6.

Please rank the following ice cream flavors in order from most to least favorite. [Drag & Drop Ranking]

	Score*	Overall Rank
Cookies and Cream	356	1
Strawberry	305	2
Vanilla	302	3
Rocky Road	302	4
Mint Chocolate Chip	299	5
Chocolate	284	6

Total Respondents 88

The table below shows the formula for computing the total rank for each answer option/row header:

Total Responses		Weight		
Rank 1 Count	x	6	=	
Rank 2 Count	x	5	=	
Rank 3 Count	x	4	=	
Rank 4 Count	x	3	=	
Rank 5 Count	x	2	=	
Rank 6 Count	x	1	=	
			+	Total Score (Answer Option X)

If there were 7 instead of 6 answer options, then answer options chosen as Rank of 1 would be given a weighted value of 7 points, Rank 2 would be weighted 6 points and so on and so forth. Items with the same score (e.g., rocky road and vanilla in the above example) are randomly assigned neighboring ranks.

OA Needs Assessment Results

NON-GOVERNMENTAL ORGANIZATIONS

Five NGOs participated in the needs assessment including four advocacy organizations and one education and research organization. The primary audiences for NGOs' outreach and education programs include the general public (80%), policymakers (80%), and scientists (20%) (Fig. 1). Additional audiences identified by NGOs include the seafood industry, tribes, and fishery-dependent communities.

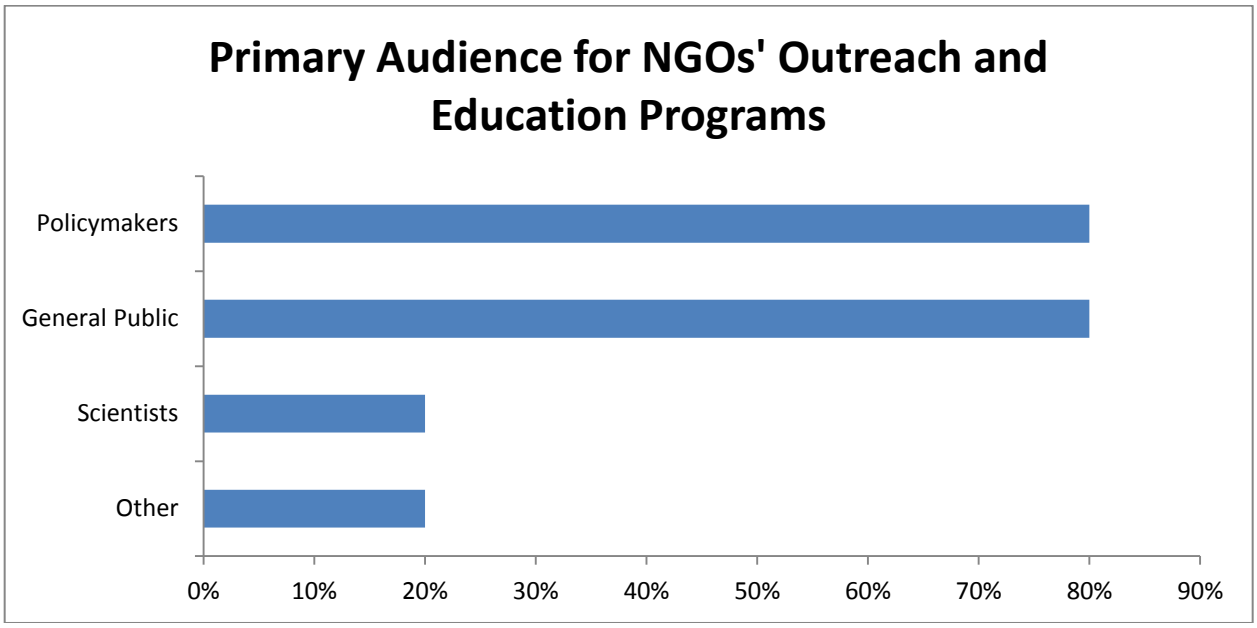

Figure-1 Primary audience for NGOs' outreach and education programs: Percent representation of audiences reported by NGOs' for outreach and education programs. Multiple responses allowed. 'Other' audiences include the seafood industry, tribes, and fishery-dependent communities.

OA Program Content

Most (80%) NGOs have a campaign or initiative related to OA (Fig. 2). For the one NGO that is not currently working on OA, there has not been discussion within the organization about developing an OA initiative or outreach strategies.

Advocacy for OA research is the major issue currently being pursued by two out of five NGOs. Other major OA-related issues currently being pursued by NGOs include ocean debris, Gulf restoration, fisheries, ocean planning, food security, fossil fuel emissions, resilience and adaptation strategies, and integrated responses to OA and other climate-related changes in coastal regions.

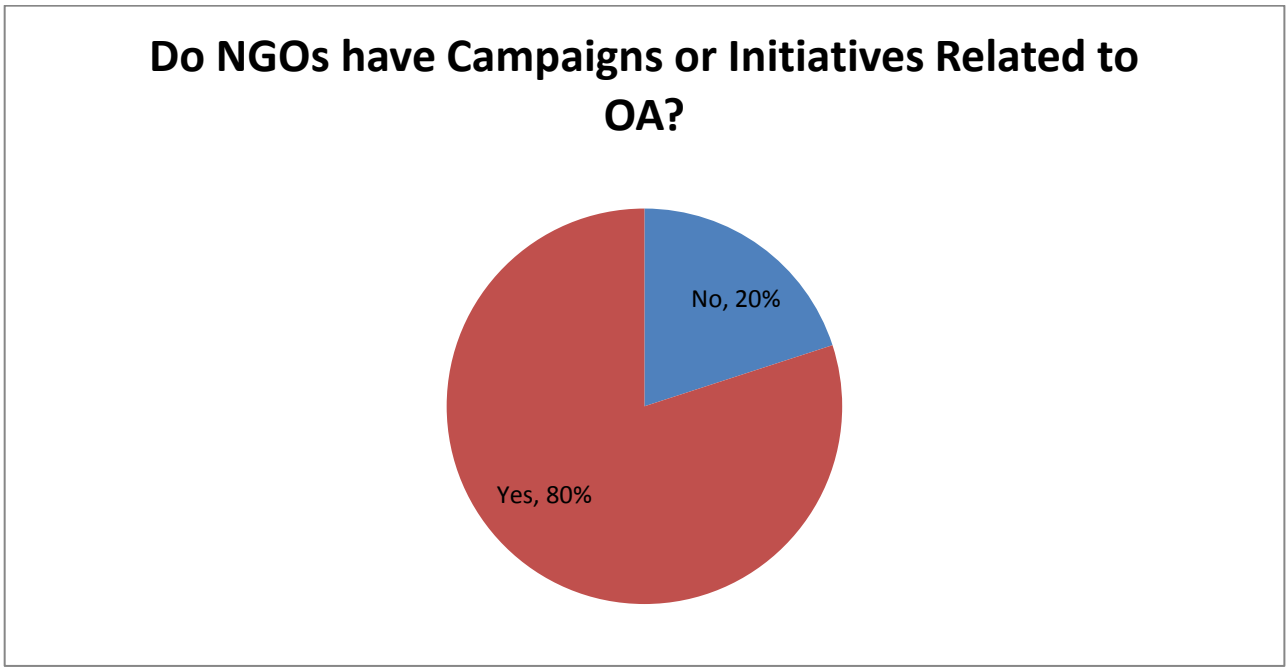

Figure-2 Percent representation of NGOs that do and do not have campaigns or initiatives related to OA.

NGOs' primary messages related to OA are focused on the effect OA has on people. For example, one organization's key message emphasizes that OA "is real, it's affecting people, and we can take action now." Similarly, another NGO stresses that "OA poses an existential threat to seafood-dependent communities, jobs and businesses, food supplies, and to ways of life in many regions."

Two of the NGOs linked the human impacts of OA to the need for more research. "There are human communities especially vulnerable to ocean acidification and we need to be supporting science that is relevant to these people to help them cope and adapt to the changing oceans." Along the same lines, another group stresses that "some coastal communities in the U.S. are especially vulnerable to ocean acidification. We need to be conducting the necessary research to help these communities reduce their harm and prepare them for the coming changes."

Experience Communicating OA Information

All four NGOs with OA programs have provided OA education to the public for more than one year (Fig. 3). Two out of five NGOs have provided OA education to the public for 4-7 years while one NGO has been engaged in OA education to the public for 1–3 years. One group has provided education to the public for more than eight years.

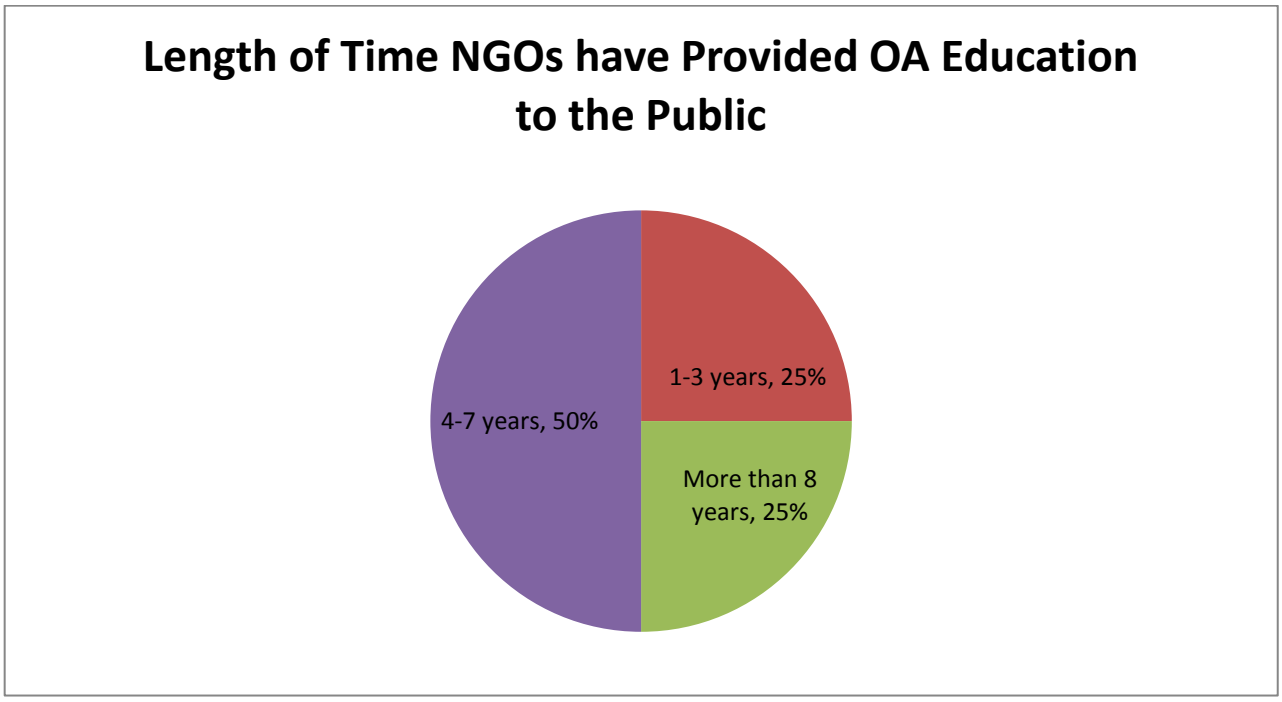

Figure-3 Percent representation of length of time NGOs have provided OA education to the public. Other option, 'less than one year', was not selected by NGOs.

Most (80%) of the respondents are currently or were previously responsible for developing OA education and outreach programming (Fig. 4).

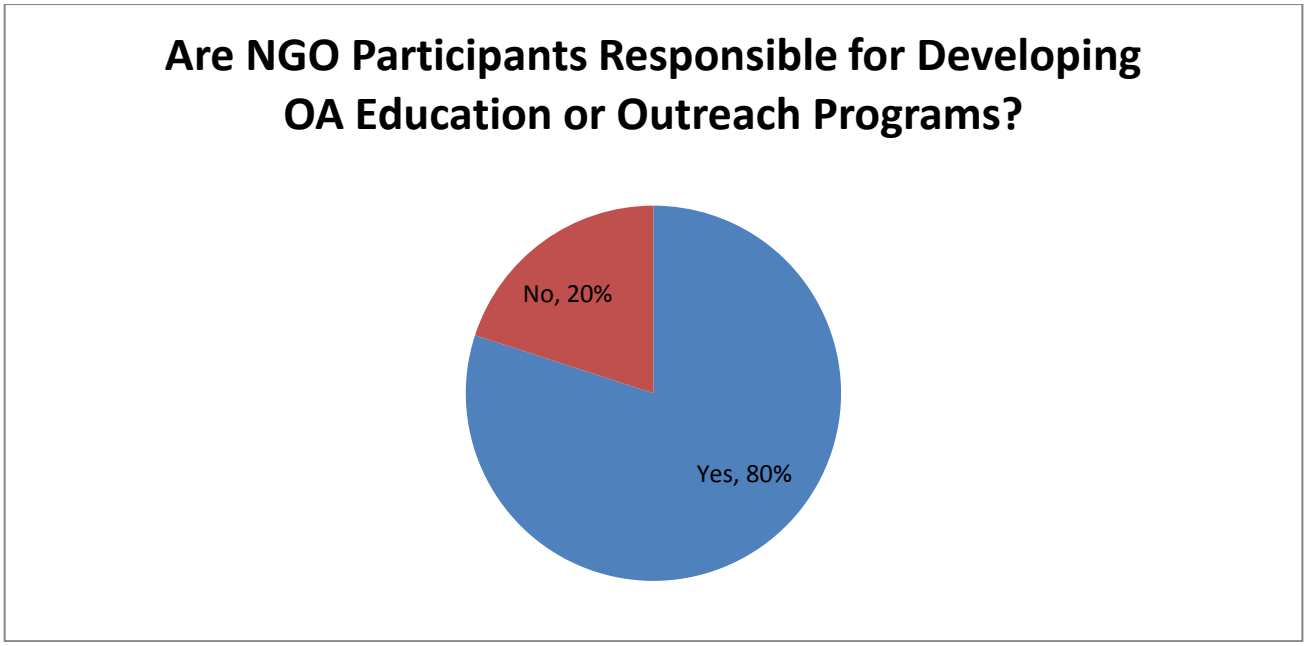

Figure-4 Percent representation of NGO participants who are/are not responsible for developing OA education or outreach programs.

The majority (80%) of NGOS are "very comfortable" with communicating OA to a public audience (Fig. 5).

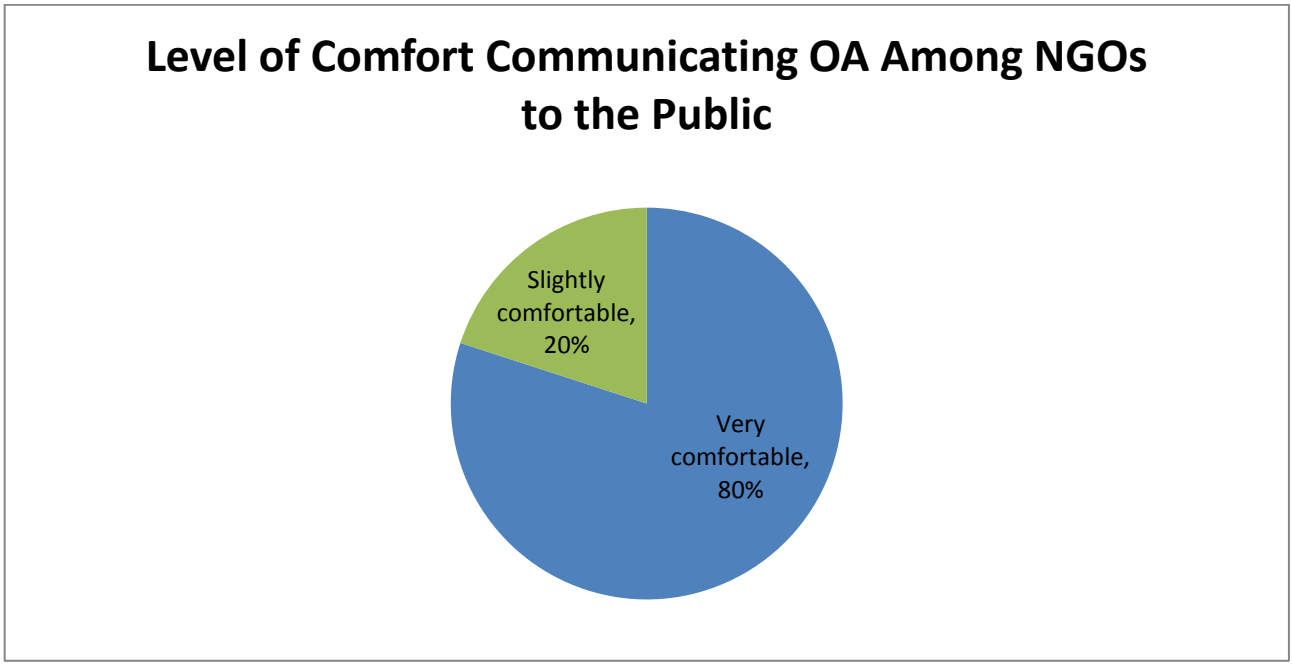

Figure-5 Percent representation of level of comfort communicating OA to the public. Other options, 'comfortable' and 'not comfortable at all', were not selected by NGOs.

Sixty percent (60%) or three out five respondents have not received formal training on how to deliver OA education (Fig 6). Among those that have received training, one received training from COMPASS and non-OA media training while the other received "NGO and scientist training" on how to deliver OA education.

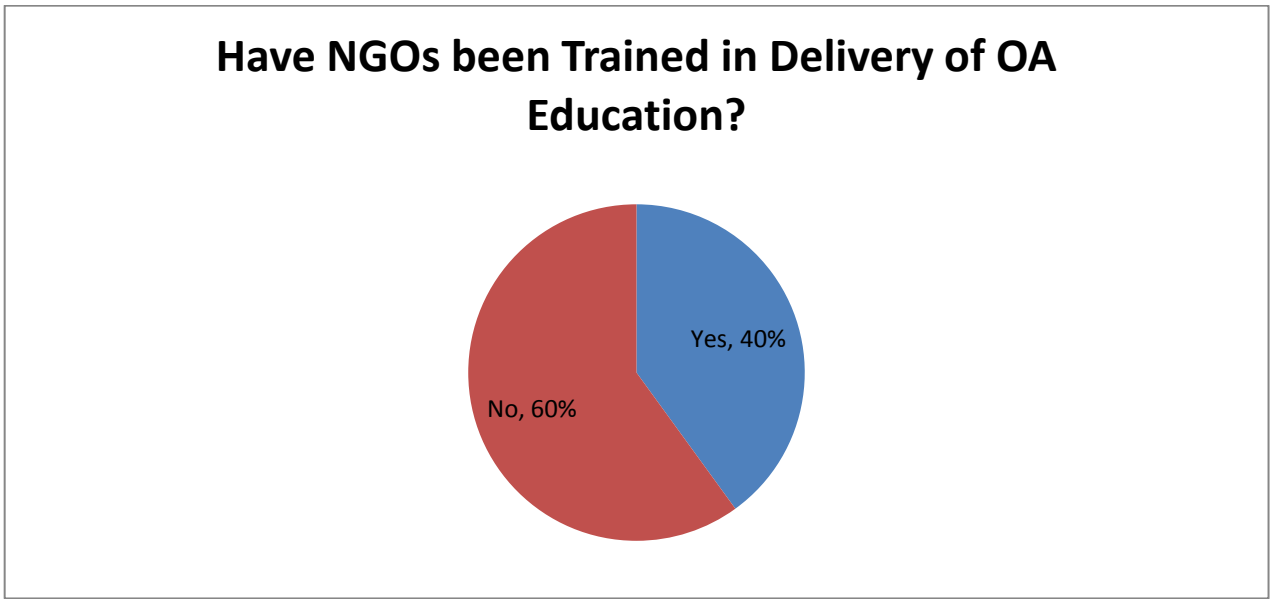

Figure-6 Percent representation of NGOs that have/have not received training in how to deliver OA Education.

Biggest OA Communication Challenges

Keeping up with recent research or science was mentioned by two of the respondents as one of the biggest challenges that their organization has had with explaining OA or preparing educational content. A lack of actionable steps available at all scales and a lack of awareness especially among the general public are also key challenges. One NGO noted that the biggest challenge is communicating about OA without inducing hopelessness and despair. In order to accomplish this, the organization places emphasis on "progress and emissions reduction and successful efforts by fishermen and shellfish growers to drive stronger responses (e.g. greater investments in science, resilience and adaptation, stronger pollution limits, etc.)."

OA Program Content and Format

Among the NGOs with OA programs, most of their OA programs are stand-alone initiative separate from their climate change programming (Fig. 7).

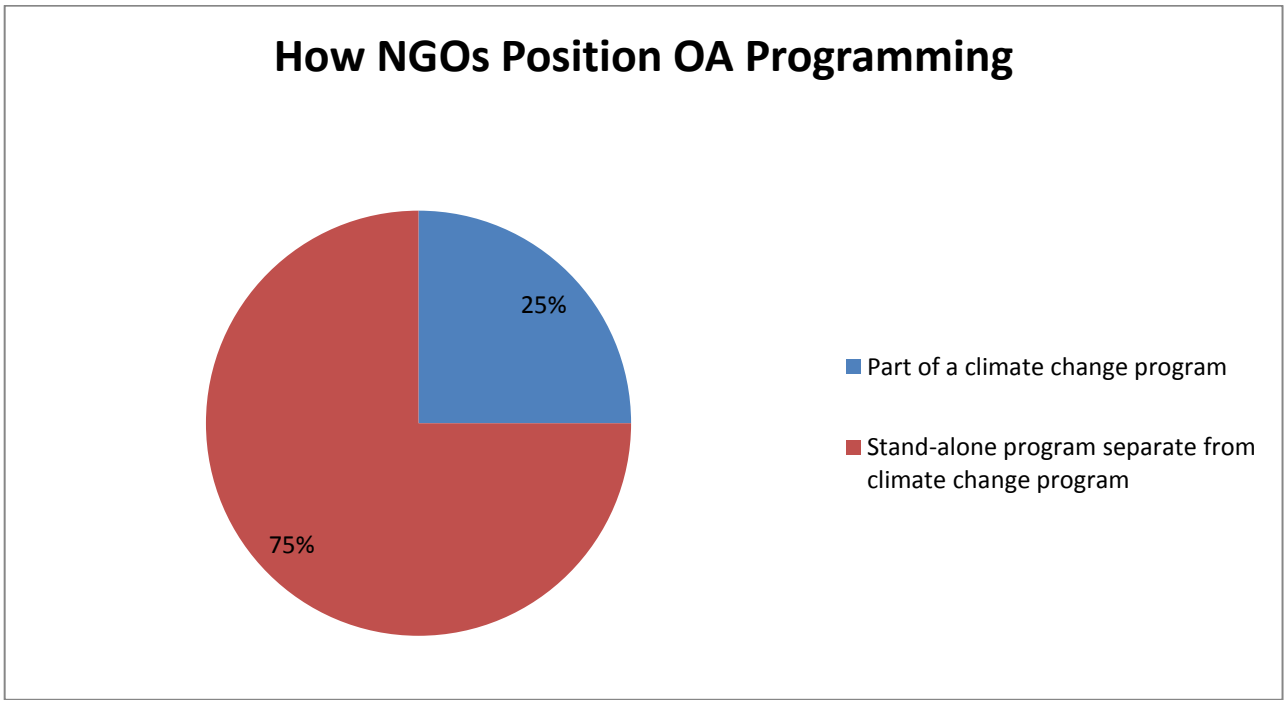

Figure-7 Percent of NGOs that include OA as part of a climate change program and NGOs with stand-alone OA programs.

NGOs have decided to focus on OA due to the urgency of the issue and its connection to other key areas of focus for their organizations. For example, one respondent noted that their organization is focused on reducing carbon dioxide emissions and improving ocean health; therefore, OA is a natural extension of their work. For another NGO, a high level of concern in the seafood industry has helped to not only make the issue a greater focus, "but the center of our strategy, which has expanded to include other climate-related stresses as our key audiences have developed the capacity and appetite to address them." Overall, NGOs view OA as a critical issue that receives "too little attention" despite its impact on people and communities.

Although NGOs are promoting a variety of solutions or recommendations to the address OA, reducing CO2 emissions and advocacy for more research are two key areas of agreement. Four out of five respondents stressed the importance of research. Not only do NGOs want to see more research investment, the research conducted should be interdisciplinary and focus on capacity building for adaptation strategies (e.g., shellfish hatchery adaptation, phytoremediation, etc.). Other solutions and recommendations include local and regional monitoring paired with local and regional action to reduce acidification, coastal resilience planning, and sequestration.

NGOs have primarily produced OA products for policymakers, commercial/industry members, and educators (Fig. 8). OA products have been produced to a lesser degree for the general public, scientists, students, and members of the media. Four of the NGOs surveyed report having produced a workshop/training and brochures for policymakers. Websites, brochures, and videos are more frequently reported as products developed for commercial/industry

members. In contrast, a workshop/training, article or blog are more often developed for scientists.

Compared to other audiences surveyed (e.g., informal educators, formal educators) for the needs assessment, NGOs are less likely to use lesson plans as an education or outreach tool.

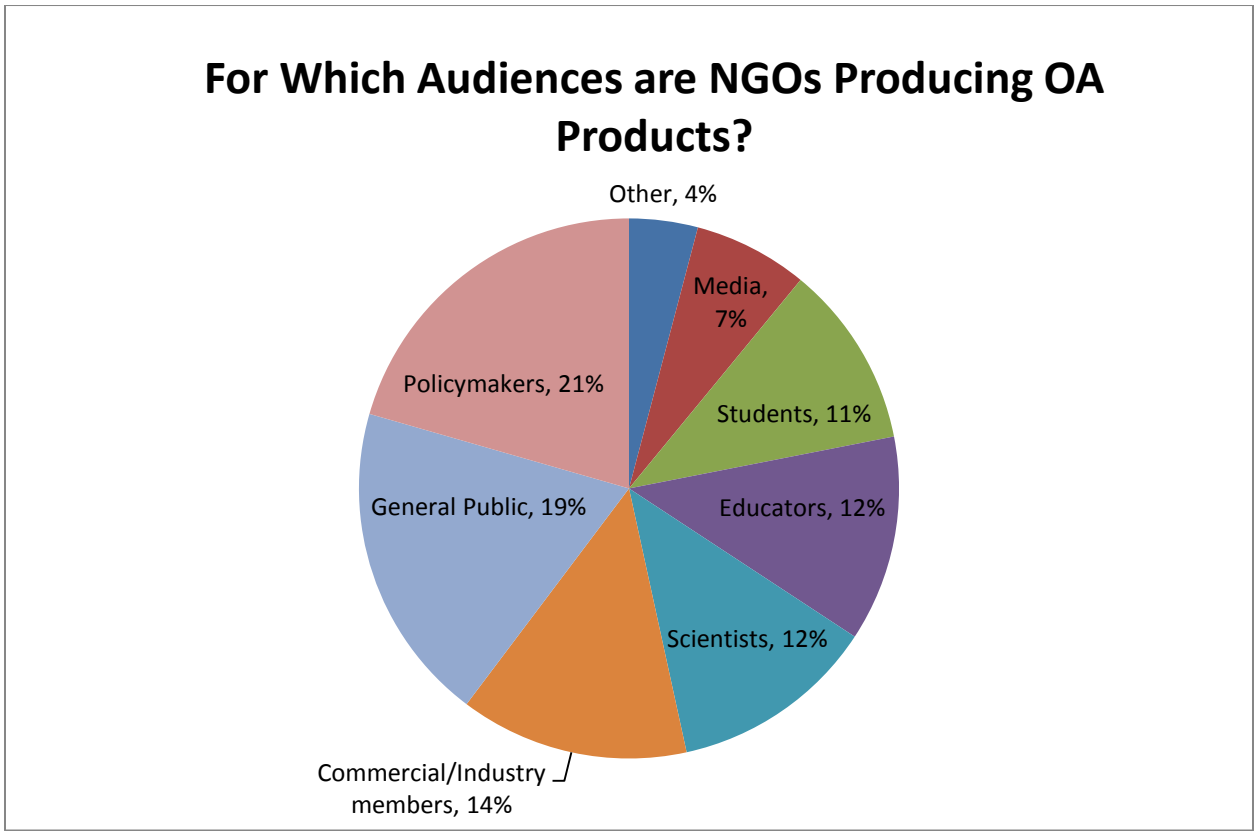

Figure-8 Percent representation of audiences reported by NGOs' for produced OA products. Multiple selections allowed. 'Other' audiences include people who depend on healthy fisheries and oceans.

OA is an ongoing priority for half of NGOs (Fig. 9). In contrast, OA is a temporary or short-term priority for 25% of NGOs while an additional 25% report that it is not clear whether OA will be a temporary or ongoing priority.

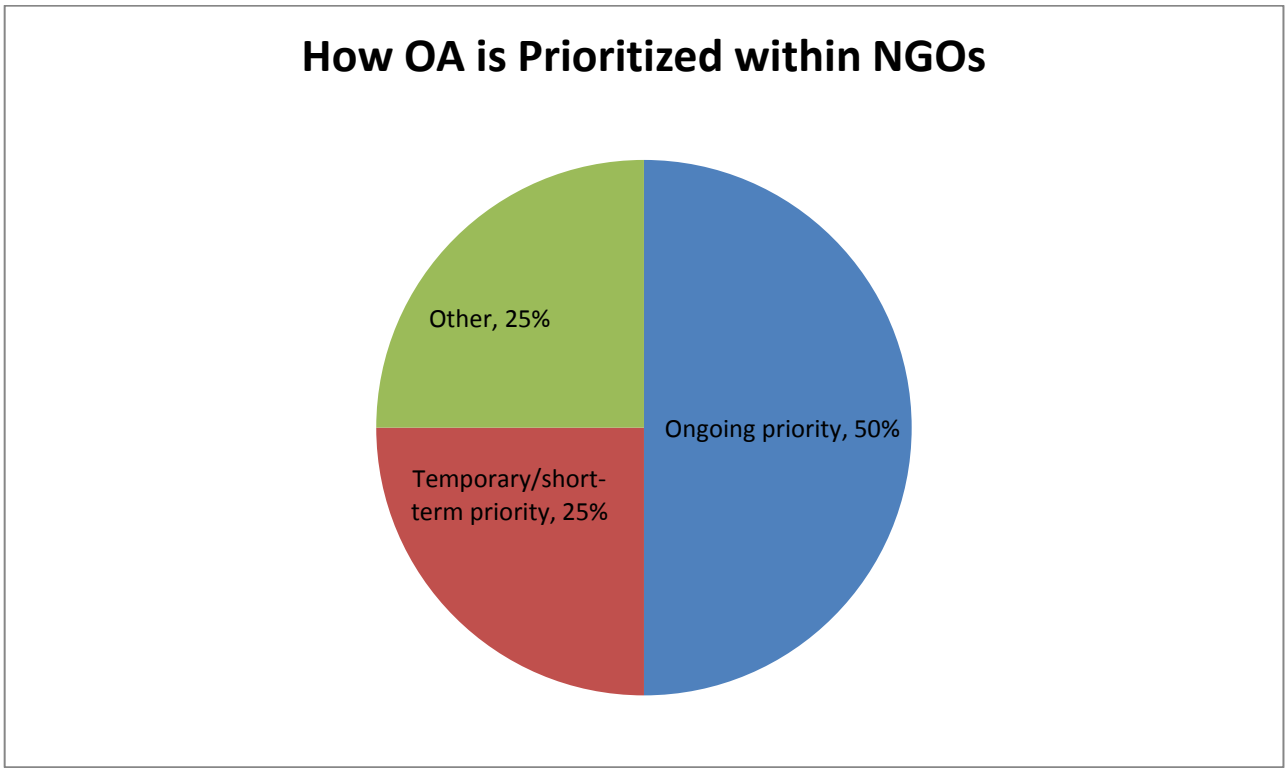

Figure-9 How OA is prioritized within NGOs: Percent representation of NGOs that report OA as an ongoing priority, temporary/short-term priority, or uncertainty/lack of clarity on how OA is prioritized within the organization ('Other').

OA Toolkit

Overall, NGOs are looking for tools to help their organizations better communicate OA. For example respondents noted that communications best practices, videos, PowerPoint presentations, handouts, infographics, and photographs are all tools that should be included in an OA education toolkit. Two out of five respondents emphasized the need for a tool that summarizes the literature and most up-to-date OA information. Information on how to align OA with other audience priorities would also be useful to NGOs.

OA Information Sources

For NGOs, scientific journals far outweigh all other sources of information for OA (Table 1). Scientific journals were ranked number one, followed by general Google searches, and a website by a NOAA entity. Information from someone within the respondents' department or organization ranked fourth as a top source of information for OA. Online forums or social networking sites, non-NOAA websites, and other resources are less frequently used as OA information sources for NGOs.

	Score*	Overall Rank
Scientific journals	13	1
General Google search	4	2
A website produced by a NOAA entity	4	3
Someone in my department of organization	3	4
Other	2	5
Online forum/social networking site	2	6
Non-NOAA websites	2	7
		Total Respondents: 5

Table-1 Ranking of top resources used for OA information among NGOs. Respondents asked to choose top three sources of information.

*Score is a weighted calculation. Items ranked first are valued higher than the following ranks, the score is the sum of all weighted rank counts. See "Methodology" section for more information on score and rank calculation.

Gaps in OA Landscape

A key gap noted in the landscape of OA education outreach and programming is the lack of targeted outreach. For example, one respondent noted that there was too little outreach targeted to vulnerable regions. Identifying actionable steps for audience members to engage in is another gap in the OA education and outreach landscape.

Several other gaps were also mentioned. These include limited and incomplete evaluation products that consider OA along with concomitant stresses, a lack of awareness among OA experts of evolving technologies for CO_2 mitigation and policies to cut carbon emissions. The latter two, according to one NGO, creates a sense of hopelessness often being communicated in OA education and programming. Rapid progress is occurring; however, according to the respondent, "Nearly all experts on OA (and climate change) lack awareness of evolving technologies for CO_2 mitigation. This field is moving fast, and some of the new technologies may be important. As a result they often communicate hopelessness." Additionally, there is concern that the government confuses OA with climate change in many of its materials. For example, one respondent stated "the government often confuses OA with CC in many materials - even official policies. This is confusing to policy implementation."

OA Information Sources

Consultations with scientists and experts (80%), a NOAA website or tools (80%), and scientific journal articles (80%) are most often used to develop OA products or programs by NGOs (Fig. 10). Non-NOAA online resources (40%) and newspapers or magazines (40%) are far less often used as resources for product or program development. Other resources cited for program and product development include the 2012 Washington Blue Ribbon Panel on ocean acidification report and the OA-ICC list and outreach documents.

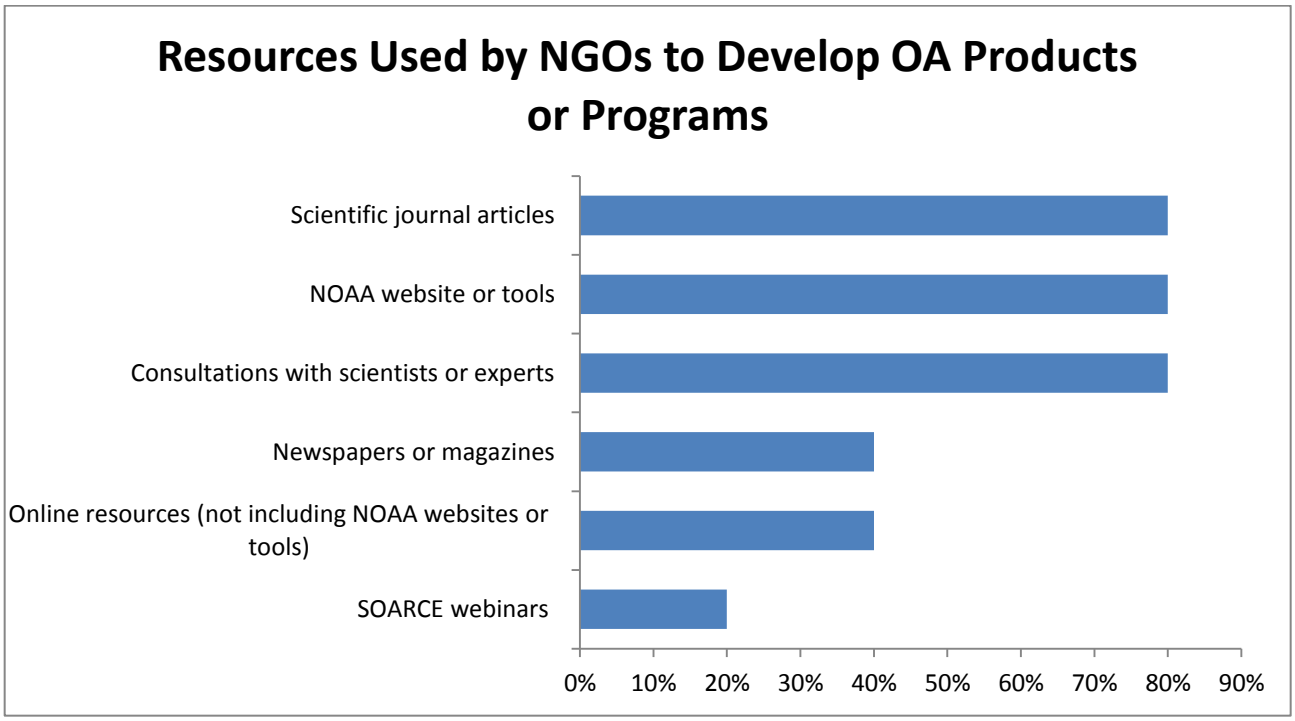

Figure-10 Percent representation of NGOs that report using the above-listed resources to develop OA products or programs.

When asked how frequently NGOs collaborate with the science community to develop OA programming, most (60%) reported that they 'frequently' collaborate with scientists (Fig. 11). Twenty percent (20%) 'occasionally' collaborate while another 20% 'rarely' collaborate with scients. NGOs frequently (60%) collaborate with the science community to develop OA programming.

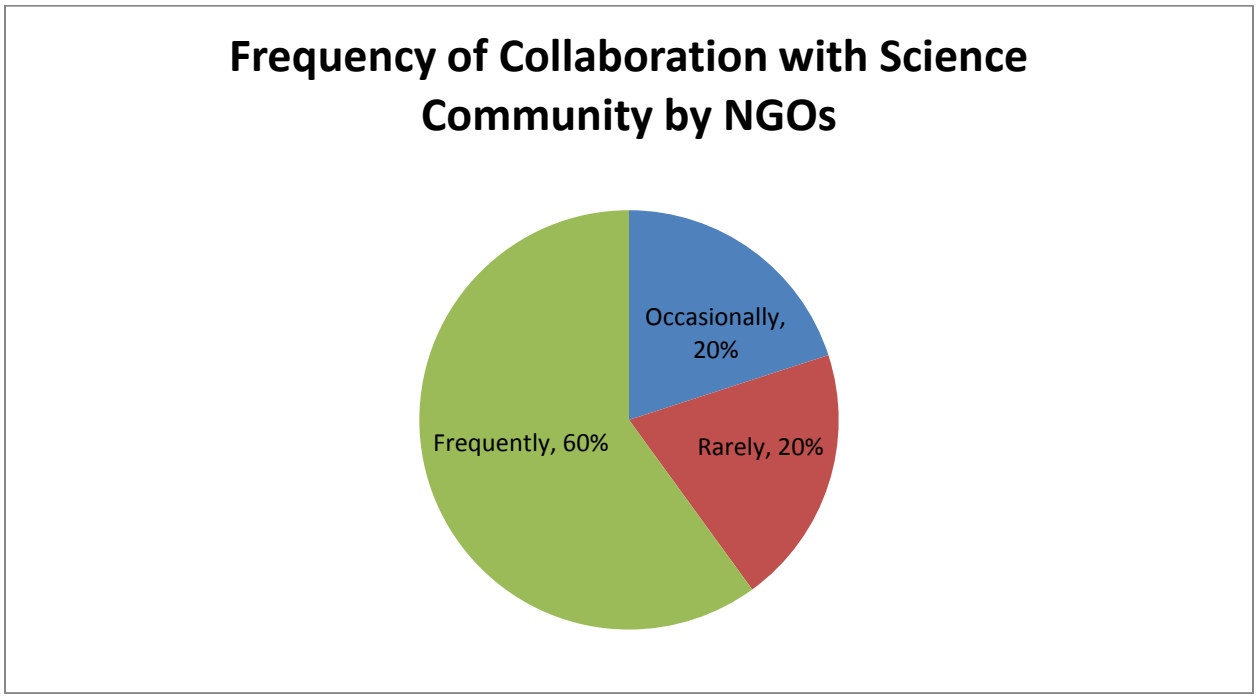

Figure-11 Percent representation of collaboration frequency with science community by NGOs.

Consultation with scientists among NGOs occurs weekly (40%) or once a month (60%) (Fig. 12).

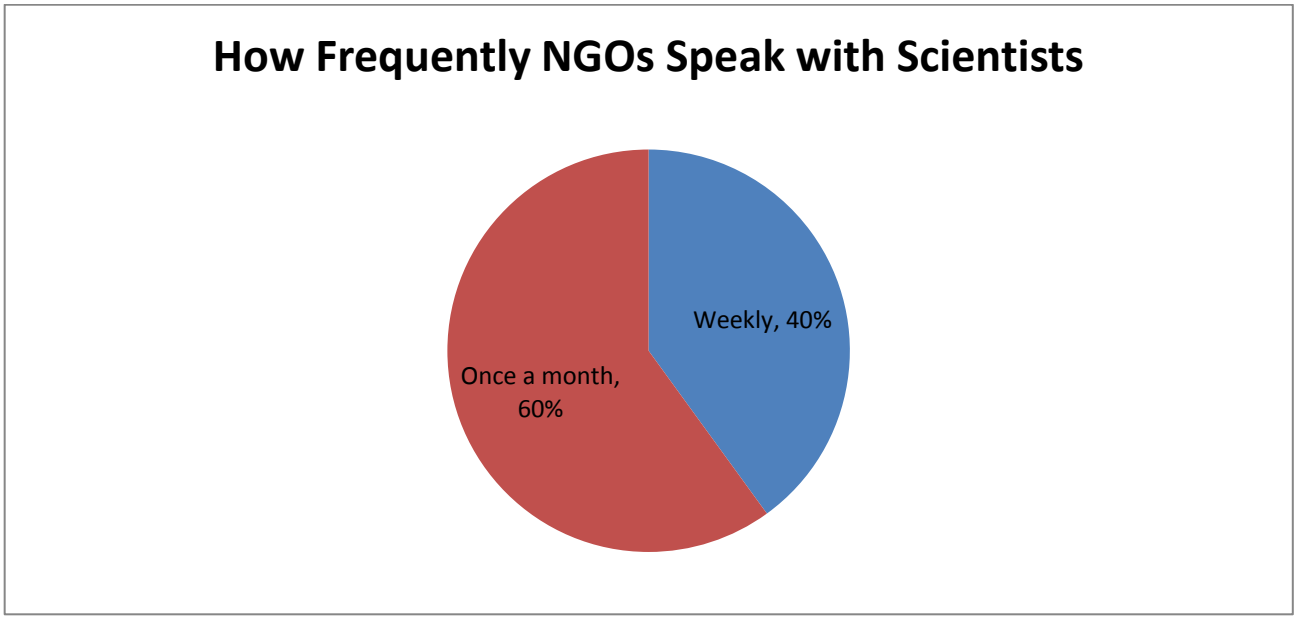

Figure-12 Percent representation of NGOs that speak with scientists weekly or once a month. Other response options including 'every few months', 'about once a year', and 'never' were not selected by respondents.

Biggest Lessons

The biggest lesson identified by NGOs is that people are eager to take action. As a result, doom and gloom generally does not work as a communication strategy. Instead, "The OA community needs to be creative in finding more ways for non-scientists to engage," noted one respondent. Another key lesson offered is the need for more storytelling to help the general public and other audiences better understand the impact of OA.

COLLABORATIVES

Six collaboratives participated in the needs assessment. The collaboratives are composed of representatives from a variety of sectors; however representatives from universities (50%), the federal government (50%), aquariums/nature centers (37.5%) and commercial industry (37.5%) were more frequently reported as primary members of the collaboratives (Fig. 13).

Seventy-five percent (75%) of all collaboratives have a campaign or initiative related to ocean acidification (Fig. 14).

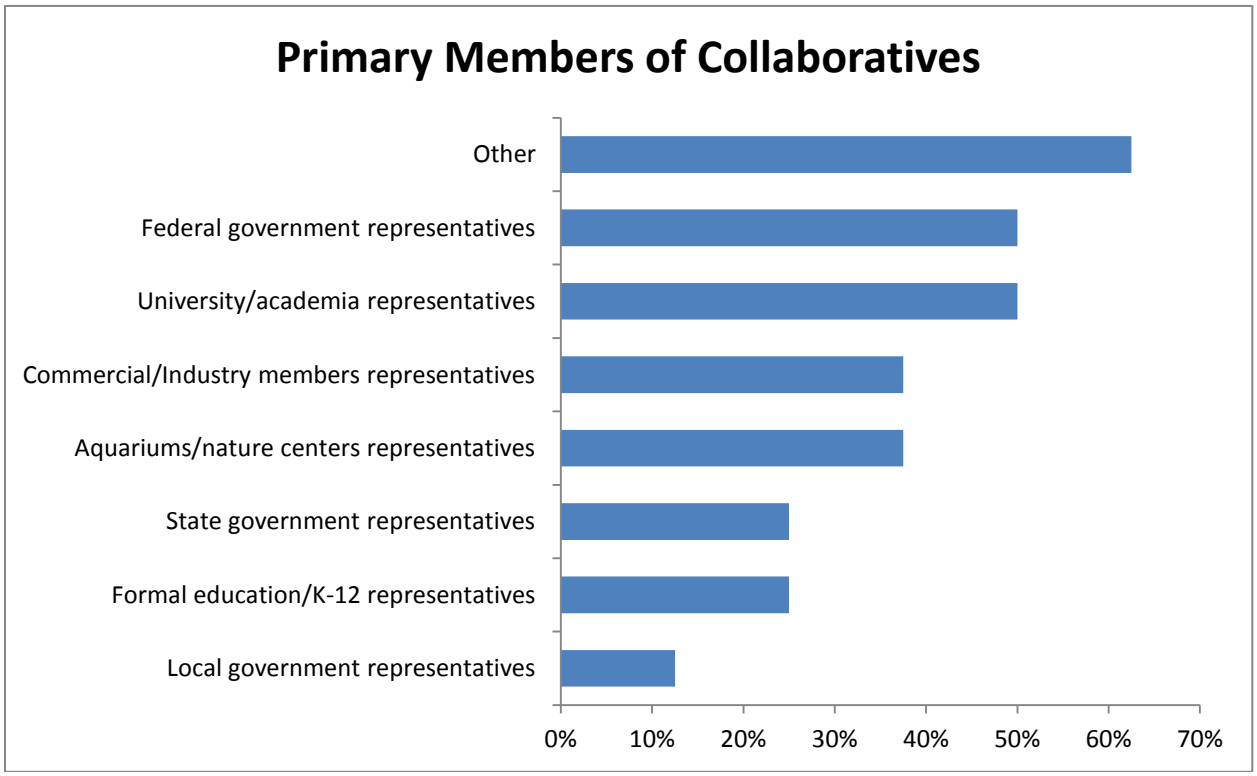

Figure-13 Percent representation of collaborative members: Other primary members include IAEA member states, Indian tribe, NGOs, agencies, businesses, representatives from tribal government, other non-profits (e.g., Polar Bears International, The Wild Center), museums, zoos, science centers, and state/national parks.

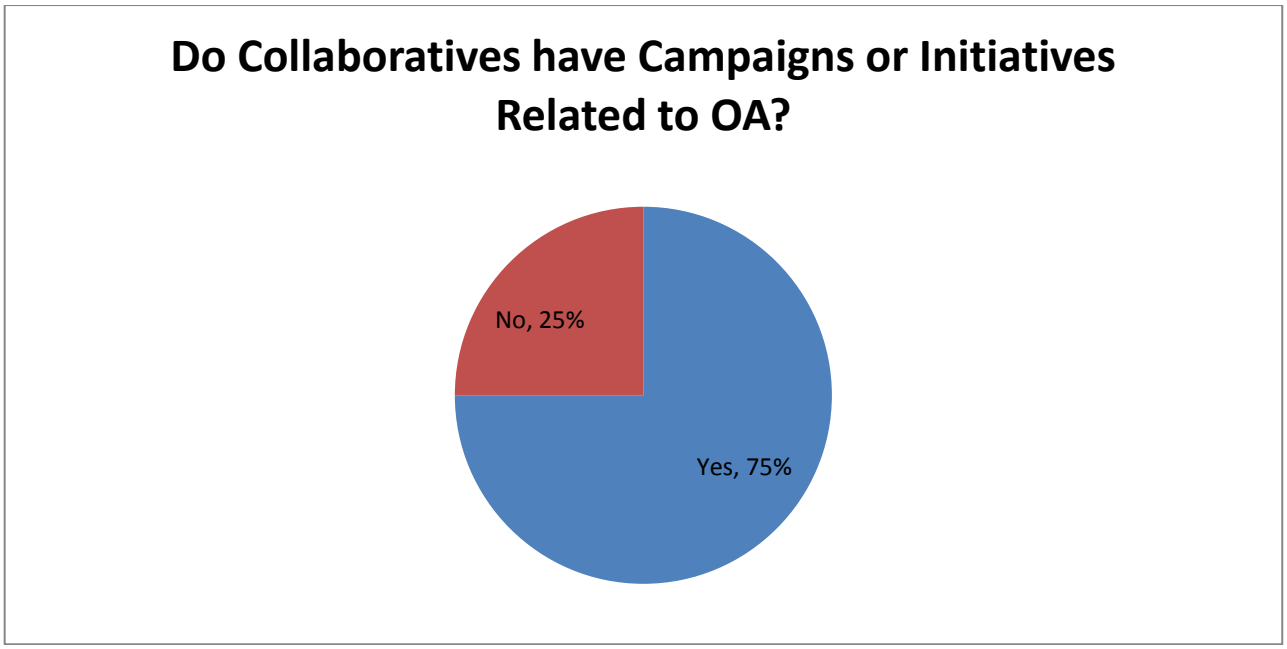

Figure-14 Percent representation of collaboratives that do/do not have campaigns or initiatives related to OA.

The general public (66.7%), policymakers (66.7%), and scientists (50%) are the most commonly reported primary audiences for the collaboratives' outreach and education programs (Fig. 15).

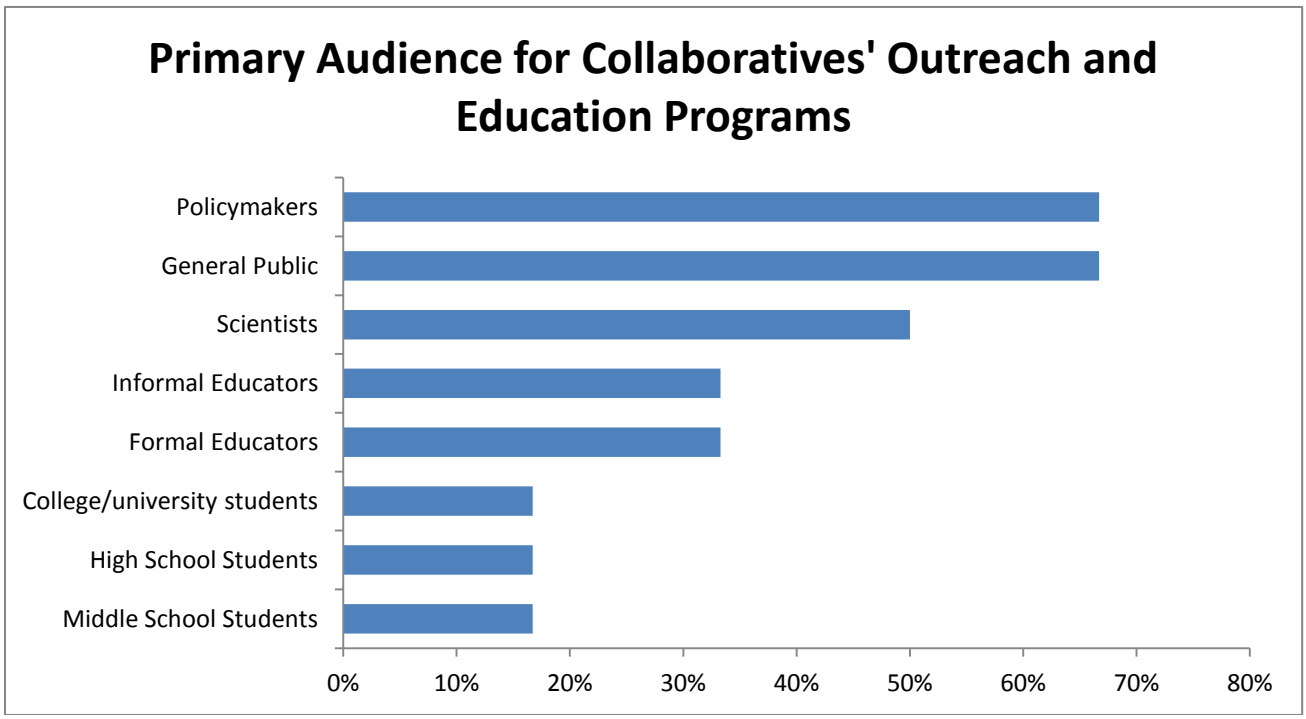

Figure-15 Percent representation of primary audiences reported by collaboratives for outreach and education programs. Multiple responses allowed. Other response include elementary students was not

selected by respondents.

How Collaboratives Work Together

Members of collaboratives work together to develop content, training, messaging, and communications on OA. Teleconferences and in-person meetings are used for discussion, generating papers and frameworks, and for conducting planning sessions.

Most respondents noted that a key benefit to working with members from different sectors is the ability to hear diverse perspectives and engage in interdisciplinary conversations about OA. This benefit translates largely into a more effective communication strategy for the collaboratives. For example, one respondent noted that his/her collaborative provides an opportunity to obtain feedback from different end users and interests, which then enables the development of more simplified messaging. Similarly, another respondent noted that the collaborative provides an opportunity to learn from practitioners about the application of communications research. Some of the challenges noted in working in a collaborative, however, include communication across sectors. One respondent noted "it took some time before the participants, from different backgrounds/sectors were able to communicate." Differing levels of scientific knowledge and disagreement on basic assumptions were also noted as challenges.

Time constraints are also a challenge reported by collaboratives. Difficulties with getting members together for a meeting and finding teachers to review OA materials are some examples of time related challenges noted by respondents.

OA Program Content

Two key themes are evident in the collaboratives' primary messages related to OA. Two respondents mentioned the effects of carbon dioxide emissions. Both noted that their collaboratives' messaging focused on the impact of CO_2 emissions caused by human activities on the chemistry of oceans. Another key theme, disruption to marine life and ecosystems was also emphasized.

For most respondents, their ocean acidification programming is part of a stand-alone program separate from their climate change programming (Fig. 16). One-third (33%) of respondents' programming related to ocean acidification is part of a climate change program.

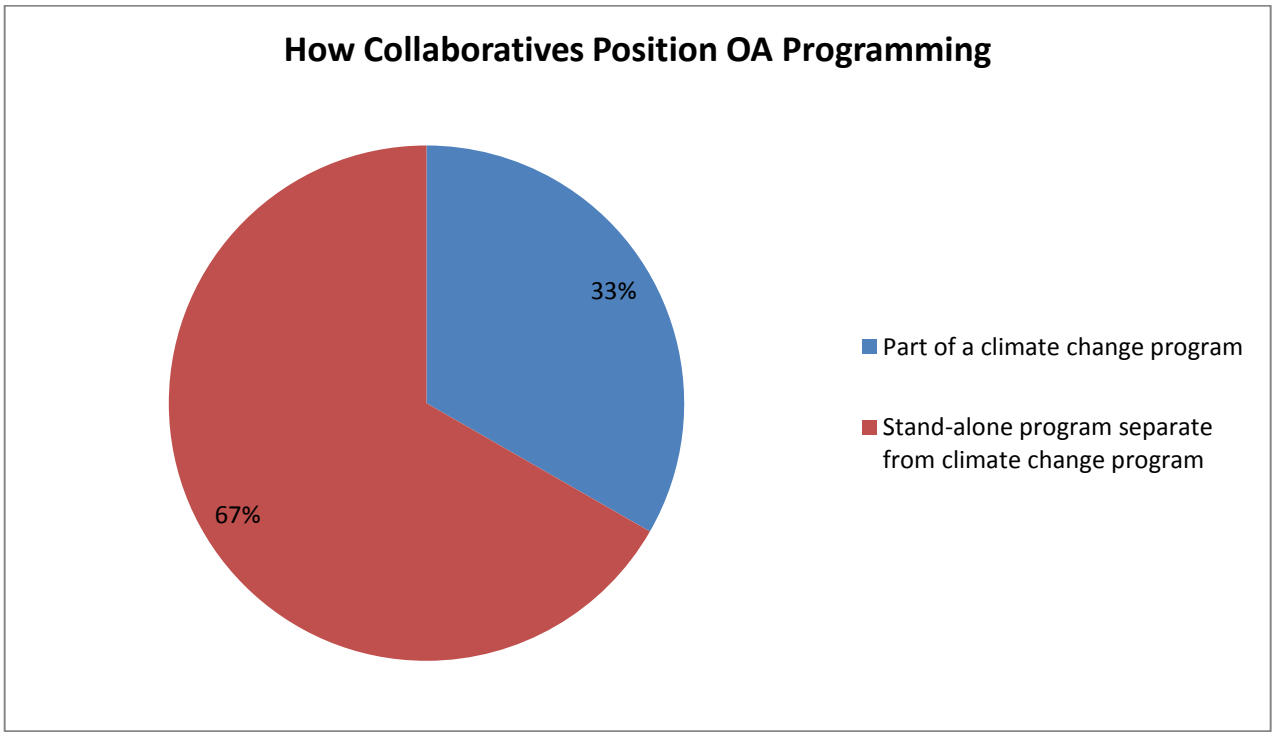

Figure-16 Percent representation of collaboratives that include OA as part of a climate change program or stand-alone OA program.

Collaboratives are currently focused on a diverse set of issues related to OA. Some of these issues include fisheries impacts, food security, animal adaptation, state and federal actions on climate change, and actions that citizens can take regarding ocean acidification. Other current areas of focus include access to OA experimental data for the international community and reaching students from underserved communities to encourage pursuit of careers related to climate and ocean change.

Most of the tools developed by collaboratives are for educators (Fig 17). Respondents report developing brochures, websites, workshops/trainings, articles, and lesson plans for educators. Websites, brochures, exhibits, and articles are products most often developed for the general public, scientists, policymakers and commercial industry. Videos were more often targeted for educators, the general public, and scientists. Additional products mentioned by respondents designed specifically for scientists include a communications research study, poster, bookmark, webinar series, and databases.

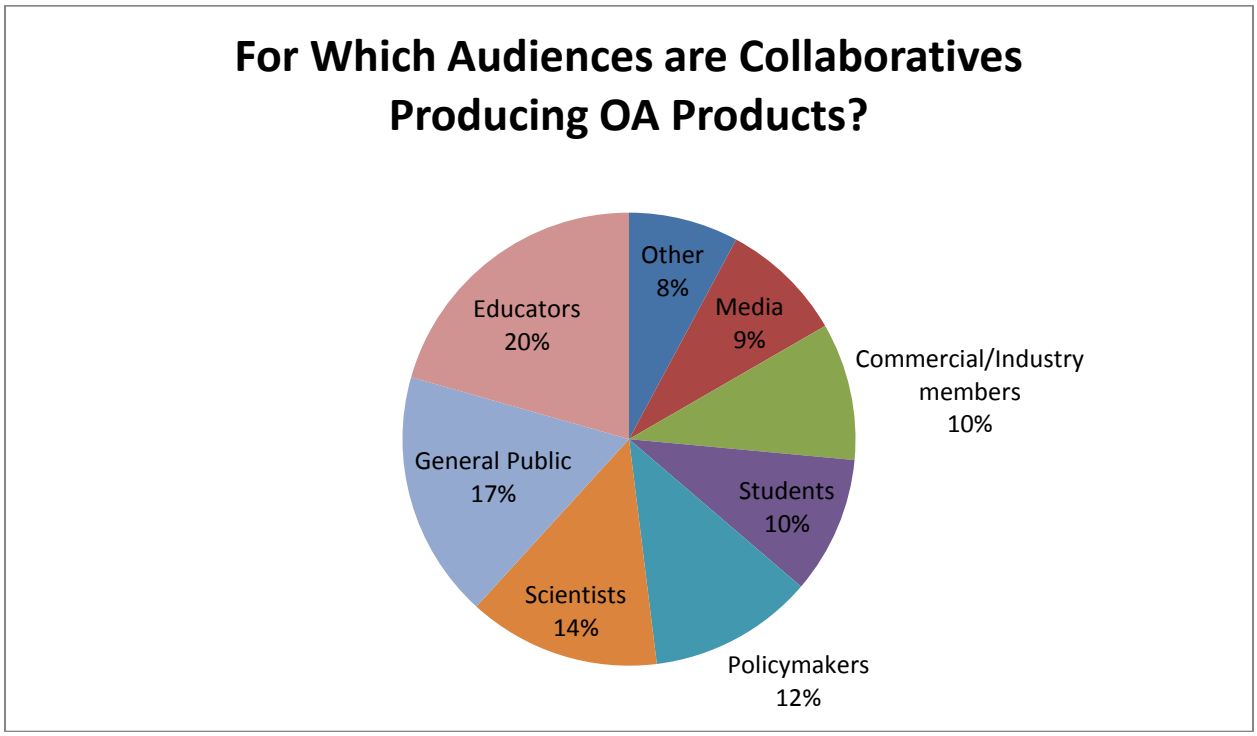

Figure-17 Percent representation of target audiences for OA products produced by collaboratives. Multiple selections allowed. 'Other' audiences include informal educators and interpreters.

Solutions or recommendations to address OA vary widely among respondents. State and federal actions, the need for more research, and adaptation and monitoring of OA are among the solutions and recommendations that are being promoted or supported by collaboratives. A key theme—reduction of CO_2 admissions— is a solution promoted by at least three collaboratives.

Biggest Communications Challenges and Lessons Learned

When it comes to challenges with explaining OA or preparing educational content, the biggest challenge is simplifying messaging so that audiences can understand OA. For example one respondent noted "explaining OA in simple terms without compromising the science" is a big challenge. Similarly, another respondent observed "the chemistry can be confusing, people don't understand the scale of the problem, staff/volunteer/public think climate change causes OA (They have learned/don't understand carbon dioxide emissions causes both)." Other challenges include "making the topic interesting", "finding OA materials that are aligned with the NGSS and common core", and relying on other groups to support education goals due to funding limitations.

Respondents reported a variety of "big lessons" learned from their OA work. For example, one respondent noted that it can "be a challenge to convey OA information without using too much jargon and without overwhelming an audience." By using the OA literacy framework and breaking up the issue into seven teachable topics, the respondent is able to focus on encouraging students to take action. Key to this is convincing students "at an emotional level" that the topic is important and relevant to them.

Another respondent focuses on the importance of the ocean to human life. "The ocean is critical to our way of life and we are changing it. We can help it adapt to these changes by reducing our everyday impacts — what we consume and how we dispose of it, how we get from place to place, and where we live and build." Another respondent stresses the importance of ending on a positive note – "OA is happening and will continue but mitigation will make a difference." Discussing the rate of change over the last 300 million years was also shared as a big lesson in helping to effectively explain OA.

OA Information Sources

The top three sources of information used by collaboratives to find OA information include websites produced by a NOAA entity, non-NOAA websites, and online forums/social networking sites (Table 2). Scientific journals, other sources of information, and general Google searches ranked at the bottom of resources used to find OA information.

	Score*	Overall Rank
A website produced by a NOAA entity	9	1
Non-NOAA websites	8	2
Online forum/social networking site	8	3
Someone in my department of organization	7	4
Scientific journals	6	5
Other	5	6
General Google search	5	7
		Total Respondents: 8

Table-2 Ranking of resources used for OA information among informal educators. Respondents asked to choose top three sources of information.

*Score is a weighted calculation. Items ranked first are valued than the following ranks, the score is the sum of all weighted rank counts. See "Methodology" section for more information on score and rank calculation.

Resources to Develop OA Products and Programs

To develop OA products and programs, collaboratives more often consult with scientists or experts (87.5%) (Fig. 18). A NOAA website or tools (75%) are also frequently used among collaboratives to develop their OA products and programs. Online resources (not including NOAA websites) (62.5%), scientific journal articles (62.5%), and newspapers or magazines (50%) are also among the top resources used to develop OA products and programs by collaboratives.

Respondents also mentioned other resources including Google scholar alerts, Facebook, Twitter, NASA, Ocean portal, NECAN, and Scuttlebutt group email.

Two respondents identified NOAA as the best resource to stay up-to-date on OA science. Other respondents identified resources shared by Southeast Ocean and Coastal Acidification Network (SOCAN) members, OA-ICC News Stream, OA blog formally European Project on Ocean Acidification (EPOCA), Woods Hole Oceanographic Institution (WHOI), and searches for "ocean acidification" information on scholar.google.com.

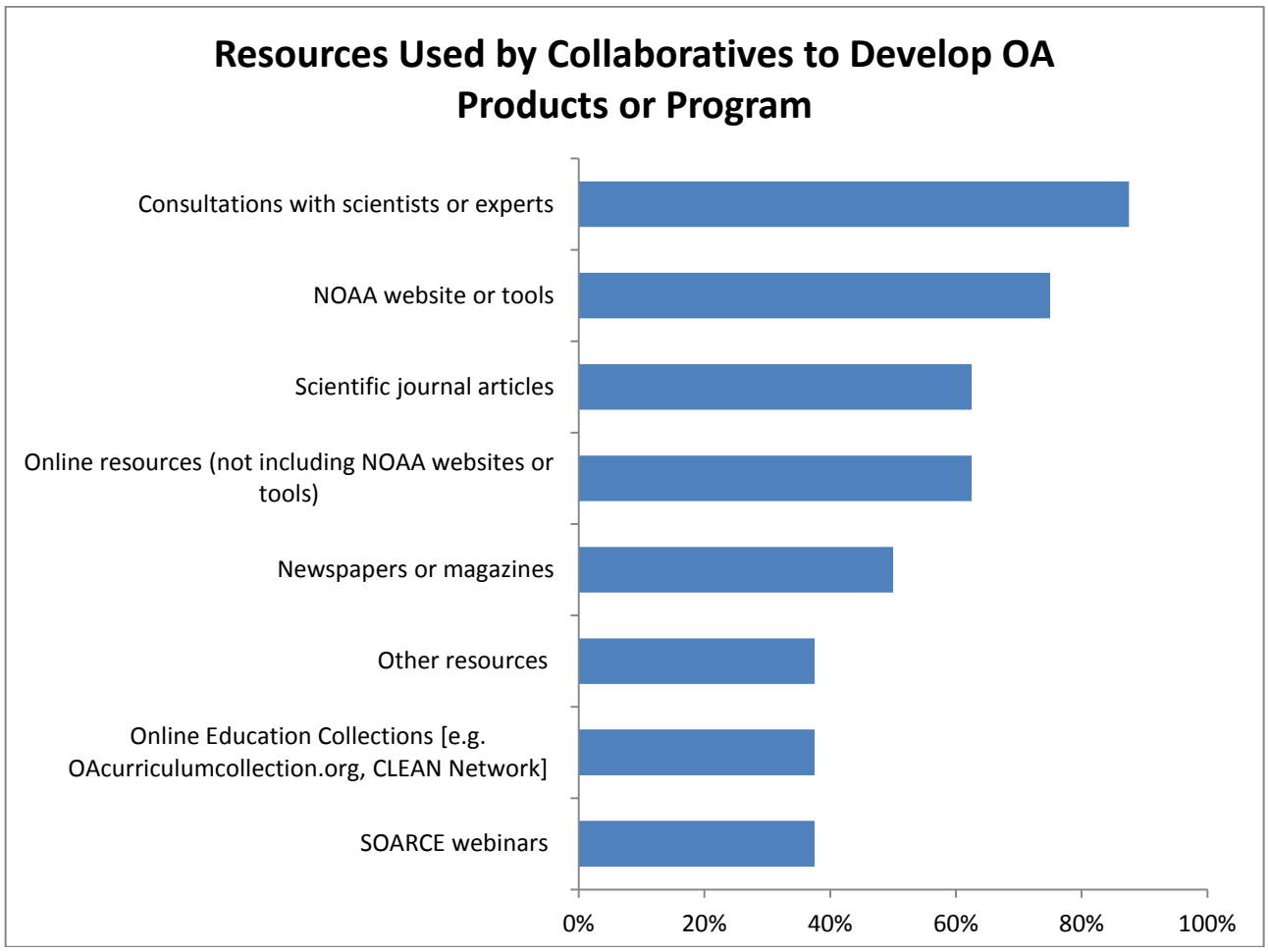

Figure-18 Resources used by collaboratives to develop OA products or programs: Percent representation of resources used to develop OA products or programs. Multiple responses allowed. Other response, books, was not selected by collaboratives. 'Other' resources used include Google and Google scholar alerts, journal alerts, Twitter, Facebook, NASA, NCA, Ocean portal, WHOI, NECAN, C-CAN, and Scuttlebutt group email.

Gaps in OA Education Landscape

Several gaps were identified in the OA landscape. These include urgency or pertinence to daily life, a newsletter, game-based curriculum aligned with NGSS, better messaging for youth and informal settings, discussion of OA as a parallel problem to climate change, a better explanation of the impacts on people (not just food security but what OA means for other biological processes). E-learning modules on OA, resources in different languages, OA games for children, and more discussion of marine science at early grade levels so that students entering upper

grade levels have more background information are other gaps identified by collaboratives in the OA education and outreach landscape.

OA Education Toolkit Needs

One pagers, definitions, a list of resources, regional brochures, videos, and web and social media content are some examples of tools that collaboratives would like to see in an OA education toolkit. Collaboratives also stressed the need for clear, simple and easy to understand graphics and/or animations. Specific content suggestions include content that is aligned with NGSS standards that could be used as curricula for schools, a questionnaire or quiz to evaluate knowledge, and examples of organisms that are impacted by OA.

SCIENTISTS AND RESEARCH INSTITUTES

Twenty-eight scientists and research institutes completed the needs assessment survey. The sample includes six university-based research institutes (21%), one independent research institute (4%), 20 scientists from government agencies (71%) and one independent science communicator (4%) (Fig. 19).

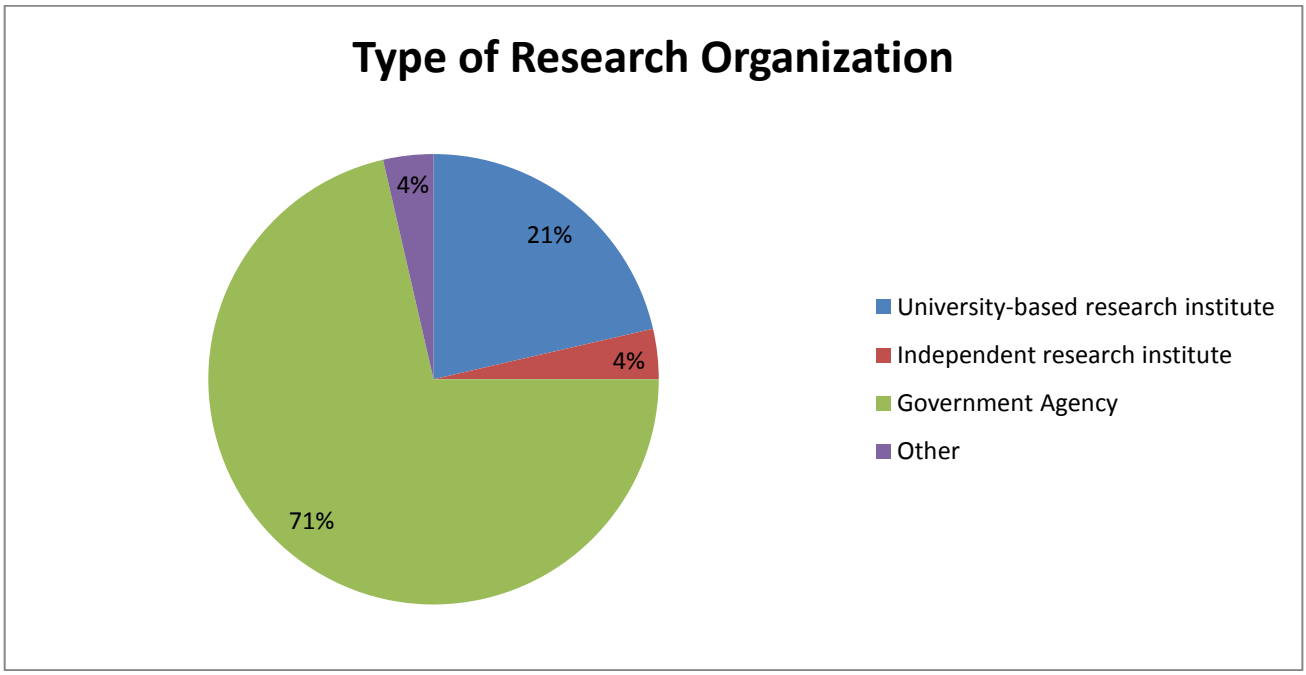

Figure-19 Percent representation of description of organization. 'Other' includes independent science communicator.

There is a varying range of OA research focus areas among scientists and research institutes. However, many of the organizations (50%) focus on biological/ecosystem response, followed by

carbonate chemistry (31%), and socio-economic (14%) (Fig. 20). Fewer organizations focus on human/societal adaptation (3%) and education research (2%).

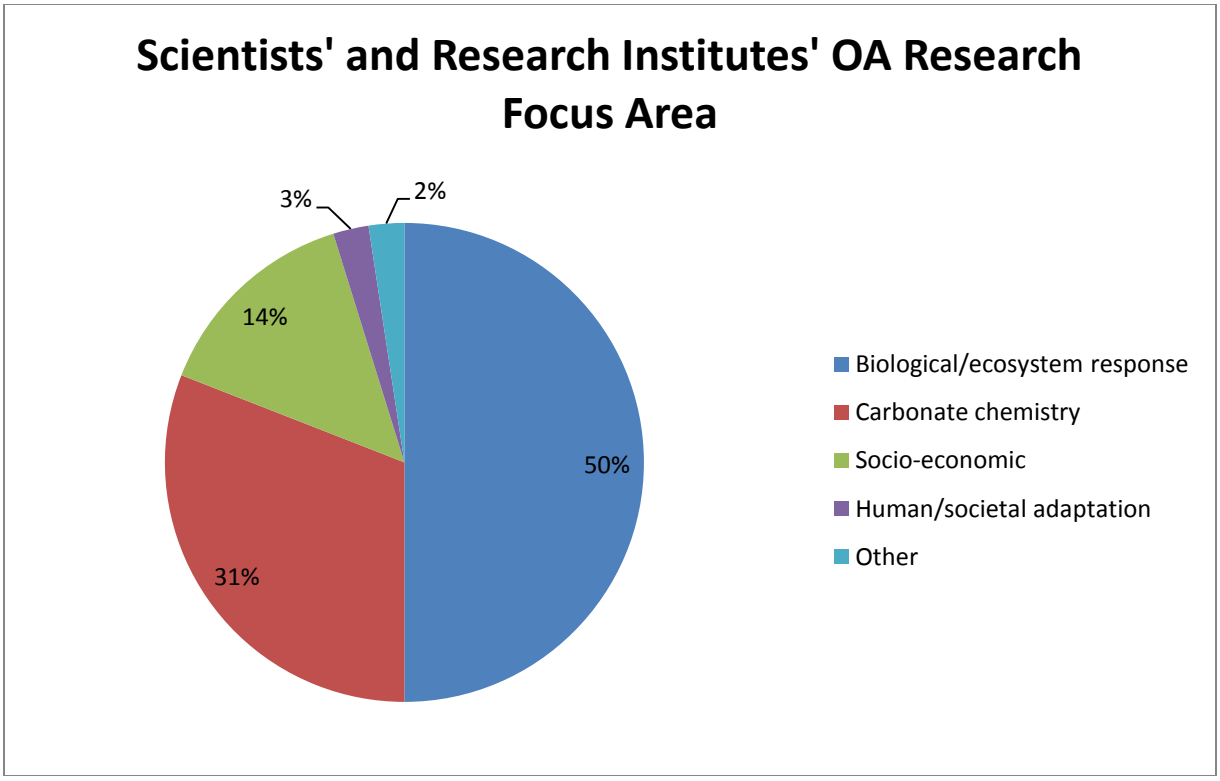

Figure-20 Percent representation of research focus areas. 'Other' includes education research.

Despite the variance in research focus areas, the majority (82%) of scientists and research institutes provide OA education to non-scientific audiences (Fig. 21). Nearly seventy percent (69.6%) provide outreach and education to the general public. Fifty-two percent (52.2%) provide OA education to policymakers and nearly forty-five percent (43.5%) to students (Fig. 22).

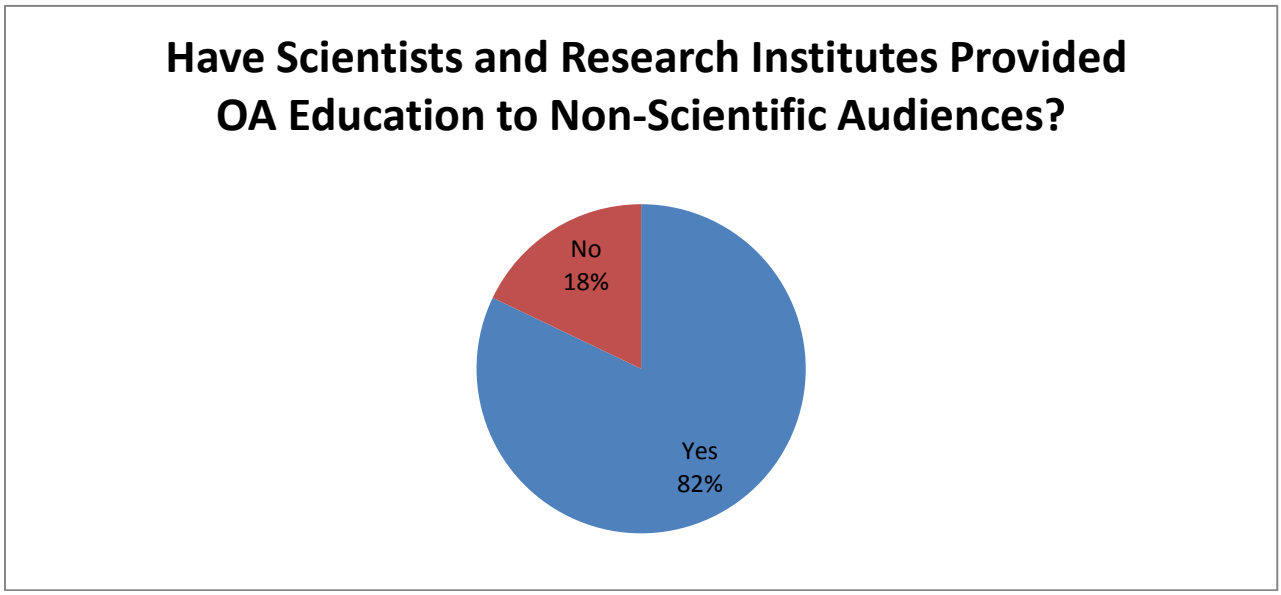

Figure-21 Percent representation of scientists and research institutes who have/have not provided OA education to non-scientific audiences.

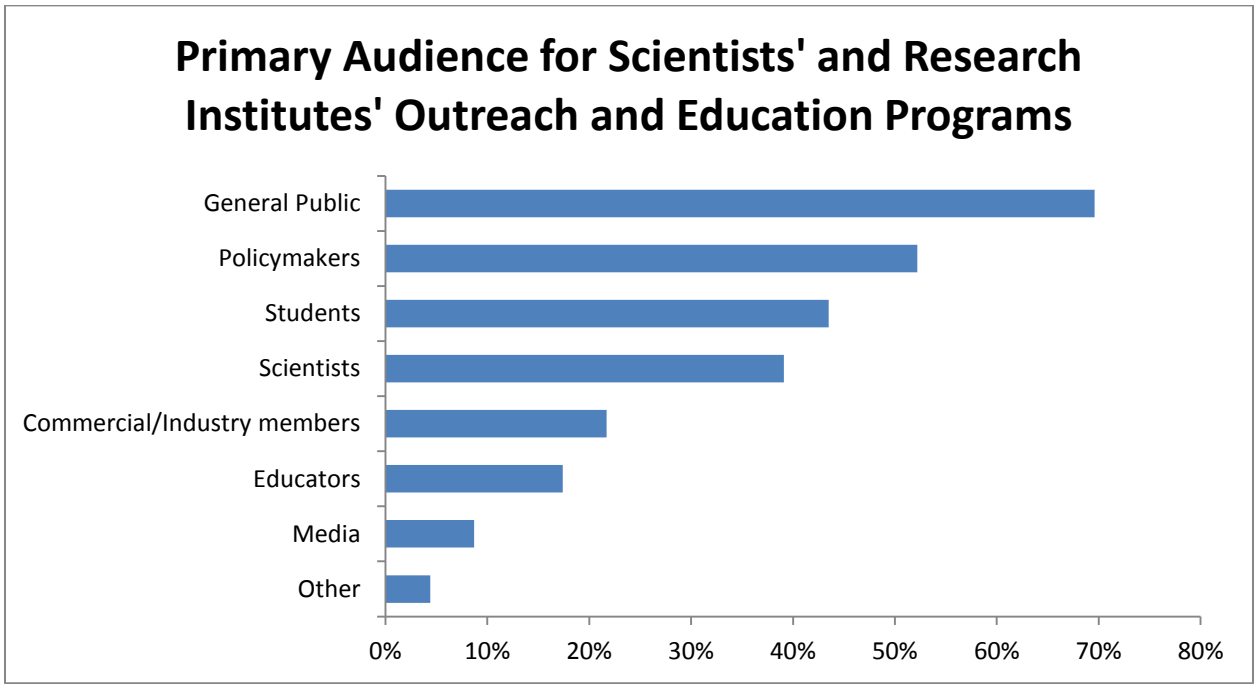

Figure-22 Primary audience for scientists' and research institutes' outreach and educational programs: Percent representation of audiences reported by scientists and research institutes for outreach and education programs. Multiple responses allowed.

Many scientists and research institutes have provided OA education to the public for several years (Fig. 23). For example, thirty percent (31%) have provided education for 1-3 years, 39% for 4-7 years, and 30% for more than 8 years.

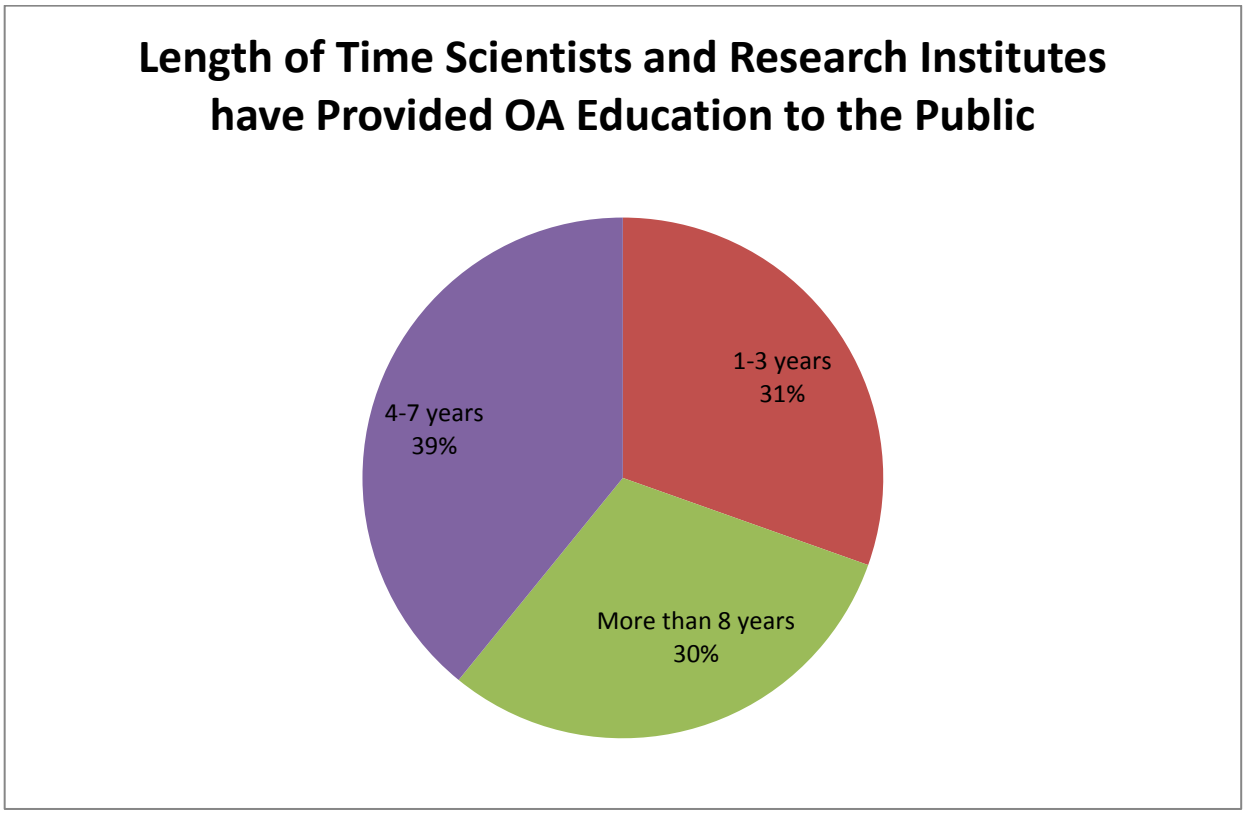

Figure-23 Percent representation of length of time scientists and research institutes have provided OA education to the public. Other response option, 'less than one year', was not selected by scientists or research institutes.

Over sixty percent (61%) of all scientists and research institutes have collaborated with educators to develop OA education or outreach programs for non-scientific audiences (Fig. 24). Similarly, the majority of scientists and research institutes are interested in working with educators and communicators to communicate or disseminate their research to a broader audience (Fig. 25).

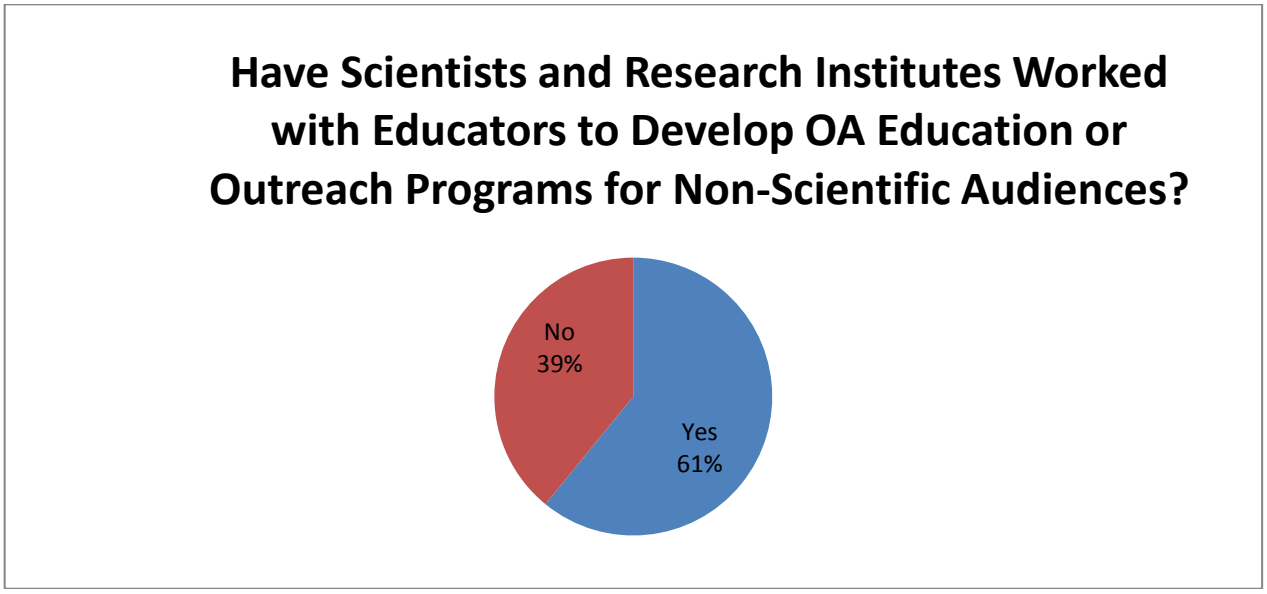

Figure-24 Percent representation of scientists and research institutes who have/have not worked with educators to develop OA education or outreach programs for non-scientific audiences.

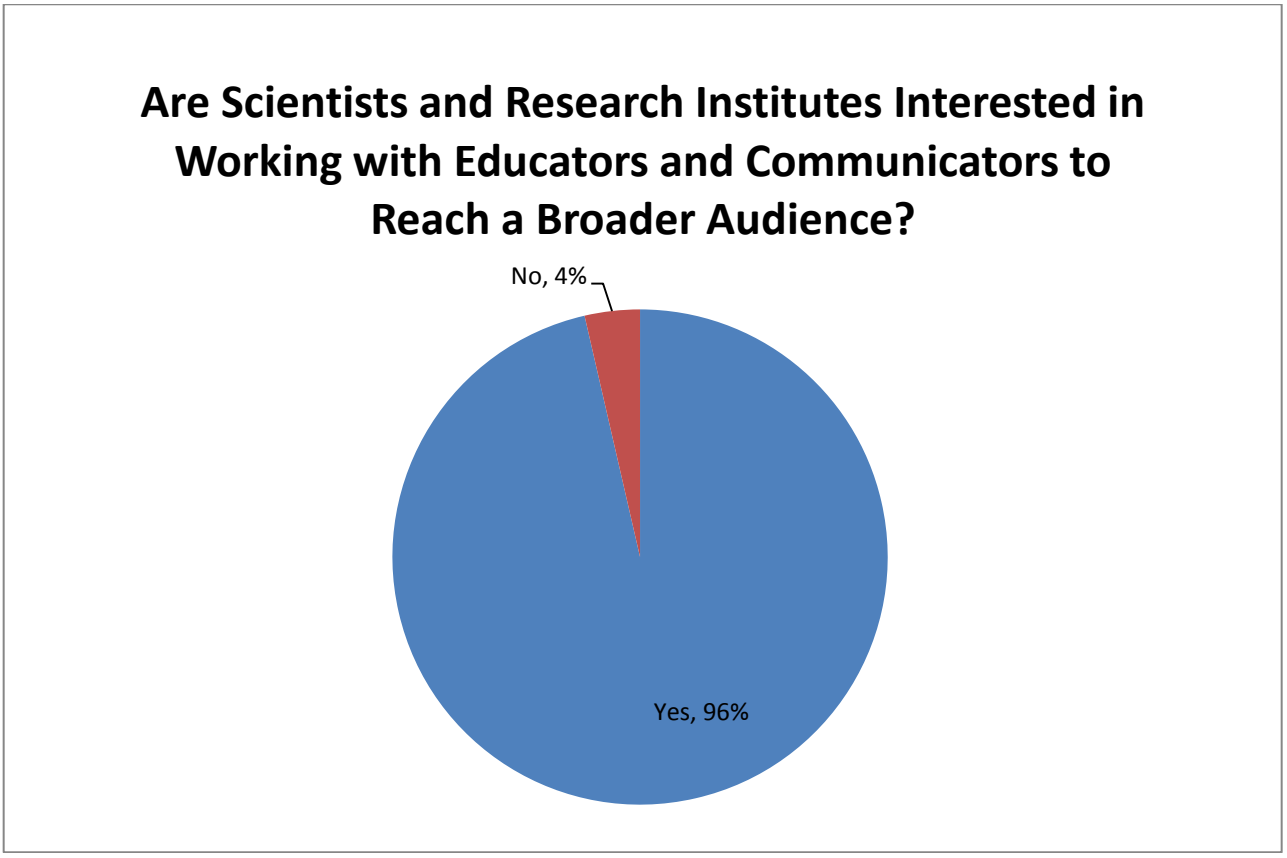

Figure-25 Percent representation of scientists and research institutions' interest in working with educators and communicators to reach a broader audience.

Although nearly two-thirds (64%) of scientists and research institutes have not received training in how to deliver OA education, more than half (54%) are "very comfortable" with communicating OA information (Figs. 26, 27). Among those who have received training in how to deliver OA education, more than a third (35%) received training from COMPASS. Other sources of training listed by respondents include AGU, NOAA, OCB workshops, and training from peers.

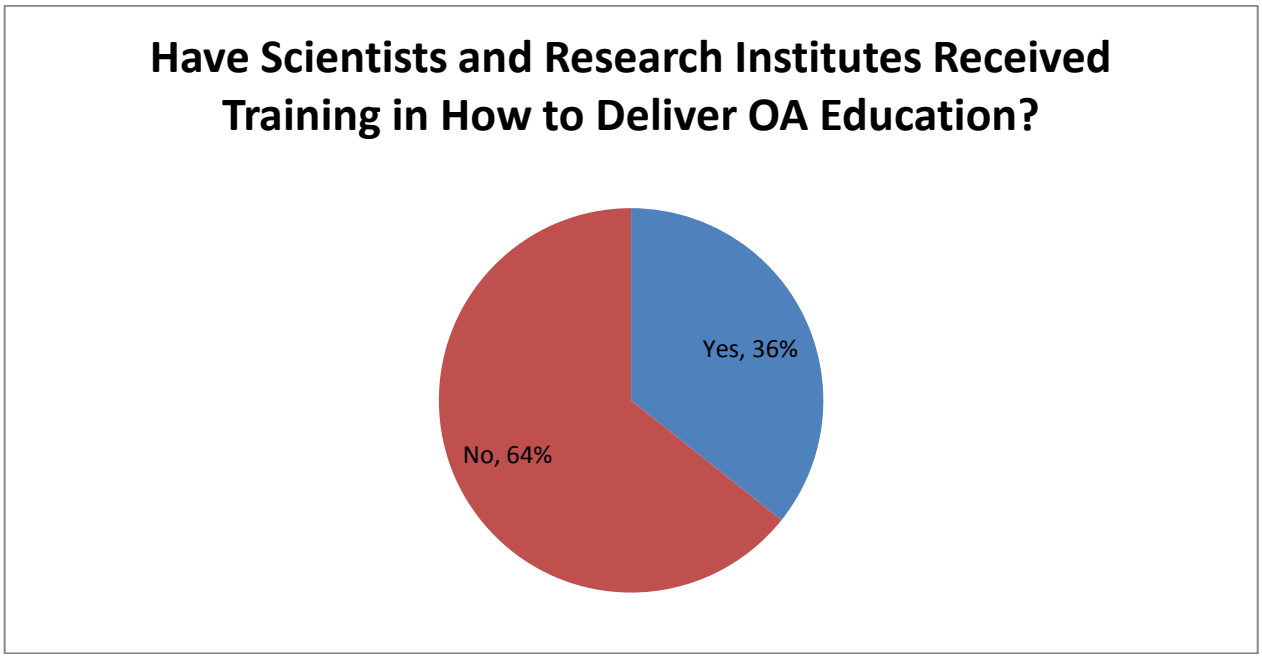

Figure-26 Percentage of scientists and research institutes that have/have not received training on how to deliver OA education.

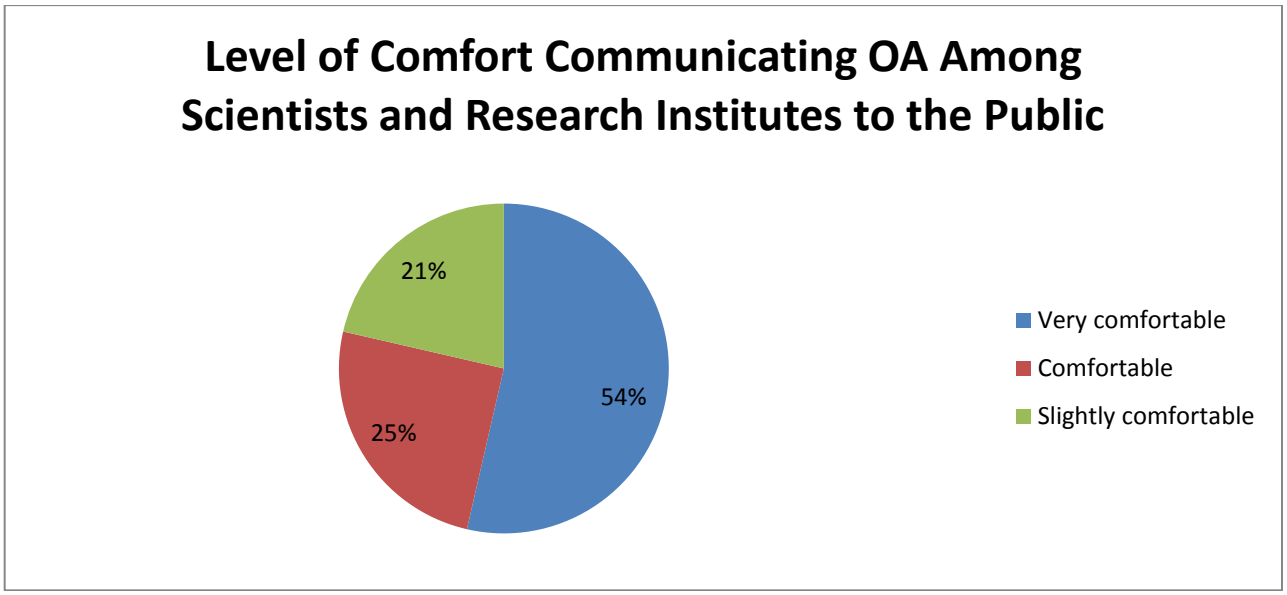

Figure-27 Percent representation of level of comfort communicating OA to the public. The 'not comfortable at all' option was not selected by scientists and research institutes.

OA Program Content

Most OA initiatives at research institutes and programs are part of a climate change program (65%) (Fig. 28).

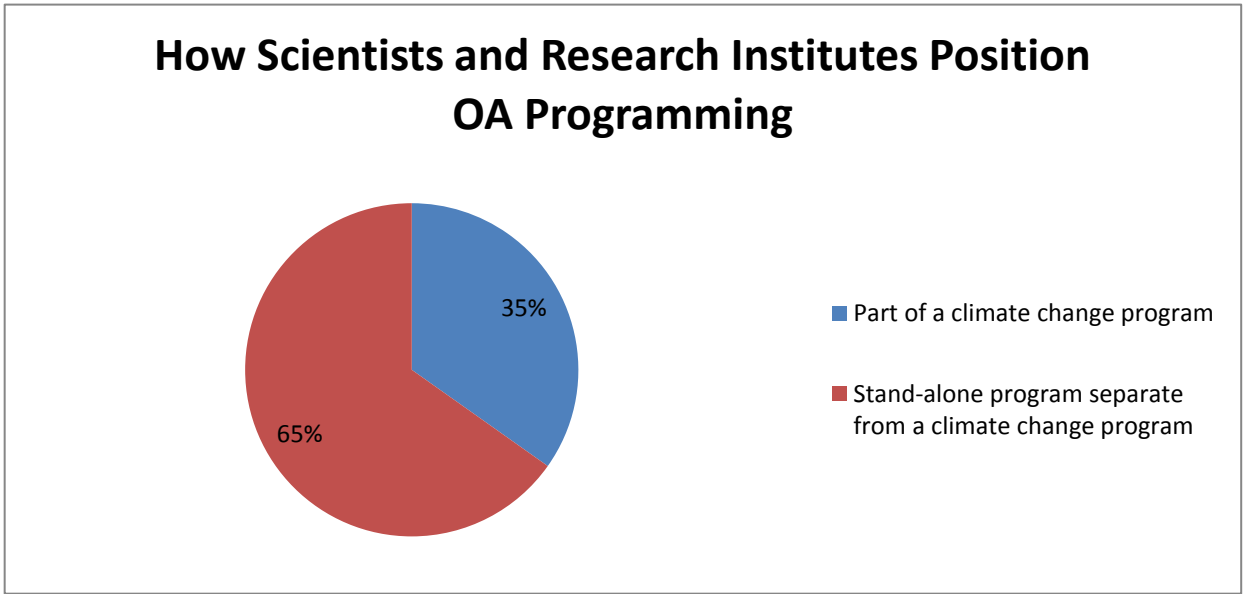

Figure-28 Percent of scientists and research institutes that include OA as part of a climate change program and scientists and research institutes with stand-alone OA programs.

Websites, articles and blogs, and workshops or training sessions are the primary OA products produced by scientists and research institutes (Figs. 29-32). There are some variations in the types of products produced for different audiences (Figs. 30-32). For example, workshops and trainings are most often produced for scientists. In contrast, lesson plans are most often developed for educators while websites are the primary vehicle for reaching the general public.

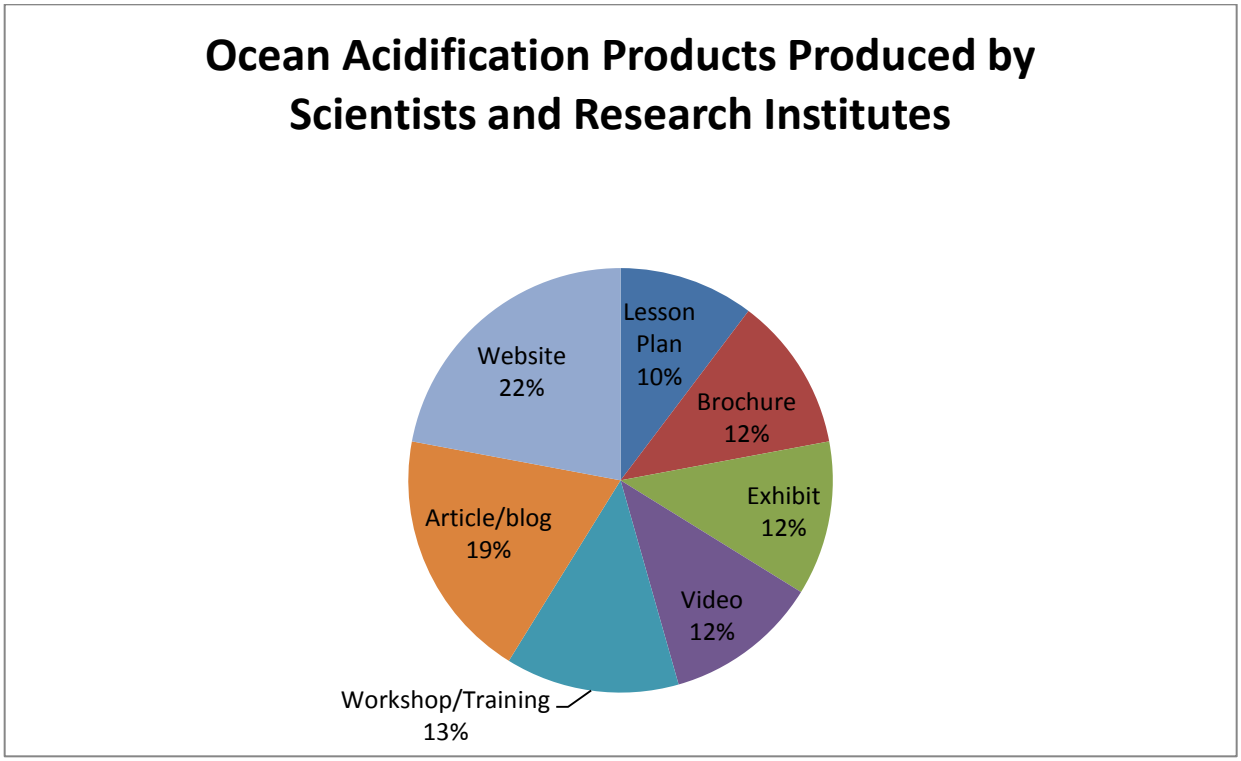

Figure-29 Percent representation of OA product types produced by scientists and research institutes. Multiple responses allowed.

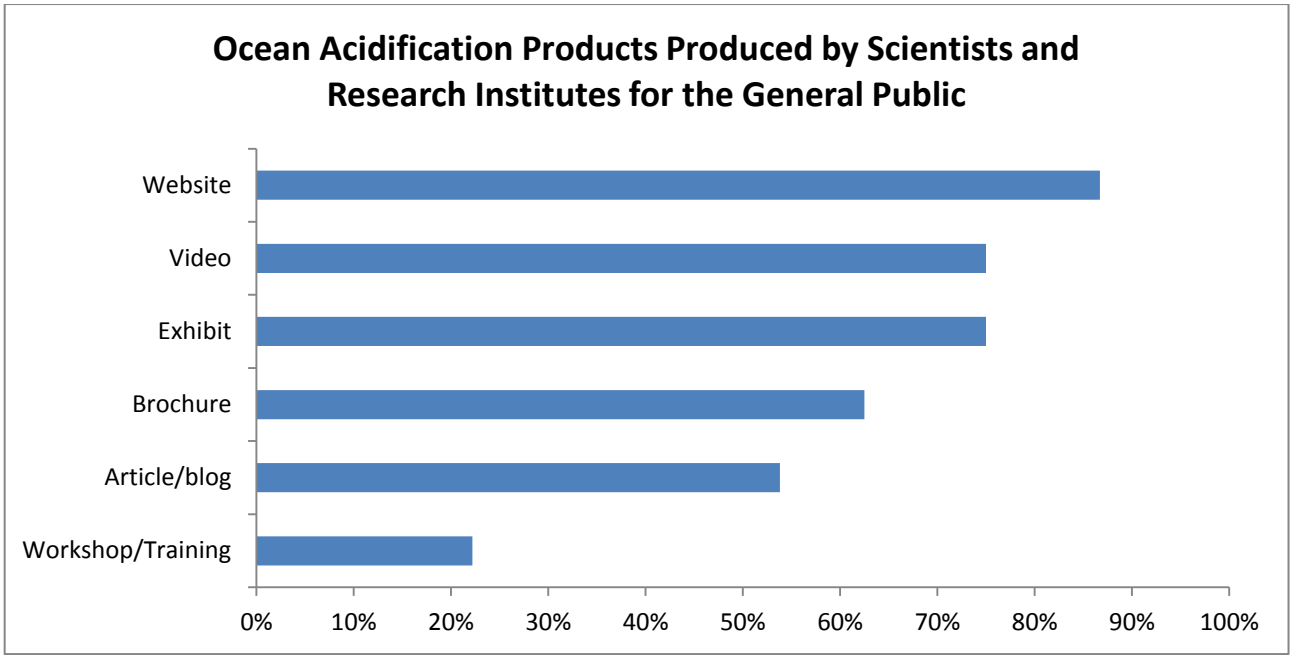

Figure-30 Percent representation of OA products produced for the general public by scientists and research institutes. Multiple responses allowed.

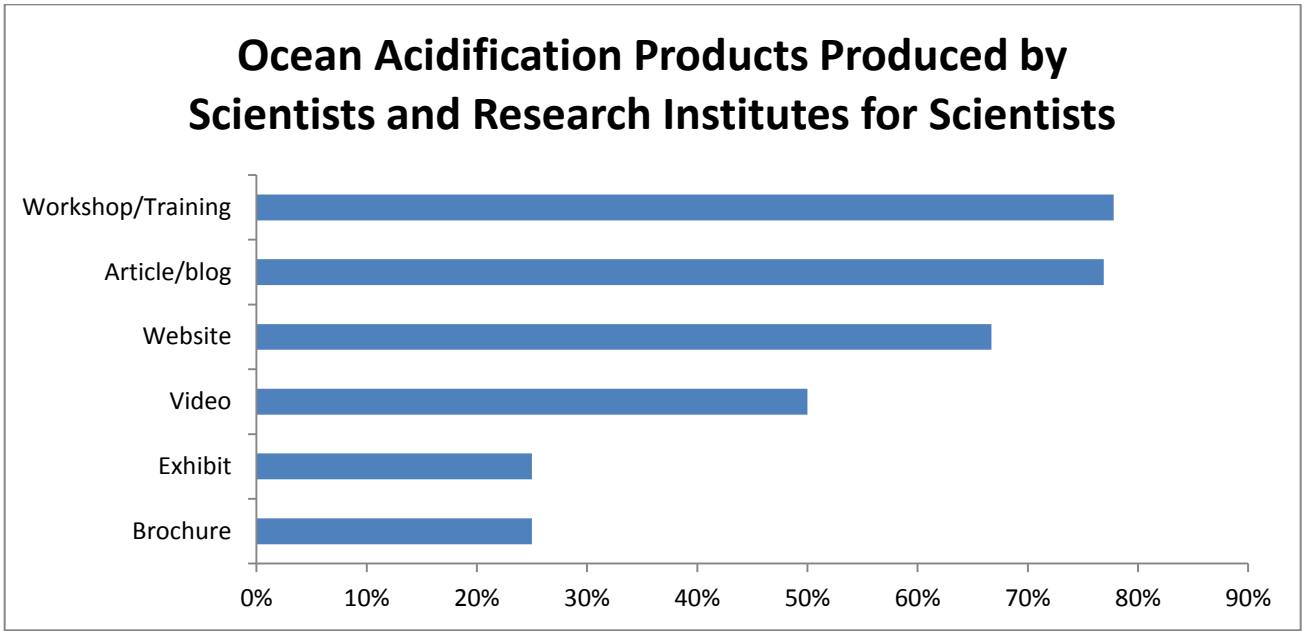

Figure-31 Percent representation of product produced for scientists. Multiple responses allowed.

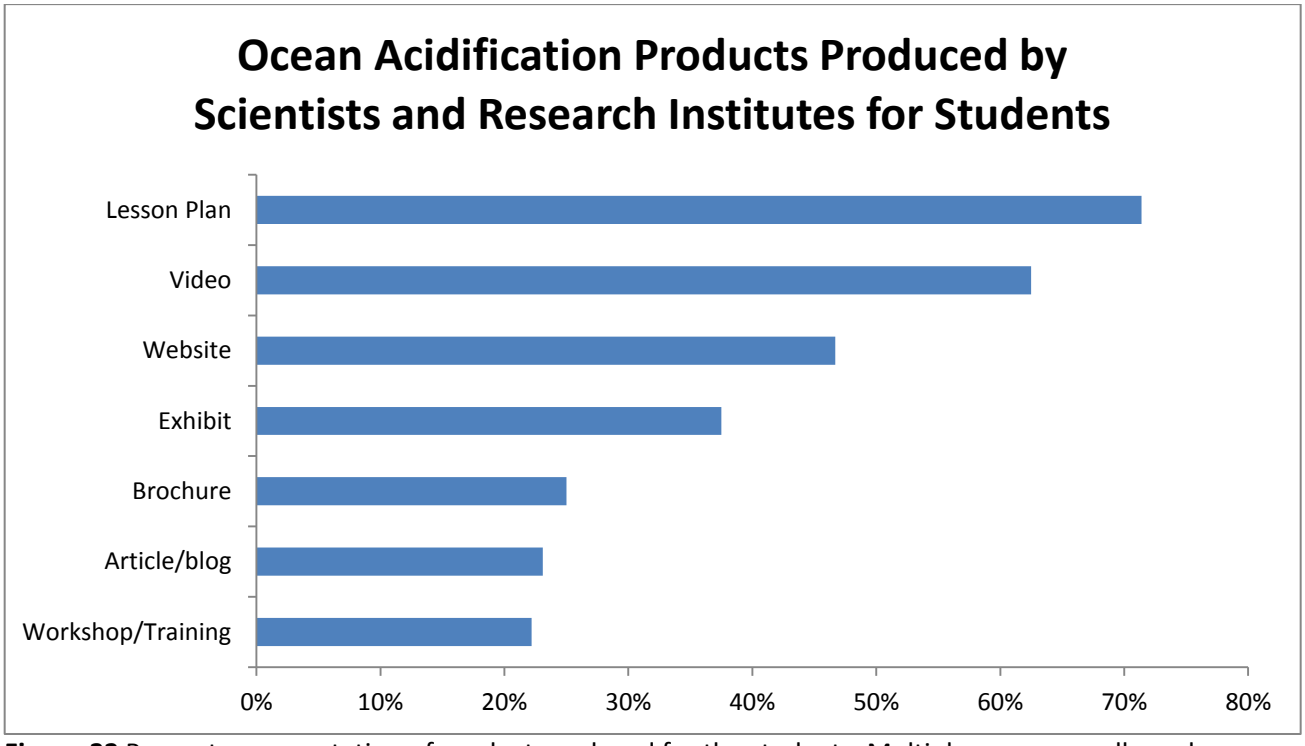

Figure-32 Percent representation of product produced for the students. Multiple responses allowed.

When asked “what is the best resource” for staying up to date on OA science, most respondents identified a NOAA website or scientific journals. To develop OA products or programming, scientists and research institutes most often use scientific journal articles (82.1%), consultations with scientists or experts (71.4%), a NOAA website or tools (67.9%), and online resources (57.1%) (Fig. 33).

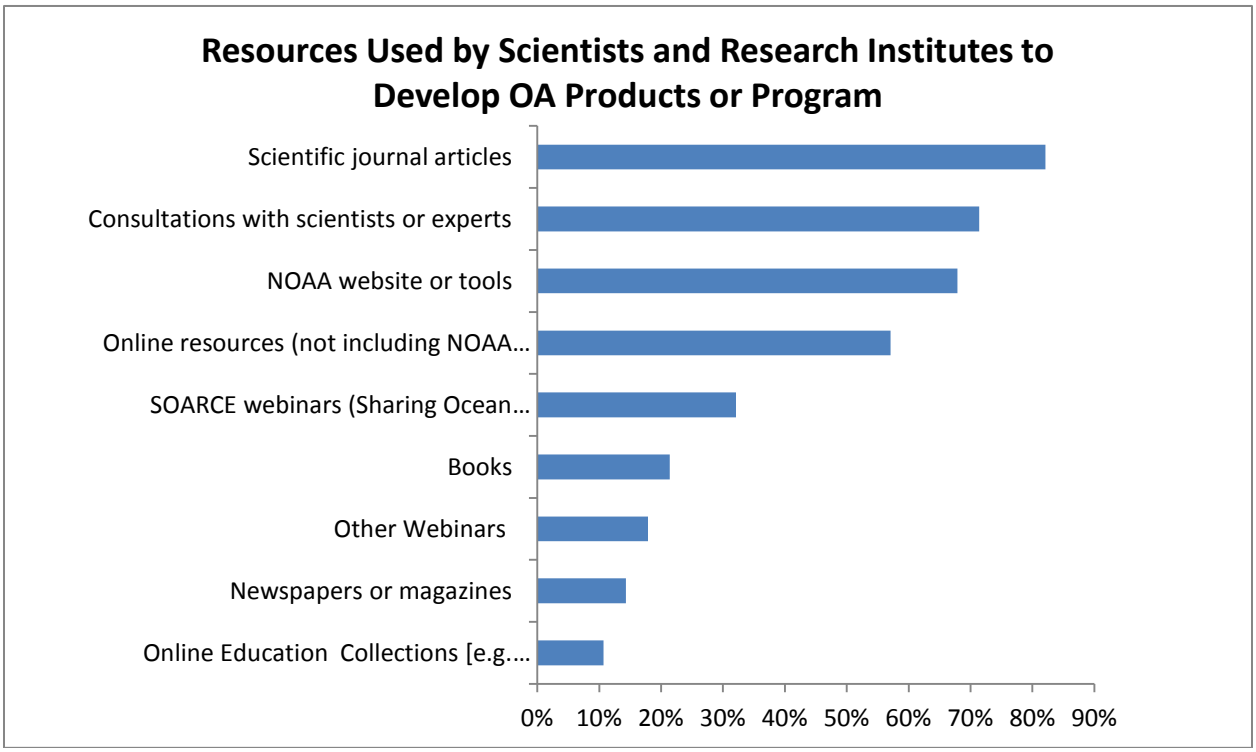

Figure-33 Percent representation of scientists and research institutes that report using the above-listed resources to develop OA products or programs. Multiple responses allowed.

Solutions and Recommendations

Scientists and research institutes are promoting several solutions to address OA including reductions in CO_2 emissions; further research; and raising awareness of OA. Some specific examples include of solutions outlined by respondents include:

- *More experimental research to understand the mechanisms by which ocean acidification affects marine resources. More attention to coastal acidification where the complexity of carbonate chemistry is greater than in the open ocean.*
- *Reduce CO2 emissions - Reduce local nutrient pollution - Protect ecosystems and foster ecosystem health to build their resilience - Work with aquaculture and fisheries industries to help them adapt to and mitigate some of the impacts of OA - Work with policy makers at all levels on OA issues - Educate people about OA so that they understand the issue and can take action on it - Do research and observations to*

document and project the progression of OA and its impacts

- *Provide information so that communities are aware of the risk and can make appropriate management and social policy decisions.*

Gaps in OA Education Landscape

Several gaps have been noted by scientists and research institutes when thinking of the broad landscape of OA education. A key gap is the lack of quality resources for the public and students. According to one respondent, of the resources that are available, "few actually have effectively reached the public and school curricula." Scientists and research institutes are also concerned with the lack of content focused on how the public can play a role in reducing OA. "Methods to empower citizen science programs that target OA" is one solution that was proposed to address this gap. Other gaps include the need to "address industries other than fisheries" and "how to make people away from the coasts understand and appreciate ocean acidification as a problem they need to worry about." Moreover, scientists and research institutes have reported that the impact on specific ocean life is far too narrow and should be broader. For example, one respondent observed that there is "too much focus on impacts on calcifying organisms and not enough on fish/invert behavior." Similarly, another respondent expressed the need for more attention to "broad ecosystem impacts" because "all [current] outreach is focused on west coast oysters and pteropods."

OA Toolkit

Scientists and research institutes want to see materials designed for all age groups, educators, and students. Hands-on activities, facts, and experiments were also recommended for inclusion in an OA education toolkit. Some specific tools identified by respondents include: "simple, convincing graphics showing how change has occurred and making predictions about likely future consequences"; "basics of OA chemistry with hands-on examples (for in person and web-based learning); and "basics of species response and consideration of ecosystem response (with games and hands-on learning activities).

FORMAL EDUCATORS

Five teachers completed the informal educators survey. The sample included four high school teachers and one middle school teacher (Fig. 34). All respondents teach at schools located in coastal communities. Most (80%) teach in the areas of environmental science and biology (60%). Other subject areas taught by respondents include chemistry, physical science, and biotechnology (Figure-35).

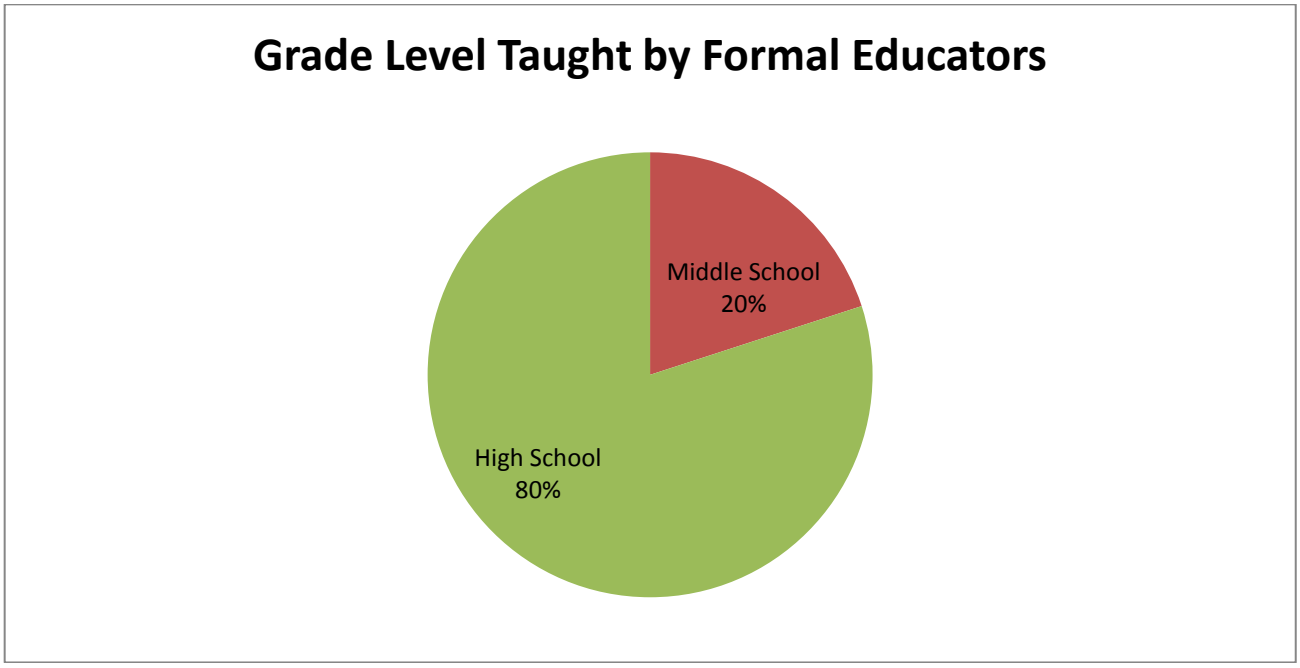

Figure-34 Percent representation of grade levels taught by formal educators. Other options, elementary and college/university, were selected by formal educators.

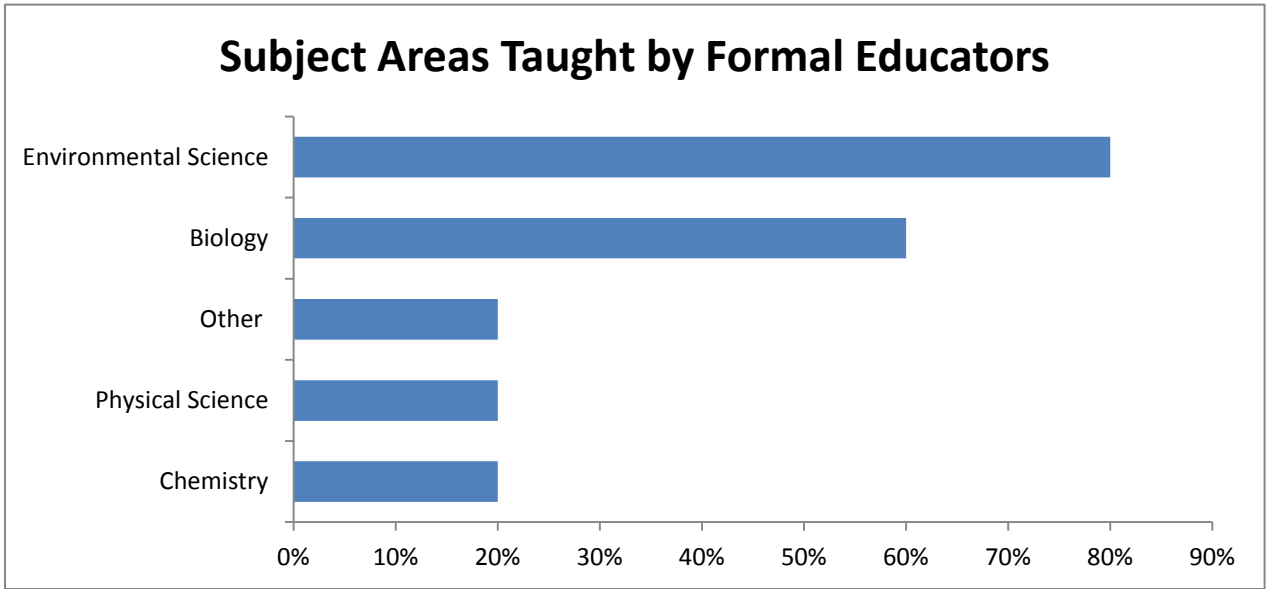

Figure-35 Percent representation of subject areas taught by formal educators. Multiple responses allowed. Other response include biotechnology.

All respondents currently teach or have previously covered OA in their classes. Three out of five teachers are "very comfortable" with teaching OA (Fig. 36). The other 40% or two out of five is "comfortable" with teaching OA. All of the respondents have received training in how to deliver OA education. Two of the teachers received training through Washington SeaGrant education

resources. Other sources of training include Baliga Lab at the Institute for Systems Biology, NOAA teacher in the Lab program at Northwest Fisheries Science Center, and workshops through various entities including NOAA, UC Santa Barbara, and the National Park Service.

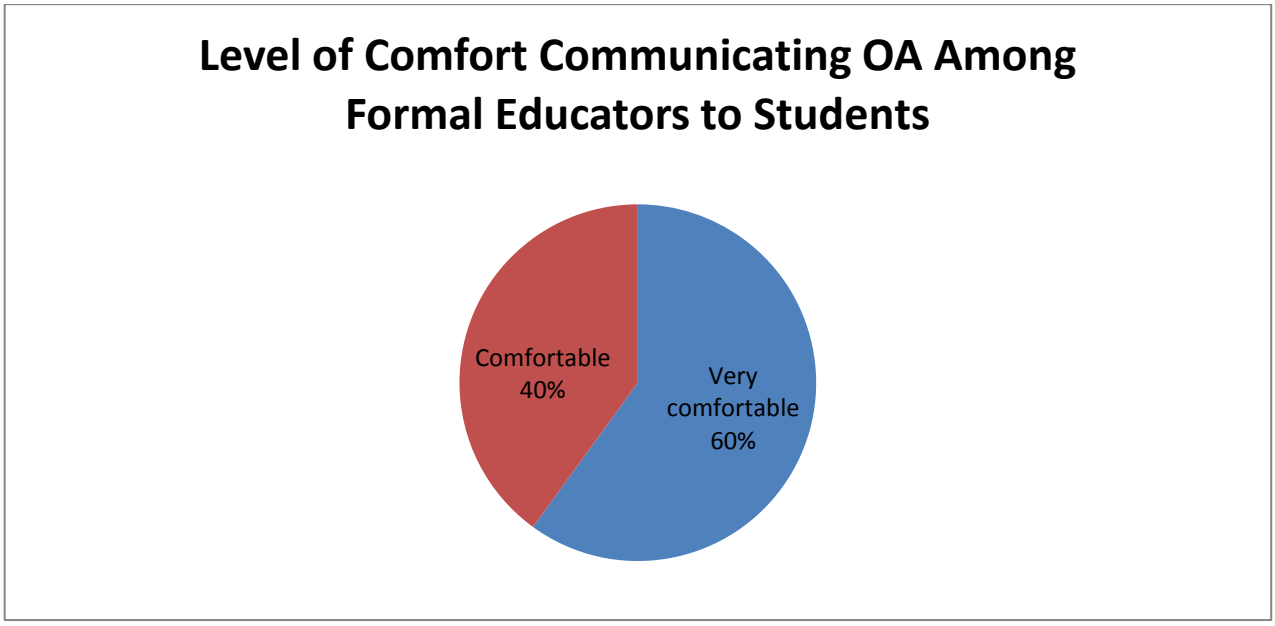

Figure-36 Level of comfort communicating OA among formal educators to students: Percent representation of level of comfort communicating OA to students. Other options, slightly comfortable and not comfortable at all, were not selected by formal educators.

To a great extent, coverage of OA and other ocean-related topics by most teachers (60%) is shaped by science standards mandated by the teachers' state or school district (Fig. 37). In contrast, one teacher reports science standards at the state or district level "somewhat" shapes his/her coverage of OA while another finds that science standards have "very little" influence on his/her coverage of OA and other ocean-related topics.

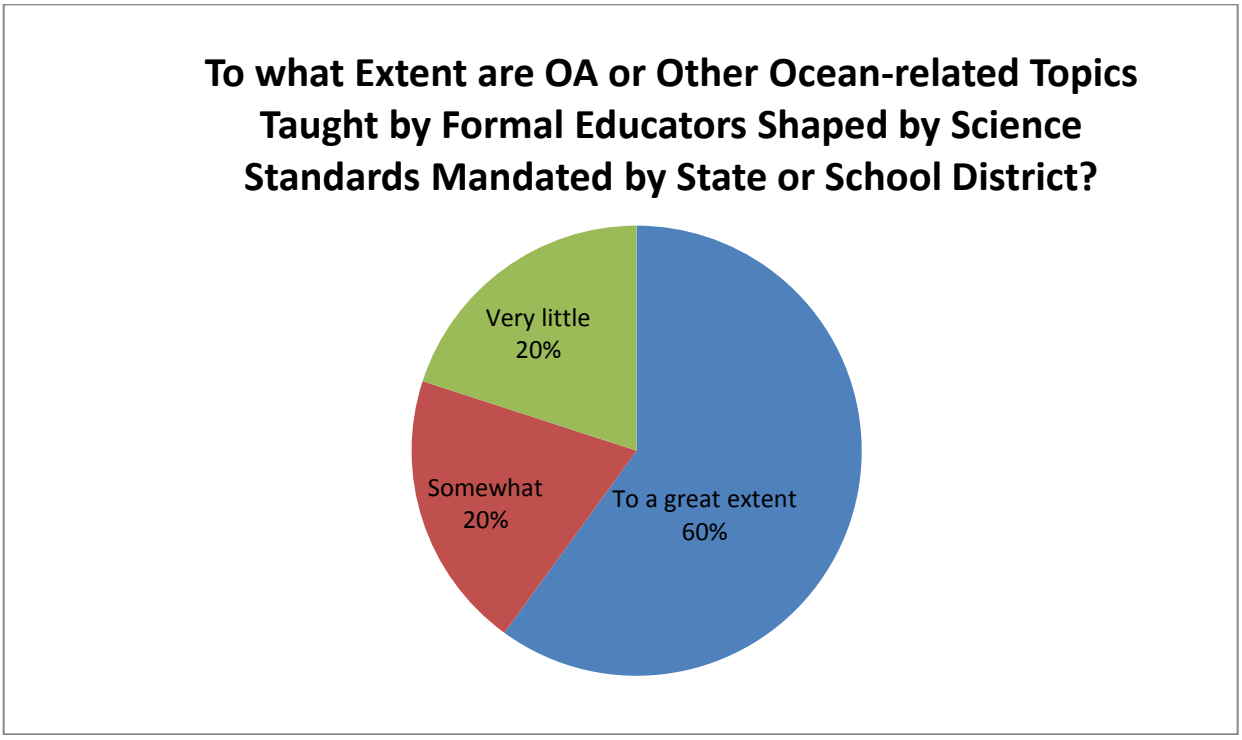

Figure-37 Percent representation of the extent that OA or other ocean-related topics are mandated by state or school district. Other option, not at all, was not selected by formal educators.

Teachers use a variety of methods to integrate OA in their teaching (Fig. 38). The two most commonly used methods by all teachers are classroom activities and guest speakers. Forty percent (40%) or two out of five teachers utilize visits to aquariums or science centers. Eighty percent (80%) of teachers use field experiments. The field experiments include out trips to the beach for oyster surveys and projects designed to provide students the opportunity to monitor cell population growth and pH changes in seawater over two weeks.

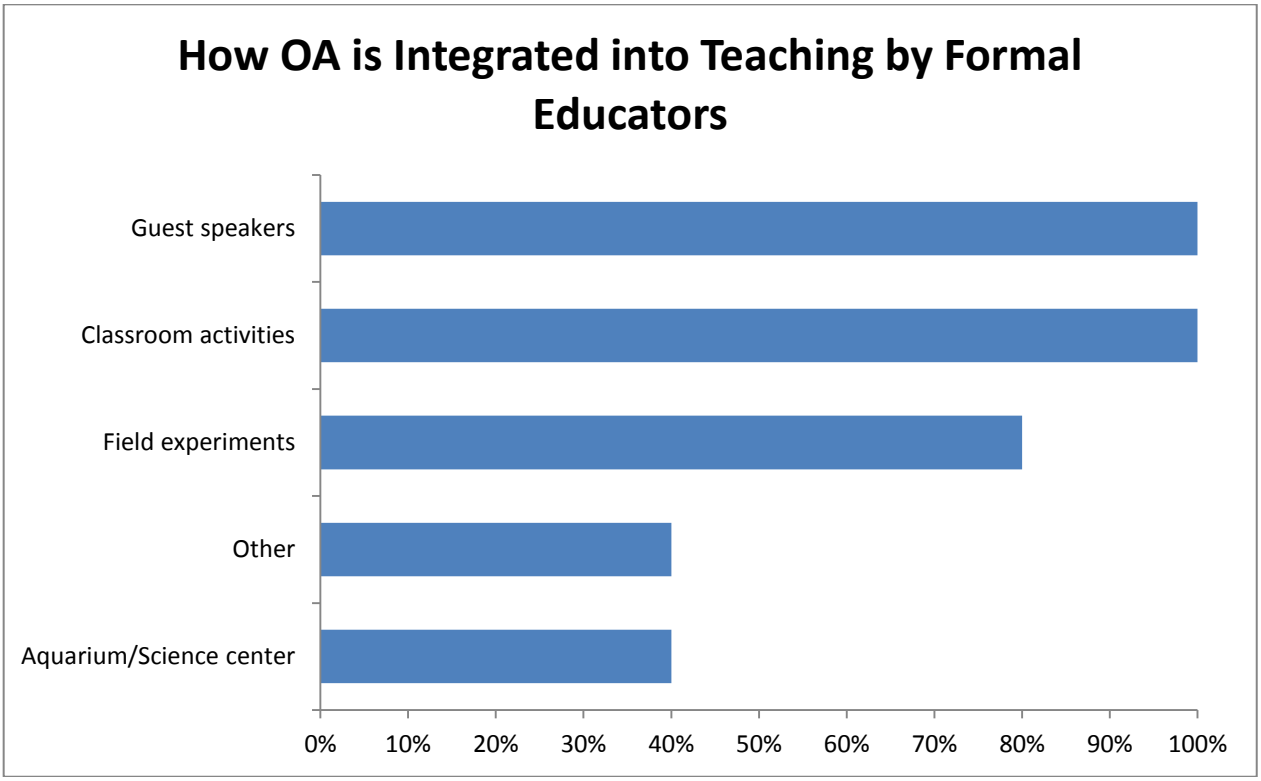

Figure-38 Percent representation of how OA is integrated into teaching. Multiple responses allowed. 'Other' responses include field trips to beach for oyster surveys and research project using diatoms in seawater and ESAW with nutrients omitted or added.

Biggest challenges and lessons for teachers

The two biggest challenges for teachers include how to present OA and time for and design of experiments for students. For example, teachers struggle with deciding what are the most important concepts for students to focus on and how to teach OA without leaving students feeling hopeless. For one teacher, this means figuring out "how do I bring the topic "home" so that students can grasp local issues." Three out of five teachers noted that experiments or long-term investigations are key challenges. Resources such as community partners to support experiments as well as oyster tanks in the classroom are helping teachers facilitate more hands-on teaching.

Respondents shared a diverse set of lessons learned from teaching OA. Given the complexity of OA, hands-on activities and visuals are helpful for students. Emphasizing solutions is also key. As one teacher noted, "staying positive and hopeful with teens is a challenge, but I keep reminding them that they can be a part of the solution and the science." A similar lesson was shared by another respondent: "Offering opportunities for students to discuss possible mitigations and teaching an understanding of adaptations and ocean chemistry."

OA Education Resources

When searching for OA education resources, teachers use search terms and phrases commonly associated with OA including: CO_2 in oceans, climate change, ocean acidification lesson plans, acid seas, ocean chemistry, carbon cycle, ocean pH, NOAA, and how climate change affects ocean environments.

Lesson plan collections are used by all respondents to help plan OA lessons (Fig. 39). Only 20% or one out of five use a state standard website as a resource for planning lessons. In addition to lesson plan collections, all respondents use other resources to plan their lessons including NOAA and National Park Service websites as well as resources from marine science centers, SeaGrant, Institute for Systems Biology Baliga Lab, See Curriculum, National Ocean Sciences Bowl NOSB, and Australian curriculum documents.

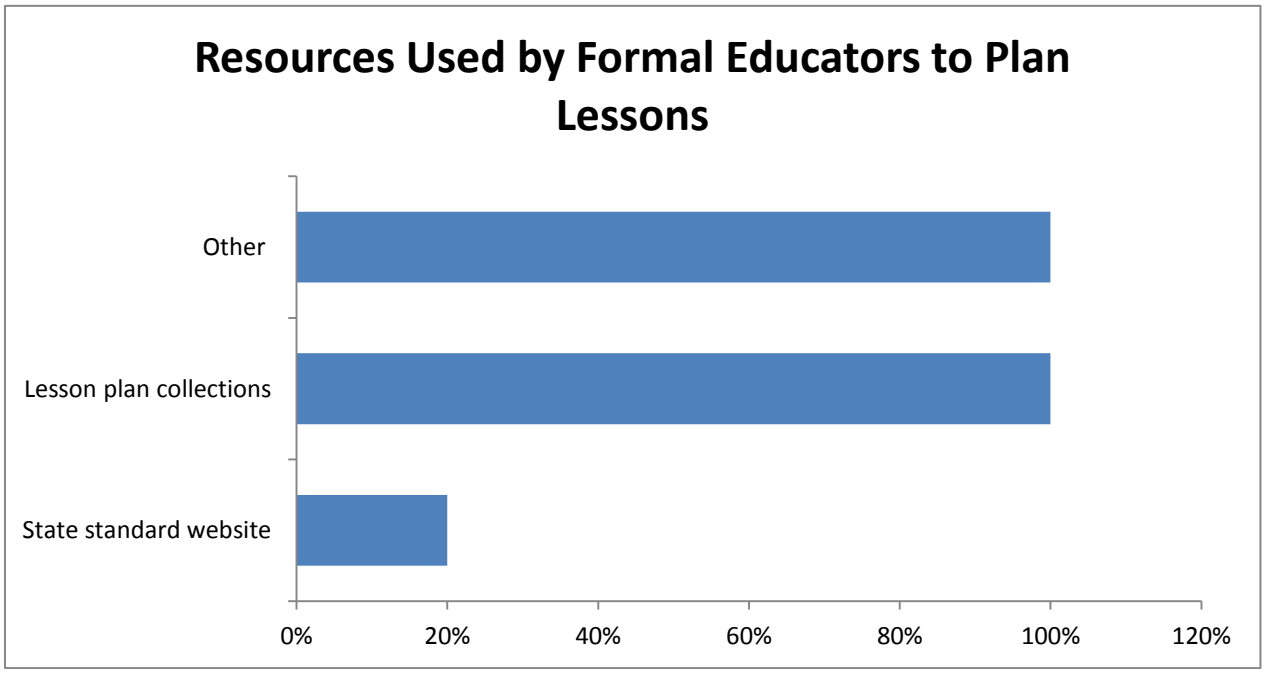

Figure-39 Percent representation of resources used to help plan lessons. Response option 'District curriculum website', was not selected by formal educators. 'Other' responses include Australian curriculum docs; ISB Baliga lab; SEE curriculum; NOAA and NPS websites; NOSB; marine science centers; and Sea Grant.

When developing OA products or content, teachers most often use a NOAA website or tools (80%), scientific journal articles (80%), and newspapers or magazines (80%) (Fig. 40). Other commonly used resources include SOARCE (Sharing ocean acidification resources for communicators and educators) webinars (60%), consultations with scientists are experts (60%), and online education collections such as OAcurriculumcollection.org (60%). Other tools include CSIRO education resources, Google resources, Institute for Systems Biology (IMAS), Baliga Lab, See Curriculum, North America Marine Educators, and clips from the Institute for Marine and Antarctic Studies.

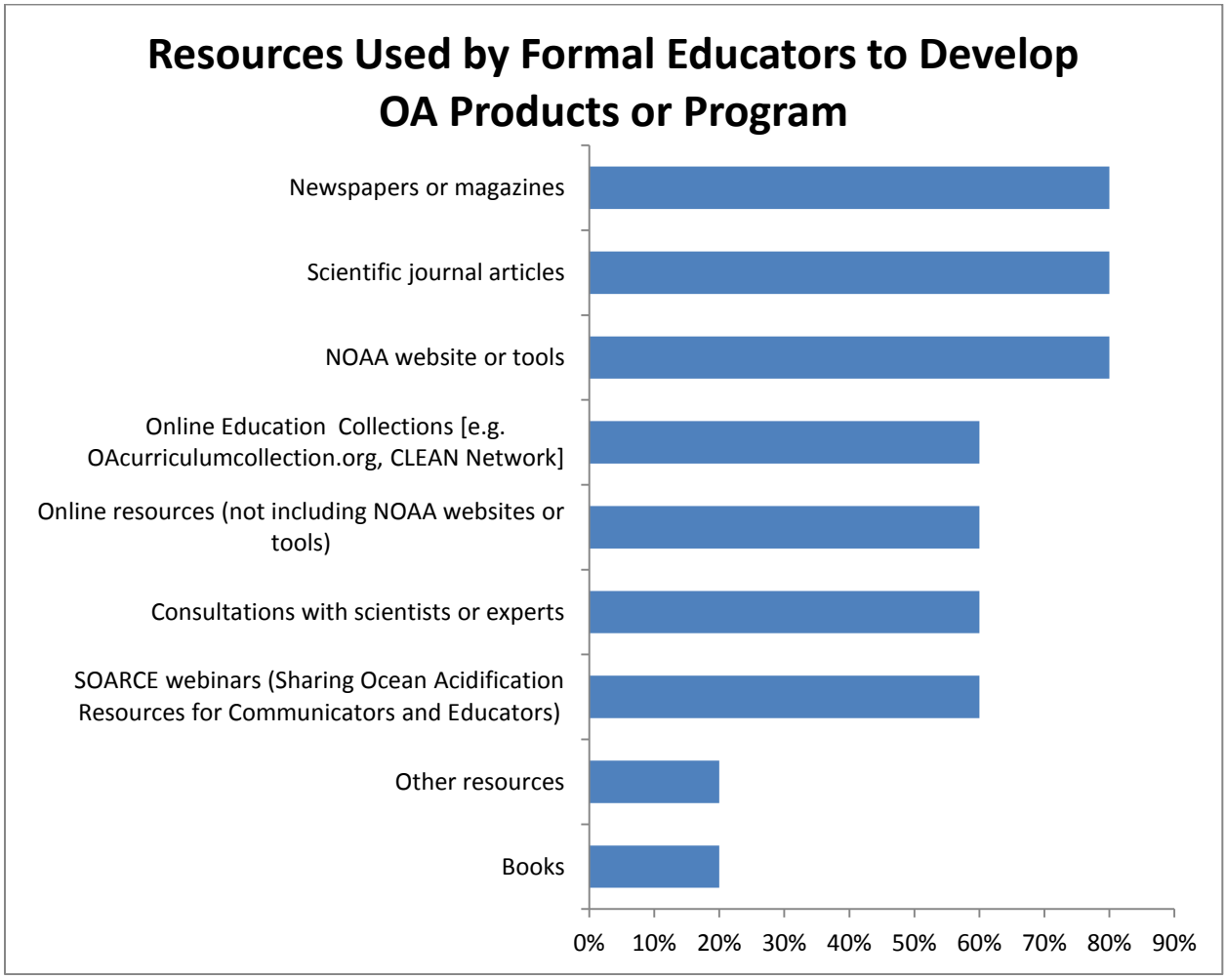

Figure-40 Percent representation of formal educators that report using the above-listed resources to develop OA products or programs. Other response include resources include CSIRO education, Google, ISB Baliga lab, SEE curriculum.

Gaps in OA Landscape

For teachers, gaps in the OA education and outreach landscape include the need for classroom labs that use Vernier sensors, resources that make OA relatable to students' lives, and a concise two-week module (Labs, videos, articles, etc.) for 9 to 12 grade students. Additionally, there is a need for more information on "how people and scientists are making a positive impact and where improvements are being made."

When queried on the ideal contents of in OA education tool kit, all teachers mentioned the need for hands-on activities. A greater variety of possible experiments, ideas for hands-on labs and inquiry-based activities that support Common Core, lab materials with shells and basic chemicals, shellfish studies, oysters in the classrooms are all examples of tools teachers would

like to see in a toolkit. Related to this need, one teacher noted that "many of the labs and demonstrations on OA...are really simple... or require really expensive Vernier interfaces and probes. I'd like to have some equipment that I can afford and that provide good inquiry activities." Film clips with good graphics" are an additional resource that should be included in a toolkit for teachers.

Teachers offered a variety of suggestions that NOAA should keep in mind regarding OA education and communication. Finding NOAA and National Park Service resources via Google search more easily would help make these resources more readily available. A newsletter with "stories from the field" addressing West and East Coast studies and guest speakers that come to the classroom was also suggested. One way this could take shape is by having a NOAA scientist that adopts a school to work on research projects and partnerships with a classroom.

Another teacher stressed the importance of using local experts and resources. Lastly, NOAA should consider how OA could also be relevant to other subject matters including math, social studies, and classes on contemporary issues.

INFORMAL EDUCATORS

Informal educators provide ocean-related education in a variety of settings outside of formal educational institutions such as schools and universities. The participants for the informal educators survey represent government agencies, nature or science centers, aquariums, and marine science labs (Fig. 41). A total of 36 informal educators completed the survey with two-thirds of respondents representing government agencies (n = 24).

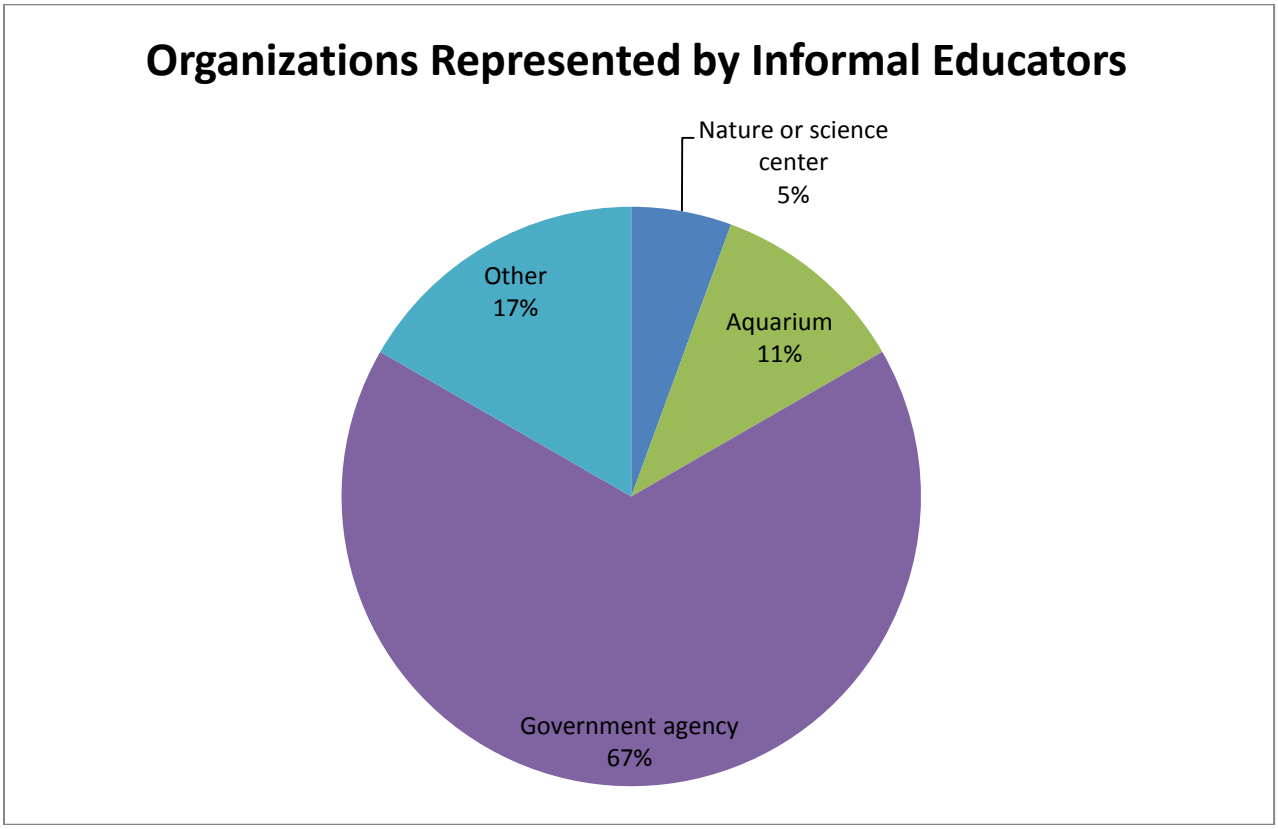

Figure-41 Percent representation of informal educators. Other response, zoo, was not selected by informal educators.

Informal educators communicate to diverse audiences; however, the primary audiences for their outreach and educations programs are the general public, educators, students, scientists, and policymakers (Fig. 42). Other audiences for informal educators' OA programming include volunteers, boaters, fishers, and divers. The most common climate and ocean-related questions asked by various audiences are: (1) what is ocean acidification, its causes, and its effect on sea life (2) what can be done to halt ocean acidification and (3) how can data concerning ocean acidification be accessed and information shared?

In addition to the aforementioned questions, informal educators receive a wide range of questions from audiences, however concern about local impacts also appear to be a common theme:

- *What does this have to do with (me) or (where we live) in the Great Lakes?*
- *What are the effects of climate change on organisms (marine mammals, invertebrates, fish, etc.)? What are the local effects of climate change (how does climate change affect me and my area)?*
- *Why are we having the coldest winters and strongest winter storms on the East coast.*
- *How will a warming ocean affect marine life here? How much is sea level going to rise and when? In general, what marine animals are found here? Are we going to get more hurricanes and northeasters?*

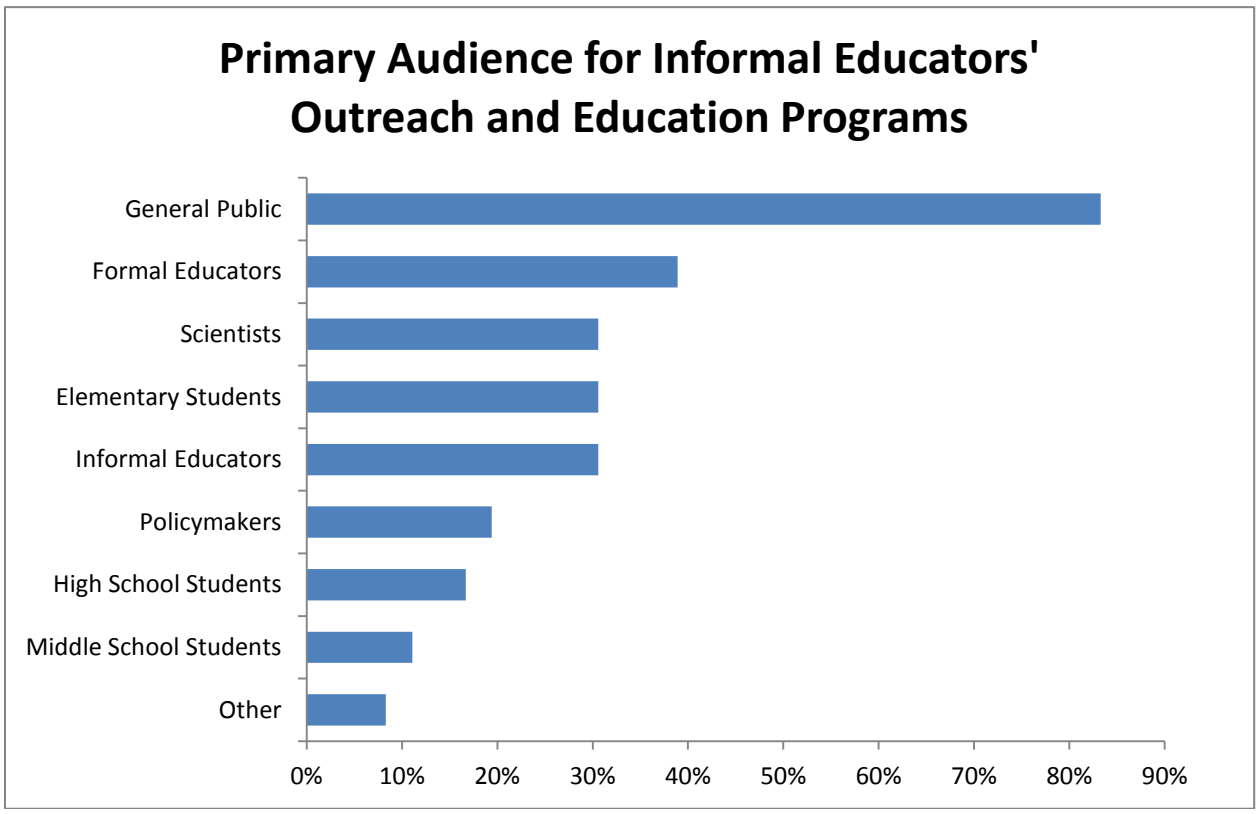

Figure-42 Percent representation of audiences reported by informal educators for outreach and education programs. Multiple responses allowed. 'Other' audiences include volunteers, boaters, fishers, and divers.

As principal developers of OA education and outreach programs for their organizations (78%) (Fig. 43), informal educators convey in their OA messages that "OA is real and is happening now." Informal educators emphasize carbon dioxide effects on oceans and marine life. Informal educators' messages also stress that humans "can lessen the impact" of OA by reducing the use of fossil fuels. An example of this messaging in action was provided by one respondent:

"Our carbon emissions are making the ocean more acidic - a process, termed Ocean Acidification- which could cause massive devastation to the marine food web and life on the planet. We can slow down the rate of change associated with ocean acidification by practicing better life habits that reduce our carbon footprint."

Experience Communicating OA Information

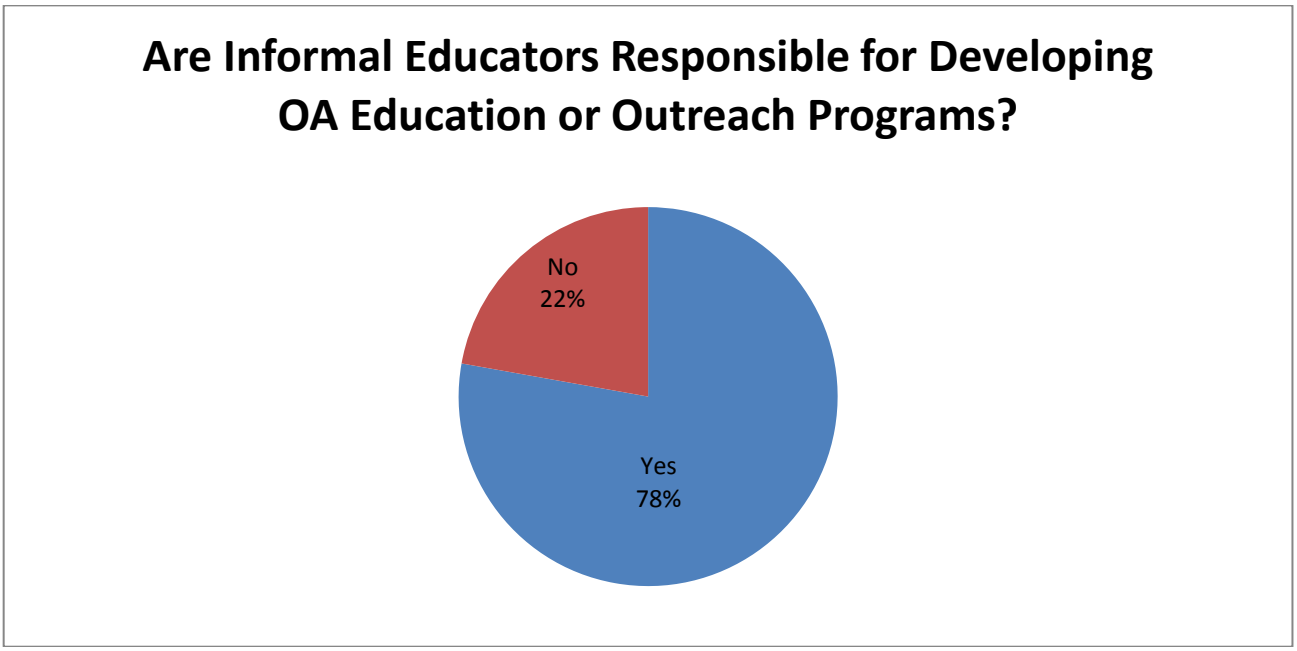

Figure-43 Percent representation of informal educators who are/are not responsible for developing OA education or outreach programs.

Generally, informal educators are "comfortable" with communicating OA to the public (Fig. 44). Most have provided OA education to the public for at least a year, with most organizations providing OA education for 1-3 years (Fig. 45).

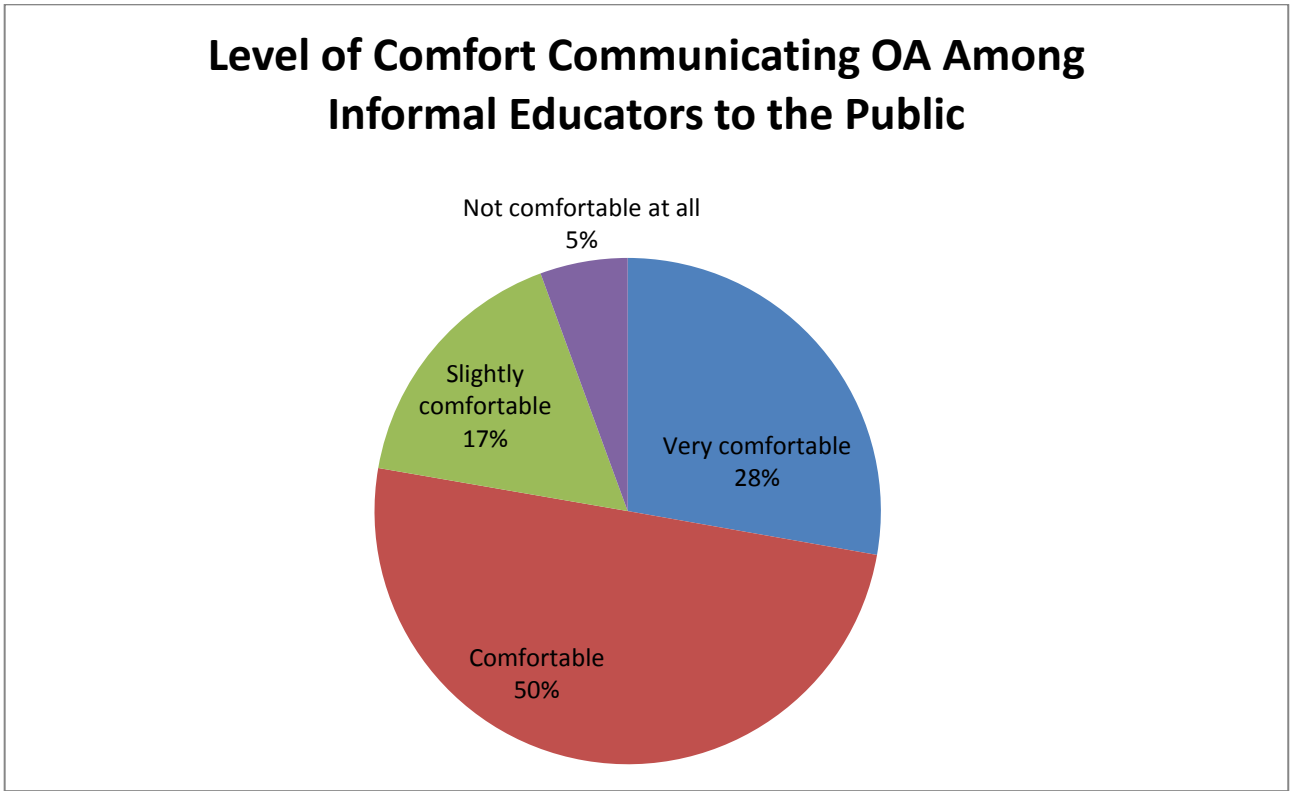

Figure-44 Percent representation of level of comfort communicating OA to the public among informal educators.

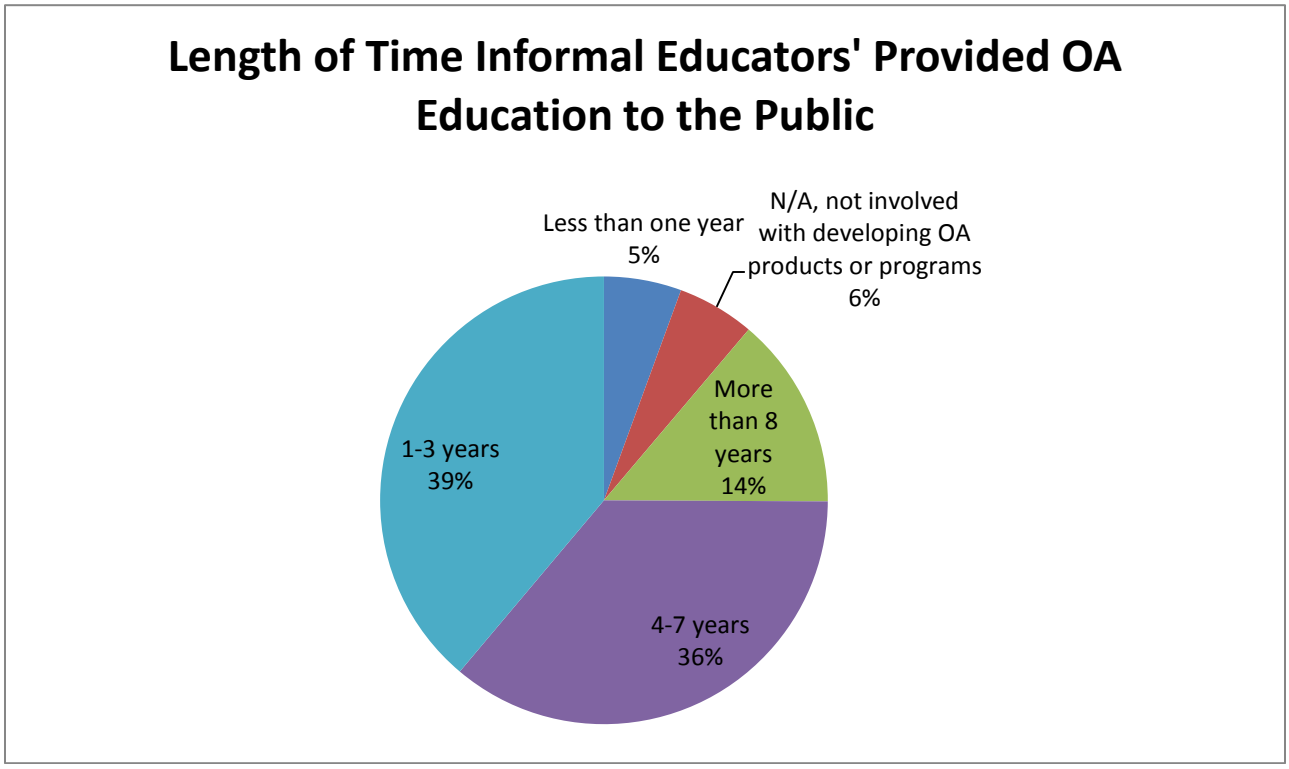

Figure-45 Percent representation of length of time informal educators have provided OA education to the public. Other option, 'less than one year', was not selected by informal educators.

OA programs at informal learning centers are often part of a climate change program (45%) or a stand-alone initiative separate from a climate change program (44%) (Fig. 46).

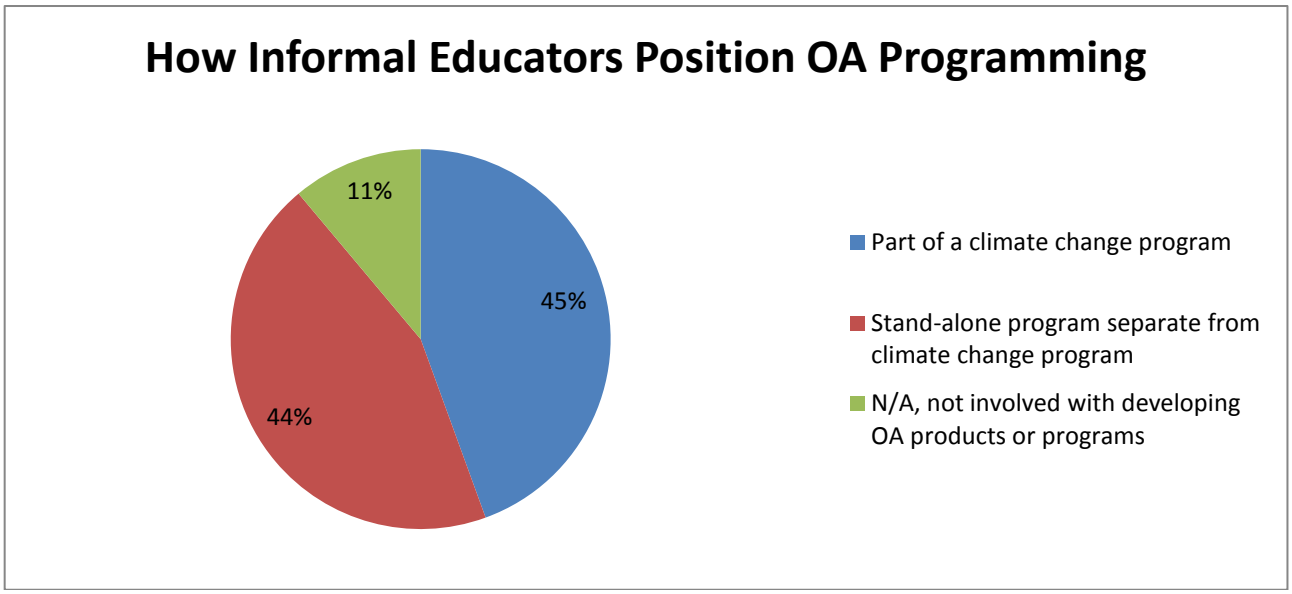

Figure-46: Percent of informal educators that include OA as part of a climate change program and informal educators with stand-alone OA programs.

OA Program Content and Format

There is considerable agreement and consistency in the recommendations and solutions being promoted by informal educators. Some of these solutions include altering personal behavior to reduce carbon footprint/individual carbon release and expanding education on the causes and effects of carbon dioxide as well as OA. Although many informal educators promote individual actions, several stress the importance of community action: "Community or regional scale solutions (supporting renewable energy initiatives and public transportation infrastructure and community gardens and CSAs, local food initiatives) are emphasized instead of individual actions such as "ride a bike", "change a light bulb", "recycle" etc. We need solutions that match the scope and scale of the problem."

Informal educators are producing products about OA that reach a wide range of audiences (Figs. 47). The most common of these products are websites (19%), articles/blogs (18%), and workshops/trainings (17%). These resources are primarily designed for the general public, educators, scientists and students.

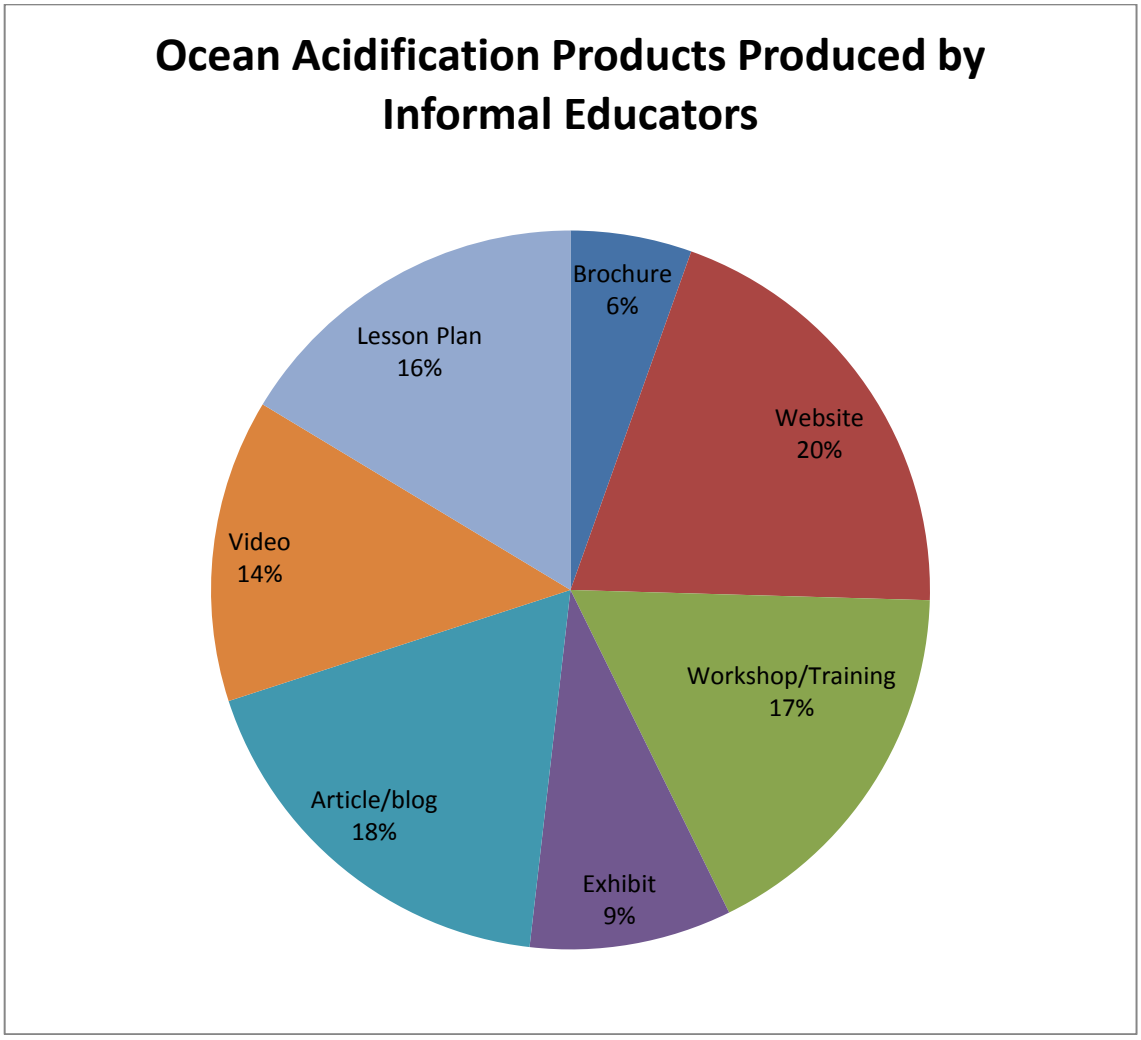

Figure-47 Percentage of informal educators that have produced the above-listed OA products. Multiple responses allowed.

Websites are the top OA products produced for all audiences served by informal learning centers (Figs. 48-51). Among products produced for educators, however, videos are also the top OA products produced by informal learning centers.

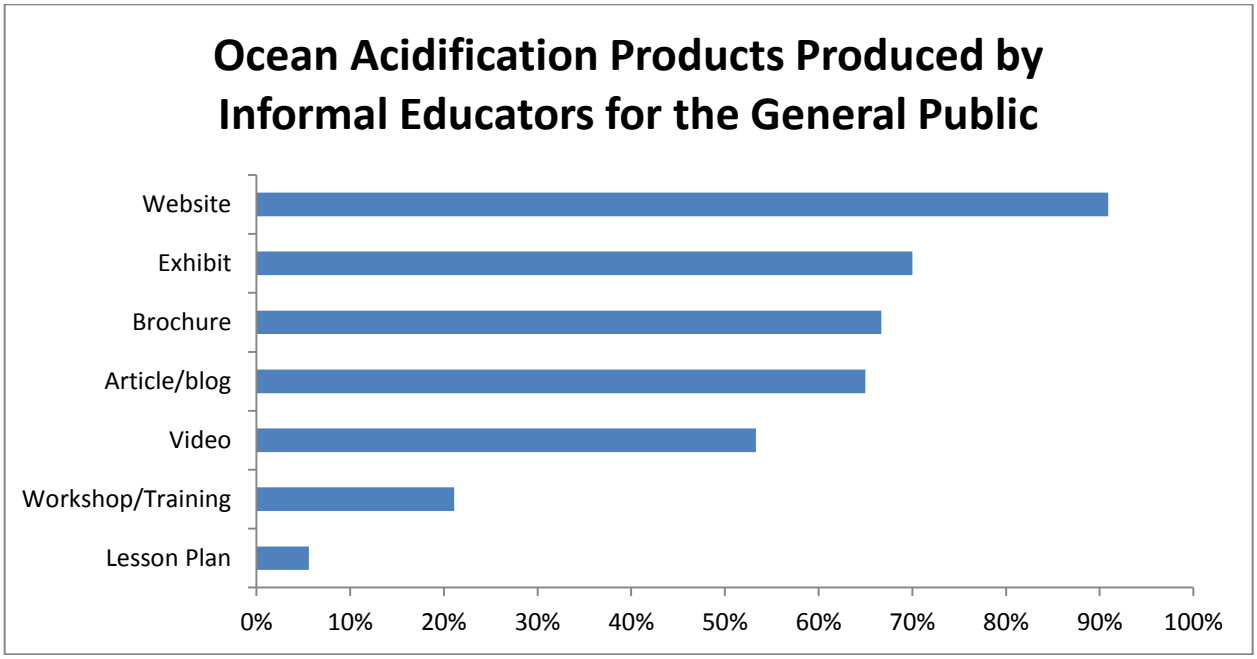

Figure-48 Percentage of informal educators that have produced the above-listed OA products for the general public. Multiple responses allowed.

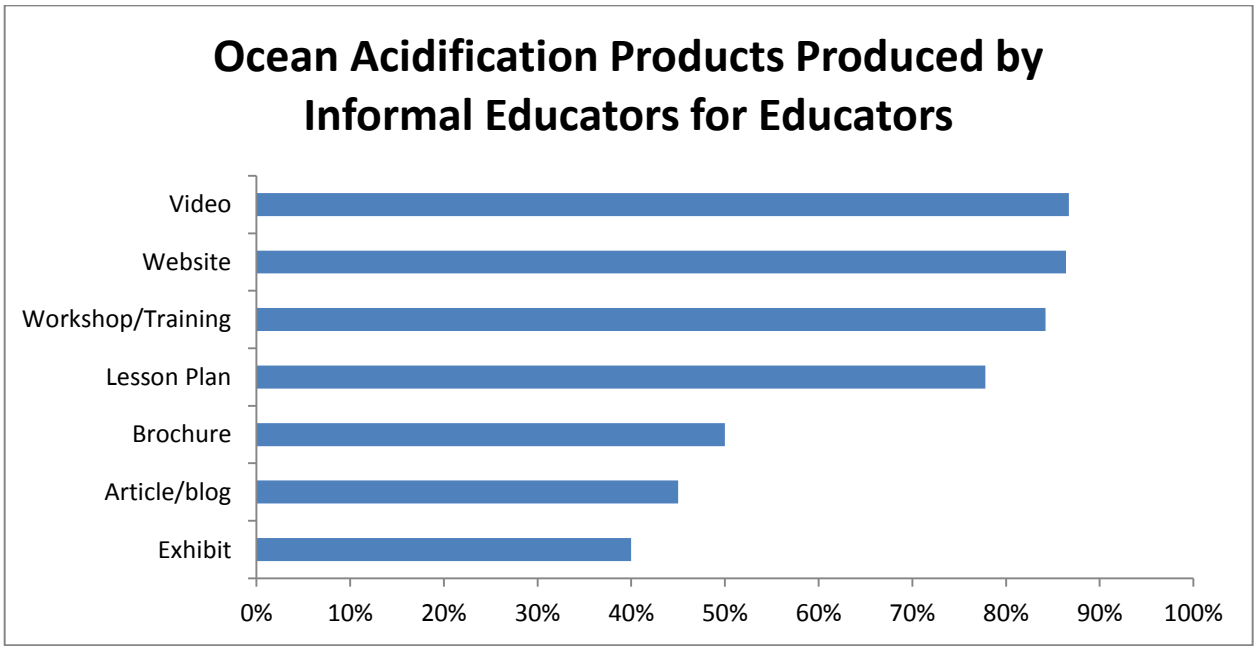

Figure-49 Percentage of informal educators that have produced the above-listed OA products for educators. Multiple responses allowed.

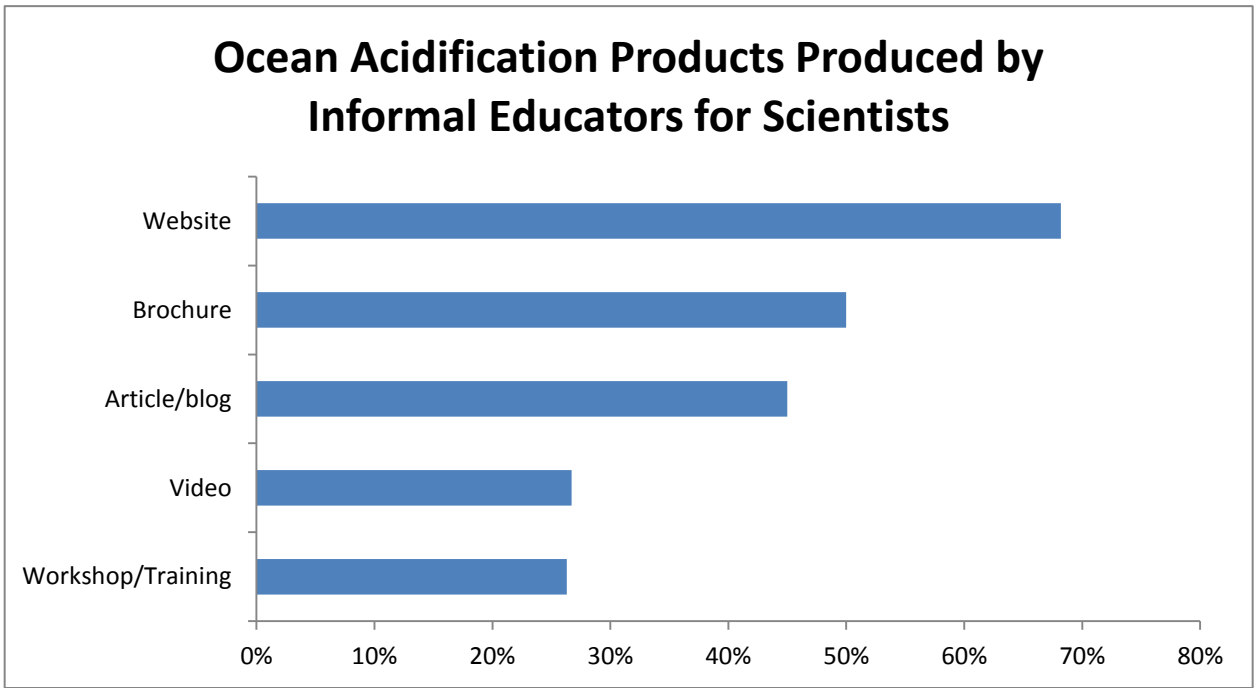

Figure-50 Percentage of informal educators that have produced the above-listed OA products for scientists. Multiple responses allowed.

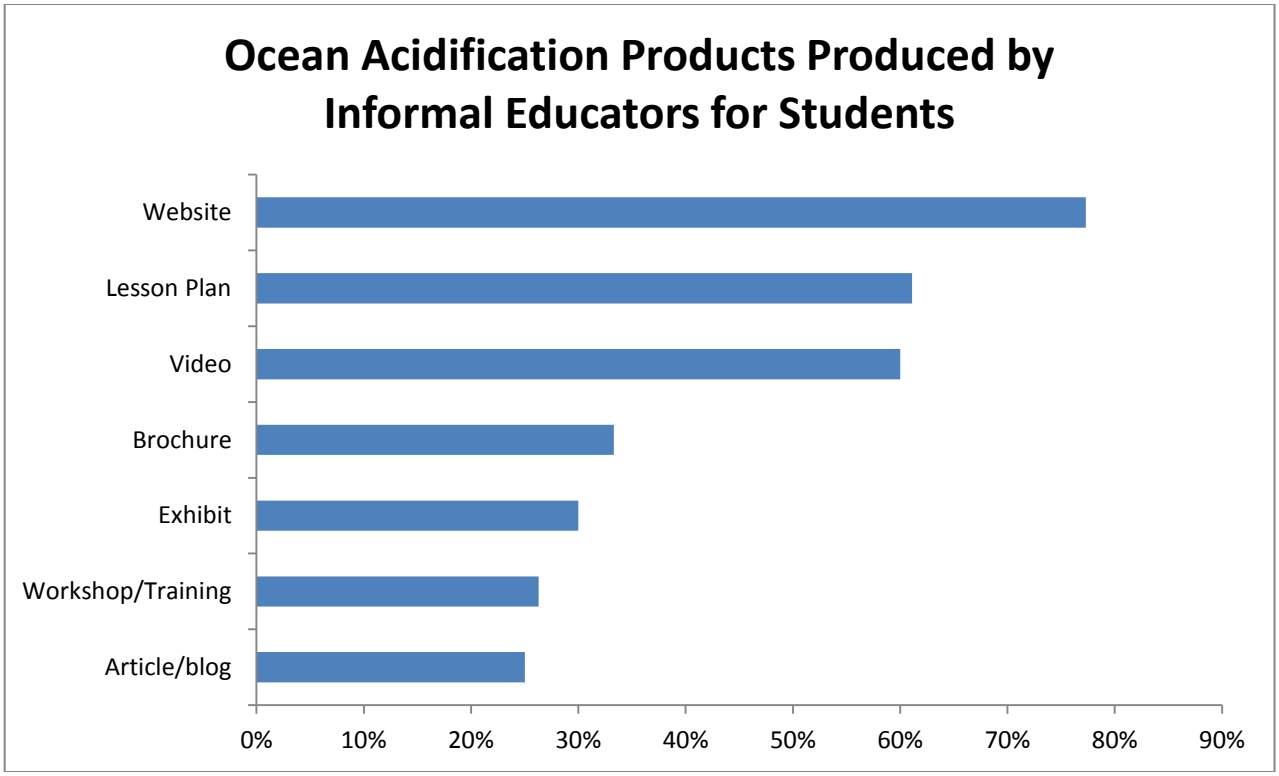

Figure-51 Percentage of informal educators that have produced the above-listed OA products for students. Multiple responses allowed.

Biggest Challenges with Explaining OA

Although more than half (58%) (Fig. 52) of informal educators have received training in how to deliver OA education from National Networks for Ocean and Climate Change Interpretation or NOAA programs/scientists, communicating OA information is still a challenge. For example, the biggest challenges with explaining OA for informal educators is the lack of funds and staff needed to support educational programs and difficulty conveying complex information. Given these challenges, there is a need for both financial and human resources as well as information that is simple and clear for non-scientific audiences.

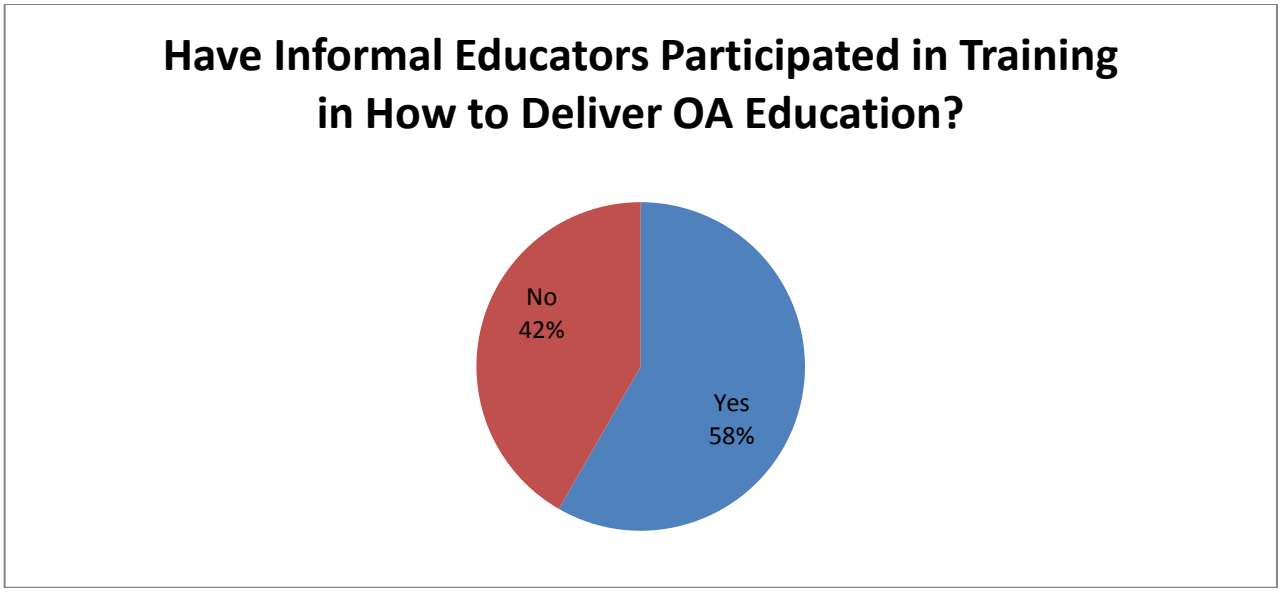

Figure-52 Percent representation of whether informal educators have/have not participated in training.

OA Informational Resources

The top three OA information sources for informal educators are a website produced by a NOAA entity, someone within the educator's department or organization, and scientific journals.

	Score*	Overall Rank
A website produced by a NOAA entity	59	1
Someone in my department of organization	51	2
Scientific journals	29	3
Non-NOAA websites	24	4
General Google search	17	5
Other	15	6
Online forum/social networking site	10	7
		Total Respondents: 36

Table-3 Ranking of resources used for OA information among informal educators. Respondents asked to choose top three sources of information.

*Score is a weighted calculation. Items ranked first are valued than the following ranks, the score is the sum of all weighted rank counts. See "Methodology" section for more information on score and rank calculation.

Informal educators use search terms such as "NOAA OA," "NOAA ocean acidification," "ocean acidification," "OA," and "climate change" to find OA information.

Most (72.2%) informal educators visit a NOAA website or tools to obtain information as well as other online resources (50%) and online education collections (30.6%). Nearly seventy percent (69.4%) of informal educators have consulted with scientists or experts, referred to scientific journal articles (44.4%), or used newspapers or magazines (33.3%) to obtain OA information. Other commonly reported sources were NASA and Climate Interpreter.

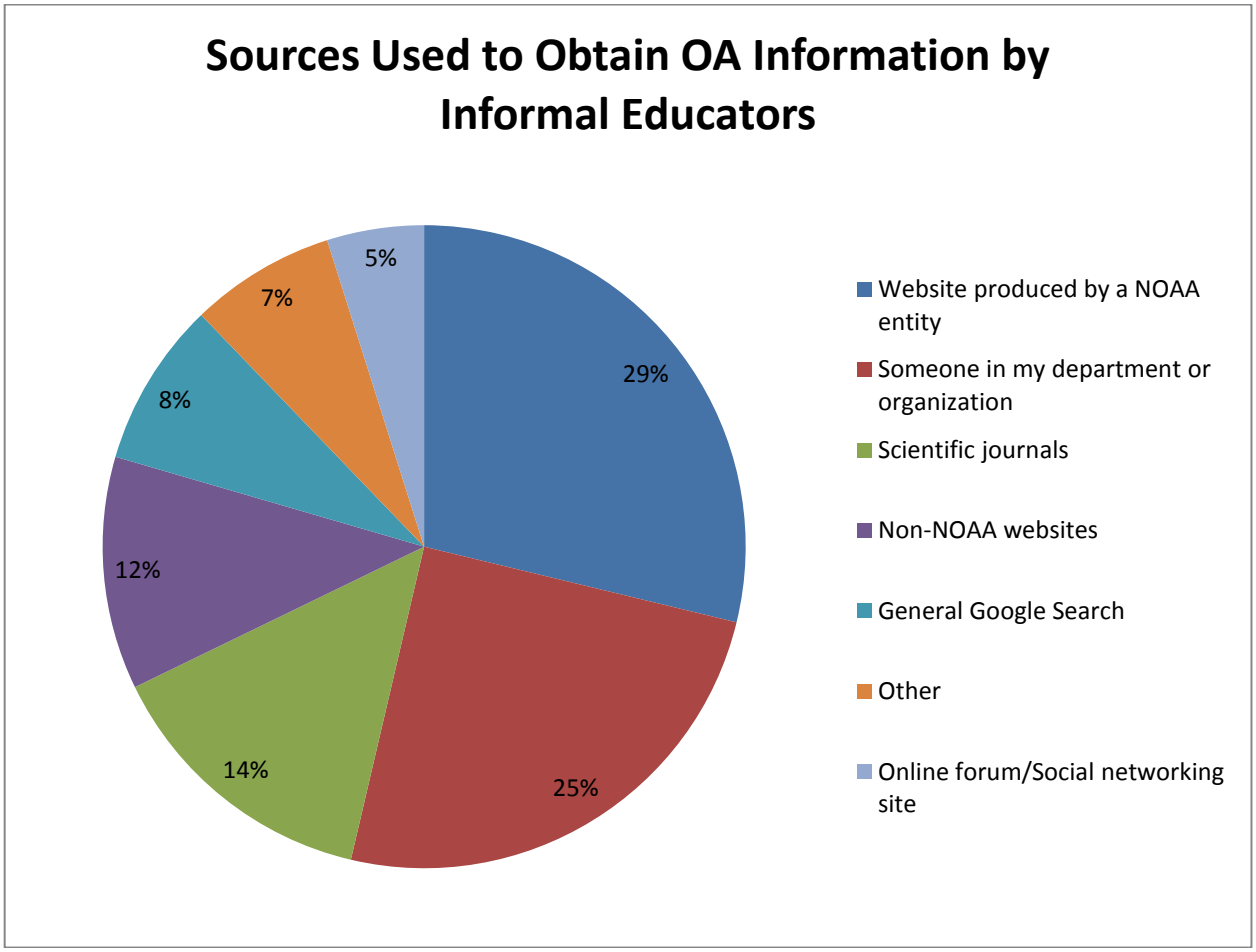

Figure-53 Percent representation of sourced used by informal educators to obtain OA information.

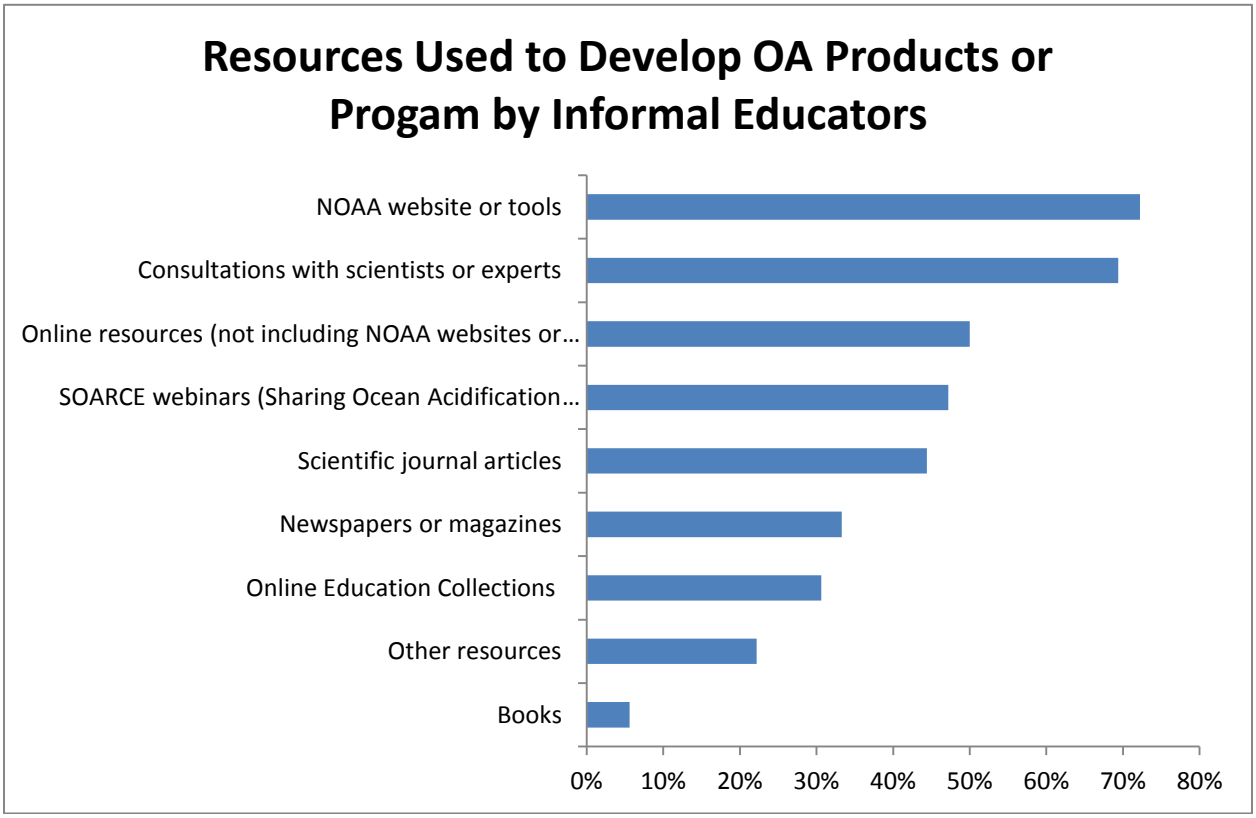

Figure-54 Percent representation of informal educators that report using the above-listed resources to develop OA products or programs**.** Other response include Climate Interpreter, NASA, Washington Sea Grant, and the University of Washington.

OA Education ToolKit

Informal educators have a need for tools to aid in informing the public about OA causes and solutions. Hands-on labs/activities, videos, demonstratives, graphics, and lectures are some of the tools that informal educators would like to see in an OA education toolkit. Informal educators also want to see in a toolkit high-quality data visualizations and models, a listing of 'what works and doesn't work' for specific audiences, and messages for different ages. Additionally, customizable materials that can be easily altered to fit varying audiences and education levels would be helpful.

Gaps in OA Education Landscape

A wide range of gaps were identified by informal educators including a need for better models and simulations that use real data, “too much focus on calcification, not enough on ecosystems and other impacts,” a lack of evaluation instruments, and better access to data interpretation. Other gaps noted by informal educators include:

- *Access to current research information in lay terms*
- *lab experiments for OA replication projects*
- *Better models and simulations that use real data. There are some good ones that are great to walk people through, but more self-explanatory ones would be a good resource.*

Or perhaps an app or game that shows what the world was like, and what the rate was, far back in history, and then comparing the rate today.

- *Getting the local slant is important -- people want to know how this will affect them directly (what they eat, where they swim, etc.), but most of what I have seen is generic, or if specific (coral reefs) has no direct impact on the local community.*
- *It's really hard to thoroughly explain OA in most outreach programs because you just don't have enough time. So there should be some type of brochure or rack card that succinctly explains OA that people could take with them.*

Biggest Lessons Learned

Several lessons have been learned by informal educators through their OA education and programming. A key lesson learned is the need for more dissemination of information on solutions to address OA. Informal educators have also observed the critical role that hands-on activities play in helping the public understand the complexities of OA. Finally, informal educators have learned that every audience must be left with a message of hope— that there is a solution to the problem. Metaphors have been effective ways to explain OA to non-scientific audiences; however, the "doom and gloom" or crisis-focused approach is ineffective.

Collaboration with Scientists

Informal educators collaborate frequently with the science community (Fig. 55). These collaborations aid in the development of tools and programming. Thirty-percent of informal educators communicate with a scientist weekly while nearly 20% communicate with a scientist once a month (Fig. 56). Another 25% communicates with a scientist every few months.

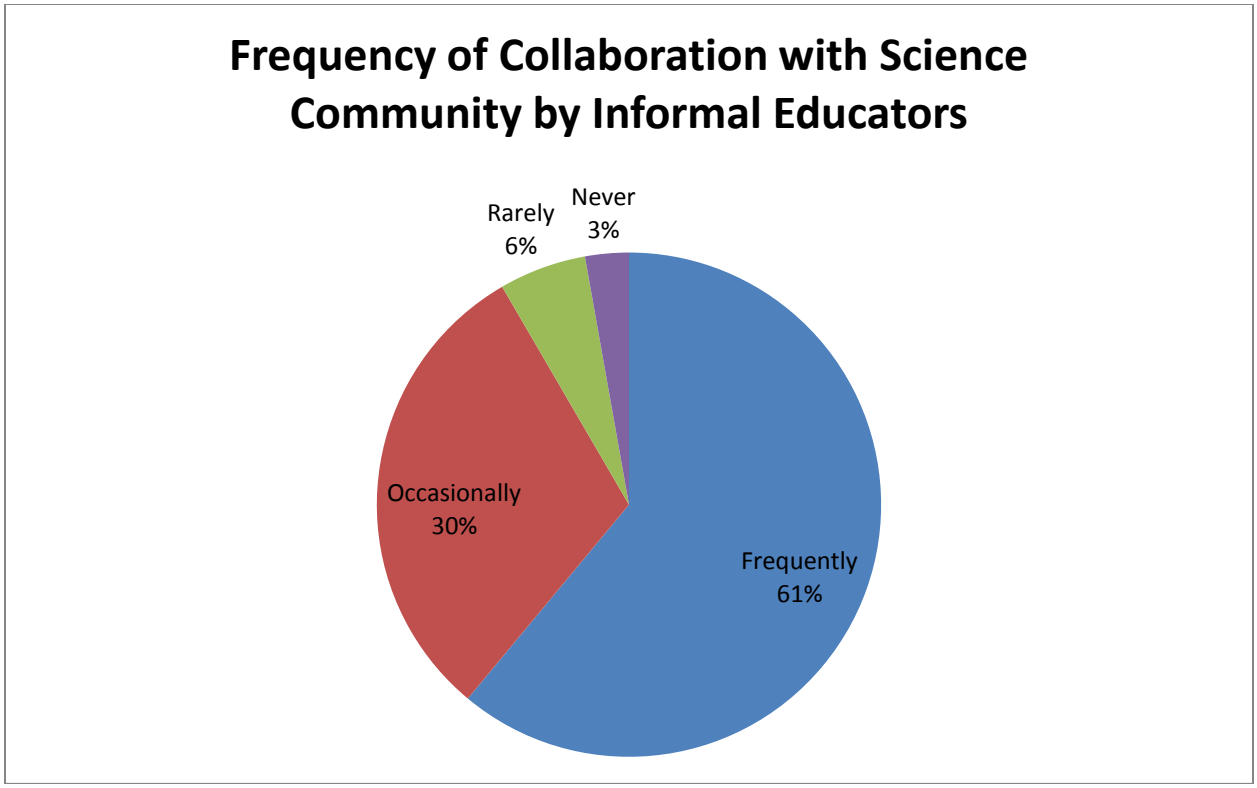

Figure-55 Percent representation of collaboration frequency with science community by informal educators.

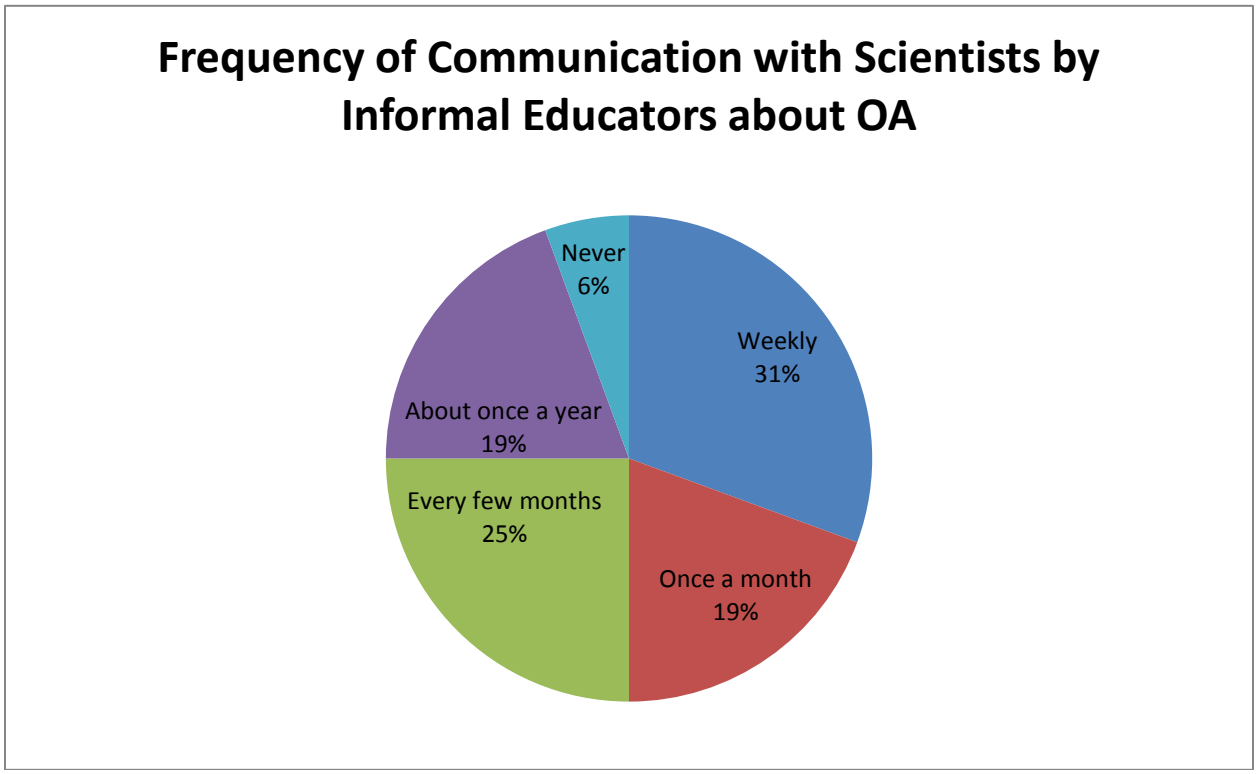

Figure-56 Percent representation of collaboration frequency with science community by informal

educators about OA.

Informal educators were especially grateful for the resources provided by NOAA and expressed the desire to see NOAA lead even more in OA education:

- *I feel that this is a topic that should be mandatory for all NOAA education coordinators to teach. It is important for the public to understand what is happening to our ocean and how they can help. However, as with our site, I am not allowed to teach it anymore. So the directive to make it a priority within each site/organization must come from the top level.*
- *It would be great to see educators and outreach specialist who are working on OA more effectively collaborate and communicate within NOAA so that messages, activities are developed and shared.*

CONCLUSIONS

Five key segments (NGOs, Collaboratives, Scientists and Research Institutes, Formal Educators, and Informal Educators) from the OA education community participated in NOAA's OA education needs assessment. The needs assessment queried respondents on a number of critical areas including primary messages currently being used to explain OA, types of products and programming that have been developed, lessons learned, challenges, and gaps in the OA education landscape, and strategies and tools needed to fill those gaps. Respondents provided critical insight on a rapidly changing environment of OA education, policy and research that requires tools to help educators and others in the OA community keep abreast of new developments and resources.

Several key themes and areas for improvement and action emerged from the needs assessment. First, the primary audiences of OA products and programs are students and the general public. These audiences often lack scientific expertise and are, therefore, in need of tools that simplify OA communication. As evidenced by needs assessment survey, websites, lesson plans, articles, and videos are produced for both students and the general public. Similar findings were observed in the comprehensive review of existing OA education products and programming conducted by NOAA (Appendices A and B). Articles and videos are the most commonly produced products, especially by organizations that have a greater number of students and the general public as their key audiences. As noted in the needs assessment findings, products such as workshop/trainings and brochures are produced to a lesser degree compared to other OA products and programming. These findings are consistent with the findings of the comprehensive review of existing OA products and programming.

Second, for formal and informal educators, hands-on materials, videos, graphics, and activities that could make the information more accessible and real for students is critical to effective teaching of OA. Although educators report comfort with communicating OA to students, the current suite of products and curriculum available, while helpful, do not fully provide teachers with the tools to easily integrate OA in their teaching. Formal educators have limited planning time and would benefit from a toolkit designed with national science standards in mind particularly since OA and/or other ocean-related topics are largely shaped by science standards mandated by state or school districts. Respondents of the survey convey that there is a level of comfort in communicating OA to students. However, the current suite of products and curriculum available, while helpful, do not fully provide teachers with the tools to easily integrate OA in their teaching. Overwhelmingly, however, educators want resources for lab and field experiments.

A third key theme that emerged from the needs assessment is the need for a positive tone in OA communications. An emphasis on progress that has been achieved and solutions (e.g., emission reduction, lifestyle changes, new technologies and policies that facilitate mitigation and adaption strategies, etc.) can strike a hopeful balance while also communicating the implications of OA.

An additional opportunity for future outreach emerges from the relatively few OA products that have been developed for the media. Many participants across sectors report the general lack of awareness about OA among the public; however few report developing education or programming for the media. Similarly, the review of exiting OA products and programming identified few OA products produced for the media. More content designed to educate the media on OA could help raise awareness and stimulate funding for more research. Respondents consistently expressed the need for more OA research. Notably, respondents often linked the necessity of OA research to their ability to effectively explain OA.

Many educators (informal and formal) are stressing local and regional impacts of OA in their work. Informal educators often receive questions about the local implications for OA and climate changes. Educators would welcome more resources to support localized approaches to OA education and programming. Some ways this can be done is through partnerships with schools and/or classrooms as well as informal learning centers. Guest speakers are another vehicle that was identified as a way to help "bring the message home."

In conclusion, many organizations and informal learning centers such as nature centers are regularly collaborating with scientists. These collaborations occur relatively frequently and facilitate the development of OA tools and programming. More collaborations that produce lesson plans and tools that formal educators can use in the classroom and for experiments would fill an important gap in OA education

Summary Analysis of NOAA Comprehensive Review of OA Education and Outreach Programming (by Audience)

As part of the needs assessment process, NOAA conducted a review of existing OA educational media (See Appendix B) produced by collaboratives, governmental organizations, NGOs, research institutes, and zoos, aquariums and museums. The table below summarizes the count of each audience's occurrence within the organization types reviewed (i.e., among 24 number of NGOs, 13 have produced education and outreach programming for other NGOS, 16 for formal educators, 20 for informal educators). The Commonly Produced Media column summarizes the number of organizations that use the specified type of media to reach their key audiences.

	Audience							
Organization Type (n)*	**NGOs**	**Formal Educators**	**Informal Educators**	**Policy Makers**	**Scientists**	**Students**	**General Public**	**Commonly Produced Media**
Collaboratives (n=11)	8	8	10	5	4	4	0	Articles (9); Videos (5); Activities (7); Brochure (1); Workshops (4); Lesson Plans (3); Webinar (3); Blogs (1); Fact sheets (0); Website (3); Media (0)
Governmental Organizations (n=37)	25	35	34	26	9	7	2	Articles (22); Videos (10); Activities (12); Brochure (3); Workshops (4); Lesson Plans (7); Webinar (3); Blogs (3); Fact sheets (6); Website (12); Media (0)
Non-governmental Organizations (n=24)	13	16	20	13	6	20	4	Articles (19); Videos (10); Activities (1); Brochure (1); Workshops (3); Lesson Plans (2); Webinar (1); Blogs (8); Fact sheets (1); Website (2); Media (1)
Research Institutes (n=14)	5	8	12	9	11	8	0	Articles (11); Videos (5); Activities (2); Brochure (0); Workshops (2); Lesson Plans (3); Webinar (2); Blogs (1); Fact sheets (2); Website (1); Media (1)
Zoos, Aquariums, and Museums (n=15)	0	15	15	0	0	15	0	Articles (11); Videos (6); Activities (5); Brochure (0); Workshops (2); Lesson Plans (3); Webinar (1); Blogs (6); Fact sheets (1); Website (0); Media (0)
International Organizations (n=8)	1	6	5	6	5	3	0	Articles (8); Videos (5); Activities (1); Brochure (1); Workshops (1); Lesson Plans (1); Webinar (0); Blogs (5); Fact sheets (3); Website (0); Media (1)
Other Relevant (non-OA specific) Resources (n=1)	0	0	0	1	1	0	1	Articles (0); Videos (0); Activities (0); Brochure (0); Workshops (0); Lesson Plans (0); Webinar (1); Blogs (0); Fact sheets (0); Website (0); Media (0)

*n=number of organizations reviewed within each organization type.

NOAA Comprehensive Review of Ocean Acidification Education and Outreach Programming

December 2015

National Oceanic and Atmospheric Administration (NOAA):
Ocean Acidification Program
Channel Islands National Marine Sanctuary (CINMS)
Office of Education
Contact: Jennifer.mintz@noaa.gov, Laura.francis@noaa.gov

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NOAA Sharing Ocean Acidification Resources for Communicators and Educators (SOARCE)
NOAA View (OA Visualizations)
Padilla Bay National Estuarine Research Reserve (NERR)
Washington Sea Grant
Smithsonian Institution's Ocean Portal
Institute for Natural Resources

Non-Governmental Organizations

Changing Seas Television Series (WPBT2)
Chesapeake Climate Action Network
Consortium for Ocean Leadership
EarthEcho International
InTeGrate: Interdisciplinary Teaching about Earth for a Sustainable Future
Khaled bin Sultan Living Oceans Foundation
Lemonsea
Marine Conservation Institute
National Geographic
National Marine Sanctuaries Foundation
Natural Resources Defense Council (NRDC)
NOVA Education
Ocean Conservancy
Ocean Foundation
Ocean Futures Society
Ocean Health Index
Oregon Explorer
Seattle Times Sea Change
Sustainable Fisheries Partnership
Teen4Oceans
The Nature Conservancy
Upwell
Waterways TV Show

Research Institutes

Alaska Center for Climate Assessment and Policy (ACCAP)
C-MORE, University of Hawaii Oceanography
Central Caribbean Marine Institute (CCMI)
Global Ocean Health - National Fisheries Conservation Center
Institute for Systems Biology
Monterey Bay Aquarium Research Institute
Mote Marine Laboratory
Ocean Margin Ecosystems Group for Acidification Studies (OMEGAS)
Oregon Climate Change Research Institute
Scripps Institution of Oceanography (Classroom Connection)
Stanford University's Inquiry to Student Environmental Action (I2SEA)
Woods Hole Ocean Carbon & Biogeochemistry (OCB)
NOAA Cooperative Research Institutes
Yale Project on Climate Change Communication

Zoos, Aquariums, and Museums (ZAMs)

Alaska SeaLife Center
Aquarium of the Pacific

Baltimore Aquarium
Cal- Academy of Science
Disney's Epcot Center
Exploratorium
Georgia Aquarium
Liberty Science Center
Monterey Bay Aquarium
New England Aquarium
North Carolina Aquarium
Pacific Science Center, WA
Patricia and Phillip Frost Museum of Science
Seattle Aquarium
Waikiki Aquarium

International Organizations

BBC
Bioacid
Digital Explorer
European Project on Ocean Acidification (EPOCA)
MedSeA
Oceana
OA.net
Plymouth Marine Laboratory (UK Ocean Acidification Research Programme (UKOA)

Key Findings/Conclusion

Overview

Ocean acidification (OA), driven by anthropogenic carbon dioxide emissions, has and will continue to cause significant impacts to the physical, chemical, and biological characteristics of the ocean and its marine organisms. This change in ocean chemistry will continue to negatively affect marine ecosystems and industries. Therefore, federal legislation has identified a need to improve monitoring, research, education, and outreach related to ocean acidification. The NOAA Ocean Acidification Education Implementation Plan outlines a strategy to improve education and outreach on OA. The first goal in the Implementation Plan calls for a comprehensive needs assessment of education and outreach programming and potential audiences.

The following document, compiled by the NOAA Ocean Acidification Program (OAP), The Office of Education (OED), and the Channel Islands National Marine Sanctuary (CINMS), encompasses a comprehensive review of existing OA education and outreach resources. The resources in this document are listed by organization and include the following categories:

- **Links** - provide any urls, pdfs or other documents associated with outreach content or programs
- **Organization**: identifies the name, location, and type of organization, the name of the program/initiative, leading point person/author, and and partnering or collaborating organizations/personnel.
- **Partners:** includes funding sources and contributors
- **Media Type:** identifies the specific type of products or activities. Possible media examples include: curriculum products, websites, multimedia materials, films/music, PSAs, presentations, webinars, case studies, interviews, reports, public information materials (brochures, one pagers, social media, displays/signs/exhibits)
- **Audience:** identifies a target category: teachers/communicators, families, students K-12, university students, policy makers/resource managers, general public, commercial/recreational users, media, scientists, nongovernmental organizations - NGOs)
- **Content** - identifies the underlying messages and key topics addressed in the media. Messages and content have been categorized under the following key topics created by the Ocean Acidification Curriculum collection (OACC) as part of the Ocean Acidification Literacy Framework:

    1. Carbon Cycle - human activities increasing the level of atm CO2; fast (biological) and slow (geological) carbon cycles, and the flow of energy; shifting the balance of carbon

    2. Ocean Chemistry - ocean absorption of CO2 and the process of acidification

    3. Physiology - how ocean acidification affects marine organisms

4. Adaptation - speed at which OA is occurring compared to adaptation

5. Ecosystem - effects of ocean acidification on marine ecosystems

6. Ecosystem Services - how OA is impacting important marine resources

7. Solutions - ocean acidification and people: cause and effect; addressing ocean acidification:engaging people, governments, and science

- **Content Level:** Identifies the level of prior information needed to understand or use resources, or the education level the resource is intended for.
- **Potential Gaps** - identifies any apparent gaps in information or differences in terminology
- **Additional Notes -** summarizes overall findings in online resources and highlights any unique characteristics
- **Keywords/search terms** - common terms frequently occurring within OA resources (for all organizations): ocean acidification, changing ocean chemistry, ocean pH, acidity, acid ocean, carbon dioxide, climate change, OA education materials, lesson plans, curriculum, K-12, video, data visualizations, educational activities, demonstrations, presentations, webinars, videos, brochures/pamphlets, FAQs, infographics, PSAs, books, blogs, moocs (massive open online courses) Edx, websites, collections, exhibits/signs, displays,journal articles (science scope), public opinion polls, conferences, collaborations, blogs, podcasts

Summaries of Organizations and Programs

Collaborative Programs

California Current Acidification Network (C-CAN)

Organization - C-CAN is a collaboration of interdisciplinary scientists, resource managers, industry, and others from local, state, federal and tribal levels dedicated to advancing the understanding of ocean acidification and its effects on the biological resources of the US west coast. Specifically, the organization aims to:

- Coordinate and encourage development of an ocean acidification monitoring network for the west coast that serves publicly available data
- Improve understanding of linkages between oceanographic conditions and biological responses
- Facilitate and encourage the development of causal, predictive and economic models that characterize these linkages and forecast effects
- Facilitate communication and resource/data sharing among the many groups, organizations and entities that participate in C-CAN or utilize C-CAN as an informational resource.

Partners - UCSB, Integrated Ocean Observing System (IOOS) Regional Associations, the West Coast Governor's Alliance, the West Coast Ocean Acidification & Hypoxia Science Panel (OAH) and others

Contact: Diane Pleschner Steel, Coordinator, dplesch@gmail.com

Media - OA monitoring principles/best practices, brochures, workshops/webinars, news articles, videos, reports, FAQs, scientific journal articles, class activities/experiments, animations, presentations, case studies, policy proceedings/speeches, links to other OA programs and projects

Audience - Communicators/interpreters, teachers, policy makers, resource managers, NGOs, scientists, They also have a general public resource section

Content - Carbon cycle, ocean chemistry, oceanography, climate change, physiology (some general, some specific to W. coast), adaptation, ecosystems, ecosystem services - economic impacts, solutions, communicating OA - problems and solutions

Content Level - Prior knowledge is very dependent on the target audience: educators/teachers for lower grade levels do not need prior knowledge since much of the content is in the form of animated videos. Content for upper grades, policy makers, and resource managers require familiarity with chemistry, ocean science, climate change. Resources for general public may require familiarity with science terms.

Potential Gaps -

Additional Notes - Site organizes resources by target audience, and resource links have material (ie fact sheets, animations) in multiple languages! Collection is very organized and comprehensive. There are a wide variety of media types for many different audiences.

Centers for Ocean Sciences Education Excellence (COSEE)

http://www.cosee.net/resources/themes/oceanacidification/

http://coseenow.net/education-resources/lesson-plans/
Organization - aims to spark and nurture collaborations among research scientists and educators to advance ocean discovery and make known the vital role of the ocean in our lives. The mission reflects the three-fold partnership, which composes each COSEE Center-partnerships between formal and informal education institutes and research institutes.
Partners - NSF, Sea Grant, NOAA, Office of Naval Research, Science, and Technology
Contact:Gail Scowcroft, Executive Director of the National COSEE Network, gailscow@gso.uri.edu
Media - lesson plans, activities, slideshows, news articles, journal articles, infographics, videos (in Eng/Spanish), presentations, links to PMEL, OA.net, EPA site, CMORE science kits,
Audience - teachers, communicators, NGOs
Content - carbon cycle, ocean chemistry, physiology, adaptation, ecosystems, ecosystem services, human causes, economic impacts
Content Level - Little to no prior knowledge needed
Potential Gaps -
Additional Notes - This site links to a great number of resources organized by topic and by audience

Ocean Literacy (COSEE)

http://oceanliteracy.wp2.coexploration.org/ocean-literacy-framework/
Organization - Ocean Literacy website is here to support anyone and everyone who is interested in promoting ocean literacy. Ideas for development and evolution are welcomed.
Partners - Lawrence Hall of Science and the College of Exploration are currently working together as a part of COSEE CA
Contact: None specified (see above COSEE contact)
Media - informational and news articles, teacher guides, lesson plan (Off Base), ocean literacy ppt and other presentations, links to other OA resources, workshops
Audience - teachers, communicators, NGOs
Content - carbon cycle, ocean chemistry, ecosystems, physiology, human impacts,
Content Level - Little to no prior knowledge needed
Potential Gaps -
Additional Notes - Great resource with foudational ocean science information. Offers a good list of external resources and indicates with science standards they meet.

Climate Interpreter

http://climateinterpreter.org/about/get-started
http://climateinterpreter.org/content/ocean-acidification
http://climateinterpreter.org/resource/ocean-acidification-basics
Organization - Climate interpreter is an online community created by the Monterey Bay Aquarium, Quilted, and Golden Arrows to provide informative, collaborative, and communication resources to those working at aquariums, zoos, national parks, national marine sanctuaries, or other informal science education centers. The site allows users to create profiles, connect with each other, and share resources about OA and climate change.

Partners - support from NSF, NOAA, some materials created by Florida Aquarium and Monterey Bay Aquarium for the Building Ocean Awareness Together (BOAT) grant from NOAA
Contact: Scott Mackenzie, Monterey Bay Aquarium, smackenzie@mbayaq.org
Media - Online courses/training modules, monthly e-newsletter, links to games, blogs, videos, interviews, infographics, graphs, interactive maps, stories, reports, articles, webinars, conference broadcasts, creative writing, book reviews, surveys, professional development resources, interactive websites/graphics, pamphlets
Audience - Educators, teachers, communicators, NGOs, policy makers
Content - Much of the site's focus is on climate change: communication, interpretation, and psychology, impacts and solutions, species' adaptation, but they also go into OA: carbon cycle, ocean chemistry, species physiology and adaptation, ecosystems, ecosystem services, importance of ocean, solutions.
Content Level - Most content does not require any prior knowledge. However, some reports may require familiarity with reading graphs/figures and basic climate change and OA knowledge.
Potential Gaps
Additional Notes

Earth System Science Education Alliance (ESSEA)

http://essea.strategies.org/module.php?module_id=131
Organization - The Earth System Science Education Alliance (ESSEA) is a NASA, NSF and NOAA-supported program implemented by the Institute for Global Environmental Strategies (IGES) to improve the quality of geoscience instruction for pre-service and in-service K-12 teachers. ESSEA is based on a series of online courses for teachers that are offered by participating institutions. These institutions and faculty receive training, technical support, the ability to create and share their own course modules, and join an active community of Earth system science educators. The inquiry-based courses provide teachers with the content knowledge and tools they need to incorporate Earth system science into their curricula. ESSEA modules are also available on this site as teacher resources.
Partners - NASA, NSF, NOAA, Institute for Global Environmental Strategies (IGES), local universities, research institutions
Contact: Bob Myers, Module author, IGES bob_myers@strategies.org
Media - OA Module: descriptions, activities, infographic, graph, links to other resources
Audience - Communicators, educators (informal and formal), students (K-12)
Content - Carbon cycle, climate change, ocean chemistry, physiology, geoengineering solutions, policy, ecosystems
Content Level - Basic ocean/climate science needed for some information
Potential Gaps -
Additional Notes - Module specifies which standards it covers and has about 25 links to OA resources, many of which are in this review.

Exploring Our Fluid Earth

http://manoa.hawaii.edu/exploringourfluidearth/

http://manoa.hawaii.edu/exploringourfluidearth/chemical/biogeochemical-cycles/acid-rain/activity-acidification
Organization - Exploring Our Fluid Earth is based on the nationally recognized Fluid Earth/Living Ocean (FELO) aquatic science curriculum. The Exploring Our Fluid Earth curriculum is grounded in the inquiry approach to learning and examines marine and freshwater systems of the earth by studying the influence of water on the planet. The modules comprise the essential elements of a year-long course in marine science at the middle and high school level. Modules focus on the physics, chemistry, biology, ecology, and technology of aquatic systems and on the researchers who study them.
Partners - University of Hawaii, NOAA, Institute of Education Sciences, U.S. Department of Education, Pacific Services Center (NOAA PSC), Curriculum Research & Development Group, Center for Marine Science Education
Contact: Lauren Kaupp, Education Specialist, Lauren_Kaupp@hawaiidoe.org
Media - Articles, modules/activities
Audience - Communicators, educators (informal and formal), students (middle - high school), stakeholders
Content - Ocean literacy principles - climate change/human impacts, physiology
Content Level - No prior knowledge needed
Potential Gaps -
Additional Notes - Website seems to still be under construction. Many of the pages are not completely filled out

National Network for Ocean and Climate Change Interpretation (NNOCCI)

http://www.nnocci.org/
Organization - NNOCCI is a collaborative, government funded, national effort to provide professional development resources in climate science and communication to educators/communicators, scientists, and managers with the aim of creating a national network of professionals who are skilled in communicating climate science to the American public.
Partners - led by New England Aquarium with the Association for Zoos and Aquariums, the FrameWorks Institute, Woods Hole Oceanographic Institution, the National Aquarium in Baltimore, Monterey Bay Aquarium, the New Knowledge Organization in partnership with Penn State University, and Ohio's Center for Science and Industry with support from the National Science Foundation's Climate Change Education Partnership (CCEP) Alliance.
Contact: Julie Sweetland, Director of Learning Frameworks Instititute, jsweetland@frameworksinstitute.org
Media - The site mainly offers resources for professional development in science communication including: workshops, online courses, and Study Circles (facilitated in-person meetings, webinars, conference calls and practical activities where participants build knowledge of ocean and climate science, communications and cultural sciences). There are also links to educational resources through Climate Interpreter and strategic framing resources from the Frameworks Institute. The shared folder on the google drive includes: OA and communication presentations, cards, activities, and reports.
Audience - NOCCI provides portal for communicators, interpreters, NGOs, and resource managers/policy makers to sign up for courses/workshops and connect with science and communication professionals as well as each other. .

Content - Workshops and courses listed on the site mention covering climate and ocean science, and solutions. Resources in shared folder include: types of audience segments for climate change, presentations on solutions, the ocean ecosystem and its services, information on GHGs, adaptation, ocean chemistry, different framing/communication approaches, OA activities problems and solutions.
Content Level - Content for online courses and workshops covers core elements of ocean and climate science, so little prior knowledge is needed. The Study Circle forum goes into more depth on strategic framing and climate change and may require basic understanding of climate science concepts.
Potential Gaps -
Additional Notes - NOCCI offers very hands-on, collaborative, and time intensive resources for climate and ocean science communication involving remote workshops, 12 week courses, and 6 month+ long study circles/group forums.

NERACOOS Northeast Coastal Acidification Network (NECAN)

http://www.neracoos.org/necan
Organization - collaboration between scientists, federal and state agency representatives, resource managers, and affected industry partners dedicated to coordinating and guiding regional observing, research, and modeling endeavors. The purpose is to better identify critical vulnerabilities, particularly with respect to regionally important and economically significant marine resources. NECAN is part of the larger Integrated Sentinel Monitoring Network coordinated by the joint Ocean and Coastal Ecosystem Health Committee of NERACOOS and the Northeast Regional Ocean Council (NROC).
Partners - other NOAA offices, Universities, research institutes
Contact:Ru Morrison (NERACOOS) Ru.Morrison@neracoos.org
Media - webinars, workshop information, magazine articles, journal articles, listserv sign up,
Audience - policy makers, resource managers, scientists, NGOs, stakeholders
Content - carbon cycle, ocean chemistry, pysiology, ecosystems, adaptation, ecosystem services, economic impacts
Content Level - Intermediate to advanced ocean science knowledge needed
Potential Gaps - Not many topics focused on solutions
Additional Notes - Majority of webinars and resources are primary research - not interpreted for non-scientific audience. Great for scientists, policy makers, and managers who are working in this space

Ocean Acidification Curriculum Collection

http://www.oacurriculumcollection.org/
Organization: The OACC is government funded collaborative effort to provide a collection of links to existing lesson plans, units, and supplemental materials on ocean acidification. Resources are compiled primarily by an internal team of researchers, resource managers, and students. However, teachers, communicators, and other users are encouraged to evaluate and provide feedback on materials as well as submit resources of their own to address any gaps.
Partners: funded/supported by the Environmental Protection Agency, US Fish & Wildlife, Washington Sea Grant, Suquamish Tribe and the Northwest Indian Fisheries Commission.

In house contributors and partners include:

- Paul Williams, Shellfish Policy Advisor, Suquamish Tribe
- Caitlin Roberts, Project Manager, OACC
- Meg Chadsey, Ocean Acidification Specialist, Washington Sea Grant
- David Ketter, Science Education Consultant
- Alexis Valauri-Orton, Curriculum Expert and Former Project Manager/Web Designer, OACC
- Karen Morrill-McClure, Guest Lecturer, Information School, University of Washington
- Karen Lippy, 8th Grade STEM Educator, West Hills STEM Academy, Bremerton, WA
- Contact oacc@suquamish.nsn.us

Media - Website includes: Data Analysis Activities, Games, Lab Activities, Lesson Plans, Online Activities, PowerPoints, Short Demonstrations/activities, videos, images, website links, infographics, scientific journal articles, 30 min - 4hr programs
Audience: OACC provides educators/communicators with OA material for K-12 students, and offers a forum where teachers and students can ask OA and climate change scientists to answer questions and help with labs.
Content - All lesson plans are aligned with one or more of the three dimensions of the Next Generation Science Standards (Crosscutting Concepts, Disciplinary Core Ideas, Science and Engineering Practices). Material is also relevant to Common Core Standards; “Key Topics” covered include: carbon cycle, ocean chemistry,physiology, adaptation, ecosystems, ecosystem services, and solutions. Additional topics: Fossil fuels, CO2 and the greenhouse effect, anthropogenic climate change, sea level rise, and IPCC documents.
Content Level - Most content is targeted for a non-scientific audience. Lower grade level lesson plans and materials require no additional knowledge since concepts are explained from a foundational level. However, some lesson plans and supplemental materials for higher grade levels (9-12) requires prior knowledge of greenhouse gases (GHGs), climate change principles, ecosystems, and familiarity reading scientific articles, IPCC graphs, figures, and reports.
Potential Gaps - Although a good number of the resources mention the need for reducing carbon emissions and may offer some examples of doing this, the “solutions” topic seems to be less of a focus in many of the lesson plans and materials.
Additional Content Notes - Can search through resources by grade level and topic, making it quicker for teachers to navigate and find what they need. It also has a non-OA foundational materials section describing what carbon and GHGs are, what acids and bases are, musical representations of how the earth is warming, and why nature/the ocean is important (explains different types of ecosystem services)

Thank You Ocean Report

http://thankyouocean.org/acid-ocean/
https://youtu.be/KMtHDfZWYI0
Organization - The campaign mission is to unite voices and amplify messages to raise ocean awareness and promote everyday actions that protect the ocean.The campaign features an inspiring public service announcement (PSA) produced by Bob Talbot, and a PSA featuring actor and activist, Edward James Olmos, an out-of-door advertising campaign, an extensive toolkit for the California Ocean Communicators Alliance, a bi-weekly podcast series featuring leaders in ocean policy, and Web site. The campaign is focused on educating the public about the importance of sustaining ocean life and inspiring Californians to practice ocean stewardship to alleviate four major threats to the ocean:

Partners - State of California, the NOAA Office of National Marine Sanctuaries and the Ocean Communicators Alliance
Contact:Matt Stout, Chief of Staff, Communications and Media, NOAA Office of National Marine Sanctuaries, matthew.stout@noaa.gov and Amy Vierra, Deputy Director, California OPC, Amy.Vierra@resources.ca.gov
Media - videos, news articles, links to other OA resources
Audience - communicators, educators, scientists, students, NGOs, policy makers, resource managers, stakeholders, families
Content - carbon cycle, human impacts, ocean chemistry, ecosystems, ecosystem services, adaptation, physiology, economic impacts, solutions,
Content Level - basic ocean science knowledge needed for certain resources
Potential Gaps -
Additional Notes -Great short video to accompany other OA resources.

West Coast OA and Hypoxia Panel (California Ocean Science Trust, OST)

http://westcoastoah.org/multiple-stressors/
Organization - OST is a non-profit boundary organization created by CA statute. They work across the traditional boundaries between government, science, and communities to build trust and understanding in ocean and coastal science. OST supports a West Coast OA and Hypoxia Panel, which is a collaboration of 20 esteemed scientists representing California, Oregon, Washington, and British Columbia. The Panel's core goal is to collaborate with decision makers across the state, regional and federal levels on these complex issues. The Panel established a series of working groups to summarize knowledge for action on key themes identified by decision makers.
Partners - State and national gov agencies, research institutes, universities, NGOs, CA Ocean Protection Council, Institute for Natural Resources
Contact: at OST Emily Knight emily.knight@oceansciencetrust.org
Media - Management plans/reports/recommendations, scientific summaries, articles, newsletters, recent news, and events
Audience - Policy makers, resource managers, scientists, communicators
Content - Implications/recommendations for policy/management, adaptation, carbon cycle, ocean chemistry, ecosystems, physiology, water quality
Content Level - Basic ocean and climate science needed
Potential Gaps -
Additional Notes - Great resource for policy makers and resource managers.

Governmental Organizations

Bridge Ocean Education Teacher Resource Center

http://web.vims.edu/bridge/?svr=1
http://www.us-ocb.org/publications/CurrentFINAL.pdf (external link)
Organization - An online collection of educational resources that provides information on global, national, and regional marine science topics. Resources are reviewed by various research and education committees. The site also gives researchers a contact point for educational outreach.
Partners - National Sea Grant Office, the National Oceanographic Partnership Program (NOPP), and the National Marine Educators Association (NMEA).
Contact: Project Co PI, Vicki Clark, vclark@vims.edu (804) 684-7172, Project Co PI, Lee Larkin, larkin@vims.edu, (804) 684-7172
Media - Articles, lesson plan (Institute for Systems Biology), current research, data, link to WHOI page, link to NMEA report on OA Impacts and policy opportunities
Audience - Educators, teachers (K-12), college students, communicators, and other stakeholders
Content - Carbon cycle, ocean chemistry, physiological reponse, ecosystems, impacts, policy implications
Content Level - Basic level ocean science needed for lessons, intermediate knowledge needed for reports and research
Potential Gaps
Additional Notes - Not much original content here, but they have links to useful resources

Integrated Ocean Observing System (IOOS)

http://www.ioos.noaa.gov/
Organization - The Integrated Ocean Observing System (IOOS) is a national-regional partnership working to provide new tools and forecasts to improve safety, enhance the economy, and protect our environment. Integrated ocean information is now available in near real time, as well as retrospectively. Easier and better access to this information is improving our ability to understand and predict coastal events - such as storms, wave heights, and sea level change. Such knowledge is needed for everything from retail to development planning.
Partners - AOOS, CariCOO, CeNCOOS, GCOOS, GLOS, MARACOOS, NANOOS, NERACOOS, PacIOSS, SCCOOS, SECOORA
Contact: Kate Culpepper, Communications Specialist, kate.culpepper@noaa.gov
Media - Videos, blog posts, data visualization platforms, animations, lesson plans and activities for using real time data, links to all regional IOOS websites, training resources to explain what data and information is available, flyers, fact sheets, press releases, archived webinars
Audience - Formal & informal educators, teachers, communicators, and stakeholders
Content - Climate change, real time water quality data, physical oceanography data, waves, winds, currents, coastal flooding, weather, coral bleaching, sea level rise, ocean acidification, most of the content is available through the regional IOOS sites
Content Level - Lesson plans and real data activities target grades 6-12

Potential Gaps - Not a lot of focus on OA in general, although more may be on individual regional websites
Additional Notes - Website mostly consolidates the products and data from the regional IOOS networks into one location

NANOOS, the Pacific Northwest regional ocean observing system of IOOS

http://www.nanoos.org/education/themes/climate.php
Organization - The Pacific region's branch of IOOS
Partners - IOOS Regions
Contact: Amy Sprenger, Engineer III, asprenger@apl.washington.edu
Media - Lesson plans, data explorer and visualization tools, mobile apps, blog posts
Audience - Formal & informal educators, teachers, communicators, and stakeholders
Content - Data collection, waves, satellites, ocean observations, basic oceanography, real time water quality for shellfish growers, OA, climate
Content Level - Lesson plans grades 6-12
Potential Gaps - Not a large focus on OA aside from the data visualization for shell growers and some general explanatory posts.
Additional Notes -

National Science Foundation Quest (KQED Science)

http://ww2.kqed.org/quest/2014/12/12/ocean-acidification-and-marine-life/
http://ww2.kqed.org/quest/collections/ocean-acidification-2/
Organization - Quest is a project of KQED (public media station for northern California) in partnership with science educators and producers, to provide engaging, relevant science and engineering resources for educators, students, and lifelong learners.
Partners - NSF, KQED Campaign 21
Contact: Main contributor: Jennifer Morton, science education specialist KCTS 9 Television in Seattle, WA scienceed@kqed.org
Media - Interactive web pages, animations, games, videos, slideshows, links to other sources
Audience - educators, teachers (K-12), communicators, and other stakeholders
Content - carbon cycle, ocean chemistry, physiology, adaptation, ecosystems, ecosystem services.
Content Level - Basic ocean science knowledge needed for resources
Potential Gaps - Not much information on solutions
Additional Notes - Excellent animations on OA chemistry, resources have strong visual components, materials also list which next generation science standards they cover.

National Sea Grant

http://seagrant.noaa.gov/WhatWeDo/ResilienceToolkit/BrowseToolkit/TabId/618/PID/5569/evl/0/TagID/231/TagName/Ocean-Acidification/Default.aspx
https://seagrant.uaf.edu/map/climate/docs/ocean-acidification.php
http://www.sccwrp.org/meetings/workshops/oceanacidificationworkshop.aspx

Organization - mission is to enhance the practical use and conservation of coastal, marine and Great Lakes resources in order to create a sustainable economy and environment. The organizations provides integrated research, communication, education, extension and legal programs to coastal communities that lead to the responsible use of the nation's ocean, coastal and Great Lakes resources through informed personal, policy and management decisions.
Partners - Universities, research institutes, other government offices and local agencies, NGOs
Contact: Nikola Garber, Deputy Director, Nikola.garber@noaa.gov
Media - current research, journal articles, factsheets, toolkit, workshop, report, FAQs, introductory guide for policy advisers and decision makers (EPOCA), infographic
Audience - educators/communicators (K-12 and up), college students, managers/policy makers, NGOs, other stakeholders
Content - impacts, ecosystems, carbon cycle, ocean chemistry, adaptation, physiology, solutions
Content Level - Basic to advanced knowledge of ocean science, chemistry, and climate change
Potential Gaps
Additional Notes- Hard to find OA on the main site. Individual Sea Grant programs go into more detail about OA and provide resources

NESDIS; NOAA Office for Coastal Management (Data in the Classroom)

http://dataintheclassroom.noaa.gov/
Organization - Government collaboration to create new curriculum modules and online tools for accessing data. The NODE project aims to develop many more modules that will facilitate access to a large and expanding collection of NOAA data and visualizations and provide a one stop place for teachers and students to access NOAA data in a relevant, meaningful way.
Partners - NOAA's National Oceanographic Data Center (NODC), Coral Reef Conservation Program (CRCP), National Estuarine Research Reserve System, National Marine Sanctuary Program
Contact: Paulo Maurin (works on Data in the Classroom but isn't at NESDIS), paulo.maurin@noaa.gov, Atziri Ibanez atziri.ibanez@noaa.gov; Nina Jackson
Media - teacher guide to understanding OA, lessons plans, activities
Audience - formal educators (10-12)
Content - carbon cycle, ocean chemistry, adaptation, physiology, ecosystems
Content Level - Little to no prior knowledge needed
Potential Gaps -
Additional Notes- Website sets up a great step-wise process for teachers to understand and go through material on site

NOAA Atlantic Oceanographic and Meteorological Laboratory (AOML)

Organizations - AOML conducts research on the physical, chemical, and biological characteristics and processes of the ocean and the atmosphere to obtain more accurate forecasting of severe storms, better use and management of marine resources, better understanding of the factors affecting both climate and environmental quality, and improved ocean and weather services for the nation.

Partners - Other NOAA offices, universities, research institutes, NGOs
Contact:- Erica Rule, AOML Communications Officer, Erica Rule@noaa.gov
Media - infographic, presentation, current projects and researcher contact info, scientific journal articles, links to other NOAA OA resources
Audience - scientists, NGOs, resource managers, policy makers, communicators
Content - carbon cycle, ocean chemistry, physiology, adaptation, human impacts (global poverty), ecosystem
Content Level - intermediate to advanced ocean and climate science needed
Potential Gaps - Limited OA educ materials
Additional Notes- Many of the materials seem outdated (scans of printed documents)

NOAA Coastal Estuarine Research Federation (CERF)

http://www.erf.org/side-meetings-at-cerf-2015
Organization - CERF is a private, non-profit, non-partisan organization dedicated to advancing the understanding and wise stewardship of estuarine and coastal ecosystems worldwide.
Partners - Other NOAA offices, Universities, research institutes, NGOs
Contact: Marie Bundy, OCM, Marie.bundy@noaa.gov
Media - Nov 2015, Oregon: Town hall meeting focused on coastal and estuarine OA monitoring, conferences, publications
Audience - scientists, NGOs, resource managers, policy makers, communicators
Content - OA progression and coastal impacts
Content Level - Intermediate to advanced ocean and climate science needed
Potential Gaps -
Additional Notes- At the 2015 CERF Meeting in Portland OR, Beth Turner (NCCOS), Libby Jewett (OAP), Marie Bundy (OCM) and Shallin Busch (OAP and NWFSC) organized a town hall meeting focused on coastal and estuarine OA monitoring. The town hall was Wednesday, November 11, 2015. Objectives:

- Discuss major hurdles to addressing Ocean and Coastal Acidification (OCA) impacts on coastal and estuarine habitats and ecosystems
- Promote integration across different OCA research and monitoring efforts and create partnerships for understanding OCA impacts and drivers in coastal and estuarine ecosystems
- Assess ongoing monitoring efforts and develop a plan to increase monitoring capacity in nearshore and coastal regions.
- How to develop an efficient and effective monitoring network for OCA in a diverse suite of coastal ecosystems?
- Do we need to develop a follow-on workshop that focuses on monitoring techniques and best practices for OCA?
- How can existing efforts be leveraged to build capacity through partnerships?

Participants included: NOAA OA Program representatives, NOAA NERRS researchers,IOOS RA's, EPA NEP researchers, Marine Labs (NAML) representatives, and representatives from other coastal research and monitoring efforts.

NOAA Coral Reef Conservation Program

http://coralreef.noaa.gov/education/
http://coralreef.noaa.gov/education/educators/resourcecd/brochures/resources/punch_b.pdf
http://coralreef.noaa.gov/education/educators/resourcecd/background/resources/acidification_bm.pdf

Organization - government collaborative that aims to support effective management and sound science to preserve, sustain and restore valuable coral reef ecosystems for future generations. CRCP funds and equips reef conservation activities by NOAA and its partners in seven US states and jurisdictions (American Samoa, the Commonwealth of the Northern Mariana Islands, Florida, Guam, Hawai`i, Puerto Rico, and the US Virgin Islands), uninhabited islands including the Northwestern Hawaiian Islands and the Pacific Remote Island Areas. They also conduct international conservation work in the Pacific Freely Associated States, and are planning future efforts in the Caribbean, Micronesia, Samoa, the Southwest Pacific, and the Coral Triangle.
Partners - NOAA Line Offices that work on coral reef issues (US Coral Reef Task Force, Coral Reef Information System), the National Ocean Service, the National Marine Fisheries Service, the Office of Oceanic and Atmospheric Research, and the National Environmental Satellite, Data and Information Service
Contact: Paulo Maurin, National Education Coordinator and Fellowship Manager, paulo.maurin@noaa.gov
Media - Data in the Classroom modules and educator training workshop, videos, activities, brochures, guides, fact sheets, links to other OA resources (OA res for high school classroom and NESDIS websites)
Audience - teachers/communicators, NGOs, policy makers, and other stakeholders
Content - carbon cycle, human impacts/solutions, physiology, ocean chemistry, ecosystems, ecosystem services/economic impacts
Content Level - Basic to intermediate knowledge needed for educ resources
Potential Gaps - Some lesson plans/activities on topic of climate change/coral threats don't go into OA at all,
Additional Notes - A great collection of educational resources! However, many of the educ. resources talk about human threats to reefs and impacts related to climate change and OA (ie "dirve less to reduce carbon emissions"), but don't specifically address (or sometimes even mention) OA. Lots of clicking involved to get to actual resource. They are organized by media type.

NOAA Education Council Resources

http://www.education.noaa.gov/

Organization - NOAA Education Council is an intragovernmental program consisting of senior staff members from NOAA's line and staff offices. It's goal is to lead and coordinate NOAA-wide education and outreach activities and priorities, and make recommendations to NOAA leadership on all aspects of NOAA's education efforts The educational resources portal was designed to assist educators in accessing materials from one centralized interface.The site also offers resources/information for educator professional development, academic scholarship, career exploration, and education grants.
Partners: Other NOAA offices, various research institutes and NGOs
Contact: education@noaa.gov

Media - Lesson plans, activities, presentations, videos, real world data, background informational articles, scientific journal articles, infographics, career profiles, interviews, interactive web pages, virtual experiments, animations, simulations, reports/summaries.
Audience - Educators (K-12) and communicators
Content - Materials cover: the carbon cycle, pH and ocean chemistry, physiology/biological response in marine organisms (real world data), adaptation, ecosystems, ecosystem services, solutions, climate change, sea level rise, science tools. They support national science education standards and are categorized by appropriate grade levels. The content on the site is considered a sample of NOAA's education resources. More can be found at each link - many of these programs and organizations are reviewed later in this report.
Content Level - The site offers a lot of introductory information on OA and related topics (for beginning, intermediate, and advanced reading levels). High school and some middle school materials require familiarity with reading data, figures, math, chemistry, and climate science concepts.
Potential Gaps -
Additional Notes -,Background information on OA is offered for different reading levels and materials are categorized by grades: elementary, middle, high (ES, MS, HS). The organizations encourages feedback on content and site usability.

NOAA Interagency Working Group on Ocean Acidification (IWG-OA)

http://oceanacidification.noaa.gov/IWGOA/Documents.aspx
Organization - Interagency working group created by the FOARAM Act that meets regularly to coordinate ocean acidification activities across the Federal government to fulfill mandates for research and/or management of resources likely to be impacted by ocean acidification..
Partners - NOAA, National Science Foundation (NSF), Bureau of Ocean Energy Management, Regulation, and Enforcement (BOEMRE), Department of State (DOS), Environmental Protection Agency (EPA), National Aeronautics and Space Administration (NASA), U.S. Fish and Wildlife Service (USFWS), U.S. Geological Survey (USGS), and the U.S. Navy. NOAA chairs the group, with vice-chairs from NSF and NASA.
Contact: Libby Jewett, Chair, IWG-OA and Director, NOAA Ocean Acidification Program
Libby.Jewett@noaa.gov
Media - reports, publications, strategic research/monitoring plan, brochures, FAQs (different languages), Fact sheets, film, links to OA sites for partner organizations and international organizations
Audience - scientists, NGOs, teachers/communicators, policy makers, and other stakeholders
Content - carbon cycle, ocean chemistry, physiology, ecosystems, ecosystem services, human causes/solutions, climate change
Content Level - Intermediate to advanced knowledge needed for reports and publications. Basic knowledge for fact sheets and brochures
Potential Gaps -
Additional Notes - Great OA specific resource that has links to a lot of the programs included in this review. More resources for research and monitoring than for educational outreach however.

NOAA National Centers for Environmental Information (NCEI)

http://www.nodc.noaa.gov/seminars/about_seminars.html
http://www.nodc.noaa.gov/oceanacidification/
https://www.climate.gov/climate-and-energy-topics/ocean-warming-acidification-1

Organization - NOAA's National Centers for Environmental Information (NCEI) are responsible for hosting and providing access to comprehensive oceanic, atmospheric, and geophysical data. From the depths of the ocean to the surface of the sun and from million-year-old tree rings to near real-time satellite images, NCEI is the Nation's leading authority for environmental information. By preserving, stewarding, and maximizing the utility of the Federal government's billion-dollar investment in high-quality environmental data, NCEI remains committed to providing products and services to private industry and businesses, local to international governments, academia, as well as the general public.
Partners - Other NOAA offices, Universities, research institutes, NGOs
Contact: ncei.info@noaa.gov
Media - Data, articles, reports, OneNOAA Science Seminars, photos, links to other gov OA resources, videos
Audience - Scientists, NGOs, resource managers, teachers/communicators, policy makers, and other stakeholders.
Content - Carbon cycle, ocean chemistry, climate change, physiology, ecosystems, adaptation
Content Level - No prior knowledge to basic knowledge needed
Potential Gaps -
Additional Notes - *From survey:* NOAA National Centers for Environmental Information (NCEI). The OneNOAA Science Seminar Series are the most complete and integrated summary of NOAA-wide science and climate seminars. This is a voluntary effort that I (Hernan E. Garcia) initiated in 2004 to help share NOAA Environmental Information with our constituents. Over time, I have been able to invite over 40 seminar partners to the OneNOAA Science Seminars effort. Partners include offices across NOAA (http://www.nodc.noaa.gov/seminars/about_seminars.html) - Hernan.Garcia@noaa.gov

NOAA National Marine Fisheries Service (NMFS)

http://www.st.nmfs.noaa.gov/ecosystems/ocean-acidification/index
http://www.st.nmfs.noaa.gov/nemo/pages/curriculum
http://www.nwfsc.noaa.gov/research/hottopics/oceanacidification.cfm
http://www.pifsc.noaa.gov/cred/ocean_acidification.php
http://www.afsc.noaa.gov/seminarseries/NOAA_lectures_2010/mcelhany-public-1_2010.pdf

Organization - Comprised of six Fisheries Science Centers around the US, NMFS is responsible for the stewardship of the nation's ocean resources and their habitat. They provide vital services for the nation: productive and sustainable fisheries, safe sources of seafood, the recovery and conservation of protected resources, and healthy ecosystems—all backed by sound science and an ecosystem-based approach to management.
Partners - Fishery Management Councils, Interstate Commissions, Advisory Committee, other gov offices
Contact:

- NMFS Alaska Fisheries Science Center - Lisa Hiruki-Raring, Education Program Coordinator, lisa.hiruki-raring@noaa.gov
- NMFS Northeast Fisheries Science Center - Maggie Mooney-Seus, Communications Officer, Marjorie.Mooney-Seus@noaa.gov
- NMFS Northwest Fisheries Science Center - Vicky Krikelas, Outreach Coordinator, in form email http://www.nwfsc.noaa.gov/contact/emailform.cfm?staffid=1156&firstname=Vicky&lastname=Krikelas
- NMFS Pacific Islands Science Center - Wende Goo, Public Affairs Information Officer / Outreach and Education Coordinator, wende.goo@noaa.gov
- NMFS Southwest Fisheries Science Center - Essie Duffie, Education/Outreach Coordinator, Essie.C.Duffie@noaa.gov
- NMFS Southeast Fisheries Science Center - Sarah Mesnick, Science Liaison, Sarah.Mesnick@noaa.gov

Media - article, OA ppt lesson and teachers' guide as part of NEMO curriculum, link to NOAA OAP program and IWG-OA, ocean science web tools
Northwest Fisheries Science Center (NWFSC): activity, fact sheet, Q&A with scientist, current projects
Pacific Islands Fisheries Center (PIFC) interactive map, current projects/research, infographics
Alaska Fisheries Science Center (AFSC): current research articles and planning, lecture series-video/slides, hands on activity
Audience - scientists, NGOs, teachers/communicators, policy makers, and other stakeholders
Content - carbon cycle, ocean chemistry, physiology, adaptation, ecosystems, ecosystem services, human impacts
Content Level - Basic to intermediate knowledge in ocean and climate science
Potential Gaps - Limited OA education resources
Additional Notes - Main site provides a quick blurb on OA and links to further information and lesson plan. Specific Fisheries Science Center websites go into more detail

NOAA American Samoa (Fagatele Bay) National Marine Sanctuary

http://sanctuaries.noaa.gov/science/conservation/pdfs/fbnms_climate.pdf
http://sanctuaries.noaa.gov/science/sentinel-site-program/american-samoa/climate-change-ocean-acidification.html
Organization - The Fagatele Bay NMS was created to promote resource protection, research, education, and cultural heritage. It is the only marine sanctuary that encompasses a true tropical reef system.
Partners - American Samoa Government, local communities, other US gov agencies, research institutes, NGOs
Contact:Gene Brighouse, Sanctuary Superintendent, Kevin Grant, Deputy Superintendent, Kevin.Grant@noaa.gov
Media - Climate change impact report mentions OA, On the general NMS site - article about OA and current research in Samoa, link to other NMS site with article about OA
Audience - teachers/communicators, NGOs, policy makers, families

Content - Ocean chemistry, physiology (corals), ecosystems, ecosystem services, adaptation, human causes/solutions, links to current research/publications
Content Level - Advanced knowledge needed for some of the climate change/OA information
Potential Gaps - There are no education resources on OA, limited information on OA and not easy to find
Additional Notes - It's not easy to find specific topics on the main Samoa Sanctuary site. I didn't find any links to the climate change report or the article on the main NMS site about OA. I had to google "American Samoa NMS ocean acidification" to find both resources.

NOAA Channel Islands National Marine Sanctuary (CINMS) Ocean Acidification Program

http://cisanctuary.org/ocean-acidification/
Organization - The CINMS Ocean Acidification Program is a collaborative effort between government agencies and local Santa Barbara/LA area organizations to provide information and resources to educators interested in ocean acidification.
Partners - COSEE West, Environmental Defense Center, Sea Grant-USC, UCSB Marine Science Institute, Santa Barbara Museum of Natural History/Ty Warner Sea Center, Longbeach Aquarium of the Pacific, National Park Service, Citrix, Highliner Studios.
Contact: Laura Francis - CINMS Education Coordinator, laura.francis@noaa.gov
Media - website, PSA, workshops, lesson plans, hands-on activities, reports, and links to other OA programs (with videos, presentations, podcasts, actions, and science kits)
Audience - teachers/communicators, K-12 students, resource managers, NGOs, media, scientists
Content - Topics: carbon cycle, ocean chemistry, physiology, adaptation, ecosystems, ecosystem services, solutions - climate change and OA communication strategies. Lessons touch upon various National Science Standards, Ocean Literacy Principles and Concepts, and Education in the Environment Initiative Principles and Concepts:
Content Level - Limited to basic climate, ocean science, and chemistry (pH) knowledge is needed for the majority of activities and lesson plans. More familiarity with OA concepts and climate science is needed to fully understand webinars, presentation, and reports.
Potential Gaps - Resources provide an excellent explanation of immediate benefits of a healthy ocean relating to ecosystems and species. Could go into more detail about how protecting the ocean directly helps people in coastal communities as well as those far from the ocean,
Additional Notes - Besides information and links to resources, the CINMS OA website also provides a PSA coupled with a call to action/pledge for users to sign as a first step in reducing their carbon footprint/protecting the ocean.

NOAA Cordell Bank National Marine Sanctuary

http://cordellbank.noaa.gov/welcome.html
Organization - Created to protect and inform the public about the marine resources/ecosystems off of the coast of Northern CA
Partners - Other gov agencies, research institutes, NGOs
Contact: Jennifer Stock - Education and Outreach Coordinator jennifer.stock@noaa.gov
Media - Resolution, reports, articles

Audience - teachers/communicators, NGOs, policy makers resource managers
Content - Effects on deep sea corals, monitoring OA
Content Level - Basic to advanced knowledge needed in ocean science topics
Potential Gaps - Very little mention of OA, and no OA specific educ. materials
Additional Notes - SAC passed a resolution in 2009 that said OA "warranted additional NOAA research, monitoring, education and outreach, and management action to reduce and mitigate its impacts." They also suggested that the 5 W. coast Sanctuaries coordinate an approach with the "West Coast Regional Office taking a leadership role in coordinating ocean acidification monitoring" with PMEL and others. Other mention of OA was in their deep sea coral monitoring projects.

NOAA Florida Keys National Marine Sanctuary

http://floridakeys.noaa.gov/corals/climatethreat.html
http://floridakeys.noaa.gov/whatsnew/around/2013/waterwaysrise.html
Organization - to promote resource protection, research, education, and public use in the waters surrounding the Florida Keys, from south of Miami westward to encompass the Dry Tortugas.
Partners - Other gov agencies, research institutes, NGOs
Contact - Mary Tagliareni, Deputy Superintendent for Operations and Education, Mary.Tagliareni@noaa.gov
Media - Articles, reports, journal articles, Waterways TV info, links to other information on OA
Audience - Teachers/communicators, NGOs, policy makers, families
Content - Ocean chemistry, physiology (coral reefs), human causes, sea level rise, ecosystem services, ecosystems,
Content Level - Familiarity with basic science concepts needed for educational resources, more advanced knowledge for report and scientific articles
Potential Gaps - Few OA materials
Additional Notes - Some of the OA links to other sites were broken

NOAA Flower Garden Banks National Marine Sanctuary

http://flowergarden.noaa.gov/science/sciprojects.html
http://sanctuaries.noaa.gov/science/sentinel-site-program/flower-garden-banks/climate-change-oce an-acidification.html
http://flowergarden.noaa.gov/document_library/advdocs/fgbsacoceanacidificationres.pdf
Organization - to promote resource protection, research, and education. It is the only National Marine Sanctuary in the Gulf of Mexico
Partners - Other gov agencies, research institutes, NGOs
Contact - Shelley Du Puy, Education & Outreach Coordinator shelley.dupuy@noaa.gov
Media - Current OA research projects, articles, OA resolutions/recommendations from the Sanctuary Advisory Council, link to National Marine Sanctuary climate change website
Audience - teachers/communicators, NGOs, policy makers
Content - physiology, human causes, adaptation, ecosystems

Content Level - The articles don't require any prior knowledge. However, basic to advanced knowledge is needed to understand current research projects and reports
Potential Gaps - There aren't any OA specific education resources and there is little mention of OA in general
Additional Notes-

NOAA Gray's Reef National Marine Sanctuary

http://graysreef.noaa.gov/education/posters/welcome.html
http://graysreef.noaa.gov/education/posters/welcome.html
Organization - Located off the Georgia Coast, the mission of Gray's Reef National Marine Sanctuary is to identify, protect, conserve, and enhance the natural and cultural resources, values and qualities of the sanctuary for current and future generations.
Partners - Other gov agencies, research institutes, NGOs
Contact:Jody Patterson Events & Volunteer Coordinator, jody.patterson@noaa.gov
Sarah Fagman, Communications Coordinator - Sarah.Fagman@noaa.gov .
Media - OA material: posters, on NMS site: OA activity, links to research
Audience - teachers/communicators, NGOs, policy makers
Content - Ocean chemistry, physiology, adaptation, human impacts, ecosystems
Content Level - Prior chemistry and ocean science knowledge needed to interpret the posters and current research, basic science needed for the activity.
Potential Gaps - Few OA materials
Additional Notes - The posters on the site were very informative, but there really wasn't any supplemental information to go with them

NOAA Gulf of the Farallones National Marine Sanctuary

http://farallones.noaa.gov/about/
Organization - Created to protect and inform the public about the marine resources/ecosystem west the San Francisco area.
Partners - Other government agencies, research institutes, NGOs
Contact:
Education and Outreach Chair, Amy Sprenger, asprenger@apl.washington.edu
Education Coordinator - Carol A. Preston carol.a.preston@noaa.gov
Media Liaison, Public Outreach Specialist - Mary Jane Schramm
maryjane.schramm@noaa.gov
Education Specialist - Rietta Hohman rietta.hohman@noaa.gov
Education Specialist - Erica Warren erica.warren@noaa.gov
Media - Current projects, research
Audience - teachers/communicators, NGOs, policy makers
Content - Brief mention of OA monitoring in one of the current research projects
Content Level - Basic to advanced knowledge needed in ocean science topics
Potential Gaps - No educational resources on OA

Additional Notes - Site is a great resource for information about Sanctuary programs, but does not provide a lot of educational resources upfront - many require contacting Sanctuary staff.

NOAA Hawaiian Islands Humpback Whale National Marine Sanctuary

http://sanctuaries.noaa.gov/science/sentinel-site-program/hawaiihumpbackwhale/climate-change-ocean-acidification.html
Organization - created to protect humpback whales and their habitat in Hawai`i. The sanctuary lies within the shallow (less than 600 feet), warm waters surrounding the main Hawaiian Islands.
Partners - Other gov agencies, research institutes/universities, NGOs
Contact: Patty Miller Education Specialist, patty.miller@noaa.gov
Media - Condition report, article
Audience - teachers/communicators, policy makers
Content - physiology (corals), ecosystem, ecosystem services, climate change
Content Level - Intermediate to advanced ocean science knowledge needed for the condition report. No prior knowledge needed for article and non-OA education materials
Potential Gaps - No education resources on OA
Additional Notes - Great non-OA specific educational resources geared more towards elementary and middle school students.

NOAA Monitor National Marine Sanctuary

http://monitor.noaa.gov/education/pdfs/rov_ocean_acidification.pdf
http://sanctuaries.noaa.gov/science/sentinel-site-program/monitor/climate-change-ocean-acidification.html
Organization - Located 16 miles off the coast of Cape Hatteras, N.C., Monitor National Marine Sanctuary protects the shipwreck of the famed Civil War ironclad, USS *Monitor*
Partners - Other gov agencies, research institutes/universities, NGOs
Contact:Shannon Ricles, Education and Outreach Coordinator, Shannon.Ricles@noaa.gov
Media - article, classroom activity, links to other OA resources, Sanctuary Management Plan
Audience - teachers/communicators, NGOs, policy makers
Content - carbon cycle, ocean chemistry, physiology, adaptaiton, ecosystems, ecosystem services, human causes/solutions
Content Level - Basic to intermediate knowledge needed in ocean science, math, and chemistry
Potential Gaps - There are few OA education materials
Additional Notes - Classroom activity meets National Education Standards, Ocean Literacy Principles, and Climate Literacy Principles

NOAA Monterey Bay National Marine Sanctuary

http://montereybay.noaa.gov/resourcepro/resmanissues/climatechange.html
Organization - MBNMS was established for the purpose of resource protection, research, education, and public use, including commercial fishing and recreational activities.

Partners - Other gov agencies, research institutes, NGOs
Contact Liz Love: Acting Education Coordinator liz.love@noaa.gov
Media - Non OA specific: activities, educator listserv (for sharing resources), maps, database, links to many many other resources (Bridge- teacher approved ocean resources), images, videos, brochures, guides/maps, reports, plans, data
Audience - teachers/communicators, NGOs, policy makers
Content - Non OA topics: commercial use, geography, ecosystems, solutions/conservation, water cycle, physiology, physical oceanography, navigation, ocean science, link to Channel Islands OA site
Content Level - Basic to advanced knowledge needed in ocean science topics
Potential Gaps - little mention of OA and hard to find OA resources
Additional Notes - The site has great links to a very comprehensive collection of educational resources. However, besides the labeled link to the Channel Islands OA site, it takes a lot of searching to find OA specific resources

NOAA Papahānaumokuākea Marine National Monument

http://www.papahanaumokuakea.gov/wheritage/climate.html
Organization - was created to "carry out seamless, integrated management to ensure ecological integrity and achieve strong, long-term protection and perpetuation of NWHI ecosystems, Native Hawaiian culture, and heritage resources for current and future generations."
Partners - Co-trustees: NOAA Secretary of Commerce, FWS Secretary of the Interior, Hawaii Department of Land and Natural Resources, other partners: gov agencies, research institutes, NGOs
Contact: Andy.Collins@noaa.gov or Kainoa.Kaulukukui@noaa.gov
Media - Informational articles, link to local Ocean Families Exploring Science Together (FEST) program
Audience - teachers/communicators, NGOs, policy makers, families
Content - Coral monitoring/physiology, climate change, adaptation, impacts/solutions
Content Level - Basic to advanced knowledge needed in ocean science topics
Potential Gaps - No specific category for OA resources. There are some that touch upon the subject, but that information is mixed in other focus topics like climate change.
Additional Notes - Some resources touch on OA, but they are not categorized by OA heading. The site does a great job of highlighting human-ecosystem relationships and management challenges,

NOAA Stellwagen Bank National Marine Sanctuary

http://stellwagen.noaa.gov/welcome.html
http://www.noaa.gov/2014_newsarchive.html
Organization - Located at the mouth of the Massachusetts Bay
Partners - Other gov agencies, research institutes/universities, NGOs, local businesses
http://stellwagen.noaa.gov/about/partners.html
Contact: Anne I. Smrcina – Education Coordinator, anne.smrcina@noaa.gov

Media - news articles, e-notes/newsletters, resolutions/recommendations from SAC
Audience - teachers/communicators, NGOs, policy makers, recreational users
Content - ocean chemistry, physiology, human causes/solutions, adaptation, ecosystems
Content Level - Basic to advanced knowledge needed in ocean science topics
Potential Gaps - There aren't any OA specific education resources and there is little mention of OA in general
Additional Notes - There are few educational resources on their site in general

NOAA Thunder Bay National Marine Sanctuary

http://thunderbay.noaa.gov/welcome.html
http://sanctuaries.noaa.gov/management/pdfs/tb_oareso.pdf
Organization - Located in northwestern Lake Huron (Michigan) , this area is also an underwater preserve with many shipwrecks and related maritime heritage resources. The organization aims to promote resource protection, research, education, and public use
Partners - Other gov agencies, research institutes, NGOs
Contact: Sarah Waters, Education Coordinator sarah.a.waters@noaa.gov
Media - Resolutions/recommendations from their Sanctuary Advisory Committee, link to NMS climate change website
Audience - teachers/communicators, NGOs, policy makers
Content - No OA specific topics, but there are articles about climate change
Content Level - Basic to no prior knowledge needed
Potential Gaps - There aren't any OA specific education resources and there is little mention of OA in general
Additional Notes -

NOAA Olympic Coast National Marine Sanctuary

http://olympiccoast.noaa.gov/
Organization - The Sanctuary provides information to the public about the science, importance, and wonder of our marine landscapes
Contact - Jacqueline Laverdure - Education and Outreach Specialist
jacqueline.laverdure@noaa.gov
Media - internal site articles, posters, flyers, and facts about other ocean topics, current projects - they do provide a link to the CINMS OA Education page
Audience - teachers/communicators, NGOs, policy makers
Content - oceanography, local sanctuary resources, brief mention of CO_2 as cause OA and its physiological effects
Content Level - Basic to advanced knowledge needed in ocean science topics
Potential Gaps - very little mention of OA
Additional Notes - Site has great ocean science resources for teachers, but no Olympic Coast-specific OA outreach or education materials - link goes to the Channel Islands OA page

NOAA Office of National Marine Sanctuaries

http://sanctuaries.noaa.gov/science/sentinel-site-program/climate-change-ocean-acidification.html
http://sanctuaries.noaa.gov/education/teachers/

Organization - The Office of National Marine Sanctuaries serves as the trustee for a network of underwater parks. Their site provides organized information and resources for all 14 National Marine Sanctuaries

Partners - Other gov agencies

Contact:sanctuaries@noaa.gov

Media - Articles, condition reports, current research/monitoring, GIS data for the various sanctuaries, link to Channel Islands OA site and OA Resources for high school classroom

Audience - teachers/communicators, NGOs, policy makers, and other stakeholders

Content - carbon cycle, ocean chemistry, physiology, ecosystems, ecosystem services, human causes/solutions

Content Level - Basic to advanced knowledge needed for articles and research. Limited to basic knowledge needed for elementary/middle school educational resources, and intermediate to advanced science knowledge needed for high school materials and up.

Potential Gaps

Additional Notes - Seems to serve as a hub for material on all of the sanctuarys' websites. They have an extensive collection of educational resources - mostly non-OA specific, and they also provide materials for evaluation and professional development.

NOAA Ocean Acidification Program (OAP)

http://oceanacidification.noaa.gov/Home.aspx

Organization - The NOAA Ocean Acidification Program is a collaborative, government program created to coordinate research, monitoring, and other activities to improve understanding of ocean acidification impacts to marine species. OAP maintains long-term monitoring; conducts research to enhance OA-sensitive ecosystem conservation, promotes OA educational opportunities and outreach; coordinates OA activities across other agencies and international ocean science bodies, and provides grants for research projects.

Partners - National Marine Fisheries Service (NMFS), National Environmental Satellite, Data and Information Service (NESDIS), National Ocean Service (NOS), other NOAA offices. OAP encourages dialogue among scientists, resource managers, stakeholders, policy makers, and the public.

Contact: Paulo Maurin, paulo.maurin@noaa.gov

Media - website has a variety of current and past research data and educational resources including: SOARCE webinars, workshops & conferences, videos, presentations, animations, blog, journal articles, synopsis and links to current projects/research/data, OA ed implementation plan, current news articles, links to other educ resources/programs as well as links to different regional OA networks.

Audience - Scientists, communicators/interpreters, teachers, resource managers, NGOs

Content - The website offers a variety of information and links covering topics of the carbon cycle, ocean chemistry, physiology/biological response, adaptation, ecosystems, ecosystem services, solutions, OA monitoring, socioeconomic impacts, data collection and management

Content Level - Educational resources - games, presentations, activities, etc. for lower grade levels explain/assist teachers in understanding OA and therefore, do not require prior knowledge.

The activities/lessons for upper grades, reports, and current project monitoring data require familiarity with climate change, ocean science, reading journal articles and figures.
Potential Gaps -
Additional Notes - OAP has a very comprehensive collection of current OA projects/data and tools for education and outreach. Projects can easily be searched by species or region, and educ. resources are categorized by media type.

NOAA Office of Education (OED)

http://www.oesd.noaa.gov/grants/NOAA_assets.html
Organization - Working with the Education Council, OED coordinates educational activities across NOAA and develops NOAA's Education Strategic Plan and policy.
Partners - Education Council, other gov agencies, research institutes, NGOs
Contact: Sarah Schoedinger sarah.schoedinger@noaa.gov or Carrie McDougall, carrie.mcdougall@noaa.gov
Media - links to all NOAA research and education programs (data in the classroom, Bay-Watershed Education and Training (B-WET), Climate resilience toolkit, etc), data visualizations, satellite imagery, real time data, articles, tools, interactive web pages, photos, videos
Audience - teachers/communicators, K-12 students, resource managers, NGOs, media, scientists, stakeholders, policy makers
Content - carbon cycle, pH/ocean chemistry, physiology/biological response in marine organisms, adaptation, ecosystems, ecosystem services, solutions, climate change
Content Level - Basic to advanced knowledge in various science topics required
Potential Gaps
Additional Notes - This is an extremely comprehensive list of all NOAA programs and resources, organized by topic. OA is searchable - links to NOAA OAP program.

NOAA Ocean Exploration and Research (OER) Program

http://oceanexplorer.noaa.gov/okeanos/edu/collection/media/wdwe_offbase.pdf
http://oceanexplorer.noaa.gov/facts/acidification.html
http://oceanexplorer.noaa.gov/okeanos/edu/collection/media/wdwe_toboldlygo.pdf
Organization - OER explores the ocean to enhance research, policy and management decisions, to develop new lines of scientific inquiry, and to advise NOAA and the Nation on critical issues by:
• Leading partnerships to accomplish national ocean exploration goals;
• Conducting interdisciplinary baseline characterizations of unknown or poorly-known ocean areas, processes, and resources;
• Increasing the pace, scope, and efficiency of exploration and research to improve the technical capability of the United States marine science community;
• Engaging and educating audiences in ocean exploration through innovative means
Partners - Other NOAA offices, research institutes, NGOs
Contact: Paula Keener, Director, Education Programs NOAA Office of Ocean Exploration and Research, paula.keener@noaa.gov
Media - Lesson plan/activities, articles, current research
Audience - educators and teachers (9-12)
Content - Carbon cycle, ocean chemistry, physiology, adaptation, ecosystem, solutions
Content Level - Basic ocean science knowledge

Potential Gaps - limited OA resources and outdated explanation of link between climate change and OA
Additional Notes - Interesting explanation: "Ocean acidification is a result of increased CO2 emissions, and is not directly related to climate change. There are many uncertainties about the causes, extent, and impacts of global climate change; but these do not apply to ocean acidification which can be observed happening right now and is highly predictable into the future. Measures to reduce global temperatures or the concentration of other greenhouse gases will have no effect on ocean acidification. Only a reduction in atmospheric CO2 concentrations will affect the acidification problem."

NOAA Pacific Marine Environmental Laboratory (PMEL) OA Educational Tools

http://www.pmel.noaa.gov/co2/story/Education
Organization - The PMEL Carbon Group has been involved in the development of a variety of educational tools for educators, students, and the broader public that describe the ocean carbon cycle and how it is changing over time. Through these resources, they strive to contribute to NOAA's goal to improve the Nation's fundamental understanding of the systems of the natural world, the relationships and interactions between the living and non-living environment, and the ability to understand and utilize scientific evidence to make informed decisions regarding environmental problems.
Partners - Other gov agencies, research institutes/universities
Contact: Lucia Upchurch, Outreach Coordinator, lucia.upchurch@noaa.gov
Media - Articles, animations, fact sheets, infographics, e-lectures, videos of interviews, congressional testimony
Audience - General public, teachers, policymakers, stakeholders
Content - Carbon cycle and ocean chemistry, ecosystem and organismal response to OA, OA impacts on shellfisheries, long-term CO2 projections, pH, saturation state, ocean sampling techniques
Content Level - Basic to advanced. Some of the content requires little prior knowledge.
Potential Gaps - No lesson plans or curriculum
Additional Notes -

NOAA Sharing Ocean Acidification Resources for Communicators and Educators (SOARCE)

http://oceanacidification.noaa.gov/areasoffocus/educationoutreach/soarcewebinarseries.aspx
Organization - SOARCE is a webinar series sponsored by the NOAA National Marine Sanctuaries and Ocean Acidification Program. The Series runs about once a month and offers OA communication tools and current scientific and communication research to promote a more integrated and effective ocean acidification education community.
Partners - NOAA National Marine Sanctuaries and Ocean Acidification Program
Contact: Co-hosts of the series: Laura Francis, laura.francis@noaa.gov, Jenn Bennett-Mintz, jennifer.mintz@noaa.gov,
Media - webinar series presentations
Audience - Formal & informal educators, teachers, communicators, and stakeholders
Content - The webinars cover both the science and communication aspects of OA including: the carbon cycle, ocean chemistry, physiology/biological response, and solutions (Internat. Student Carbon Footprint Challenge), OA communication: strategies, tools, framing, stories, case studies;

how to use different OA resources, data, and virtual experiments.Content of presentations also includes Common Core Standards
Content Level - Webinars are targeted to a non-scientific audience - little to no prior knowledge is needed. However, some basic OA knowledge may be needed depending on the topic.
Potential Gaps
Additional Notes

NOAA View (OA Visualizations)

http://www.nnvl.noaa.gov/view/
Organization - Website to view over 100 environmental variables using data from satellites, climate models, and other observation devices.
Partners - NOAA PMEL and GFDL
Contact: vizlab.webmaster@noaa.gov
Media - Global visualization maps
Audience - Formal & informal educators, teachers, communicators, resource managers, policy makers, scientists, and stakeholders
Content - global ocean models of pH, aragonite saturation state, and CO2 flux from 1860-2100 based on the latest IPCC models
Content Level - Basic, some prior understanding of pH or basic chemistry may be helpful but there is information that explains each dataset
Potential Gaps - Map projections only
Additional Notes - Visualizations can be downloaded by year or for use on Science on a Sphere

Padilla Bay National Estuarine Research Reserve (NERR)

http://www.padillabay.gov/educationcurriculum.asp
Organization - The National Estuarine Research Reserve System is a network of 28 coastal sites designated to protect and study estuarine systems. Established through the Coastal Zone Management Act, the reserves represent a partnership program between NOAA and the coastal states. NOAA provides funding and national guidance, and each site is managed on a daily basis by a lead state agency or university with input from local partners.
Partners - Other NOAA offices, state government agencies, universities, research institutes, NGOs
Contact: alex@padillabay.gov or Atziri Ibanez atziri.ibanez@noaa.gov
Media - ACLIPSE (Advancing Climate Literacy through Investment in Inservice and Pre-service Science Educators) curriculum currently in progress, presentations, exhibit
Audience - Formal & informal educators, teachers, communicators, and stakeholders
Content - Coming soon
Content Level - No prior knowledge knowledge needed
Potential Gaps -
Additional Notes - *From survey: "*Padilla Bay NERR, one of 28 Research Reserves located in Washington State got a NOAA Environmental Literacy grant to develop OA curriculum for pre-service middle school science teachers called ACLIPSE (Advancing Climate Literacy through Investment in Inservice and Pre-service Science Educators). This is curriculum is currently in development and will be shared with educators at a Teachers on the Estuary workshop (date to be determined).

In addition, Padilla Bay NERR is working with their local university education department (Woodring College of Education at Western Washington University) to include some of this content in existing science education classes. They include presentations about OA at their conferences, YES (Youth Earth Summit for high school environmental clubs) and Storming the Sound (for regional environmental educators). Finally, Padilla Bay NERR is also developing a computer kiosk exhibit about climate change that will include a section on OA." - Atziri Ibanez

Washington Sea Grant

Organization - WA Sea Grant is a federal program that supports marine research, education, and outreach, and works with communities, managers, businesses, academic institutions, and the public to strengthen understanding and sustainable use of ocean and coastal resources.
Partners - University of Washington, federal, state, and local government, Washington tribes, schools districts, and businesses.
Contact: Meg Chadsey mchadsey@uw.edu
Media - website, fact sheets, video and ppt presentations, activity demonstrations, handouts, news articles, sci journal articles, current research, interviews, reports, links to SOARCE, C-CAN, OACC,
Audience - educators/communicators (grades 8 and up), college students, managers/policy makers, NGOs, other stakeholders
Content - Covers carbon cycle and ocean chemistry/pH on a large scale, and looks at local physiology/biological responses, adaptation, ecosystems, ecosystem services, and actions/solutions.
Content Level - The education and outreach activities/presentations have background information on OA - little prior knowledge needed. However, the articles in the educational resources section, as well as resources (scientific journal articles, reports) on the rest of the site, require prior chemistry and ocean science to college level science knowledge. .
Potential Gaps -
Additional Notes - The majority of resources and information on this site is targeted to a more scientifically-literate audience

Smithsonian Institution's Ocean Portal

http://ocean.si.edu/ocean-acidification
http://www.si.edu/
http://ocean.si.edu/ocean-news/five-questions-uta-passow-how-oil-spill-affects-movement-carbon-ocean
Organization - Founded in 1846, the Smithsonian is the world's largest museum and research complex, consisting of 19 museums and galleries, the National Zoological Park, and nine research facilities. The Ocean Portal is part of the Smithsonian Institution's Ocean Initiative. Together with the National Museum of Natural History's Sant Ocean Hall and the Sant Marine Science Chair, the Ocean Portal supports the Smithsonian's mission to increase the public's understanding and stewardship of the Ocean.
Partners - Smithsonian Institution's Ocean Initiative, National Museum of Natural History's Sant Ocean Hall, and the Sant Marine Science Chair, other partners: research institutes, government agencies, NGOs

Contact: Emily Frost, Ocean Portal Managing Editor, frosteg@si.edu
Media - Articles, photos, videos, animation - Alliance for Climate Edu, graphs, past and current research, lesson plans, activities, case studies, links to other resources, scientist interview, slideshow.
Audience - Communicators, educators (informal and formal), students, stakeholders, resource managers, policy makers
Content - Climate change, carbon cycle, ocean chemistry, physiology (coral reefs, echinoderms, plants/algae, fish), adaptation, ecosystems, ecosystem services, economic impacts, solutions
Content Level - Little to no prior knowledge needed
Potential Gaps -
Additional Notes - One of the animations does a great job of explaining the chemistry of why organisms are having a hard time building shells. Articles go into OA impacts on multiple organisms, not just the main players. Lesson plans indicate which standards they cover. Many links to other OA resources. Internal search for OA categorizes resources by media type.

Institute for Natural Resources

Organization - Provides a digital resource library that integrates and provides access to data from state and federal agencies, local governments, university scientists and citizens to support informed decisions and actions by people concerned with natural resources, environment, and communities in Oregon and the West.
Partners - Oregon State University, Institute for Natural Resources, Oregon Department of Administrative Services Geospatial Enterprise Office,
Contact: Janine Salwasser, Program lead, janine.salwasser@oregonstate.edu
Media - articles, stories, maps, tools, reports, publications, data, videos, links to external resources
Audience - teachers, communicators, students, NGOs, policy makers, resource managers, stakeholders
Content - carbon cycle, climate change, ecosystem impacts, physiology
Content Level - Basic ocean and climate science needed
Potential Gaps -
Additional Notes - Resources provide a good introduction to OA. Not many education-specific resources like lesson plans, etc.

Non-Governmental Organizations

Changing Seas Television Series (WPBT2)

http://www.changingseas.tv/episode603.html
http://www.changingseas.tv/episode102.html
http://www.wpbt2.org/pressreleases/cseasfilmfestival.html
Organization - Changing Seas is a public television series produced by WPBT2 in Miami, Florida. The series takes viewers on an exciting adventure to the heart of our liquid planet.
Partners - Series supported by the Batchelor Foundation, Divers Direct, Do Unto Others Trust, Emocean Sports, Friends of Changing Seas
Contact: Alexa Elliott, Series Producer, webmaster@wpbt.org
Media - Changing Seas TV episodes: Galápagos: Windows into the Future (2014), Mission to Inner Space (2009), press release
Audience - Communicators, educators (informal and formal), students, stakeholders, families
Content - Carbon cycle, human impacts, climate change, ocean chemistry, coral physiology, ecosystems, ecosystem services
Content Level - No prior knowledge needed
Potential Gaps -
Additional Notes - This lead was from survey respondent. Interesting videos!

Chesapeake Climate Action Network

http://chesapeakeclimate.org/
Organization - The Chesapeake Climate Action Network (CCAN) is the first grassroots, nonprofit organization dedicated exclusively to fighting global warming in Maryland, Virginia, and Washington, D.C. Their mission is to build and mobilize a powerful grassroots movement in this unique region that surrounds our nation's capital to call for state, national and international policies that will put us on a path to climate stability.
Partners - Energy Action Coalition
Contact: Kristen Friedel, Executive Assistant & Special Projects Coordinator, kristen@chesapeakeclimate.org, 240.396.2025
Media - Infographics, brochures, blog posts, links to articles about climate
Audience - Public, stakeholders, policymakers
Content - Effects of food choices on climate, carbon cycle, solutions to climate change and the carbon problem
Content Level - All background information is given
Potential Gaps - Almost no mention of OA
Additional Notes - It appears that some sections have not be updated recently. Good focus on solutions both personal and governmental.

Compass

http://www.compassonline.org/about
Organization - a team of science-based communication professionals working at the intersection of science, policy, and communications to help scientists develop the skills, insight and expertise to engage with the right audiences at the right times. They facilitate connections between scientists, policymakers and the media, thereby creating space for scientists to share their knowledge. They also introduce scientists to each other, and keep track of the scientific trends that are relevant to decision makers. They share our insights into the policy and media communities, to help scientists frame and advance their research questions..
Partners - Government agencies, NGOs, univeristies, businesses, community stakeholder groups
Contact: Nancy Baron, Director of Science Outreach, nancy.baron@compassonline.org, (805) 450-3158
Media - presentations, congressional briefing, OA communication workshops, panel discussions, articles, lists upcoming events, speakers
Audience - scientists, teachers, communicators, students, NGOs, policy makers, resource managers, stakeholders
Content - carbon cycle, ocean chemistry, physiology, adaptation, ecosystems, ecosystem services, solutions,
Content Level - No prior knowledge needed
Potential Gaps -
Additional Notes - Great resource for information about OA events and workshops

Consortium for Ocean Leadership

http://oceanleadership.org/moderate-increase-of-oceanic-acidification-leads-to-a-dramatic-shift-in-benthic-habitats/
http://oceanleadership.org/
Organization - Washington, DC-based nonprofit organization that represents more than 100 of the leading public and private ocean research and education institutions, aquaria and industry with the mission to advance research, education and sound ocean policy.
Partners - members include universities, research institutes, gov agencies, and other non-profits
Contact: Kristen Yarincik, Director of Research and Education kyarincik@oceanleadership.org
Media - informational articles, current news articles, links to scientific journal articles
Audience - communicators, educators, scientists, students, NGOs, policy makers, resource managers, stakeholders
Content - climate change, ocean chemistry, physiology (plankton), adaptation, ecosystems (deep sea), invasive species
Content Level - basic to no science knowledge needed for most resources
Potential Gaps - no materials specifically for educators, no links to main OA sites
Additional Notes - Great site for staying up to date on the latest OA findings. Group summarizes recent sci journal articles into shorter, more digestible pieces

EarthEcho International

http://earthecho.org/educator-resources/virtual-field-trip-engineering-ocean-solutions

Organization - EarthEcho International's mission is to inspire young people worldwide to act now for a sustainable future. Nonprofit 501c3 organization founded in 2000 by siblings Philippe and Alexandra Cousteau in honor of their father Philippe Cousteau Sr. Their tools and interactive resources equip youth to identify and solve environmental challenges in their own communities.
Partners - Businesses, NGOs, research institutes
Contact: Allie Toomey, Education Coordinator, education@earthecho.org
Media - Video, virtual field trips, lesson plans, actiona guide
Audience - Communicators, educators (informal and formal), students, stakeholders
Content - Climate change, carbon cycle, physiology, ecosystems, ecosystem services, adaptation, solutions, OA xprize
Content Level - No prior knowledge needed
Potential Gaps -
Additional Notes - Many of the resources require registration on the site to access.

InTeGrate: Interdisciplinary Teaching about Earth for a Sustainable Future

http://serc.carleton.edu/integrate/workshops/risk_resilience/case/82001.html
http://serc.carleton.edu/integrate/workshops/risk_resilience/activities/81316.html
Organization - InTeGrate is a 5-year, NSF-funded STEP Center grant (2012 -2016). The STEP (STEM Talent Expansion Program) Center program enables "a group of faculty representing a cross section of institutions of higher education to identify a national challenge or opportunity in undergraduate education in science, technology, engineering, and mathematics (STEM) and to propose a comprehensive and coordinated set of activities that will be carried out to address that challenge or opportunity within a national context. Goals of InTeGrate are: develop curricula that will dramatically increase Earth literacy of all undergraduate students, increase the number of majors in the geosciences and related fields who are able to work with other scientists, social scientists, business people, and policy makers to develop viable solutions to current and future environmental and resource challenges.
Partners - STEP Center, NSF, universities, American Meteorological Society, American Geological Institute, American Geophysical Union, Centers for Ocean Sciences Education Excellence, Geological Society of America, Incorporated Research Institutions for Seismology, National Association of Geoscience Teachers, National Council for Science and the Environment, Ocean Leadership and Integrated Ocean Drilling Program, On the Cutting Edge.
Contact: Cathy Manduca, Director Science Education Resource Center, cmanduca@carleton.edu, 507-222-7096
Media - lesson plans, activities, teaching summaries, links to other Oregon-related OA materials, listservs for all their programs
Audience - university and college educators
Content - carbon cycle, physiology, adaptation, economic impacts, ecosystems
Content Level - Basic ocean and climate science needed
Potential Gaps -
Additional Notes - Great resource for college level lesson plans and activities about OA and other current environmental/earth science topics

Khaled bin Sultan Living Oceans Foundation

https://www.livingoceansfoundation.org/
https://www.livingoceansfoundation.org/education/portal/
Organization - The Khaled bin Sultan Living Oceans Foundation is a non-profit environmental science organization and ocean research foundation established to help preserve, protect and restore the world's oceans and aquatic resources through research, education, and outreach. Their mission is to protect and restore ocean health by providing science-based solutions.
Partners - international and national partners: scientists, universities, research institutes, NGOs, businesses
Contact: Amy Heemsoth, Director of Education, info@lof.org
Media - blog articles, current research, radio casts, scientific articles, art, workshops, seminars, films, education portal with background info for teachers, quizzes, graphics, photos, videos, and interactive media-maps, etc.
Audience - communicators, educators, scientists, students, NGOs, policy makers, resource managers, stakeholders
Content - carbon cycle, ocean chemistry, physiology, adaptation (coral reefs), ecology, ecosystems, human impacts, economic impacts
Content Level - No prior knowledge needed
Potential Gaps - not many materials with OA focus
Additional Notes - This site has great ocean science educational resources, many touch on OA (via coral reef ecology), but it's not a focus. All the curricula are developed in accordance with Next Generation Science Standards (NGSS), the Ocean Literacy Essential Principles and Fundamental Concepts (OL), and the Common Core State Standards (CCSS).

Lemonsea

http://lemonsea.org/lemonsea-project/
Organization - LEMONSEA was created in 2014 by a group of students passionate about the protection of the environment and more precisely by ocean preservation. Considering that Ocean Acidification is at the root of many of the issues that ocean conservation faces, we believe in the necessity of awareness raising in order to tackle the main drivers of acidification in a holistic approach. Their approach is focused on three main areas: to create innovative educational tools to popularize and facilitate the science on issues linked to Ocean Acidification; to contribute to the dissemination of knowledge by sharing relevant content on Ocean Acidification; to work with organizations or individuals committed to research and advocacy on Ocean Acidification issues.
Partners - Universities, local schools, research institutes, NGOs.
Contact: Monica Lafon Co Founder of Lemonsea.org, contact@lemonsea.org
Media - Infographics, videos, animations, articles, interviews, publications, reports, upcoming events
Audience - Communicators, educators, scientists, students, NGOs, policy makers, resource managers, stakeholders
Content - Carbon cycle, climate change, ocean chemistry, raising awareness for COP21, links between ocean and climate, physiology, adaptation, ecosystems, solutions.
Content Level - No prior knowledge needed
Potential Gaps - No lesson plans/activities
Additional Notes - Great resource for connecting OA to the climate conference happening in France. Lots of videos and infographics. Resources geared more towards public audience.

Marine Conservation Institute

http://www.marine-conservation.org/what-we-do/program-areas/ocean-acidification/
http://www.marine-conservation.org/media/filer_private/2011/04/18/mcbi_current.pdf
Organization - Marine Conservation Institute uses the latest science to identify important marine ecosystems around the world and then advocates for their protection. They work with scientists, politicians, government officials and other organizations to identify key threats to areas in the sea and then build workable solutions.
Partners - Antarctic and Southern Ocean Coalition, Conservation Alliance for Seafood Solutions, Deep Sea Conservation Coalition, Global Ocean Biodiversity Initiative, High Seas Alliance, Mission Blue, One World One Ocean, Holland America Line, Sargasso Sea Alliance, Seattle Aquarium
Contact: Vienna Saccomanno, Conservation Projects Coordinator Vienna.Saccomanno@marine-conservation.org
Media - site articles, blogs, news articles, reports, scientific journal articles, previous workshops/meetings
Audience - scientists communicators, students, NGOs, policy makers, resource managers, stakeholders
Content - climate change, carbon cycle, ocean chemistry, physiology, adaptation, ecosystems, ecosystem services, economic implications, solutions/policy options,
Content Level - Basic to advanced ocean/climate science knowledge needed for some materials
Potential Gaps - no materials specifically for educators
Additional Notes - Mostly reference materials, journals articles, and an in depth report on policy implications

National Geographic

http://ocean.nationalgeographic.com/ocean/explore/pristine-seas/critical-issues-ocean-acidification/
http://video.nationalgeographic.com/video/short-film-showcase/140623-oceans-warming-evt?source=relatedvideo
http://ngm.nationalgeographic.com/2011/04/ocean-acidification/kolbert-text
Organization - The National Geographic Society has been inspiring people to care about the planet since 1888. It is one of the largest nonprofit scientific and educational institutions in the world. Its interests include geography, archaeology and natural science, and the promotion of environmental and historical conservation.
Partners - NGOs, businesses, research institutes/universities
Contact: Melina Gerosa Bellows, Chief Education Officer, kids@ngs.org
Media - articles, pictures, infographics, animation, episode of "Strange Days on Planet Earth", links to other OA sites with reports, videos, articles
Audience - stakeholders, resource managers, communicators, NGOs, general public, families, students, policy makers
Content - carbon cycle, ocean chemistry, climate change/human impacts, physiology, adaptation, solutions
Content Level - No prior knowledge needed
Potential Gaps - No materials specifically for educators
Additional Notes -Great articles that go into a little more depth about the issue.

National Marine Sanctuaries Foundation

http://nmsfocean.org/
http://nmsfocean.org/article/2012/06/26/government-underfunding-critical-marine-research
Organization - created to assist the federally managed National Marine Sanctuary Program with education and outreach programs designed to preserve, protect and promote meaningful opportunities for public interaction with the nation's marine sanctuaries.
Partners - Friends of National Marine Sanctuaries, Friends of NOAA, Sanctuary Cruises Whale Watching, Sea Salts of Hawai'i, Qatar Foundation International, LLC (QFI) for "Ocean for Life," , Khaled bin Sultan Living Oceans Foundation, A Slice of Kianti's, and other local businesses
Contact: iShannon Yee, Policy and Conservation Manager, Shannon.m.yee@gmail.com
info@nmsfocean.org
Media - articles, PSA, links to reports
Audience - scientists communicators, students, NGOs, policy makers, resource managers, stakeholders
Content - carbon cycle, ocean chemistry, physiology, ecosystems, human impacts, OA funding and policy
Content Level - No prior knowledge needed
Potential Gaps -
Additional Notes - Great information on what projects are being funded and what future needs the foundation seeks to address. Very little original content on OA however.

Natural Resources Defense Council (NRDC)

http://www.nrdc.org/oceans/acidification/
Organization - Environmental action group, combining the grassroots power of more than 2 million members and online activists with the courtroom clout and expertise of nearly 500 lawyers, scientists and other professionals.Staff work with businesses, elected leaders, and community groups on the following issues: Curbing Global Warming and Creating the Clean Energy Future; Reviving the World's Oceans; Defending Endangered Wildlife and Wild Places; Protecting Our Health by Preventing Pollution; Ensuring Safe and Sufficient Water; Fostering Sustainable Communities
Partners - other non-profits, community groups, gov agencies, universities, businesses, policy institutes
Contact: Sarah Chasis, Senior Attorney and Director, Oceans Program, Press Contact: Anne Hawke, ahawke@nrdc.org,, 202-513-6263
Media - video (Sigourney Weaver), interactive map, infographics, case studies, links to other NOAA OA materials, articles, current projects/research
Audience - scientists communicators, students, NGOs, policy makers, resource managers, stakeholders
Content - climate change, ocean chemistry, physiology, adaptation, economic impacts, solutions
Content Level - basic to no science knowledge needed for most resources
Potential Gaps - no materials specifically for educators
Additional Notes - great infographics and introductory article on OA. Case studies from fishermen all over the country illustrate how effects of OA may vary in different locations. Great OA resource links, substantial material for "solutions" topic.

NOVA Education

http://www.pbs.org/wgbh/nova/earth/lethal-seas.html
http://www.pbs.org/wgbh/nova/search/results/page/1/include-teachers/only?q=acidification
Organization - NOVA Education tailors NOVA's digital resources for educators in science, technology, engineering, and mathematics. Our free educator library is produced according to teaching standards and includes videos, audio segments, lesson plans, and interactives designed to facilitate effective classroom integration. NOVA Education is committed to creating digital learning resources that work for educators.
Partners - Woods Hole Oceanographic Institute, Georgia Institute of Technology, Australian Institute of Marine Science, St. Joseph's College of Maine, UCSB, James Cook University, Antarctic Climate & Ecosystems CRC
Contact: Brooke Havlik, Education Manager, NOVAeducation@wgbh.org
Media - Documentary: Lethal Seas (2015), teacher videos, article
Audience - Communicators, educators (informal and formal), students, stakeholders, families
Content - Coral reef physiology and adaptation in Papua New Guinea, climate change, carbon cycle, ocean chemistry, adaptation, ecosystems, ecosystem services
Content Level - No prior knowledge needed
Potential Gaps -
Additional Notes - They have a handful of videos for teachers about OA.

Ocean Conservancy

http://www.oceanconservancy.org/our-work/ocean-acidification/?referrer=https://www.google.com/
http://www.ecy.wa.gov/water/marine/oa/20120523_publicopinion_presentation.pdf
Organization - Ocean Conservancy educates and empowers citizens to take action on behalf of the ocean. From the Arctic to the Gulf of Mexico to the halls of Congress, Ocean Conservancy brings people together to find solutions for our water planet. Informed by science, our work guides policy and engages people in protecting the ocean and its wildlife for future generations.
Partners - Government agencies, NGOs, univeristies, businesses, community stakeholder groups
Contact: Sarah Cooley, Science Outreach Manager for Ocean Acidification program
Media - articles, videos, blogs, infographics, current projectsa and research, data visualizations, links to other resources
Audience - teachers, communicators, students, NGOs, policy makers, resource managers, stakeholders
Content - carbon cycle, ocean chemisrty, physiology, adaptation, ecosystems, ecosystem services, economic impacts, solutions
Content Level - No prior knowledge needed
Potential Gaps - few formal education materials
Additional Notes - They present OA impacts on both the east and west coasts. Articles are well written, and easy to understand and digest. There are little to no formal education resources. This site geared toward information and updates on OA

Ocean Foundation

https://www.oceanfdn.org/resources/ocean-acidification

Organization - The Ocean Foundation is a unique community foundation with a mission to support, strengthen, and promote those organizations dedicated to reversing the trend of destruction of ocean environments around the world. The Ocean Foundation works with donors who care about our coasts and oceans to provide financial resources to marine conservation initiatives.

Partners -

Contact: Karen Muir , Vice President, Operations, kmuir@oceanfdn.org

Media - Fact sheets, videos, reports, articles, blog posts

Audience - General public

Content - Climate change, OA, ocean sustainability, fisheries and effects of climate change and OA on fisheries and the economy, hypoxia, carbon calculator

Content Level - Most content does not require much prior knowledge although there are links to journal articles and more technical reports that may be difficult for audiences without some general knowledge.

Potential Gaps -

Additional Notes -

Ocean Futures Society

http://www.oceanfutures.org/news/blog/ocean-acidification-crumbling-shells-sea

Organization - Ocean Futures Society is committed to educating the public on marine conservation and finding sustainable solutions to protect our ocean planet. From creating educational programs around the world that immerse children in nature, to communicating the importance of sustainable living, to producing documentaries that shed light on the state of the planet, Ocean Futures Society reaches both large and small audiences, winning hearts, and helping people fall in love with nature.

Partners - sustainable/ocean minded businesses, other NGOs

Contact: Laura Beands Leulier, Education Associate/Naturalist, lbrands@oceanfutures.org

Media - infographic, news articles (nat and internat), photos, blogs/newsletters

Audience - general public, students

Content - climate change, carbon cycle, ocean chemistry, physiology, adaptation, ecosystems, ecosystem services, economic implications, solutions

Content Level - No prior knowledge needed

Potential Gaps - no materials specifically for educators, no links to more OA information

Additional Notes - Although the site has one very clear and comprehensive article about OA from 2014, there is little else beyond a couple of blog updates about the topic

Ocean Health Index

http://www.oceanhealthindex.org/methodology/components/ocean-acidification

Organization - The Ocean Health Index is a valuable tool for the ongoing assessment of ocean health. By providing a means to advance comprehensive ocean policy and compare future progress, the Index can inform decisions about how to use or protect marine ecosystems. The Index is a collaborative effort, made possible through contributions from more than 65 scientists/ocean experts and partnerships.

Partners - National Center for Ecological Analysis and Synthesis (NCEAS), Sea Around Us, Conservation International, National Geographic, and the New England Aquarium.
Contact: Lindsay Mosher, Coordinator, lmosher@conservation.org
Media - Articles, infographics, data, links to other OA resources and journal articles
Audience - Communicators, educators, students (upper level), resource managers, policy makers, scientists, stakeholders
Content - Carbon cycle, ocean chemistry, climate change, ecosystem, ecosystem services, human impacts, ocean chemistry, physiology, human health, economic impact
Content Level - Basic to intermediate ocean/climate science needed for some information
Potential Gaps - Not to much information on solutions.
Additional Notes - Article gave a nice overview of OA and the methodology they used to measure its impact. Links to infographics and raw data were dispersed throughout description.

Oregon Explorer

http://oregonexplorer.info/topics/ocean-acidification?qt-subtopic_quicktab=0&ptopic=4063
Organization - Interactive website that encourages science exploration. They provide an array of topics, places, tools, and data to explore.
Partners - Oregon State University, Institute for Natural Resources, Oregon Department of Administrative Services Geospatial Enterprise Office,
Contact: Janine Salwasser, Program lead, janine.salwasser@oregonstate.edu
Media - Articles, stories, maps, tools, reports, publications, data, videos, links to external resources
Audience - Teachers, communicators, students, NGOs, policy makers, resource managers, stakeholders
Content - Carbon cycle, climate change, ecosystem impacts, physiology
Content Level - Basic ocean and climate science needed
Potential Gaps -
Additional Notes - Resources provide a good introduction to OA

Seattle Times Sea Change

http://apps.seattletimes.com/reports/sea-change/2013/sep/11/pacific-ocean-perilous-turn-overview/
Organization - Sea Change is the result of months of research by photographer Steve Ringman and reporter Craig Welch, who traveled from Dutch Harbor, Alaska, in the North Pacific to Papua New Guinea in the South Pacific to detail what is at stake as ocean chemistry changes. Nearly every important peer-reviewed study available — hundreds in all — was examined for the project. About 150 people in the United States and around the world were interviewed, while scientists in a half-dozen countries were coaxed into sharing early glimpses of pending research to make sure readers received the most up-to-date work in the proper context. Welch and Ringman visited hatcheries, research labs and fish-processing plants in four states.
Partners - National and International scientists, research institutes, fishers, supported by Pulitzer Center.
Contact: Craig Welch reporter, Steve Ringman, photographer sringman@seattletimes.com
Media - Videos, research updates, articles, photos, maps, case studies, live chat
Audience - Communicators, educators (informal and formal), students, stakeholders

Content - Carbon cycle, ocean chemistry, climate change, ecosystem, ecosystem services, human impacts, ocean chemistry, physiology (variety of animals), adaptation, economic impact, political hurdles/solutions.
Content Level - No prior knowledge needed
Potential Gaps - No OA resources specifically for educators
Additional Notes - Very visual site with great resources for OA information. Articles and videos lay out material in a very tangible, story-like way and focus on human aspects of issue - case studies- impacts to fisheries and livelihoods.

Sustainable Fisheries Partnership

http://www.sustainablefish.org/
https://www.sustainablefish.org/global-programs/global-ocean-health
Organization - Sustainable Fisheries Partnership (SFP) is a young and dynamic, business-focused NGO that is reshaping the world of corporate responsibility through the creation of powerful information tools and a methodology that allows companies to directly engage with suppliers of natural resources. It does not campaign or provide eco-labels, but works to reduce the barriers to action by industry in creating a more sustainable world. SFP operates through two main principles: information and improvement.
Partners - companies, nonprofit organizations, universities, and local communities
Contact: Blake Lee-Harwood, Strategy, Communications and Analysis Director, blake.lee-harwood@sustainablefish.org
Media - articles, current initiative descriptions, links to videos, testimonials, slideshows, press releases, infographics, reports
Audience - stakeholders, resource managers, communicators, NGOs
Content - ecosystems, physiology, economic impacts (fisheries and aquaculture), adaptation, lessons learned, climate change, carbon cycle, ocean chemistry
Content Level - little to no prior knowledge needed
Potential Gaps - no materials specifically for educators
Additional Notes - Information more pertinent to commercial users, resource managers, and other related organizations/businesses. Reports and media focus on implications for those with economic interests in the issue.

Teen4Oceans

http://teens4oceans.ning.com/blog/ocean-acidification-it-s-complicated
Organization - The purpose of the Teens4Oceans programs is to provide activities, resources, and experiences to youth who are passionate about ocean conservation. Students learn about their personal connections to our ocean and become informed young adults.
Partners - 5 Gyres, Audobon Society, Centro Ecologico Akumal, Colorado Parks and Wildlife, Dive BVI, FL International University, Monterey Bay Seafood Watch, Ocean Legacy Foundation
Contact: Zack Rago, Research and Outreach Coordinator
Media - Blog posts, infographic, photos
Audience - Communicators, educators (informal and formal), students
Content - Climate change, carbon cycle, physiology, ecosystems
Content Level - No prior knowledge needed
Potential Gaps - Not many OA resources

Additional Notes - Site features a blog, videos, forum, photos, and events for teens to get involved with ocean conservation. OA not a focus, but mentioned.

The Nature Conservancy

http://blog.nature.org/science/2013/05/20/ocean-acidification-the-next-big-threat-to-coral-reefs/
http://www.nature.org/ourinitiatives/habitats/oceanscoasts/explore/toxic-oceans.xml
Organization - The Nature Conservancy is the leading conservation organization working around the world to protect ecologically important lands and waters for nature and people. They operate in all 50 states and more than 35 countries — protecting habitats from grasslands to coral reefs.
Partners - Government organizations, companies, non-profits, local stakeholders, indigenous communities, multi-lateral/bilateral institutions, white papers, case studies, reports
Contact:Stephanie Wear, Global Marine Team, Geraldine Henrich-Koenis, Media Contact Phone: (703) 841-3939, E-mail: ghenrich-koenis@tnc.org
Media - blog articles, pictures/infographics, news articles, videos, current TNC projects, Q/A with scientist, links to presentations, journal articles
Audience - stakeholders, resource managers, communicators, NGOs, general public, families, students, policy makers
Content - climate change, carbon cycle, ocean chemistry, adaptation, physiology (coral reefs) human impacts, ecosystems, ecosystem services, solutions
Content Level - little to no prior knowledge needed
Potential Gaps - no materials specifically for educators
Additional Notes - Many of the resources on the topic of OA were blog articles. They are posted quite frequently and contain relevant, up-to-date information, report summaries, and links to research.

Upwell

http://www.upwell.us/about-upwell
http://www.upwell.us/oceanacidification#overlay-context=
https://docs.google.com/document/d/1AdLfo_u3fzLpKAT4OjClcwCJHH9Uph2HFDtIM0zVmVE/edit
Organization - Look for trends in what people are saying online related to ocean issues, curate and contextualize the best ocean content, create tools, and forge connections to help these conversations push past sticking points. Overall trying to bring value to the work of ocean conservationists by making missed opportunities a thing of the past. Their three main activities include: monitoring and analyzing online conversations, leading data-driven attention campaigns, and sharing knowledge with the sector.
Partners - members include those from universities, research institutes, gov agencies, and other non-profits
Contact:tips@upwell.us or Rachel Dearborn, Campaign Lab Director, http://www.upwell.us/hire-upweller
Media - articles, music video, webinar, reports
Audience - resource managers, communicators, educators, scientists, students, NGOs, stakeholders
Content - physiology, adaptation, trends online in talking about OA, communication techniques
Content Level - No prior knowledge needed

Potential Gaps - no materials specifically for educators
Additional Notes -Comprehensive Tide Report about what and how people are talking about OA online, what terms they're using, where they're coming from, etc. It just came out in 2015 so it might be a great starting point in terms of measuring effectiveness of OA implementation actions later on.

Waterways TV Show

https://www.youtube.com/user/WaterwaysTVShow
Organization - Waterways is an environmental education series focusing on the health and study of the south Florida and Florida Keys natural ecosystems. They do interviews with pre-eminent scientists along with stunning visuals from the mosaic of habitats that encompass south Florida. This series covers everything from the swamps of the Everglades to the coral reefs of the Florida Keys.
Partners - Sponsored by the Florida Keys National Marine Sanctuary, Everglades National Park and the US Environmental Protection Agency
Contact: Erik Hutchins, Director (can message through youtube station)
Media - October 23, 2014: Documentary on Ocean Acidification “OA and Tortugas Tide Gauge"
Audience - Communicators, educators (informal and formal), students, stakeholders, families
Content - Ocean chemistry, carbon cycle, climate change, rate of change, physiology, adaptation, ecosystems, ecosystem services, solutions, current OA monitoring
Content Level - No prior knowledge needed
Potential Gaps -
Additional Notes - Video is about 26min

Research Institutes

Alaska Center for Climate Assessment and Policy (ACCAP)

https://accap.uaf.edu/
http://cpo.noaa.gov/ClimatePrograms/ClimateandSocietalInteractions/RISAProgram/RISATeams/ACCAP.aspx

Organization - ACCAP partners with stakeholders to inform realistic community plans and climate adaptation strategies using the most scientifically accurate, reliable, and up-to-date information. Stakeholder interaction and outreach is integrated into every aspect of ACCAP's work, including climate modeling and addressing regional vulnerabilities. These interactions include needs assessment, vulnerability assessment, as well as user collaboration in downscaling models, designing research studies, and developing, testing, and evaluating research information products and tools. ACCAP's core activities integrate research and decision-support tool innovation.
Partners - Scientists, engineers, State and local planners, policy-makers, governments, transportation, natural resource and land management agencies, Native non-profit organizations and Alaska Native tribes, Industry, NGOs
Contact: Jeremy Mathis Director, OA Research Center at Univ of AK Fairbanks, jmathis@sfos.uaf.edu, Tina Buxbaum, Program Manager, ACCAP, tmbuxbaum@alaska.edu
Media - current projects, decision suppport tools, journal articles, infographics, reports, links to other resources, webinars, podcasts, OA video
Audience - resource managers, policy makers, communicators, NGOs
Content - OA vulnerability index, public perception, climate change, economic impacts, needs assessment
Content Level - basic ocean/climate science knowledge needed
Potential Gaps -
Additional Notes - Focus on OA in Alaska, provides a good number of documents and resources

C-MORE, University of Hawaii Oceanography

http://cmore.soest.hawaii.edu/education/teachers/science_kits/ocean_acid_kit.htm

Organization - The Center for Microbial Oceanography: Research and Education (C-MORE) is a recently established (August 2006) NSF-sponsored Science and Technology Center designed to facilitate a more comprehensive understanding of the diverse assemblages of microorganisms in the sea, ranging from the genetic basis of marine microbial biogeochemistry including the metabolic regulation and environmental controls of gene expression, to the processes that underpin the fluxes of carbon, related bioelements and energy in the marine environment. C-MORE's primary mission is: Linking Genomes to Biomes.
Partners - University of Hawaii, School of Ocean and Earth Science and Technology, NSF
Contact: kits@soest.hawaii.edu, Jim Foley
Media - Website, downloadable lesson plans, OA "kits" for education labs
Audience - Grades 6-12

Content - Ocean acidification lesson plans, powerpoints (both narrated and non-narrated), student worksheets, and lab kits which include pH and CO2 probes, and equipment necessary to perform a few simple experiments which are detailed in the lesson plans, lab kits are available for short term use by contacting the program. Lesson plans are available for integrating into different courses (e.g., biology, chemistry, environmental sciences, marine science, etc)
Content Level - Background content is provided, so very little prior knowledge would be needed for the educator or students
Potential Gaps -
Additional Notes - Address Ocean Literacy Principles 2,3, and 6 as well as some science and math standards for Hawaii, California, and Oregon, yeast experiment was developed for NGSS

Central Caribbean Marine Institute (CCMI)

http://reefresearch.org/research/climate-change-ocean-acidification/
http://reefresearch.org/files/uploads/Research_Report_2013.pdf
http://reefresearch.org/files/uploads/Education_Report_2013.pdf
Organization - The Little Cayman Research Centre (LCRC) serves as the heart and home-base of CCMI's research and education programs, providing the laboratories, classroom, accommodations, vehicles, boats, and oceanographic instrumentation for scientists to conduct vital research. CCMI resident scientists focus on three core areas of research: Ocean Health and Resilience, Biodiversity, and Science & Society.
Partners - Universities, NGOs, research institutes
Contact: Tom Sparke, Education and Programme Coordinator, tsparke@reefresearch.org
Media - Videos, articles, current research, infographics, scientific journal articles, reports, research experience for undergrad (REU), marine ecology camp w/ OA activities (grades 9-12), camps and workshops for other students
Audience - Teachers/communicators, managers, students, policy makers, scientists, NGOs
Content - Climate change, ocean chemistry, physiolog,and adaptation of corals, ecosystems, solutions
Content Level - basic knowledge for articles and education materials, advanced knowledge needed for scientific journal articles and some reports
Potential Gaps -
Additional Notes - Great resource for informational articles and current Caribbean research on OA.

From questionnaire: "July 27, 2009: Video of the Little Cayman CREWS Station on YouTube, September 10, 2015: Video clip used to introduce topics and highlight the research focus of line offices and labs that make up the NOAA Southeast and Caribbean Regional Collaboration Team (SECART) at their annual Summit meeting."

Global Ocean Health - National Fisheries Conservation Center

http://globaloceanhealth.org/resources/video/
Organization - Focused primarily on ocean acidification (OA), Global Ocean Health is a program of the National Fisheries Conservation Center. The program's mission is to protect seafood supplies, coastal communities and marine ecosystems from ocean acidification and related impacts by enabling people and businesses that depend on these resources to confront the causes and consequences of this devastating, pollution-induced threat. Those who earn a living

from healthy seas can exert a powerful influence for policies to protect them. They do not lobby. Instead, they help resource-dependent people acquire the skill and knowledge to shape stronger policy themselves.
Partners - Inter-American Tropical Tuna Commission, Iudicello & Assoc. Consulting, Landye Bennett Blumstein, Sustainable Fisheries Partnership and NFCC, Hawaii Institute of Marine Biology & Oceanography
Contact: Dr. Brock B. Bernstein, President, brock@brockbernstein.com
Media - Videos, "technical videos", animations, time lapse maps/visualizations, reports, journal publications, OA conferences/events, links to webinars (SOARCE), news articles.
Audience - Communicators, educators (informal and formal), scientists, resource managers, policy makers, students, stakeholders, NGOs
Content - Economic impacts, carbon cycle, ocean chemistry, physiology, policy, adaptation, ecosystems, climate change, stakeholder knowledge, individual solutions.
Content Level - No prior knowledge needed for majority of resources. Advanced knowledge needed for "technical" resources/videos
Potential Gaps - No lesson plans or education-specific OA resources
Additional Notes - Compiled videos, articles, webinars, and media from all different US and international organizations. Very comprehensive collection of materials. They also have an entire tab on "How You Can Help".

Institute for Systems Biology

http://see.systemsbiology.net/series/ocean-acidification-systems-approach-global-problem/
https://www.systemsbiology.org/news/tag/ocean-acidification/
Organization - Institute for Systems Biology (ISB) is a nonprofit biomedical research organization based in Seattle. They participate in the formation of companies, and strategically partner with industry to transfer technologies, products and new concepts generated by their projects. They also transfer knowledge via advanced courses for postdocs and professionals; curriculum development for high schools; professional development for K-12 and college faculty; and influencing education policy at the state and national levels.
Partners - universities, research institutes, businesses
Contact: Claudia Ludwig, Education Program Manager, cludwig@systemsbiology.org
Media - journal articles, article summaries, OA modules/lessons with teacher instruction, activities, labs, worksheets, videos, additional resources, interactive media
Audience - scientists, managers, communicators/teachers (grades 5-12)
Content - carbon cycle, physiology, ocean chemistry, adaptation, ecosystems, ecosystem services, human impacts, student engagement, climate change
Content Level - basic knowledge needed for education materials and intermediate to advanced ocean/climate science knowledge needed for articles and reports
Potential Gaps -
Additional Notes - Provide Systems Education Experiences with 6 comprehensive OA modules (great intro video about the modules), teacher opportunities, student internships, Full list of software downloads and tools for analysis also available

Monterey Bay Aquarium Research Institute

http://www.mbari.org/earth/mar_chem/ocean_acid/oa_lesson.html

http://www.mbari.org/highCO2/
http://www.mbari.org/topics/chemistry/chem-main.htm
Organization - The mission of MBARI is to achieve and maintain a position as a world center for advanced research and education in ocean science and technology, and to do so through the development of better instruments, systems, and methods for scientific research in the deep waters of the ocean. MBARI emphasizes the peer relationship between engineers and scientists as a basic principle of its operation.
Partners - Universities, research institutes, government agencies, NGOs, businesses
Contact: George Matsumoto, Senior Education and Research Specialist, mage@mbari.org
Media - News articles, journal articles, fact sheet, lesson plans, data map, infographic, video, current research and data, links to other OA resources, talks, reports, posters, conference materials
Audience - Teachers/communicators, managers, students, policy makers, scientists, NGOs
Content - Carbon cycle, ocean chemistry, climate change, physiology, adaptation, ecosystems, ecosystem services, communicating OA
Content Level - Basic climate/ocean science knowledge needed
Potential Gaps - OA materials are found under different headings on the site - have to use internal search to find many.
Additional Notes - This website has a plethora of information, tools, media, and resources on OA. An internal webpage search brings up 10pgs of links to materials.

Mote Marine Laboratory

https://mote.org/research/program/ocean-acidification
Organization - An independent marine research institution comprised of marine scientists committed to the belief that the conservation and sustainable use of our oceans begins with research and education. Organization includes an aquarium and field stations.
Partners - NGOs, aquariums, universities, research institutes, businesses, government agencies
Contact: Aly Bussey Assistant Vice President for Education alybusse@mote.org, Emily Hall Staff Scientist and OA Program Manager emily8@mote.org
Media - OA roundtable meeting report, articles, current research, fun facts, events,
Audience - teachers/communicators, managers, students, policy makers, scientists, NGOs
Content - carbon cycle, ocean chemistry, physiology, adaptation, human impacts,
Content Level - No prior knowledge needed
Potential Gaps - There could be more information/links on the OA page
Additional Notes - OA page is a little light on information, but the education section provides a variety of resources - they are very strong in programming/events. Comment from questionnaire: September 2, 2015: Meeting report created from the Florida OA Roundtable hosted by the Ocean Conservancy at the Mote Marine Lab in Sarasota, FL

Ocean Margin Ecosystems Group for Acidification Studies (OMEGAS)

http://omegas.science.oregonstate.edu/
http://web.stanford.edu/group/microdocs/
Organization - OMEGAS is a consortium of scientists from different institutions along the US West Coast. This interdisciplinary research group was established with an award from the National Science Foundation. By bringing together researchers with diverse expertise across

disciplines and institutions, OMEGAS seek to meet society's demands for scientific information on ocean acidification across the California Current Large Marine Ecosystem (CCLME). Interdisciplinary collaborations across institutions focus research to determine how ocean acidification affects marine organisms, populations, and ecosystems.
Partners - NSF, Oregon State University, UC Santa Barbara, UC Davis, UC Santa Cruz, Monterey Bay Aquarium Research Institute, Stanford University, Univ of Hawaii, Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO)
Contact:Carol Blanchette, Research Biologist at UCSB, blanchet@lifesci.ucsb.edu
Media - current research, journal articles, posters, data, listserv, materials from conferences, upcoming events, blog, microdocumentary
Audience - scientists, managers, communicators
Content - physiology, ocean chemistry, oceanography, adaptation, ecosystems, ecosystem services
Content Level - Intermediate to advanced ocean/climate science knowledge needed
Potential Gaps -
Additional Notes -This is a great collection of current research, data, meetings, and events happening in the OA field. Information is geared mostly for a scientific audience.

Oregon Climate Change Research Institute

http://occri.net/climate-science/potential-impacts-of-climate-change/coastal-and-marine
http://occri.net/wp-content/uploads/2011/01/OCAR2010_v1.2.pdf
Organization - Created by Oregon legislation in 2004, the purpose of the institute is to: facilitate research by Oregon University System faculty on climate change and its effects on natural and human systems in Oregon; serve as a clearinghouse for climate change information; provide climate change information to the public in integrated and accessible formats; support the Oregon Global Warming Commission in developing strategies to prepare for and to mitigate the effects of climate change on natural and human systems; and provide technical assistance to local governments to assist them in developing climate change policies, practices and programs
Partners - Oregon universities, gov agencies, research institutes
Contact:Dr. Philip Mote, Director, pmote@coas.oregonstate.edu
Media - scientific journal articles, climate assessment report, current projects
Audience - scientists, managers, policy makers, communicators
Content - carbon cycle, ocean chemistry, physiology, human impacts
Content Level - intermediate to advanced ocean/climate science knowledge needed
Potential Gaps -
Additional Notes -Resources are geared toward a more scientific audience and cover local Oregon-related aspects of OA.

Scripps Institution of Oceanography (Classroom Connection)

https://scripps.ucsd.edu/research-topics/ocean-acidification
http://earthref.org/SCC/activities.htm
http://earthref.org/SCC/lessons/2013/seawaterchemistry/
Organization - Scripps is a research center for ocean, earth and atmospheric science research, education, and public service The Scripps Classroom Connection (SCC) aims to systematically and simultaneously improve communication skills of Earth Science graduate students and K-12

education in the San Diego Unified School District (SDUSD). The SCC iis based on a close collaboration between UC San Diego's Scripps Institution of Oceanography (SIO), and the SDUSD,. Key efforts and outcomes of our project include: (1) Development of an enduring, pedagogically-robust curriculum in Earth Sciences through a collaboration between scientists, teacher-educators, teachers and graduate students; (2) Training of a new breed of graduate students that is equally comfortable communicating their science to their specialist peers and to lay audiences; (3) Effectively raising Earth Science literacy in schools laying a foundation for a public that becomes an effective steward of our planet Earth.
Partners - Universities, research Institutes, San Diego Schools, scientists, NGOs, government organizations
Contact: Heather Page hnpage@ucsd.edu, Alison Dickens adickens@sandi.net
Media - lesson plans, news and scientific articles, current research, seminars
Audience - teachers/communicators, managers, students, policy makers, scientists
Content - physiology, adaptation, ocean chemistry, carbon cycle, climate change, human impacts
Content Level - basic to no prior knowledge needed
Potential Gaps - The Classroom Connection portal is not easily found on the main website
Additional Notes - Scripps has a classroom connection portal with comprehensive resources for teachers on a variety of ocean science topics. Each lesson plan also lays out which standards are met.

Stanford University's Inquiry to Student Environmental Action (I2SEA)

http://web.stanford.edu/group/inquiry2insight/cgi-bin/i2sea-r1b/i2s.php
http://i2sea.stanford.edu/AcidOcean/AcidOcean.htm
http://virtualmarinescientist.com/
Organization - Inquiry to Student Environmental Action (I2SEA), promotes international collaboration among secondary school and university students as they learn about, discuss, and envision solutions to shared environmental challenges. In particular, they offer free, interactive digital learning tools relating to marine and environmental sciences:
Partners - Hopkins Marine Station of Stanford University, The Sven Lovén Centre for Marine Sciences at the University of Gothenburg (Sweden),
Contact: Géraldine Fauville - Marine Education Project Manager geraldine.fauville@gu.se; Pam Miller - Curriculum & Outreach Coordinator pam.miller@stanford.edu, International contact at Sven Loven Center: Michael Klages, Director, Michael.Klages@loven.gu.se or Marie Moestrup Jensen, Marine Biologist and Communications Officer, marie.moestrup.jensen@loven.gu.se.
Media - slideshow, interactive maps, infographics, virtual laboratory, exercises, interative talk, carbon footprint challenge and calculator, links to other OA resources
Audience - Teachers/educators (high school and university students)
Content - Climate change, human impacts, ocean chemistry, physiology, life cycles, adaptation, ecosystems, solutions
Content Level - No prior knowledge needed
Potential Gaps -
Additional Notes - Great inventory of interactive media resources. Lesson plans also specify which science standards and ocean literacy principles they cover

Woods Hole Ocean Carbon & Biogeochemistry (OCB)

http://www.us-ocb.org/
http://www.us-ocb.org/about/outreach.html
Organization - OCB was established in 2006 as one of the major activities of the U.S. Carbon Cycle Science Program, an interagency body that coordinates and facilitates activities relevant to carbon cycle science, climate, and global change issues. The scientific mission of OCB is to study the evolving role of the ocean in the global carbon cycle, in the face of environmental variability and change through studies of marine biogeochemical cycles and associated ecosystems.
Partners - Universities, research institutes, government agencies
Contact: Simone Alin, Affiliate Associate Professor University of WA, simone.r.alin@noaa.gov
Media - Videos, links to books, fact sheets, articles, related links
Audience - Teachers/communicators, managers, students, policy makers, scientists
Content - Carbon cycle, ocean chemistry, physiology, ecosystems, economic impacts, adaptation, solutions
Content Level - Basic to no prior knowledge needed
Potential Gaps -
Additional Notes - Lots of links to OA resources

NOAA Cooperative Research Institutes

http://ci.noaa.gov/Locations.aspx
http://www.ci-mas.org/res_themes_03.html
http://www.fau.edu/searchpage/google_results.php?q=acidification&cx=00295302709250065967 3%3Ao7kscwfqif0&cof=FORID%3A11
http://www.northerngulfinstitute.org/outreach/conferences/2011/presentations/12-4_Lohrenz_pres.pdf
https://scripps.ucsd.edu/search/site/acidification
http://hmsc.oregonstate.edu/visitor-center/education/educator-resources/education-kits
Organization - The NOAA Cooperative Institutes are academic and non-profit research institutions that demonstrate the highest level of performance and conduct research that supports NOAA's Mission Goals and Strategic Plan. Cooperative Institutes are located at institutions whose geographic expanse extends from Hawaii to Maine and from Alaska to Florida. Currently, NOAA supports 16 Cooperative Institutes consisting of 42 universities and research institutions across 23 states and the District of Columbia.
Partners - NOAA, universities, other research institutes
Contact: Various - see contact list
Media - Current research, photos, data, news, reports, research articles, workshops, seminars, lesson, presentations, case studies, links to other resources, videos, education kits
Audience - Scientists, students (high school and college), communicators
Content - Climate change, carbon cycle, ocean chemistry, physiology, adaptation, ecosystems, solutions
Content Level - Basic ocean science knowledge needed
Potential Gaps -
Additional Notes - Good information on current OA research. Very few OA education materials

Yale Project on Climate Change Communication
http://environment.yale.edu/climate-communication/search/results/02a2b4967f01ff96be0c4e8d96b4a926/
http://environment.yale.edu/climate-communication/files/ClimateChangeKnowledge2010.pdf
Organization - The Yale Project on Climate Change Communication: Conducts research on public climate knowledge, risk perceptions, decision-making and behavior; Designs and tests new strategies to engage the public in climate science and solutions; Empowers educators and communicators with the knowledge and tools to more effectively engage their audiences.
Partners - Universities, other research institutes
Contact: climatechange@yale.edu, (203) 432-5055
Media - Report on American's Knowledge of Climate Change
Audience - Scientists, communicators, resource managers, policy makers
Content - Climate change, physiology, carbon cycle
Content Level - No prior knowledge needed
Potential Gaps -

Additional Notes - Interesting survey results about public's understanding of CC and OA

Zoos, Aquariums, and Museums (ZAMs)

Alaska SeaLife Center

http://www.alaskasealife.org/
https://www.youtube.com/watch?v=-PWIJI8-9nA
http://www.alaskasealife.org/New/education/?page=firstpage.php
Organization - The Alaska SeaLife Center generates and shares scientific knowledge to promote understanding and stewardship of Alaska's marine ecosystems.Center-based research projects help scientists discover reasons for declining marine animal populations and environmental changes. The Alaska SeaLife Center provides care for sick and injured marine animals, yielding important information about wildlife populations. From early education to Elderhostel, the Alaska SeaLife Center educational programs and presentations are designed to expand the public's knowledge of Alaska's marine ecosystems. The exhibits immerse visitors in Alaskan marine ecosystems and provide opportunities to watch animals in naturalistic habitats as well as research settings.
Partners - Ocean Alaska Science & Learning Center, Coastal America, North Pacific Research Board, University of Alaska Fairbanks
Contact: Laurie Morrow, Senior Education Manager lauriem@alaskasealife.org
Media - Reports, teacher workshop (integrating ocean principles into classroom), short video
Audience - Teachers/communicators, students, stakeholders, families
Content - carbon cycle, ocean chemistry, human impacts/climate change, physiology, ecosystems, solutions
Content Level - No prior knowledge needed
Potential Gaps - Few online resources on OA
Additional Notes -

Aquarium of the Pacific

http://www.aquariumofpacific.org/
http://www.aquariumofpacific.org/multimedia/player/ocean_acidification
Organization - The Aquarium of the Pacific's mission is to instill a sense of wonder, respect, and stewardship for the Pacific Ocean, its inhabitants, and ecosystems. Their vision is to create an aquarium dedicated to conserving and building Natural Capital (Nature and Nature's services) by building Social Capital (the interactions between and among peoples).
Partners - ZAMs, NOAA Sanctuaries (Channel Islands), NOAA Fisheries Service, CA Dept of Fish and Wildlife, CA Coastal Conservancy, ThankYouOcean, WWF, 350.org, city agencies
Contact: Dave Bader, Director of Education, dbader@lbaop.org , 562-951-1633
Media - Videos, animations, articles, events/lectures, webinars, reports, blogs, presentations
Audience - Teachers/communicators, students, stakeholders, families
Content - Climate change, carbon cycle, ocean chemistry, physilology, adaptation, ecosystems, human impacts, policy, solutions
Content Level - No prior knowledge needed
Potential Gaps -
Additional Notes - Great video webinars with scientists from PMEL. Lots of informational articles.

Baltimore Aquarium

http://www.aqua.org/blog/2014/october/ocean-adification-what-you-need-to-know
http://www.aqua.org/blog?tag=ocean-acidification
http://www.aqua.org/~/media/Files/Learn/Education%20Baltimore%20PDFs/Teacher%20Booklets/Biomes_Booklet_2-4.pdf

Organization - Mission is to inspire the conservation of the world's aquatic treasures. They help in restoring the wetlands of the Chesapeake Bay and in educating more than 100,000 Maryland school children a year, both at the Aquarium and in the classroom. The Aquarium's conservation and education programs, coupled with the many affordable-access programs offered to Maryland residents, ensure that nearly 400,000 Marylanders are able to visit the Aquarium each year.
Partners - Universities, businesses, government agencies, NGOs, other ZAMs
Contact:Andrew Rossiter, Director of State Aquarium, andrewro@hawaii.edu
Media - Articles, blog posts, OA task force reports, infographics, audio files, links to resources, press releases, interview, 2012 summit for oceans and climate change, outreach program for students
Audience - Communicators, educators (informal and formal (6-12)), students, stakeholders, families
Content - Carbon cycle, climate change, ocean chemistry, physiology, adaptation, ecosystems, ecosystem services, solutions
Content Level - No prior knowledge needed
Potential Gaps -
Additional Notes - Mostly blog articles on this topic, which do a great job of telling the whole story, from the larger causes to what people can do on an individual level. They have one outreach program for middle school and high school students. Although not OA related currently, the site also provides updates on legislation affecting environmental health.

Cal- Academy of Science

http://www.calacademy.org/explore-science/ocean-acidification-research
http://www.calacademy.org/explore-science/demystifying-ocean-acidification
http://www.calacademy.org:8080/sites/default/files/assets/docs/pdf/ftprogram-rock-oceanshellssummary.pdf

Organization - Offers programs of research, education, and public engagement to explore, explain, and sustain life on Earth. Organization has researchers all over the world. They work with governments, people, and organizations around the globe to help inform critical conservation decisions.
Partners - Universities, businesses, government agencies, NGOs, other ZAMs
Contact: Heather Doggett, Director of Visitor Programs, 410-576-3800 (admin line - no contact information available)
Media - Exhibit descriptions, news articles, blog posts, current research, lesson plans/activities, animations, links to videos, other resources, info on field trip programs and seminars
Audience - Communicators, educators (informal and formal), students, stakeholders, families
Content - Climate change, carbon cycle, ocean chemistry, physiology, adaptation, ecosystems, ecosystem services, economic impacts, solutions
Content Level - No prior knowledge needed

Potential Gaps -
Additional Notes - Lots of articles: describe new publications, current research, economic impacts, solutions and other topics. Activities and lesson plans identify which standards they cover. Also have descriptions of exhibits and programs

Disney's Epcot Center

https://disneyworld.disney.go.com/attractions/animal-kingdom/disney-animals-coral-reefs/
http://disneyparks.disney.go.com/blog/2014/05/wildlife-wednesdays-world-oceans-day-celebration-june-4-at-the-seas-with-nemo-friends-at-epcot/
Organization - Educational Disney theme park about the future & other countries.
Partners - Universities/local schools, businesses, NGOs, other ZAMs
Contact:Youth Education Program, online form: https://www.disneyyouth.com/about-disney-youth/contact-us/ask-a-question/, (877) 939-6884
Media - Article/description of exhibit, conservation efforts, info on events/programs for World Oceans Day, video of coral restoration projects
Audience - Communicators, educators (informal and formal), students, stakeholders, families
Content - Carbon cycle, climate change, ocean chemistry, physiology, ecosystems, solutions
Content Level - No prior knowledge needed
Potential Gaps -
Additional Notes - Have a coral exhibit in the future of the ocean section that talks about OA. Also a really cool video on coral restoration program in the Florida Keys sponsored by Disney. It briefly mentions OA.

Exploratorium

http://www.exploratorium.edu/
http://www.exploratorium.edu/snacks/ocean-acidification-in-cup
http://www.exploratorium.edu/visit/calendar/our-souring-seas-ocean-acidification-may-10-2014
Organization - The Exploratorium is a museum of science, art, and human perception located in San Francisco, California. They create tools and experiences that encourage active exploration: hundreds of explore-for-yourself exhibits; a website with over 50,000 pages of content; film screenings; workshops for lifelong learners including day camps for kids and family investigations; evening art and science events for adults—plus much more. They also offer professional development programs for educators that are at the forefront of changing the way science is taught. They share exhibits and expertise with museums worldwide.
Partners - Community Science Workshop Network, Discovery Cube, Boys & Girls Clubs of San Francisco, Techbridge, Center for Informal Learning and Schools (CILS) Research Team; Funding from S.D. Bechtel Jr. Foundation and the National Science Foundation.
Contact: Mary Miller,Science writer, Producer and Director for the Exploratorium's partnership with NOAA,mmiller@exploratorium.edu
Media - Activities/lesson plans (snacks), videos, articles, talks with scientists,
Audience - Teachers/communicators, students, stakeholders, families
Content - Carbon cycle, climate change, ocean chemistry, physiology, adaptation, ecosystems
Content Level - Basic chemistry knowledge would help for some of the activities, but technically none required

Potential Gaps - Little information on solutions
Additional Notes - They have a number of hands on science activities (snacks) that cover OA and various science standards

Georgia Aquarium

http://www.georgiaaquarium.org/
Organization - The Georgia Aquarium is the largest in the world, with about 120,000 animals. Along with education and outreach at the museum, it also partners with local universities to support conservation efforts and research both locally and outside of the US.
Partners - Businesses, universities, research institutions, other ZAMs
Contact: Joe Handy, Guest Experience and Education, jhandy@georgiaaQuarium.org
Media - Articles, species fact sheets, workshops
Audience - Communicators, educators (informal and formal), students, stakeholders, families
Content - Climate change, carbon cycle, physiology
Content Level - No prior knowledge needed
Potential Gaps - Few online OA educational resources and information
Additional Notes - Website focuses mainly on encouraging visitation. Very few articles came up in a google search for the aquarium and OA. http://www.huffingtonpost.com/dr-dave-randle/sustainable-tourism_b_4971673.html (feedback from a guest about not having much on climate change, OA, etc)

Liberty Science Center

http://lsc.org/
http://marine.rutgers.edu/outreach/pulsetalks/200710/activities.htm
Organization - Dedicated to bringing the excitement of science to people of all ages, Liberty Science Center houses 12 museum exhibition halls, a live animal collection with 110 species, giant aquariums, a 3D theater, the nation's largest IMAX Dome Theater, live simulcast surgeries, tornado and hurricane-force wind simulators, K-12 classrooms and labs, and teacher-development programs.
Partners - Universities, businesses, government agencies, NGOs, other ZAMs, COSEE
Contact: Patrick McQuillan, Vice President STEM Education, guestcomments@lsc.org
Media - Lecture, videos, presentation, worksheet, guides, activities, resources, past research symposium
Audience - Communicators, educators (informal and formal), students, stakeholders, families
Content - Carbon cycle, climate change, ocean chemistry, physiology, adaptation, ecosystems, solutions
Content Level - No prior knowledge needed
Potential Gaps -
Additional Notes - Internal search yeilded no results on OA, but a google search brought up Pulse- public lecture series hosted by Rutger and the PSC on climate and OA with links to resources

Monterey Bay Aquarium

http://www.montereybayaquarium.org/
https://futureoftheocean.wordpress.com/tag/ocean-acidification/
Organization - Organization aims to inspire conservation of the oceans. They have more than 35,000 creatures representing over 550 species that fill 34 major galleries, nearly 200 exhibits in all
Partners - MBARI, Center for Ocean Solutions, universities, local businesses
Contact: Sarah Mae Nelson, Director of Guest Experience Programs, snelson@mbayaq.org
Media - Articles (pictures, infographic, videos, actions for public), blog post about Xprize challenge
Audience - Communicators, educators (informal and formal), students, stakeholders, families
Content - Carbon cycle, climate change, ocean chemistry, physiology, adaptation, ecosystems, ecosystem services, policy updates, solutions
Content Level - No prior knowledge needed
Potential Gaps - No OA resources specifically for educators, internal search did not bring up all relevant information
Additional Notes - Internal site search brought up one blog post about OA xprize. Other OA resources of theirs are on Climate Interpreter site (collaboration between both of those organizations). Google search found OA blog articles with more resources and updates on current ocean/climate policy.

New England Aquarium

http://www.neaq.org/conservation_and_research/climate_change/climate_change_and_the_oceans.php
http://ocean.si.edu/sites/default/files/lesson_plan/additional_files/Impact%20of%20a%20Changing%20Climate%20on%20Coral%20Reefs.pdf
http://iprc.soest.hawaii.edu/users/tobiasf/Outreach/Outreach.html
Organization - The aquarium combines education, entertainment and action to address the most challenging problems facing the ocean. They offer a wide variety of educational programs and conservation initiatives.
Partners - Universities, businesses, government agencies, NGOs, other ZAMs
Contact: John Anderson - Director of Education janderson@neaq.org
Media - Articles, graphs, news articles, exhibits, lesson plans, activities, links to infographic animations and articles, conference presentations, blog articles, events, reports
Audience - Communicators, educators (informal and formal), students, stakeholders, families
Content - Carbon cycle, ocean chemistry, physiology, ecosystems, adaptation, solutions, current communication efforts at the aquarium, climate change, solutions
Content Level - No prior knowledge needed for majority of resources
Potential Gaps -
Additional Notes - New England Aquarium is collaborating with other aquariums across the country to lead a national effort to more effectively communicate the impacts of climate change and ocean acidification on marine animals, habitats and ecosystems.

North Carolina Aquarium

http://www.ncaquariums.com/fort-fisher/teachersstudents/climate-change-and-the-aquarium

https://www.youtube.com/watch?v=kxPwbhFeZSw
http://www.ncaquariums.com/outreach/changing-oceans
Organization - A system of three public aquariums located in Kure Beach, Roanoke Island and Pine Knoll Shores. All are operated by the Aquariums Division of the North Carolina Department of Natural and Cultural Resources. NC Aquarium Society purchased Jennette's Pier in Nags Head, the oldest pier along the Outer Banks. Year-round education programs and week-long summer camps focused on ethical practices in recreational fishing, marine science, and resource conservation are conducted at the pier. It's also used as a platform for ocean-related scientific research projects.
Partners - Universities, businesses, government agencies, NGOs, other ZAMs
Contact: Jennifer Metzler-Fiorino, Jennifer.Metzler-Fiorino@ncaquariums.com
Media - Articles, video, links to other climate change resources, outreach programs (lab activities), OA education report
Audience - Communicators, educators (informal and formal), students, stakeholders, families
Content - Climate change, carbon cycle, ocean chemistry, physiology (shellfish), ecosystems, ecosystem services
Content Level - No prior knowledge needed
Potential Gaps - Few online OA educational resources and information
Additional Notes - Site has a few articles about OA, and offers OA programs (covering NC standards) for teachers upon request, They also received a grant to promote green energy by testing different messaging on OA and climate change and then determining which topic/message encouraged visitors to purchase renewable energy certificates

Pacific Science Center, WA

http://pacsci-joomla.adhostclient.com/Carbon-Monitoring/carbon-monitoring
https://www.pacificsciencecenter.org/
Organization - The Pacific Science Center is a science museum located in Seattle, Washington and designed by Minoru Yamasaki for the 1962 World's Fair in Seattle. They aim to inspire a lifelong interest in science, math and technology by engaging diverse communities through interactive and innovative exhibits and programs.
Partners - corporate sponsors, other ZAMs, NGOs, government agencies
Contact:Zeta Strickland, Education Manager, zstrickland@pacsci.org
Media - None online
Audience - teachers/communicators, students, stakeholders, families
Content - N/A
Content Level -
Potential Gaps -
Additional Notes - Could not find any OA specific resources/exhibits/programs listed on the website. Internal search did not find anything either. Did not have permission to visit first link.
*From survey: "*Most of our products/activities were created with help from Pacific Science Center staff as potential things to be included in their OA Discovery Cart that staff roll out to complement the Atmospheric CO2 sensor on the space needle. We have a few props that we use to help us talk about OA at informal outreach events (ie. Science Weekend at an aquarium or science center). Most were created in partnership with Pacific Science Center (in Seattle, WA) for their Ocean Acidification Cart. 1. Poster with simple explanation about OA, 2. lego activity--building a shell in an regular or acid ocean, 3. toy car and CO2 tank and water with color indicator to show

changing pH. 4. pH color chart and scale for comparison We also have some one-page flyers describing Ocean Acidification research at Northwest Fisheries Science Center." - Casey Ralston

Patricia and Phillip Frost Museum of Science

http://www.miamisci.org/

Organization - Museum currently closed until Summer 2016. Mission is to inspire people of all ages and cultures to enjoy science and technology, in order to better understand ourselves and our world.
Partners - University of Miami, local NGOs
Contact: Education – 305-646-4226
Media - **OA booth for the Miami Underwater Festival** - from survey respondent
Audience - Communicators, educators (informal and formal), students, stakeholders, families
Content -
Content Level -
Potential Gaps -
Additional Notes - No online OA resources came up in internal search or in google search

Seattle Aquarium

http://www.seattleaquarium.org/ocean-acidification-and-carbon-footprint
https://www.youtube.com/watch?v=YJZgwloP50I&feature=youtu.be

Organization - The Seattle Aquarium is the ninth largest aquarium in the U.S. by attendance. Their mission is to inspire Conservation of Our Marine Environment, through exhibits, events, conservation and education programs, research activities and more.
Partners - Universities, businesses, government agencies, NGOs, other ZAMs
Contact: Jim Wharton,Director of Conservation & Education, (206) 693-6206, j.wharton@seattleaquarium.org or Nicole Killebrew, n.killebrew@seattleaquarium.org
Media - Videos, blog posts, volunteer events, informational articles, current research/monitoring, links to other OA resources
Audience - Communicators, educators (informal and formal), students, stakeholders, families
Content - Solutions, carbon cycle, ocean chemistry, physiology, climate change, carbon emissions, ecosystems adaptations
Content Level - No prior knowledge needed
Potential Gaps - Few online OA educational resources
Additional Notes - Aq has really neat programs aimed at climate change/OA solutions. They treat them as one in the same and really emphasize that link. They engage volunteers with programs to plant trees to sequester carbon, support community solar, etc. Aq also aims to go carbon neutral.

Waikiki Aquarium

http://www.waikikiaquarium.org/

Organization - Second oldest aquarium in the US that aims to inspire and promote understanding, appreciation and conservation of Pacific marine life and increase public awareness of the ecology

and conservation of marine life and reef habitats through aquarium exhibitory, research and education.
Partners - Universities, businesses, government agencies, NGOs, other ZAMs
Contact: Andrew Rossiter, Director of State Aquarium, andrewro@hawaii.edu
Media - Information about presentations, demonstrations, papers, events (interactive lessons), scientific journal article
Audience - Communicators, educators (informal and formal), students, stakeholders, families
Content - Climate change, carbon cycle, coral physiology, adaptation, ecosystems
Content Level - No prior knowledge needed
Potential Gaps - Few OA resources online
Additional Notes - Although there was mention of OA demonstrations, articles, lectures, activities, etc happening at the aquarium, there were no resources on their website.

International Organizations

BBC

https://www.youtube.com/watch?v=zXFK3dWfFsk
http://www.bbc.co.uk/search?q=Ocean+Acidification&sa_f=search-serp&suggid=
http://news.bbc.co.uk/2/hi/science/nature/7933589.stm
Organization - The BBC is the world's leading public service broadcaster. Its mission is to enrich people's lives with programmes that inform, educate and entertain.
Partners - Businesses, government, NGOs, research institutes
Contact: Kim Shillinglaw, Commissioning Editor, Science and Natural History, kim.shillinglaw@bbc.co.uk
Media - Documentary (2015, 32min), videos, articles, infographics, photos, interviews, radio broadcasts
Audience - Communicators, educators (informal and formal), students, NGOs, families, stakeholders, policy makers, resource managers
Content - Carbon cycle, climate change, ocean chemistry, physiology (CO_2 vents in Papau New Guinea), ecosystems, political issues, solutions, ecosystem services
Content Level - No prior knowledge needed
Potential Gaps -
Additional Notes - Lots of visual materials. Also interesting to note that they have been featuring OA in news articles and videos since 2009.

Bioacid

http://www.bioacid.de/front_content.php?idcat=583&idlang=22
Organization - As one of the largest national research programmes on ocean acidification, BIOACID has contributed to quantifying the effects of ocean acidification on marine organisms and their habitats, unravelling the mechanisms underlying the observed responses, assessing the potential for evolutionary adaptation, and determining how these responses are modulated by other environmental drivers. BIOACID aims to synthesize the information gained on ocean acidification impacts in an integrated assessment of sensitivities and uncertainties in order to identify the potential thresholds associated with ocean acidification, evaluate possible socio-economic consequences, identify management options and communicate its knowledge towards a wide audience, ranging from the scientific community, stakeholders and decision makers to the general public.
Partners - Federal Ministry of Education and Research (BMBF), GEOMAR Helmholtz Centre for Ocean Research Kiel
Contact: Dr. Michael Meyerhöfer, Coordinator mmeyerhoefer@geomar.de
Media - News articles, journal publications, current research, events, data, links to other international OA resources
Audience - Scientists, resource managers, communicators, policy makers
Content - Carbon cycle, climate change, ocean chemistry, physiology, ecosystems, ecosystem services, solutions

Content Level - Intermediate to advanced knowledge needed in ocean/climate science
Potential Gaps -
Additional Notes - This is a great resource with the latest international news and research on OA. More geared towards a scientific audience.

Digital Explorer

http://oceans.digitalexplorer.com/resources/
Organization - Provides free classroom resources for UK and international schools, educational events and workshops.
Partners - Global Change Institute (Queensland), Plymouth Marine Laboratory, University of Exeter and University of Queensland.
Contact: Josh Johnson, Curriculum Director (Science), info@digitalexplorer.com
Media - Lesson plans, experiments/labs, blog posts, articles, current research, classroom poster, case studies, slideshow, science booklet, data for classroom usage
Audience - Communicators, educators (formal), students
Content - Carbon cycle, physiology, ocean chemistry, climate change, ecosystems
Content Level - Basic chemistry and ocean science knowledge needed for some resources
Potential Gaps -
Additional Notes - Great resource for educators - classroom activities, articles, posters.

European Project on Ocean Acidification (EPOCA)

http://www.epoca-project.eu/
http://www.epoca-project.eu/index.php/restricted-area/documents/cat_view/15-education-files.html
http://www.epoca-project.eu/index.php/what-do-we-do/education/educational-activities/hands-onexperiments.html
Organization - The EU FP7 Integrated Project EPOCA (European Project on OCean Acidification) was launched in June 2008 with the overall goal to advance our understanding of the biological, ecological, biogeochemical, and societal implications of ocean acidification. The EPOCA consortium brings together more than 160 researchers from 32 institutes and 10 European countries.
Partners - Research Institutes and Universities (full list http://www.epoca-project.eu/index.php/who-are-we/institutions.html)
Contact: Jean-Pierre Gattuso, Project coordinator, gattuso@obs-vlfr.fr or Lina Hansson, Project manager, hansson@obs-vlfr.fr
Media - Current research, data, blog articles, journal publications, news and media coverage, book, report on best practices, guides, classroom and lab visits, infographics, posters, brochures, flyers, FAQs, experiments/activities, videos, articles, photos, trainings, workshops, meetings, public deliverables,
Audience - Scientists, resource managers, communicators (formal and informal), policy makers, stakeholders
Content - Theme I: Past and present changes in ocean chemistry
Theme II: Impacts of OA on organisms and ecosystems
Theme III: Improving models to predict OA impacts
Theme IV: Summary of results for business leaders, policy-makers and the general public

Content Level - No prior knowledge to advanced ocean science and climate knowledge needed
Potential Gaps -
Additional Notes - Very comprehensive collection of many different kinds of media organized into four different themes for dissemination among scientist and those beyond the scientific community

MedSeA

http://medsea-project.eu/
http://medsea-project.eu/outreach/media/
Organization - The European Mediterranean Sea Acidification in a Changing Climate (MedSeA) initiative is a project funded by the European Commission. It involves 22 institutions (including 6 associated partners) from 12 countries. MedSeA assesses uncertainties, risks and thresholds related to Mediterranean acidification at organismal, ecosystem and economical scales. It also emphasizes conveying the acquired scientific knowledge to a wider audience of reference users, while suggesting policy measures for adaptation and mitigation that will vary from one region to another.
Partners - Universities and research institutes in Europe and Africa
Contact: Patrizia Ziveri, Project Coordinator, patrizia.ziveri@uab.cat
Media - Articles, blog posts, journal publications, news, videos, interviews, links to educational videos, class labs, fact sheet, virtual lab, carbon footprint calc, key summary documents, events/training, links to other OA groups
Audience - Policy makers, educators, scientists, resource managers, stakeholders
Content - Climate change, carbon cycle, physiology, adaptation, ecosystems, ecosystem services, economic impacts, solutions/mitigation
Content Level - No prior knowledge to advanced ocean science and climate knowledge needed
Potential Gaps -
Additional Notes - Great collection of resources and research from the Mediterranean area

Oceana

http://usa.oceana.org/what-ocean-acidification
http://oceana.org/blog/topics/ocean-acidification
http://oceana.org/sites/default/files/reports/Ocean_Acidification_The_Untold_Stories.pdf
Organization - An international organization focused on protecting and restoring the world's oceans. Organization is dedicated to achieving measurable change by conducting specific, science-based campaigns. They have locations in USA/Canada, Europe, South America, and Asia.
Partners - NGOs, businesses, research institutes, governments
Contact: Alyssa Carnegie, Communications Director http://belize.oceana.org/contact or Dustin Cranor, Communications Director, dcranor@oceana.org
Media - Articles, infographics, current projects, blog posts, case studies
Audience - Communicators, educators (informal and formal), students, stakeholders, families
Content - Climate change, ocean chemistry, carbon cycle, physiology, ecosystems, ecosystem services, economic impacts
Content Level - No prior knowledge needed
Potential Gaps - No OA resources specifically for educators, no links to other OA resources

Additional Notes - Good introductory information. Resources targeted more for the general public than educators/communicators.

OA.net

http://ocean-acidification.net

Organization - International collaboration aimed at bringing information on ocean acidification to scientists, policymakers and the public. The site and resources are maintained by The International Geosphere-Biosphere Programme (IGBP), whose mission is to coordinate international research on global-scale and regional-scale interactions between Earth's biological, chemical and physical processes and their interactions with human systems.
Partners - International Geosphere-Biosphere Programme (IGBP), Intergovernmental Oceanographic Commission (IOC-UNESCO), Scientific Committee on Oceanic Research (SCOR), Ocean Acidification International Coordination Center (OA-ICC), Future Earth, Korean Institute of Ocean Science & Technology (KIOST)
Contact: Wendy Broadgate, Deputy Director, Natural Sciences, IGBP wendy@igbp.kva.se
Media - Articles, current research, policy summaries, data, presentations, publications, symposium materials, links to regional and international groups, videos, animations, publications, fact sheets, teaching tools.infographics
Audience - Policy makers, educators, scientists, resource managers, stakeholders
Content - Climate change, ocean chemistry, carbon cycle, physiology, adaptation and mitigation, ecosystems, ecosystem services, social impacts
Content Level - No prior knowledge to advanced ocean science and climate knowledge needed
Potential Gaps -
Additional Notes - Good resource targeted toward policy makers and the general public. Lots of intro material, scientific evidence, current research, and updates about OA.

Plymouth Marine Laboratory (UK Ocean Acidification Research Programme (UKOA)

http://www.pml.ac.uk/Research/Projects/UK-Ocean-Acidification-Research-Programme-(UKOA)
http://www.oceanacidification.org.uk/
http://www.oceanacidification.org.uk/Resources

Organization - The 5 year UK Ocean Acidification Research Programme (UKOA) works alongside the international partner programmes as the UK's response to widespread concerns about the increasing acidity of our oceans. UKOA research aims to increase understanding of how marine organisms, biodiversity and ecosystems respond to ocean acidification, improving knowledge of their resistance or susceptibility to acidification. Through making the results available, UKOA can inform and advise policy makers involved with climate change negotiations and managers of marine bioresources on the potential size and timescale of risks. This will allow for development of appropriate mitigation and adaptation strategies and inform negotiation of CO2 emissions reduction.
Partners - Universities, research institutes, German OA program (BIOACID), European research program (EPOCA),Mediterranean program (MedSeA), US ocean acidification research program.
Funders: Department for Environment, Food and Rural Affairs (Defra), the Natural Environment Research Council (NERC) and the Department of Energy and Climate Change (DECC)
Contact: Tim Smyth, Head of Science - Marine biogeochemistry and ocean observations, tjsm@pml.ac.uk

Media - Current research, articles, policy messages, publications, news events, infographics, graphs, data, presentations, training courses (scientists), videos, animations, links to other OA resources, blogs. fact sheets, guides
Audience - Policy makers, educators, scientists, resource managers, stakeholders
Content - Climate change, carbon cycle, physiology, adaptation, ecosystems, biodiversity impacts, ecosystem services, socio economic impacts, solutions
Content Level - No prior knowledge to advanced ocean science and climate knowledge needed
Potential Gaps -
Additional Notes - This site has a great compilation of resources and links to other organizations.

Key Findings/Conclusion

Ocean acidification is one of the issues at the forefront of the climate crisis. Therefore, it is and will continue to be widely discussed through various forms of media. Within the diverse array of resources reviewed in this report, the following trends have been identified:

Content

- **There is less information about "solutions" than other topics outlined in the Ocean Acidification Literacy Framework**

Many of the resources (produced by all organizations) include introductory information about what OA is, how it's caused, and what its impacts are. However, very few organizations go beyond to describe what people are doing about it on a national and local level. There are also very few resources that touch on policy or the government's role in OA.

- **Many organizations discuss climate change and OA separately**.

Although many websites mention increased levels of carbon dioxide as the driver for OA, many do not make a clear connection between climate change, human driven levels of CO2, and ocean acidification. There are also some websites that talk about climate change, but do not mention OA very much, or even at all.

- **Physiological impacts to calcifying organisms are very well discussed**

Websites do a thorough job of describing how OA will affect different organisms, especially economically important species. Case studies, interviews, videos, and research profiles help support this topic.

- **Many organizations specify which science standards are met through their content/lessons**

The topic of ocean acidification does satisfy many curriculum standards and would seem to integrate well into the formal education setting.

- **Most resources do not require a significant amount of prior ocean science knowledge**

Those that do are usually targeting other scientists or resource managers. However, not all of the websites specify who their intended audience is, which could potentially cause confusion.

- **Up-to-date OA information is somewhat difficult to parse out**

A few sites have an OA news section or blog with the most up-to-date information and links to new research/articles. Most other sites compile everything together.

Media

- **Not all existing OA media is accessible online**

Especially for aquariums and museums, information and media from OA exhibits, workshops, or presentations is not always available online.

- **Many sites provide links to external OA resources**

Government agencies and research institutes in particular, provide links to each other. This can help with search engine optimization (SEO).

Audience

- **Collaboratives and Research Institutes tend to have more resources specific to educators**

Many of the collaboratives and research institutes provide highly organized and comprehensive resources for teachers and informal educators (lesson plans, activities, modules, training, workshops), while most other organizations do a great job of providing supplemental materials (infographics, videos, news, links, etc).

- **Few resources specifically target policy makers, resource managers, and industry stakeholders**

Although most resources can be understood and used by the above groups, there are few that tailor information specifically to these audiences. Most provide foundational information for a general audience.

Technical

- **Internal site searches and website organization varies greatly**

Not all sites have functional internal searches, which can really help in finding specific topics. Many sites are also not organized by topic or media type. For example, if a teacher needed a short video about OA, it would be easier for her/him to google it rather than look through a known or trusted site.

- **SEO and responsive or mobile friendly websites/apps**

Mobile friendly sites will increase SEO and usability. Currently, the following resources rank higher for SEO. These are the first page results for a google search of “ocean acidification” (this will vary).

0. (Ads: Center for Biological Diversity and Terramar Project on OA)
    1. PMEL “OA”
    2. PMEL “What is OA?”
    3. Wikipedia
    4. Smithsonian Ocean Portal
    5. National Geographic “Pristine Seas”
    6. National Geographic “OA”

Further Information on OA and Climate Change Communication

- **Upwell Tide Report** - A full comprehensive analysis of what, who, where, and how effective OA communication is online (2012 - 2014).
- **Yale Climate Change Survey** - 2010, Gauges public opinion and perception about climate change and related issues (a couple questions about OA).
- **Project Drawdown** - A broad coalition of researchers, scientists, graduate students, PhDs, post-docs, policy makers, business leaders and activists that present the best available information on climate solutions in order to describe their beneficial financial, social and environmental impact over the next thirty years. Describes when and how humanity can reach climate drawdown, the point at which greenhouse gas concentrations in the atmosphere begin to decline on a year-to-year basis. Use mapping and modeling to show how one hundred existing, substantive solutions can continue to scale over the next three decades. They also offer interactive webinars so coalition members and the public can stay informed on approaches and solutions.