

The Ocean Acidification Regional Vulnerability Assessment Workshop Report



NOAA Technical Memorandum OAR-OAP-4

U.S Department of Commerce | National Oceanic and Atmospheric Administration | Oceanic and Atmospheric Research

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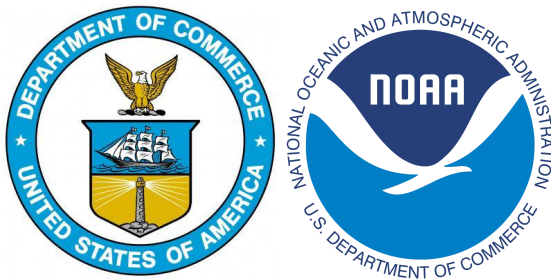
Convened by NOAA Ocean Acidification Program
September 22-24, 2021

Halle Berger, Courtney Cochran, Erica Ombres, and Alexandra Puritz

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Photo: A man and two children explore an exposed mudflat in New Hampshire with a rake and container. New Hampshire Fish & Game.

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The organizers extend sincere appreciation to the speakers and panelists at the workshop:

Simone Alin	NOAA Pacific Marine Environmental Lab
Catie Alves	NOAA Northeast Fisheries Science Center
Meg Chadsey	Washington Sea Grant / NOAA Pacific Marine Environmental Lab
Lisa Colburn	NOAA Northeast Fisheries Science Center
Darcy Dugan	Alaska Ocean Observing System / Alaska Ocean Acidification Network
Christopher Edwards	University of California Santa Cruz
Tobias Friedrich	University of Hawai'i at Mānoa
Marjorie Friedrichs	Virginia Institute of Marine Science
Karen Hudson	Virginia Institute of Marine Science
Thomas Hurst	NOAA Alaska Fisheries Science Center
Susan Inglis	Commercial Fisheries Research Foundation
Brian Katz	Oregon State University
Dominique Kone	California Ocean Science Trust
Kaitlyn Lowder	The Ocean Foundation
Melissa Melendez	University of Hawai'i at Mānoa
Jan Newton	University of Washington
Ryan Okano	State of Hawai'i Division of Aquatic Resources
Melissa Poe	Washington Sea Grant

Charlotte Regula-Whitefield	Oregon Department of Fish and Wildlife / Oregon Coordinating Council on Ocean Acidification and Hypoxia
Emily Rivest	Virginia Institute of Marine Science
Christopher Sabine	University of Hawai'i at Mānoa
Joe Schumacker	Quinault Indian Nation Department of Fisheries
Samantha Siedlecki	University of Connecticut
Ana Spalding	Oregon State University
Aaron Strong	Hamilton College
Andie Wall	Kodiak Area Native Association
Erika Wolters	Oregon State University
David Wrathall	Oregon State University

List of Abbreviations

COOR Act	Coordinated Ocean Observations and Research Act
IWG-OA	Interagency Working Group on Ocean Acidification
OA	Ocean Acidification
OAP	Ocean Acidification Program
RVA	Regional Vulnerability Assessment

Executive Summary

The NOAA Ocean Acidification Program (OAP) hosted a virtual workshop September 22-24, 2021 to bring together OAP-funded regional vulnerability assessment (RVA) project teams to discuss plans for new projects and hear lessons learned and results from projects wrapping up.

RVA proposals were solicited to address an important gap in understanding socioeconomic consequences of ocean acidification. Projects focus on informing where social vulnerabilities exist or are emerging and provide actionable information for marine resource decision makers. Projects may synthesize existing chemical and biological data or collect new socioeconomic data; they vary in scope and outcomes, with some projects focused on data synthesis or model creation, with others identifying social adaptation strategies. The first projects were funded in 2017, with additional projects funded in 2020 and 2021, so project teams participating in the workshop ranged from just starting to wrapping up their projects.

Main objectives of the workshop included helping the interdisciplinary community understand one another better, identifying important research gaps to guide future funding objectives, helping new projects avoid common pitfalls, and facilitating networking and collaborations. The first day of the workshop was open for anyone to attend with the goal of introducing a larger audience to the RVA projects.

The theme for the first day of the workshop was lessons learned; it included welcoming remarks, plenary talks, and discussions on challenges and lessons learned from the initially funded RVA projects. The second day's theme was methods and frameworks and featured a stakeholder panel discussion, tutorial breakout sessions, and lightning talks by the new RVA projects. The third and final day was focused entirely on gaps and consisted of a panel discussion and breakout sessions.

Bringing the different project teams together led to many fruitful discussions. Project teams discussed common barriers or challenges to conducting RVAs, the need for communication and relationship-building with stakeholders, and identified a number of research gaps. There was interest in furthering connections between RVA project teams through future workshops or webinars. Additionally, the workshop exposed new individuals to the RVA projects on the first day, potentially expanding the number of people interested in being involved in this work going forward.

Lessons Learned (Day One)

Welcoming Remarks

Dr. Libby Jewett, Director of the NOAA Ocean Acidification Program (OAP), set the stage for the workshop by introducing OAP's approach to funding regional vulnerability assessments (RVA). OAP recognizes that foundational environmental and biological sensitivity data are not available in each region and has thus structured funding calls in a way that allows for and adapts to this issue (i.e., providing options to conduct workshops or data syntheses that build towards future RVAs). Ongoing challenges include engaging stakeholders who may not be familiar with or worried about ocean acidification (OA) and transitioning the results from these projects to long term solutions.

Plenaries & Discussion

The welcoming remarks were followed by three plenary talks. The first plenary by Dr. Christopher Sabine (University of Hawai'i at Mānoa) provided a brief history of OA research and how the focus has evolved (i.e., from global to coastal monitoring and from single species, single stressor experiments to multi-stressor ecosystem studies). Dr. David Wrathall (Oregon State University) then discussed convergent approaches to vulnerability assessments using examples from habitability assessments. Finally, Dr. Lisa Colburn (NOAA Northeast Fisheries Science Center) talked about the ["wicked problem"](#) of linking social and ecological dimensions, drawing from her experience developing Community Social Vulnerability Indicators, the difference between transdisciplinary and interdisciplinary projects, and how it can be hard to have a project like this that crosses both boundaries.

The plenary talks were followed by a discussion session, which opened with an audience question asking, "Is there a limit to how many disciplines can be included before a project gets unwieldy? More expertise is always great, but are there any diminishing returns?" Dr. Lisa Colburn responded that it is not necessarily the number of disciplines that is important, but rather whether you have included the right ones. Referencing the work of Norris et al. (2016), she noted that building a transdisciplinary team is so complex that the paper does not even get into managing the team. The discussion then moved to other challenges associated with RVAs, which included conducting multi-stressor experiments in the field, attributing potential industry impacts to OA, and providing actionable knowledge to stakeholders. The speakers agreed that it is important to be clear about what a vulnerability assessment can do (e.g., identify drivers) and consider the context when deciding how to report the results (e.g., whether a low-med-high scale is appropriate). Social indicators can be ground truthed by going out into communities and asking them about the social forces at play.

Challenges & Lessons Learned: Talks & Panel Discussion

Day One of the workshop concluded with talks from the completed (or near complete) RVA projects. In addition to giving an overview of the project, speakers were asked to discuss challenges that arose during the project, how those challenges were overcome, and, if

applicable, how that influenced the outcomes (i.e., what did they wish they had known at the start of their project?). The session included the following talks:

- Seed Crisis at Whiskey Creek - Brian Katz (Oregon State University)
- The Olympic Coast as a Sentinel: An Integrated Social-Ecological Regional Vulnerability Assessment to Ocean Acidification - Dr. Simone Alin (NOAA Pacific Marine Environmental Lab)
- A Predictive Model for Ocean and Coastal Acidification Thresholds for the Gulf of Maine - Dr. Aaron Strong (Hamilton College)
- Vulnerability of the Largest U.S. Estuary to Acidification: Implications of Declining pH for Shellfish Hatcheries in the Chesapeake Bay - Dr. Marjorie Friedrichs (Virginia Institute of Marine Science)
- Development of an Atlantis Model for Hawai'i to Support Ecosystem-based Management - Dr. Kaitlyn Lowder (currently The Ocean Foundation and formerly The Joint Institute of Marine and Atmospheric Research/ Pacific Islands Fisheries Science Center)

Speakers shared many of the same challenges, such as addressing data gaps, combining different data types, engaging stakeholders, and managing transdisciplinary teams. Lessons learned from these challenges included working with partners in advance to establish compatible data collection, front-loading time to co-develop project plans and complete administrative tasks (e.g., data sharing agreements), seeking regular input from stakeholders, being flexible and patient, and forming continuing relationships that outlast the project.

During the discussion session, speakers shared several pieces of advice for new RVA teams. These included gathering stakeholders before the beginning of the project and building strong relationships between them and the team. It is important to build consensus in the very early stages of a project and to regularly communicate (i.e., more than once a year) with stakeholders. These strong relationships will make it easier to pivot as the project progresses. It is also important to be aware of who has not been brought to the table and may need to be included, even if outside of a formal advisory group. Speakers also advised to not underestimate the time needed to develop these relationships and to complete a project.

Speakers were also asked if it is necessary to complete data synthesis before beginning an RVA. They shared that it is not necessary, but could be helpful; for some projects, data may be coming from partners and one may need to do iterative rounds of analysis. They also advised OAP to lengthen the project periods from three to five years to allow projects sufficient time for collaboration. Additionally, continuing to provide spaces for researchers across disciplines to meet and collaborate is important, as a continued focus on the social impacts of OA is needed.

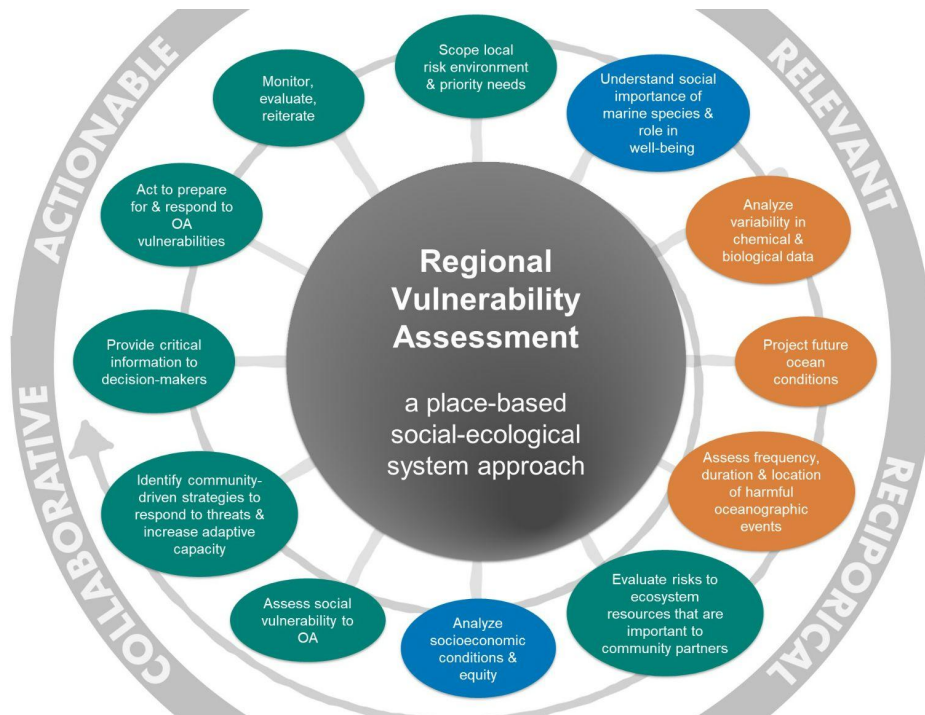


Photo: “Olympic Coast as a Sentinel: a place-based social-ecological system approach to regional OA vulnerability assessment.” Newton, J; Poe M; Schumacker, J. (2021). Co-Production of Knowledge for Olympic Coast Social-Ecological Systems and Change. Presentation at NOAA Ocean Acidification Program Workshop.

Frameworks & Methods (Day Two)

Stakeholder Perspectives Panel Discussion

Day Two of the workshop began with a stakeholder perspectives panel discussion. The moderators - Dr. Melissa Poe (Washington Sea Grant) and Dr. Meg Chadsey (Washington Sea Grant/NOAA Pacific Marine Environmental Lab) - kicked off the session with a brief video¹ about the Olympic Coast RVA, followed by a discussion of their experiences engaging tribal members in the project. The project included tribal partners as co-PIs and looked at species that were important to the tribes, as well as social indicators of community wellbeing and resilience.

The panel consisted of Dr. Susan Inglis (Commercial Fisheries Research Foundation), Karen Hudson (Virginia Institute of Marine Science), Ryan Okano (State of Hawai'i Division of Aquatic Resources), Dominique Kone (California Ocean Science Trust), and Andie Wall (Kodiak Area Native Association).

The panel was first asked what elements make it possible to engage with stakeholders as equal partners in the research process. Speakers mentioned understanding what is important and why

¹ <https://www.youtube.com/watch?v=9EOLSr4ZoDs>

to your partners, building two-way trust and being willing to be vulnerable yourself, and finding out what information will be relevant to the community. Also discussed was being cognizant of the capacity of the community to be involved and offering compensation, including stakeholders as PIs to allow for better communication, building time into the project for meaningful engagement and outreach, and taking into account the best way to reach stakeholders (some may not be tech savvy).

The next question posed was what barriers to engagement the panel has experienced and how these have been overcome. The panel shared that it is important to fully understand what barriers exist and to build projects around these barriers from the onset, offering support and continuing to build trust and close relationships with stakeholders. Challenges included making sure the entire team was up to speed on the disciplinary components, having to switch engagement strategies to keep interest, and knowing how to make the project seem relevant to stakeholders even if projected impacts are not yet occurring. The sea scallop project shared an example of addressing this last point. During a pilot workshop with industry members, several barriers were identified, including the stakeholders not thinking they should be worried about OA. Project members were able to develop talking points to address the stakeholders' questions, and will continue to answer additional questions as they arise and provide updates on project results.

Tutorial Breakout Sessions

The stakeholder panel was followed by tutorial breakout sessions focused on specific topics related to the development and application of RVAs. Each tutorial was led by an expert who gave a brief introduction to the topic followed by an interactive discussion with the attendees. Following the breakout sessions, attendees were asked to share one thing they learned on a jamboard presented to all of the workshop participants.

Dr. Catie Alves (NOAA Northeast Fisheries Science Center) gave a tutorial about ensuring underrepresented community participation, drawing from her work on the sea scallop RVA. This topic is relevant because OA is not only an environmental problem, but a social problem as well. Attendees learned that the trust and relationship-building discussed in the stakeholder panel directly relates to engaging diverse communities; it is important that the community understands and sees the results of their input. Furthermore, language is often a barrier, so projects should include community liaisons who speak the languages of the community members and who can help phrase questions in ways that community members can clearly understand.

Dr. Ana Spalding and Dr. Erika Wolters (Oregon State University) gave a tutorial on the use of surveys, interviews, and focus groups in RVAs. Attendees learned that Institutional Review Board approval can take a long time but is not required for interviewing policymakers or representatives of an organization. Attendees also learned that the distributor of the survey or interview matters; student-led surveys often receive more responses than faculty-led surveys. It is also important to maintain consistency in approaches by those interviewing. For focus groups, it is important to be intentional about participation. There are heterogeneous and homogeneous focus groups, and each has their own benefits and drawbacks.

Dr. Christopher Edwards (University of California Santa Cruz) gave a tutorial on OA-relevant models and how they can be used and improved for RVA applications. Attendees learned that it is important to communicate directly with the modelers because a lot of back and forth is needed to do the most meaningful work. For example, the temporal and spatial scales of the model will depend on what exact questions are being asked.

Brian Katz (Oregon State University) gave a tutorial about virtual engagement using geovisualization for top-down and bottom-up discussions. Attendees were asked to perform a role play exercise and provide input (data from “an unexpected change”) based on a hypothetical role (shellfish farmer, hatchery employee, or restoration manager) in the Chesapeake Bay area. Attendees learned that it is important to be clear about how sensitive information will be used in order to build trust and enhance partnerships. The use of zones to map sensitive data is a potential solution when working with partners that do not want to share specific location information. It is also important to consider potential accessibility issues (e.g., font size, colors, etc.) when creating products.

Dr. Jan Newton (University of Washington), Dr. Melissa Poe (Washington Sea Grant), and Joe Schumacker (Quinault Indian Nation Department of Fisheries) gave a tutorial about co-production of knowledge based on their experiences from the Olympic Coast RVA. Attendees learned that it is imperative to engage with stakeholders and co-producers early and involve them as co-PIs beginning with the proposal stage and throughout the research process. Among the infinite range of things you could study, Indigenous people and stakeholders will inform the researcher what they should study that can make a difference to resilience most relevant to local conditions, and then work with them on how to study it. It is also vital to be respectful of interviewees’ time and perspectives, and to attempt to demonstrate how their responses will be used. One critical aspect they note is that co-production takes time, time to establish and maintain relationships and two-way information flow. However, the result is highly valuable for both science and implementation. They note that the mechanisms to sustain these kinds of relationships beyond the project or support for training for those new to this approach are lacking.

Darcy Dugan (Alaska Ocean Observing System/Alaska Ocean Acidification Network) gave a tutorial on the dissemination of research results to relevant communities and their continued engagement with examples from Alaska fishers, crabbers, community samplers, and coastal communities. Attendees learned that it is important to know one’s audience and stakeholders well, so outreach products can be carefully tailored to them; a modular approach can be used, so that parts can be emphasized for different audiences. Co-development should be used to best meet the needs of the end user, going back and forth as much as necessary. Attendees also learned that continuing to share new results is key for keeping stakeholders engaged, but it is also critical to communicate what they should do with the information.

New Project Plans: Lightning Talks & Discussion

Day Two of the workshop concluded with lightning talks from the new RVA projects describing the goals of their projects and the plans for executing them. The session included the following talks:

- Evaluating OA Vulnerability and Interactions Among Traditional and Emerging Coastal Alaska Industries - Dr. Thomas Hurst (NOAA Alaska Fisheries Science Center)
- Assessing Vulnerability of the Atlantic Sea Scallop Social-Ecological System in the Northeast Waters of the US - Dr. Samantha Siedlecki (University of Connecticut)
- Assessing Community Vulnerability to Ocean Acidification Across the California Current Ecosystem - Dominique Kone (California Ocean Science Trust)
- Assessing the OA Temporal and Spatial Patterns around Hawai'i - Dr. Tobias Friedrich (University of Hawai'i at Mānoa)
- Designing a Framework for an Ocean Acidification Vulnerability Assessment in Puerto Rico Through Stakeholder Interviews, Science Synthesis, and a Regional Workshop - Dr. Melissa Melendez (University of Hawai'i at Mānoa)
- Vulnerability of Oyster Aquaculture and Restoration to Ocean Acidification and Other Co-Stressors in the Chesapeake Bay - Dr. Emily Rivest (Virginia Institute of Marine Science)

The talks were followed by a discussion with the speakers. They were first asked about how they approached broadly casting the net when applying an industry or species lens for an RVA, and how to bound the social impact when looking from an industry perspective. Suggestions included doing a science synthesis to help identify a focus area or species, using stakeholder input to hone the focus, and bringing together existing efforts in a region or locality.

Speakers were then asked how to identify the “right” timeline for looking at impacts and how to communicate the timeline to stakeholders. One speaker suggested it is important to consider the level of vulnerability of the community, while another stated it is important to connect how long-term trends will affect stakeholders. For one project, it has been challenging to provide modeling outputs on the correct timeline to meet the needs of different stakeholders and to match social projections.

There was also a suggestion to coordinate RVAs that might have common interests. The organizers hoped that this workshop would generate those types of connections.

Another question asked how to match the sophistication of data visualizations to stakeholder communities as visualizations become more sophisticated. The panel shared that it is important to consider the current knowledge of the audience and what they are focused on or what could be learned through the visualization. Other challenges to consider include addressing privacy issues when sharing spatial information and how to visualize uncertainty.

Gaps (Day Three)

Day Three of the workshop began with an overview of the Ocean Chemistry Coastal Community Vulnerability Assessment mandated by the Coordinated Ocean Observations and Research Act of 2020 (COOR Act) by Courtney Cochran, coordinator of the Interagency Working Group on Ocean Acidification (IWG-OA). The report will address gaps in monitoring, research, and knowledge about impacts to economically and socially important species, along with potential

impacts to human communities from OA. As required by the legislation, the IWG-OA is writing these reports in collaboration with the Coastal Acidification Networks, who are providing important information on regional needs and priorities. No new research or data analyses will be conducted for the report, but results from completed and ongoing RVAs will be highlighted.

Identifying Gaps Panel Discussion

The overview of the IWG-OA vulnerability report was followed by an identifying gaps panel discussion moderated by Dr. David Wrathall (Oregon State University). Before introducing the panelists, he laid the groundwork for the panel with reflections from the Ekstrom et al. (2015) paper, which assessed the vulnerability of U.S. shellfisheries to OA. The paper highlighted several data and knowledge gaps, including species thresholds and interactions with other stressors.

The panel included Dr. Charlotte Regula-Whitefield (Oregon Department of Fish and Wildlife/Oregon Coordinating Council on Ocean Acidification and Hypoxia), Dr. Melissa Melendez (University of Hawai'i at Mānoa), Dr. Samantha Siedlecki (University of Connecticut), Dr. Catie Alves (NOAA Northeast Fisheries Science Center), Dr. Chris Sabine (University of Hawai'i at Mānoa), and Dr. Jan Newton (University of Washington). Each panelist was asked to share three to five key gaps that they found important.

In addition to the lack of an RVA project in the Gulf of Mexico, common gaps included data for species of interest (e.g., thresholds, responses to multiple stressors), monitoring in areas of interest, economic and social data at the appropriate scale, transdisciplinary training, metrics to evaluate success, methods for sustaining relationships, convincing stakeholders to care about OA, and translating results into solutions.

The panel also discussed the challenge of addressing multiple drivers. This may require multiple solutions and case studies, fit-for-purpose conclusions, and consideration of information gaps. The panelists were asked what they would study with unlimited resources. Answers included co-location of biological and chemical measurements, assembling a multidisciplinary team to study corals, developing open data and tools, collecting data for managers, creating more regional models, and developing multi-stressor thresholds for different species. The panel also discussed how different research teams can help each other rather than compete. Suggestions included training people to work across disciplines, incorporating students into work, and developing best practices.

Identifying Gaps Breakout Sessions

Following the panel discussion, attendees split up into three breakout rooms moderated by the panelists to discuss gaps surrounding three themes: intellectual merit, challenges, and societal relevance and solutions. Each breakout group was asked to consider the current state of the field, where the field needs to be, and the key steps or breakthroughs that are necessary to get there. Following the breakout session, a representative from each group reported their outcomes to the plenary.

Intellectual Merit (Dr. Samantha Siedlecki & Dr. Jan Newton):

We may need to move out of our comfort zones to enhance our work and explore the multidimensional research space. There may be blindspots in new lines of research. One example of a reason to explore this is that researchers may be missing event-scale observations or not capturing the full range of multi-stressors within research currently in the “comfort zone”. A more flexible funding mechanism may be appropriate for addressing this more high-risk work potentially responsive even to disruptive events, but some blindspots may remain because of feasibility (e.g., some species cannot be cultivated in a lab yet).

There is a need for best practices for consistent data collection across all disciplines. There is also a need to offer training for trans-disciplinary work, especially for students, either through augmenting existing efforts or creating a new pathway. There is interest in better understanding how to use thresholds or what constraints exist around adaptive capacity measures. There are clear parallel lines of research on adaptive capacity performed in all disciplines present in the breakout sessions that could be explored across disciplines within RVA work that would be exploratory. There is also a need to facilitate communication between stakeholder groups, and to fund further work based on the outcomes of RVAs.

Challenges (Dr. Melissa Melendez & Dr. Chris Sabine): Identifying OA-specific actions that relate to clear management actions is critical. We need to make a clear connection between OA conditions and the management action needed to ameliorate them; this will make solutions more tangible. It is also a challenge to get the public to be more concerned about OA; today, they are more concerned with rising temperature and migrating fish, etc. Another challenge is that the timescale for OA impacts can be so protracted that ecosystems can be destroyed before the OA impact is actually observed. Potential solutions include first “embracing the chaos” by accepting that OA is one of many stressors and thinking about how to simultaneously address impacts from multiple stressors. Researchers should also consider the role that genetics can play in informing implementation of solutions. Machine learning could also help with meta-analysis and literature syntheses; the research community needs better tools to identify what works and needs to make sure techniques are accessible. Another opportunity for collaboration is better understanding the role of aquaculture. It is not clear if there are unidentified impacts of OA on aquaculture and how it could be used as a solution. Aquaculture may be very beneficial for First Nations as it may serve to increase food security.

Societal Relevance & Solutions (Dr. Catie Alves & Dr. Charlotte Regula-Whitefield): There is a need to find a mechanism to spark discussion with people who are not thinking about OA but have a connection to the ocean. One solution could be to encourage and incentivize scientists to publish outside of journals in media that is more accessible, especially in regions with limited communication on OA (e.g., op-eds, podcasts, new media). Researchers should leverage work that has been done to assess social vulnerability to inform future work in understudied regions. There could be parallels to an area where there is not yet an RVA (e.g. Louisiana and Alaska). It is also important to listen to communities that are already being forced to adapt.

Summary of Workshop Results

The RVA workshop was successful in meeting its goals and objectives. The workshop facilitated networking and collaboration across all of the funded RVA projects, allowing researchers from different disciplines and regions to learn from each other and connect. Projects that were further along shared important lessons learned throughout the process along with insights into challenges and barriers that they faced during their research. An important topic across sessions was meaningful involvement and communication with stakeholders to ensure that their needs were being met. Participants also gave recommendations to OAP on improving RVA projects, including facilitating best practices, increasing the project period and providing funding for implementing recommendations that come out of RVA projects. The workshop participants also had a robust discussion on remaining research gaps that set the stage for future work in OA vulnerability assessments.

OAP thanks the organizers, speakers, and participants for their contributions to a successful workshop. OAP is exploring avenues to continue building this community, such as hosting a webinar series, creating a vulnerability assessment team on the [Ocean Acidification Information Exchange](#), and hosting future workshops. Several of the workshop participants also expressed interest in writing a high-level synthesis paper based on the discussions around identifying gaps. The workshop concluded with happy hour breakout rooms to encourage informal conversations among participants.

References

Ekstrom, J. A., Suatoni, L., Cooley, S. R., Pendleton, L. H., Waldbusser, G. G., Cinner, J. E., ... and Portela, R., 2015. Vulnerability and adaptation of US shellfisheries to ocean acidification. *Nature Climate Change*, 5(3), pp.207-214.

Norris, P. E., O'Rourke, M., Mayer, A. S., and Halvorsen, K. E., 2016. Managing the wicked problem of transdisciplinary team formation in socio-ecological systems. *Landscape and Urban Planning*, 154, pp.115-122.

Appendix 1. Workshop Agenda

NOAA Ocean Acidification Program Regional Vulnerability Assessment Workshop

September 22-24, 2021

Virtually via GoToWebinar and Google Meet

Goal: Get all OAP RVA project teams together to discuss plans for new projects & hear lessons learned/results from projects that are wrapping up

Objectives: (1) Help the interdisciplinary community understand one another better, (2) Identify important research gaps to guide funding objectives, (3) Help new projects avoid common pitfalls, (4) Facilitate networking and collaboration

Day 1 Lessons Learned (Open to any NOAA OAP PIs or collaborators)

1:00-1:30 pm ET – Welcoming Remarks & Overview

- Logistics - Halle Berger (NOAA Ocean Acidification Program)
- Welcome - Libby Jewett (NOAA Ocean Acidification Program)

1:30-3:00 pm ET – Plenaries & Discussion

- Plenary 1 - Christopher Sabine (University of Hawai'i at Manoa)
- Plenary 2 - David Wrathall (Oregon State University)
- Plenary 3 - Lisa Colburn (NOAA Northeast Fisheries Science Center)
- Q&A - moderated by Courtney Cochran (NOAA Ocean Acidification Program)

Break

3:15-4:50 pm ET– Challenges & Lessons Learned: Talks & Panel Discussion

- Seed Crisis at Whiskey Creek - Brian Katz (Oregon State University)
- The Olympic Coast as a Sentinel: An Integrated Social-Ecological Regional Vulnerability Assessment to Ocean Acidification - Simone Alin (NOAA Pacific Marine Environmental Lab)
- A Predictive Model for Ocean and Coastal Acidification Thresholds for the Gulf of Maine - Aaron Strong (Hamilton College)
- Vulnerability of the Largest U.S. Estuary to Acidification: Implications of Declining pH for Shellfish Hatcheries in the Chesapeake Bay - Marjy Friedrichs (Virginia Institute of Marine Science)
- Development of an Atlantis Model for Hawaii to Support Ecosystem-Based Management - Kaitlyn Lowder (The Ocean Foundation)

- Q&A - moderated by Victoria Moreno (Oregon State University)

4:50-5:00 pm ET – Wrap up - Victoria Moreno (Oregon State University)

5:00 pm ET – **Adjourn**

Day 2 Frameworks & Methods (OAP RVA project teams/stakeholders)

1:00-1:15 pm ET – Welcome - Erica Ombres (NOAA Ocean Acidification Program)

1:15-2:15 – Stakeholder Perspectives Panel Discussion

- Introduction by the Moderators - Melissa Poe (Washington Sea Grant) & Meg Chadsey (Washington Sea Grant/NOAA Pacific Marine Environmental Lab)
- Panelists- Susan Inglis (Commercial Fisheries Research Foundation), Karen Hudson (Virginia Institute of Marine Science), Ryan Okano (State of Hawai'i Division of Aquatic Resources), Dom Kone (California Ocean Science Trust), & Andie Wall (Kodiak Area Native Association)

Break

2:30-3:30 – Tutorial Breakout Sessions

- Ensuring Underrepresented Community Participation - Catie Alves (NOAA Northeast Fisheries Science Center)
- Surveys, Interviews, and Focus Groups - Ana Spalding & Erika Wolters (Oregon State University)
- OA-relevant Models and How They Can Be Used and Improved - Christopher Edwards (University of California Santa Cruz)
- Virtual Engagement Using Geovisualization For Top-Down, Bottom-Up Discussions - Brian Katz (Oregon State University)
- Co-Production of Knowledge - Jan Newton (University of Washington), Melissa Poe (Washington Sea Grant), & Joe Schumacker (Quinalt Indian Nation Department of Fisheries)
- Dissemination of Research Results to Relevant Communities & Their Continued Engagement - Darcy Dugan (Alaska Ocean Observing System/Alaska Ocean Acidification Network)

Break

3:45-4:45 – New Project Plans: Lightning Talks & Panel Discussion

- Evaluating OA Vulnerability and Interactions Among Traditional and Emerging Coastal Alaska Industries - Thomas Hurst (NOAA Alaska Fisheries Science Center)
- Assessing Vulnerability of the Atlantic Sea Scallop Social-Ecological System in the Northeast Waters of the US - Samantha Siedlecki (University of Connecticut)

- Assessing Community Vulnerability to Ocean Acidification Across the California Current Ecosystem - Dom Kone (California Ocean Science Trust) & Ryan Hasert (Oregon State University)
- Assessing the OA Temporal and Spatial Patterns around Hawai'i - Tobias Friedrich (University of Hawai'i at Manoa)
- Designing a Framework for an Ocean Acidification Vulnerability Assessment in Puerto Rico Through Stakeholder Interviews, Science Synthesis, and a Regional Workshop - Melissa Melendez (University of Hawai'i at Manoa)
- Vulnerability of Oyster Aquaculture and Restoration to Ocean Acidification and Other Co-Stressors in the Chesapeake Bay - Emily Rivest (Virginia Institute of Marine Science)
- Q&A - moderated by Thomas Hurst (NOAA Alaska Fisheries Science Center)

4:45-5:00 pm ET – Wrap up - Thomas Hurst (NOAA Alaska Fisheries Science Center)

5:00 pm ET – **Adjourn**

Day 3 Gaps (OAP RVA project teams/stakeholders)

1:00-1:15 pm ET – Welcome - Courtney Cochran (NOAA Ocean Acidification Program)

1:15-2:30 – Identifying Gaps Panel Discussion

- Moderator - David Wrathall (Oregon State University)
- Panelists - Charlotte Regula-Whitefield (Oregon Department of Fish and Wildlife/Oregon Coordinating Council on Ocean Acidification and Hypoxia), Melissa Melendez (University of Hawai'i at Manoa), Samantha Siedlecki (University of Connecticut), Catie Alves (NOAA Northeast Fisheries Science Center), Chris Sabine (University of Hawai'i at Manoa), & Jan Newton (University of Washington)

Break

2:45-3:45 pm ET – Identifying Gaps Breakout Sessions

- Intellectual Merit
- Challenges
- Societal Relevance & Solutions

3:45-4:15 pm ET – Report outs

4:15-4:30 ET - Wrap up, next steps & thanks

4:30 pm ET – **Adjourn** (optional happy hour breakouts)

Appendix 2. Participant List

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