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OUTCOME #2: Identify Data and Evidence Needs for OA Mitigation and Adaptation Strategies, From Local to Global

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What is OARS?

Partners across the Ocean Acidification Research for Sustainability UN Decade Program (OARS) aim to expand OA monitoring and research that help decision-makers better understand climate impacts to marine resources and explore local actions that increase resilience.

Key components of the OARS program include:
- enhancing regional collaborative efforts
- coordinating capacity building in science
- codesigning and implementing observation and research to address the threat of OA
- communicating and delivering the outputs to policy makers and communities.

How does outcome 2 contribute to OARS objectives and to the UN Decade of Ocean Science?

Ocean warming, acidification and deoxygenation have gained increasing recognition across international and domestic policy platforms, including the UN Framework Convention on Climate Change, the UN Sustainable Development Goal Agenda, the Convention on Biological Diversity and the national climate strategies or ocean policy (Fullam et al., 2021). To date, international science coordination has emphasized the need to enhance coastal observations and regional baselines, to contribute to global indicators, and to develop research around keystone species (Tilbrook et al., 2019).

While this work must continue across different scales—governments and end-users need examples of targeted information that support discrete choices about localized mitigation, adaptation, and preparedness strategies in the face of ongoing climate change. This is especially true when setting management targets, tailoring responses to potential interference of ecosystem services and marine resources that human communities depend on at local and coastal scales.

44 It is the vision of OARS that increased regional, national, and local understanding of climate-related
45 changing ocean conditions impacts on fisheries, aquaculture and ecosystem services will allow for
46 enhanced management and policy prioritization. This in turn will lead to more impactful outcomes
47 including fisheries and aquaculture resilience strategies, ecosystem restoration and conservation
48 choices, nature-based projects, blue carbon or marine carbon dioxide removal strategies, coral-reef
49 restoration, targeted land-based pollution controls, climate responsive marine spatial planning and
50 marine management efforts.

51 However, identifying appropriate policy goals and management tools for achieving desired outcomes
52 requires a better understanding of the data, evidence, accuracy, evaluation, and time scale required
53 for supporting distinct outcomes.

54 For example, some outcomes may include helping policy and decision makers communicate more
55 clearly the impacts of climate change on marine ecosystems and resources, thus accelerating policies
56 that aim to reduce global greenhouse gas and carbon dioxide emissions.

57 Achieving more detailed outcomes (as listed above) will require varying precision in assessing local
58 conditions (including multiple- stressors and source attributions) and evaluating the best interventions
59 or management responses.

60 To attain OARS objectives across the Ocean Decade it is critical that the global research community
61 provides a roadmap—*or increased guidance*—to summarize the type of data and information
62 available (or must be strengthened) to support specific objectives.

63 **Guiding framework for OARS #2 include the following preliminary questions:**

64 (1) What are climate and ocean policy/ decision makers charged with managing or regulating? What
65 are the policy, regulative and management frameworks that presently (or can be evolved to)
66 integrate ocean knowledge into their decision-making?

67 (2) What can policy makers, decision makers or marine resource users do with this information at
68 different scales? What decisions can additionally targeted information help inform?

69 (3) What is the quality of data and how much is needed to support the different objectives?
70 (*These will include* guiding climate-response fisheries management plans, targeting areas for
71 marine/ coastal habitat restoration or conservation, enhancing coral reef health, determining
72 effective aquaculture adaptation strategies, reducing nutrient run-off from specific sources,
73 strengthening water quality regulations due to new thresholds for impairments).

74 **Preliminary inputs**:

75 Activities that increase or strengthen OA knowledge for identifying appropriate actions (mitigation
76 and adaptation) are represented across multiple OARS outcomes and must be undertaken in parallel
77 to engaging stakeholders and end-users who apply mitigation and adaptation actions. These include,
78 are not limited to:

79 ● Building baselines to measure coastal variability and trends.
80 ● Monitoring and understanding functional biodiversity and ecological interactions.
81 ● Enhancing climate response and preparedness and strengthening predictive models.
82 ● Conducting species-specific research to determine vulnerability and adaptation potential of
83 significant species—whether economically or culturally.
84 ● Conducting nationwide or regional vulnerability assessment to identify the risks that ocean
85 warming, acidification, and loss of oxygen pose to economies and coastal and marine
86 resources. These should include improving knowledge of biological impacts to marine species

87 and ecosystem services within the region, along with locally appropriate adaptation actions
88 or interventions.
89 ● Developing, testing, and deploying nature-based solutions—including shell dissolution
90 techniques and restoration of mangrove, seagrass, salt marsh, and kelp forest—
91 and evaluating their net effect on ecosystems.
92 ● Exploring aquaculture techniques that aim to predict and mitigate corrosive conditions.
93 ● Exploring how land-based pollution, including nitrogen and wastewater inputs, exacerbate
94 coastal acidification and deoxygenation trends.
95

Preliminary outputs:

97 To support all OARS outcomes and advance primary inputs, outcome #2 must help articulate to policy
98 makers, decision-makers and marine resource users what can be done with the data and information
99 available vs. what actions or decisions require more discrete data, increased accuracy, ongoing
100 modelling, monitoring or research.

101 In parallel, outcome #2 must help solicit policy, management, information needs and marine use
102 priorities across a broader community of stakeholders. Indeed, this two-way information exchange is
103 the foundation of outcome #2 and will guide the work plan over the next several years.

104 Outcome #2 will be the preliminary link between stakeholders and all other OARS outcomes. It will
105 aim to: (1) act as guide for other outcomes to assess what knowledge is required, and how best to
106 deliver it; and (2) serve as a critical translator of science knowledge for real life application.

107 To accomplish these aims, outcome #2 will:

108 • Support and enhance institutional process for outlining stakeholder needs around climate and
109   ocean information.
110 • Develop new tools to identify, and satisfy, ocean data/information/ reporting requirements
111   for policy, governance, and marine resource users.
112 • Optimize the translation of science applications to accelerate stakeholder uptake and
113   utilization.
114 • Codesign processes for streamlining/ mapping "stakeholder needs to stakeholder action."
115 • Establish better metrics to evaluate success of knowledge delivery and uptake.

116

117

Preliminary products:

119 To support ongoing work, case studies and collaborations across OARS activities and expanding
120 membership, outcome #2 working group members will begin a rudimentary mapping exercise to help
121 illuminate potentially relevant data/ information needs for discrete decision-making applications at
122 different scales (global, regional, and local). This initial exercise will include an emphasis on:

123   1. examining sensitivity of key species and ecological consequences under OA and evaluating
124   response strategies.
125   2. the relevance of local conditions to land-based interactions and activities.
126   3. the role of coastal habitat and aquatic vegetation to support OA mitigation and
127   remediation.
128   4. the relevance of OA information to evaluate water quality or management indicators and
129   thresholds.

130   5. the relevance of OA information to evaluate blue carbon or marine carbon dioxide removal.
131   6. accelerating policies that aim to reduce global greenhouse gas and carbon dioxide
132   emissions.

133   Starting with a scale-dependent model approach—and informed by knowledge gained from initial
134   mapping exercises— the outcome #2 working group will create an "*OA Knowledge for Decision*
135   *Making*" cheat sheet (**see Appendix A**). The cheat sheet will serve as a **basic rubric** for broadly
136   categorizing data and evidence across applications/outcomes at different spatial (*governance/*
137   *jurisdiction)* and temporal scales. This basic rubric will serve as an initial jumping off point and will be
138   designed to help organize other OARS outcomes around case studies that are most applicable to their
139   outcome aims and charges.

140   Once developed, the "*OA Knowledge for Decision Making*" rubric may take on more dynamic
141   qualities, providing a roadmap for all OARS outcomes to engage their own additional stakeholders,
142   decision makers and marine resource users. Multiplying OARS outcome discussions and case studies
143   around a core decision making rubric will, ideally, help populate and further outline key data and
144   evidence needs required for advancing geographically and spatially unique policy, management, and
145   resilience objectives across marine end users.

146   **Preliminary outreach:**

147   Over 2023-2024, the outcome #2 working group will seek to expand its membership and core
148   audience. The goal is to engage with a global audience that well represents marine resource managers,
149   climate policy leads, Tribal and First Nation governments, commercial and subsistence fisheries and
150   aquaculture leads, and civil society initiatives focused on nature-based solutions, innovative
151   mariculture, water quality and coastal zone health and the climate-ocean policy nexus. It will do this
152   through specific invitations to engage in outcome #2 work through the OA Alliance, partner academic
153   institutions, governments, intergovernmental organizations and NGOs—as well as a series of
154   regionally coordinated webinars and workshops.

155   In parallel to these efforts, outcome #2 will shepherd a running list of identified "shovel ready" OA
156   monitoring or research projects that have discrete management or adaptation application built into
157   their proposals. This list will be shared, when appropriate, as public, and private funding sources are
158   identified over the next several years of the OARS program.

159

160   **Preliminary markers of success:**

161   Finally, it is important that outcome #2 outline how it will measure success, both as a working group
162   and on a larger scale. This could include a myriad of metrics:

163   -   Discrete metrics might include perspective diversity of outcome #2 working group;
164   investments made in projects outlined by working group; co-benefits of potential actions
165   taken; development of OA indicators through outcome #2.
166   -   Longer-term metrics might include reductions of CO_2 concentration in the atmosphere;
167   increased level of biodiversity (or population size for key species); increased resilience
168   demonstrated across specific ecosystems; increased integration across climate-ocean policy
169   priorities; OAH appearing across national climate preparedness reports.

170   **Preliminary inputs to support activities and outputs:**

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Benchmarks:

While the entire OARS community is invited to join in case study and product development occurring under outcome #2, preliminary benchmarks are envisioned as follows:

2022

- Assemble and convene outcome #2 working group members.
- Develop "**OA Knowledge for Decision Making**" cheat sheet as a rubric for getting started: broadly organizing/ categorizing data and evidence needs for myriad applications at different scales.
- Establish metrics/ measurements of success for OARS#2.
- Begin a list of "shovel ready" OA monitoring or research projects that have discrete management or adaptation application built into their proposals.

2023

- Assemble and convene outcome #2 working group members; seek to expand its membership and core audience.
- Continue utilizing "**OA Knowledge for Decision Making**" cheat sheet for organizing/ characterizing evidence needs fit for purpose. Serves as a jumping off document/ decision tree for beginning discussions across policy, decision makers and marine resource users.
- Strategically engage stakeholders, decision makers and marine resource users to jointly outline or define discrete case studies that utilize evidence fit for specific outcomes.
  - This will be accomplished through specific invitations to engage in outcome #2 work through the OA Alliance, partner academic institutions, governments, or NGOs—as well as a series of regionally coordinated webinars and workshops.

2024

- Design a support product that explores current guidance for "Developing OA Indicators for Purpose." (*This could take the format of a dashboard for OA indicators for management, and adaptation.)*
Continue shepherding list of "shovel ready" OA monitoring or research projects with public and private funders, including international climate financing regimes.
(*This could be part of a summary report out/ next steps associated with, "Climate Financing for Ocean Adaptation and Resilience Measures" hosted by the OA Alliance, Commonwealth Blue Charter, TOF and IOC-UNESCO on June 27, 2022.)*

Events and workshops:

While the entire OARS community is invited to join in events and activities occurring under outcome #2, preliminary events and workshops are envisioned as follows:

June 2022:

- UN Ocean Conference

  - SDG 14.3 side event featuring outcome #2 themes, June 29.
  - "Climate Financing for Ocean Adaptation and Resilience Measures" breakfast meeting with GEF, GCF and Commonwealth Blue Charter, June 27.

August 2022:

- First meeting of outcome #2 working group members (2 hours).

September 2022:

214 ● High CO_2 World Symposium

215   ○ Unveil "**OA Knowledge for Decision Making**" cheat sheet rubric draft + white paper.
216   ○ Informal meeting of OARS co-campions to review rubric draft and identify synergies
217   with other outcome leads.
218   ○ Continue to identify key metrics/ measurements of success for OARS#2.

219 December 2022:

220 ● Finalize "**OA Knowledge for Decision Making**" cheat sheet rubric.

221 February 2023:

222 ● Second meeting of outcome members (2 hours)
223 ● Outline 2023 work plan that:
224   ○ Continues utilizing "**OA Knowledge for Decision Making**" as jumping off document/
225   decision tree for supporting discussions across policy and decision makers and marine
226   resource users.
227   ○ Identifies specific opportunities in 2023 to engage stakeholders.
228   ○ Continues shepherding a "shove ready" list of OA monitoring and research projects
229   with built in management or adaptation applications with public and private funders,
230   including climate financing regimes.
231   ○ Yields a support product that explores current guidance for "Developing OA Indicators
232   for Purpose." (*This could take the format of a dashboard for OA indicators for*
233   *management, and adaptation.).*

234 March 2023:

235 ● Outcome #2 co-champions will attend and organize content at Monaco Ocean Week; this will
236   include an emphasis on stakeholder recruitment and identifying funding support.

237 April 2023

238 ● Outcome #2 co-champions will participate in OA Alliance mini-workshop with GEF small grants
239   program, UNEP, and relevant development banks regarding approaches for securing funding
240   for long-term regional climate-ocean change projects—including monitoring and targeted
241   research/evaluation.

242 June 2023:

243 ● Outcome #2 co-champions (and some working group members) will attend and organize
244   content at the ASLO Aquatic Science Meeting, 4th – 9th in Palma de Mallorca, Spain. This will
245   include hosting a focus/discussion group with invited stakeholders with an emphasis on seafood
246   growers.

247 July 2023:

248 ● Third meeting of outcome members (2 hours).

249 September 2023:

250 ● Outcome #2 co-champions will (and some working group members) will engage in OA Alliance
251   events taking place at Climate Week in New York. This will include events with policy makers
252   and department leads working to advance "OA Action Planning efforts" and assessing the
253   necessary data/ information for management actions related to evaluating blue carbon
254   ecosystems and clean water criteria.

255   November 2023:

256   ● Outcome #2 co-champions will meet with Ocean SODA/ OA Satellite Observations project
257   leads and assess lessons learned from year one working with stakeholders' information needs.

258   **<u>Outcome 2 working group members (invited to date):</u>**

259   ● Dr. Martin Hernandez Ayon, Universidad Autónoma de Baja California
260   ● Dr. Jan Newton, GOA-ON co-chair
261   ● Kirsten Isensee, IOC-UNESCO
262   ● Dr. Fei Chai, University of Maine
263   ● Dr. Cliff Law, National Institute of Water and Atmospheric Research, New Zealand
264   ● Dr. Sam Dupont, University of Gothenburg
265   ● Dr. Wiley Evans, Hakai Institute
266   ● Pacific Coast Collaborative Partners (Oregon, California, Washington, British Columbia)
267   ● Government of United States/Canada/ Sweden/ Mexico
268   ● Dr. Helen Findlay, Plymouth Marine Laboratory
269   ● Dr. Sarah Cooley, Ocean Conservancy
270   ● Queen Quet, Gullah Geechee Nation
271   ● Olympic Coast Sentinel Site co-chairs (Micah Horwith; Tommy Moore)
272   ● Dr. Martha Sutula, Southern California Coastal Water Research Project
273   ● Professor Piero Calosi, Université du Québec à Rimouski
274   ● Dr. Aaron Strong, Hamilton College
275   ● Western Indian Ocean Marine Science Association
276   ● Secretariat of the Pacific Regional Environment Programme
277   ● Kelp reforestation in Northern Norway (UN Decade Endorsed companies), climate smart
278   investment.
279

References

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291 **Appendix A: Example "OA Knowledge for Decision Making" Cheat Sheet (still under development**
292 **in Feb. 2023):**

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294 **USE AS RUBRIC** = Broadly categorizes data and evidence with possible applications/ outcomes across
295 different spatial (*governance/ jurisdiction)* and temporal scales, jumping off document/ decision tree
296 for beginning discussions across policy, decision makers and marine resource users.

297 **USE AS TEMPLATE (Blue squares)** = Utilizes the Rubric to engage stakeholders, decision makers and
298 end users of information to jointly outline case studies that utilize or define key evidence for specific
299 outcomes. Dynamic, used to support all OARS outcomes—thus building an ongoing discrete set of
300 data/ evidence needs.

301

Scale	Decision Making Relevance	What Information Is Available/ Possible	What It Tells You	Instrumentation or Tools Required	Time Scale Needs	Ready Factor	Policy to Support Implementation *(Links to Outcome #7)*	What's Needed in Your Location? *(Additional information, evidence, evaluation)*	Example Projects or Case Studies
Global	Support messaging of climate-ocean change risks, impacts and mitigation/adaptation needs across international frameworks. Inform understanding of regional climate-ocean change dynamics across ocean basins.	Global monitoring of OA trends reported through IPCC or other regional climate-ocean observing reports. UN SDG 14.3.1 reflecting international monitoring efforts	Global trends and projections of OA caused by atmospheric CO_2 emissions.	Global ocean observing systems that include: X, Y, Z. Satellite Obs that include: X, Y, Z *(Coordinated with outcome #1)*	>15 years	Broadly Message Act	Ocean mitigation and adaptation aspects across: UNFCCC; UN Sustainable Development Goal Agenda; Global Stocktake; and Convention on Biological Diversity. Reporting through UN SDG 14.3.1.		Global Ocean Observing Systems/ Coordinating bodies GOA-ON IOC-UNESCO as sherpa of UN SDG 14.3.1

Scale	Decision Making Relevance	What Information Is Available/ Possible	What It Tells You	Instrumentation or Tools Required	Time Scale Needs	Ready Factor	Policy to Support Implementation (*Links to Outcome #7*)	What's Needed in Your Location?	Example Projects or Case Studies
Regional (*what do we mean here?*)	Inform regional climate risk assessments. Inform targeted blue investments or insurance needs. Inform climate resilient regional fisheries and aquaculture strategies. Inform coral reef resilience goals and strategies. Inform food security and sovereignty goals and strategies. Inform MPA, MSP, coastal / terrestrial activities.	Monitoring networks documenting regional trends of OA, SST, and DO. Coastal variations from a baseline. Research that illuminates biological impacts to keystone species, ecosystems, and human services. Modelling that helps hindcast or forecast ocean and coastal conditions. Satellite Obs that help predict exposure of corrosive conditions, undersaturation or prolonged temperature increase.	Reveal targeted monitoring and research needs that are most useful for meeting regional goals: 1. Potential impacts to—or tolerance of-- keystone species, ecosystems, and marine resources that are being managed the region. 2. Highlight hot spots or areas that have more compounding stressors/ seasonality changes. 3. Highlight areas that may have more buffering capacity to OA and provide more hospital conditions for species and ecosystems.	Regional ocean observing systems that include: X, Y, Z. Satellite Obs that include X, Y, Z. Hindcasting, Forecasting and Modelling. Lab research; experimentation. Resource mapping. (*Coordinated with outcomes #1, 3, 4.*)	>10 years	Broadly Message Act	Regional bodies or MOUs that yield increased multi-jurisdictional/ocean basin collaboration and leverage funding for: 1. Regional risk and vulnerability assessments; including socio-economic and cultural vulnerabilities posed. 2. Targeted monitoring and modelling that helps hindcast or forecast ocean and coastal conditions. 3. Targeted research that illuminates biological impacts to keystone species, ecosystems, and human services. 4. Recommendations that directly inform or support: regional fisheries and aquaculture plans; sustainable development agendas; marine resource management; and climate mitigation or adaptation strategies.		Regional Ocean Observing Systems/ Coordinating bodies GOAON Hubs Pacific Training Center on OA OSPAR OA Report/ Recs WIOMSA OA Monitoring Report 2022 NZPPOA Vulnerability Assessment Others?

Scale	Decision Making Relevance	What Information Is Available/ Possible	What It Tells You	Instrumentation or Tools Required	Time Scale Needs	Ready Factor	Policy to Support Implementation (Links to Outcome #7)	What's Needed in Your Location?	Example Projects or Case Studies
National (*Within EEZ*)	Inform national climate risk assessments. Inform targeted blue investments or insurance needs. Annual predictions for reef conditions and/ or fisheries stock assessments. Carbon sequestration potential (*or other co-benefits*) of marine veg. and coastal wetlands. Inform targeted regulations, closures, MPAs/ MSP. Inform terrestrial activities & coastal development. Strengthen water quality directives or regulations. Strengthen coral reef initiatives.	Coastal variations from a baseline. Research that illuminates biological impacts to keystone species, ecosystems, and human services. Multiple stressor modelling in areas of high priority (estuaries and bays; fisheries/aquaculture growing operations; reef systems). Coastal and marine habitat mapping. Targeted research to evaluate adaptation and resilience strategies.	Reveal targeted monitoring & research needs that are most useful for informing and evaluating national actions: 1. adaptation potential/ needs of keystone species and industries. 2. locations or episodes of increased stress or vulnerability. 3. Areas where marine veg. and coastal wetlands are useful for mitigation or remediating impacts. 4. Evaluation of Blue Carbon, Nature Based Solutions or other adaptation techniques. 5. Where land use practices and terrestrial inputs are exacerbating impacts along coastline. 6. monitoring and evaluation of marine CDR techniques.	Satellite Obs that include X, Y, Z. National monitoring programs that include X, Y, Z. Hindcasting, Forecasting and Modelling. Lab research; experimentation. Resource mapping. (*Coordinated with outcomes #3, 4, 5*)	>5 years		National OA Action Plans or OA Legislation that: 1. Identify nationally important marine resources and concerns. 2. Engage multi-sectorial and diverse actors to chart priorities, existing knowledge/science resources, and implementation responsibilities. 3. Provide recommendations to: mitigate causes; assess vulnerabilities; identify local research and monitoring needs; build adaptation and resilience strategies; educate government authorities and resource managers. 4. Leverage authorities and mandates within: national climate mitigation and adaptation plans; marine strategic frameworks or national ocean policies; national reef resilience strategies or fisheries management policies.		

Scale	Decision Making Relevance	What Information Is Available/ Possible	What It Tells You	Instrumentation or Tools Required	Time Scale Needs	Ready Factor	Policy to Support Implementation *(Links to Outcome #7)*	What's Needed in Your Location?	Example Projects or Case Studies
Local	Inform local climate risk assessments.

Inform targeted blue investments or insurance needs.

Carbon sequestration potential (*or other co-benefits)* of marine veg. and coastal wetlands.

Targeted marine uses, regulations, closures, or protected areas.

Hatchery practices, fisheries management, or alt. grow-out systems of freshwater pond aquaculture.

Inform terrestrial activities & coastal development.

Strengthen water quality directives or regulations of wastewater, stormwater, ag run-off,

Inform community-based adaptation | Changes or fluctuation in local conditions.

Research that illuminates biological impacts to keystone species, ecosystems, and human services.

Multiple stressor modelling in areas of high priority (estuaries and bays; fisheries/aquaculture growing operations; reef systems).

Coastal and marine habitat mapping.

Targeted research to evaluate adaptation and resilience strategies. | Reveal targeted monitoring and research needs that are most useful for informing and evaluating local, community and commercial actions:

1. Wild species, community resources or commercial practices that are at risk.

2. Community or commercial techniques that could remediate harm and build resilience.

3. Target land -based contributions or other pollutions that are exacerbating harmful conditions.

4. Where additional management or regulation schemes are needed to support resilience.

5. Areas where marine veg. and coastal wetlands are useful for mitigation or remediating impacts. | Forecasting and Modelling.

Lab research; experimentation.

Resource mapping.

Local and community monitoring.

(*Coordinated with outcomes #3, 4, 5*) | >3 years | | Local OA Action Plans, community, or commercial charters that:

1. Identify locally or commercially important marine resources and concerns.

2. Engage multi-sectorial and diverse actors to chart priorities, existing knowledge/science resources, and implementation responsibilities.

3. Provide recommendations to: mitigate causes; assess vulnerabilities; identify local research and monitoring needs; build adaptation and resilience strategies; educate government authorities, seafood growers, resource managers and the public.

4. Leverage authorities and mandates within local climate mitigation and adaptation plans; water quality and pollution regulation schemes; wastewater | | |

and resilience priorities.		6. Evaluation of Blue Carbon, Nature Based Solutions, or other adaptation techniques. 7. Instances where targeted marine CDR methods may support mitigation/ adaptation.			infrastructure; coastal zone policies; shoreline development strategies.	

** Ready factor= What is required to "take action" vs "regulate" vs. "broadly message co-benefits"