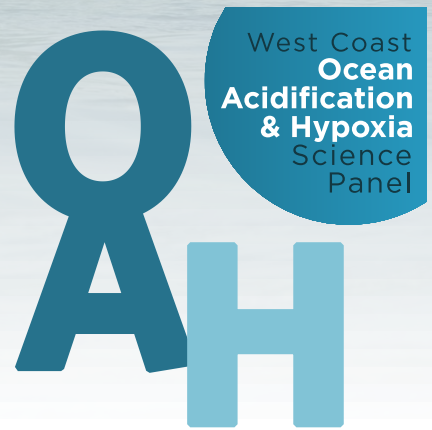
Coalescing Science for Policy:

Perspectives from the West Coast Ocean Acidification and Hypoxia Science Panel



The West Coast Ocean Acidification & Hypoxia Science Panel

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The West Coast Ocean Acidification & Hypoxia Science Panel

- 20 leading scientific experts from across the West Coast
- Appointed by the States of California, Oregon, Washington State, and British Columbia
- Charge of Science Panel:
  - Summarize the state of scientific knowledge
  - Identify management options

6 Major Findings

- OAH will have severe environmental, ecological and economic consequences for the West Coast
- Global carbon emissions are the dominant cause of OA
- There are actions we can take to lessen exposure to OA
- We can enhance the ability of ecosystems and organisms to cope with OA
- Accelerating OA science will expand the management options available
- Inaction now will reduce options and impose higher costs

Panel Products Overview

Roadmap of Local Management Options to Addresss OAH

RESEARCH

MONITORING

REDUCE EXPOSURE

ENHANCE ABILITY OF BIOTA TO COPE

Reduce nutrient and carbon inputs

Advance carbon removal strategies

Reduce other stressors

Promote adaptive capacity

Actions:

Locate hotspots

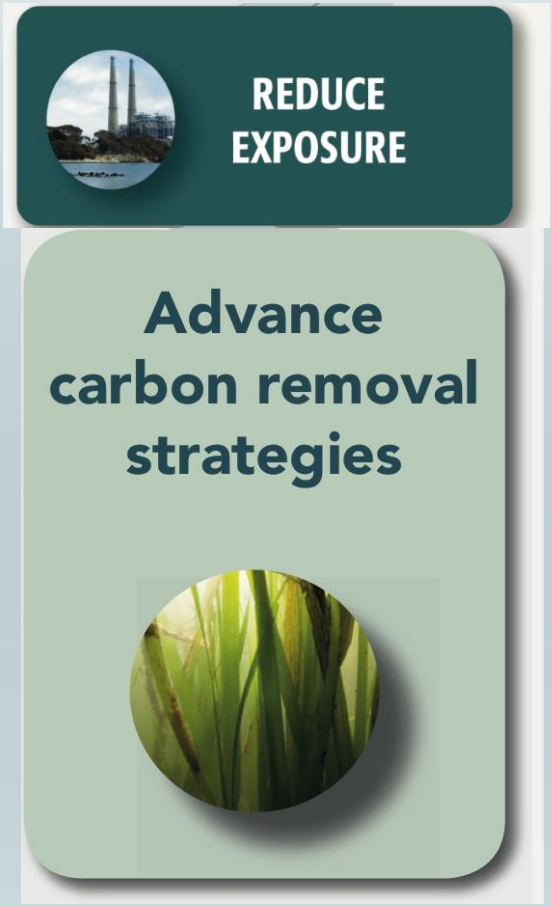
Inventory areas where local pollutant inputs are likely to exacerbate OAH

Advance science

Develop robust predictive models

Incentivize action

Develop incentive-based strategy for reducing pollutant inputs

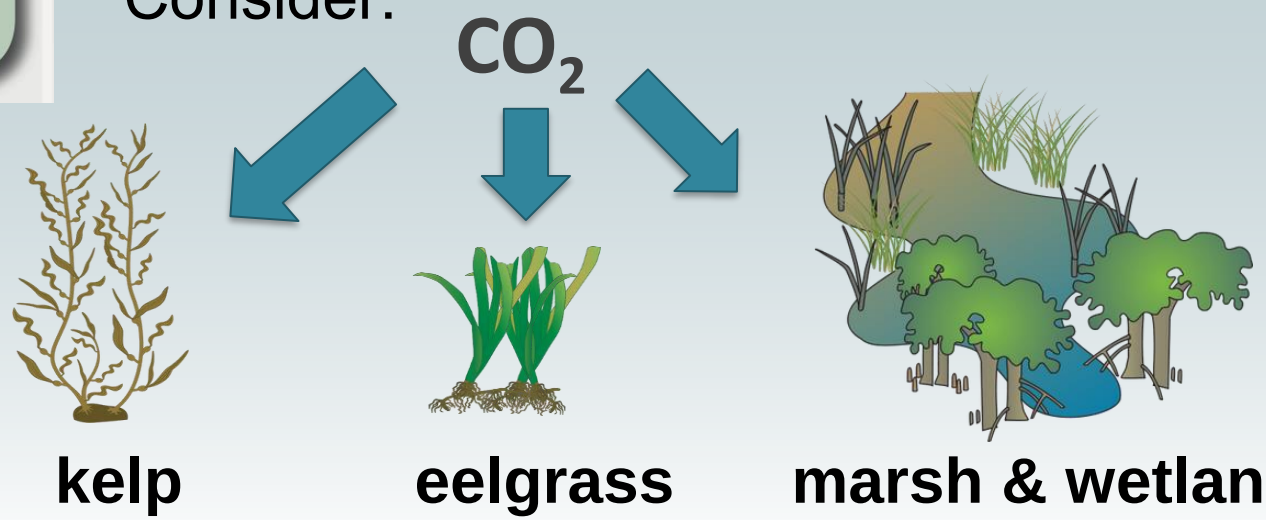


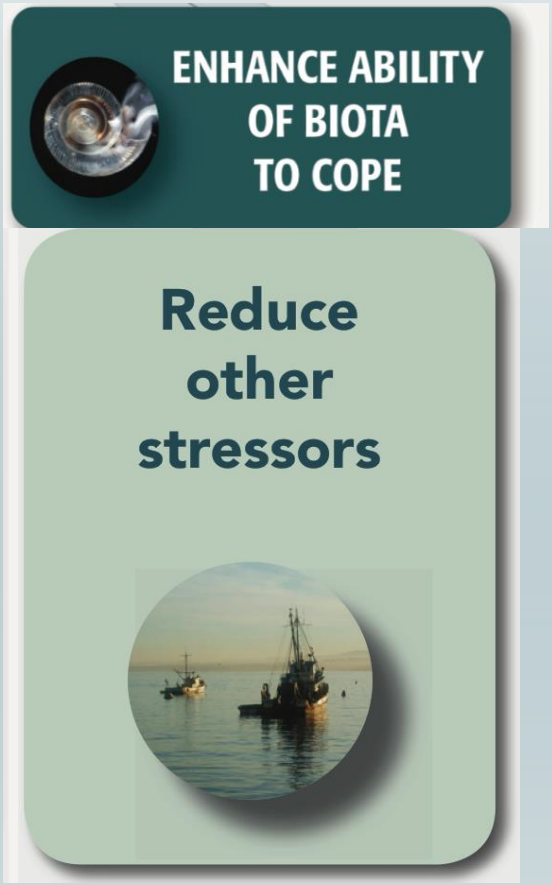
Actions:

Use demonstration projects to evaluate locations optimal for implementing CO_2 removal strategies.

Inventory locations where conservation or restoration of aquatic vegetation habitats can be successfully applied to mitigate OA

Consider:

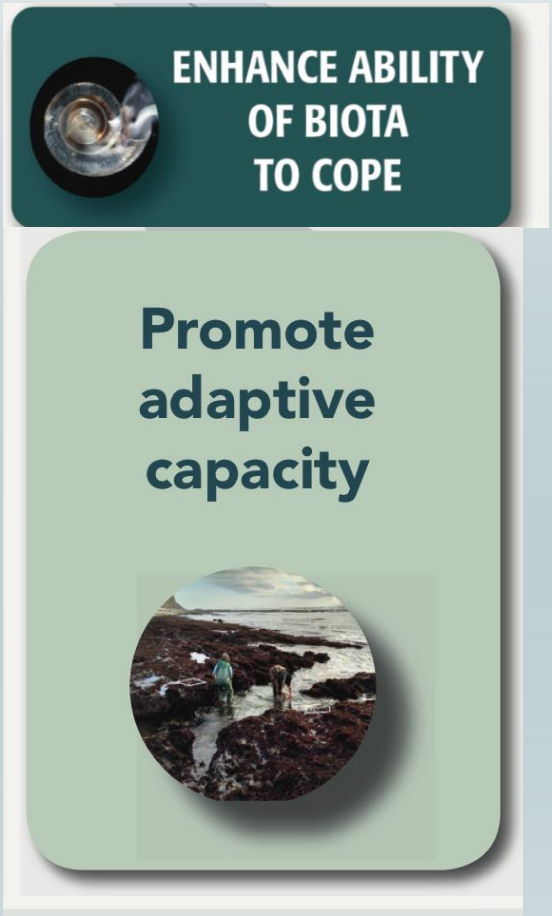




Actions:

Comprehensive Management

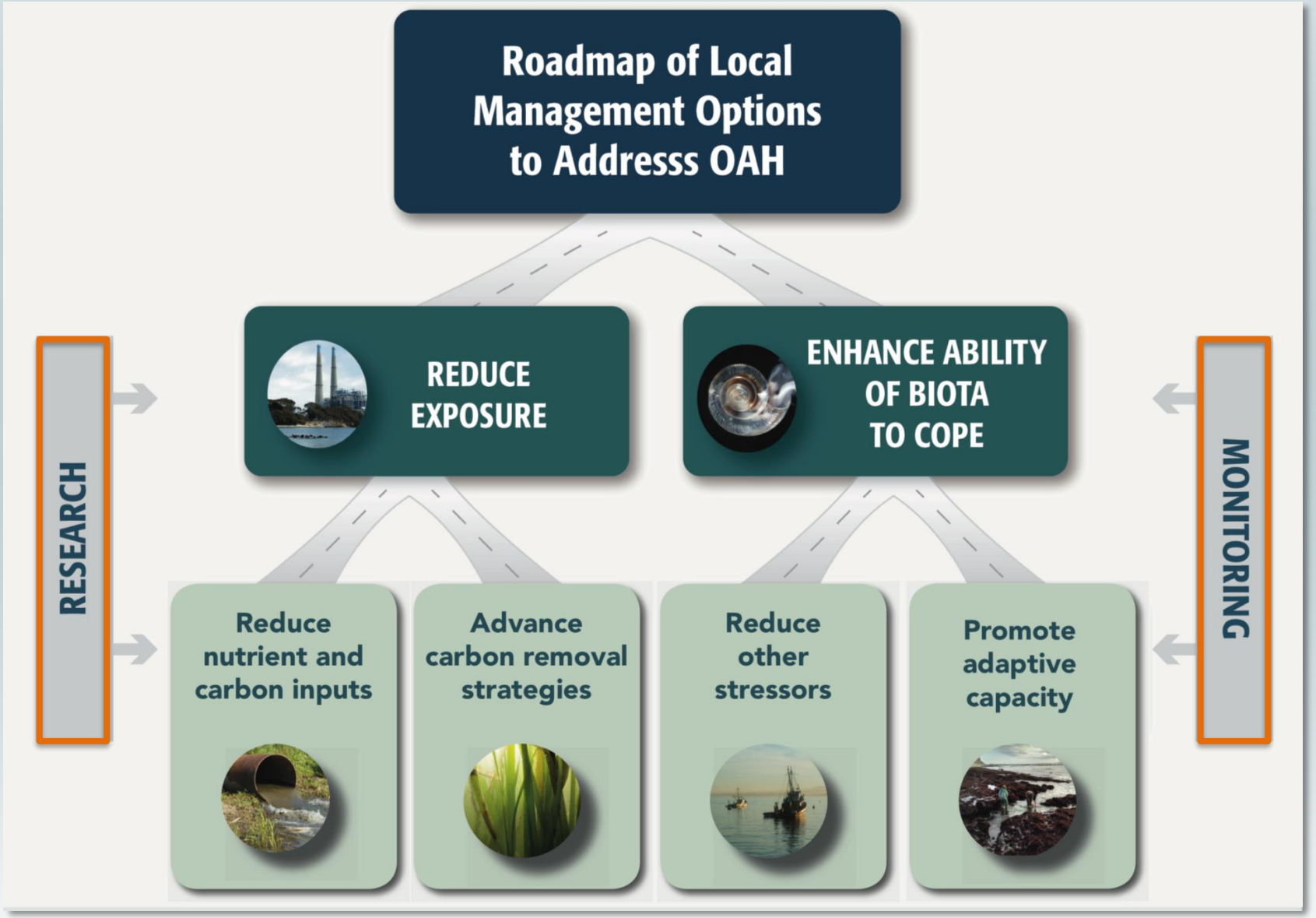
Integrate OA effects into the management of ocean and coastal ecosystems and biological resources.



Actions:

Inventory the co-location of protected areas and areas vulnerable to OAH.

Evaluate the benefits and risks to active enhancement of adaptive capacity.


Roadmap of Local Management Options to Addresss OAH
REDUCE EXPOSURE
ENHANCE ABILITY OF BIOTA TO COPE
RESEARCH
MONITORING
Reduce nutrient and carbon inputs
Advance carbon removal strategies
Reduce other stressors
Promote adaptive capacity

Research & monitoring

A fundamental need and benefit

Actions:

- **Establish a coordinated research strategy**
- **Build out and sustain West Coast monitoring program that meets management needs**
- **Revise water quality criteria**
- **Expand scientific engagement to meet evolving management needs**

Panel Products Overview

- **Ocean Acidification and Hypoxia Monitoring Network: Tracking the Impacts of Changing Ocean Chemistry to Inform Decisions**

  The Panel has outlined a strategic framework for ocean acidification and hypoxia (OAH) related monitoring intended to provide rigorous decision-support to policymakers and managers at a West Coast-wide regional scale. This document describes key attributes of an OAH monitoring network, and recommends practical steps for implementing a West Coast network.

- **Modeling Tools: Summary of Needs to Enhance Understanding of Ocean Acidification and Hypoxia in Coastal Oceans**

  Numerous Panel discussions have underscored the need for improved modeling tools to assess the effectiveness of any potential OAH-related management action. This document outlines specific modeling needs for coupled oceanic physical and biogeochemical models as well as for ecosystem models. This document also outlines specific steps that will help build on existing infrastructure and enhance prioritization and coordination within the modeling community for meeting management needs.

- **Multiple Stressor Considerations: Ocean Acidification in a Deoxygenating Ocean and Warming Climate**

  The Panel recognizes that understanding changes to ocean chemistry is confounded by factors that may co-vary or counter-vary with OA. The outcomes of interacting environmental changes are likely to exert important compounding effects on species and ecosystems. This document describes the need for considering acidification in the context of multiple stressors to marine ecosystems.

- **Ocean Acidification and Hypoxia Research Priorities to Inform Decisions and Develop Solutions**

  This document prioritizes research initiatives focused on providing the knowledge needed to effectively manage the West Coast and oceans in the face of multiple stressors. This document is designed to help decision-makers to strategically hone in on knowledge gaps that inhibit thoughtful action on OAH.

- **Ocean Acidification Science Needs for Natural Resource Managers of the North American West Coast** *(published in the journal Oceanography)*

  This document describes potential management actions and associated science needs that will assist managers in making decisions around whether and how best to address OA. Although decision-makers with a role to play in responding to OA come from diverse sectors, some commonalities emerge in their information needs, including a need for a comprehensive monitoring program and a range of models that identify areas that are most and least vulnerable to future OA-triggered changes.

- **What Changes in the Carbonate System, Oxygen, and Temperature Portend for the Northeastern Pacific Ocean: A Physiological Perspective** *(published in the journal BioScience)*

  The northeastern Pacific Ocean is undergoing changes in temperature, carbonate chemistry, and dissolved oxygen concentration. Here, the Panel examines how single- and multiple-stressor effects on physiology may drive changes in individual or species behavior, and the structure of marine ecosystems.

- **Water Quality Criteria for an Acidifying Ocean: Challenges and Opportunities**
  (in press in the journal Ocean and Coastal Management)

  When monitoring data indicate that water quality standards are not being met, management agencies have the option under Section 303(d) of the Clean Water Act to list the water body as impaired. This document describes the state of the science for making an impairment assessment in the context of this Clean Water Act process, and in cases where data needed to perform assessments are limited. The document also recommends strategies for improving monitoring programs and water quality criteria.

- **Supporting Ecosystem Resilience to Address Ocean Acidification and Hypoxia**

  This product provides practical guidance about the opportunities to incorporate OAH management strategies into existing ecosystem-based management frameworks – an important near-term, actionable management approach intended to ameliorate the likely impacts of OAH on marine resources and ecosystems.

The West Coast
Ocean Acidification & Hypoxia
Science Panel

Acknowledgements

- Convened by the Ocean Science Trust at the request of the California Ocean Protection Council.
- Funded by the California Ocean Protection Council, Ocean Science Trust, the Coastal Impacts Assistance Program, and the States of Oregon and Washington.

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Thank you
http://westcoastoah.org/

WC OAH P and WA OA BRP crosswalk

MRAC
25 April 2016

- There is strong consistency between the two panels/processes with respect to recommendations for action.
- WA led the way for the nation in specifying actions that can be taken to address ocean acidification. The WCOAHP findings reinforce the direction taken and recommendations made by WA and expand them to include interactions with hypoxia. The recommendations of the WCOAHP reflect the growing scientific understanding of the changes that are occurring or are likely to occur.
- Two important advances represented in the findings of the WCOAHP are 1) an emphasis on the effects of multiple stressors (OA, hypoxia, temperature) on biological and ecological responses; and 2) the utility and need for west coast wide coordination.
- In WA, many of the science actions recommended by WCOAH match those previously recommended by the BRP. A subset of these actions currently is being funded by the WA Legislature and implemented via the WA OA Center, often in collaboration with our federal partners NOAA and EPA and the U.S. IOOS regional association, NANOOS. The science and monitoring work is being coordinated by WOAC and continually communicated to the MRAC, providing the critical link to policy makers and the Legislature in WA. We find this structure to be an efficient means of connecting science with policy and recommend that this type of coordination could be implemented along the west coast.

WCOAH

- THEME 1: **REDUCE** EXPOSURE
- **Reduce** local pollutant inputs that exacerbate OAH
- Advance approaches that **remove** CO_2 from seawater
- Revise water quality criteria

- THEME 2: INTEGRATE OAH INTO MANAGEMENT OF ECOSYSTEMS & BIOTA
- Reduce co-occurring stressors on ecosystems
- Advance the **adaptive** capacity of marine species and ecosystems

- THEME 3: EXPAND AND INTEGRATE KNOWLEDGE
- Establish a coordinated **research** strategy
- Build out and sustain West Coast **monitoring** program that meets management needs
- Expand scientific **engagement** to meet evolving **management** needs

OA BRP

- **Reduce** Emissions of Carbon Dioxide
- **Reduce** Local Land-Based Contributions to Ocean Acidification
- Increase Our Ability to **Adapt** to and Remediate the Impacts of Ocean Acidification
- Invest in Washington's Ability to **Monitor** and **Investigate** the Causes and Effects of Ocean Acidification
- Inform, Educate and Engage Stakeholders, the Public, and **Decision Makers** in Addressing Ocean Acidification
- Maintain a Sustainable and Coordinated **Focus** on Ocean Acidification

THEME 1: REDUCE EXPOSURE

Recommendation 1: Reduce local pollutant inputs that exacerbate OAH

- Action 1.1: Generate an inventory of areas where local pollutant inputs are likely to exacerbate OA.

- Quantify key natural and human-influenced processes that contribute to acidification based on estimates of sources, sinks, and transfer rates for carbon and nitrogen. (Action7.2.1) [KEA]* *EPA/Ecology*

- Implement effective nutrient and organic carbon reduction programs in locations where these pollutants are causing or contributing to multiple water quality problems. (Action 5.1.1 [KEA]

- Support and reinforce current planning efforts and programs that address the impacts of nutrients and organic carbon. (Action 5.1.2) [KEA]

- If it is scientifically determined that nutrients from small and large on-site sewage systems are contributing to local acidification, require the installation of advanced treatment technologies. (Action 5.2.1)

- If determined necessary based on scientific data, reduce nutrient loading and organic carbon from point source discharges. (Action 5.2.2)

- Action 1.2: Develop robust predictive models of OAH.

- Establish the ability to make short-term forecasts of corrosive conditions for application to shellfish hatcheries, growing areas, and other areas of concern. (Action 7.4.1) [KEA]WOAC***

- Enhance the ability to predict the long-term future status of carbon chemistry and pH in Washington's waters and create models to project ecological responses to predicted ocean acidification conditions. (Action 7.4.2)

- Develop new models or refine existing models to include biogeochemical processes of importance to ocean acidification. (Action 7.2.2)

- Enhance the ability to model the response of organisms and populations to ocean acidification to improve our under-standing of biological responses. (Action 7.4.3)

- Action 1.3: Develop an incentive-based strategy for reducing pollutant inputs.

- Adopt legislation that will allow sewer connections in rural areas to limit nutrients entering marine waters where it is determined to be necessary based on water quality impacts. (Action 5.1.4)

THEME 1: REDUCE EXPOSURE

Recommendation 2: Advance approaches that remove CO_2 from seawater

- Action 2.1: Use demonstration projects to evaluate which locations are optimal for implementing CO_2 removal strategies.

- Investigate and develop commercial-scale water treatment methods or hatchery designs to protect larvae from corrosive seawater. (Action 6.2.3) [KEA]* *WOAC*

- Maintain and expand shellfish production to support healthy marine waters. (Action 6.1.2)

- Use shells in targeted marine areas to remediate impacts of local acidification on shellfish. (Action 6.1.3)

- Action 2.2: Generate an inventory of locations where conservation or restoration of aquatic vegetation habitats can be successfully applied to mitigate OA.

- Develop vegetation-based systems of remediation for use in upland habitats and in shellfish areas. (Action 6 .1.1) [KEA]

- Action 2.3: Consider CO2 removal during the habitat restoration planning process.

- Preserve Washington's existing native seagrass and kelp populations and where possible restore these populations. (Action 6.3.1)

- Identify, protect, and manage refuges for organisms vulnerable to ocean acidification and other stressors. (Action 6.3.2) [KEA]

- Support restoration and conservation of native oysters. (Action 6.3.3)

Recommendation 3: Revise water quality criteria

- Action 3.1: Agree on parameters that will be part of OAH criteria.

- Assess the need for water quality criteria relevant to ocean acidification. (Action 5.1.3)

THEME 2: INTEGRATE OAH INTO MANAGEMENT OF ECOSYSTEMS & BIOTA

Recommendation 4: Reduce co-occurring stressors on ecosystems

- Action 4.1: Integrate OA effects into the management of ocean and coastal ecosystems and biological resources.

- Conduct laboratory studies to assess the direct effects of ocean acidification, alone and in combination with other stressors, on local species and ecosystems. (Action 7.3.2) [KEA]* WOAC

- Determine the association between water and sediment chemistry and shellfish production in hatcheries and in the natural environment. (Action 7.3.1) [KEA]

- Conduct field studies to characterize the effects of ocean acidification, alone and in combination with other stressors, on local species. (Action 7.3.3)

- Develop and incorporate acidification indicators and thresholds to guide adaptive action for species and places. (Action 6.2.4)

Recommendation 5: Advance the adaptive capacity of marine species and ecosystems

- Action 5.1: Inventory the co-location of protected areas and areas vulnerable to OAH.
- Action 5.2: Evaluate the benefits and risks to active enhancement of adaptive capacity.

- Investigate genetic mechanisms and selective breeding approaches for acidification tolerance in shellfish and other vulnerable marine species. (Action 6.3.5)

- Use conservation hatchery techniques to maintain the genetic diversity of native shellfish species. (Action 6.3.4)

THEME 3: EXPAND AND INTEGRATE KNOWLEDGE

Recommendation 6: Establish a coordinated research strategy

- Action 6.1: Create agreement among the multiple organizations that fund OAH research to establish joint research priorities.

- Charge, by gubernatorial action, a person in the Governor's Office or an existing or new organization to coordinate implementation of the Panel's recommendations with other ocean and coastal actions. (Action 9.1.1) [KEA]* *WA Govt*

Recommendation 7: Build out and sustain West Coast monitoring program that meets management needs

- Action 7.1: Define gaps between monitoring efforts and management needs.

- Establish an expanded and sustained ocean acidification monitoring network to measure trends in local acidification conditions and related biological responses. (Action 7.1.1) [KEA] * *WOAC*

- Ensure continued water quality monitoring at the six existing shellfish hatcheries and rearing areas to enable real-time management of hatcheries under changing pH conditions. (Action 6.2.1) [KEA] * *WOAC*

- Expand the deployment of instruments and chemical monitoring to post-hatchery shellfish facilities and farms. (Action 6.2.2)
- Develop predictive relationships for indicators of ocean acidification (pH and aragonite saturation state). (Action 7.1.2)
- Support development of new technologies for monitoring ocean acidification. (Action 7.1.3)

- Action 7.2: Enhance comparability of and access to OAH data.

- While not a BRP Action, WOAC is doing this via NANOOS for water data; need progress on biological data

Recommendation 8: Expand scientific engagement to meet evolving management needs

- Action 8.1: Create a science task force.

- Create an ocean acidification science coordination team to promote scientific collaboration across agencies and organizations and connect ocean acidification science to adaptation and policy needs (Action 9.1.2) [KEA]* *WOAC*

Additional WBRP

- Identify key findings for use by the Governor, Panel members, and others who will act as ambassadors on ocean acidification. (Action 8.1.1) [KEA]
- Increase understanding of ocean acidification among key stake-holders, targeted audiences, and local communities to help implement the Panel's recommendations. (Action 8.1.2) [KEA]
- Build a network of engaged shellfish growers, tribes, and fishermen to share information on ocean acidification with key groups. (Action 8.1.3)
- Provide a forum for agricultural, business, and other stake-holders to engage with coastal resource users and managers in developing and implementing solutions. (Action 8.1.4) [KEA]
- Develop, adapt, and use curricula on ocean acidification in K-12 schools and higher education. (Action 8.2.1)
- Leverage existing education and outreach networks to disseminate key information and build support for priority actions. (Action 8.2.2)
- Share knowledge on ocean acidification causes, consequences, and responses at state and regional symposiums, conferences, workshops, and other events. (Action 8.2.3)

Take away

- There is strong consistency between the two panels/processes with respect to recommendations for action.
- WA led the way for the nation in specifying actions that can be taken to address ocean acidification. The WCOAHP findings reinforce the direction taken and recommendations made by WA and expand them to include interactions with hypoxia. The recommendations of the WCOAHP reflect the growing scientific understanding of the changes that are occurring or are likely to occur.
- Two important advances represented in the findings of the WCOAHP are:
  1) an emphasis on the effects of multiple stressors (OA, hypoxia, temperature)
  on biological and ecological responses; and
  2) the utility and need for west coast wide coordination.

Major Findings of the Panel

1. OAH will have severe environmental, ecological and economic consequences for the West Coast, and requires a concerted regional management focus.

2. Global carbon emissions are the dominant cause of OA.

3. There are actions we can take to lessen exposure to OA.

4. We can enhance the ability of ecosystems and organisms to cope with OA.

5. Accelerating OA science will expand the management options available.

6. Inaction now will reduce options and impose higher costs.

Next Steps: *Discussions between the Pacific Coast Collaborative and the U.S. Interagency Working Group on Ocean Acidification*

Background: **The Pacific Coast Collaborative -** In 2007, the Governors of California, Oregon and Washington and the Premier of British Columbia signed an agreement creating the Pacific Coast Collaborative (PCC). The Governors and Premier selected climate and energy as two primary areas of focus. In 2013, the PCC issued a West Coast Climate and Energy Agenda, a progressive set of actions committed to by each jurisdiction, designed to reduce greenhouse gas emissions. Ocean acidification was included in the West Coast Agenda, and the primary task outlined was for the states to engage with federal government partners and stakeholders to build a combined program that is capable of dealing with challenges as complex, wide spread and high risk as ocean acidification.

- July 2015 - The Pacific Coast Collaborative (Jay Manning, Cat Kuhlman, Gabriela Goldfarb, Thomas White, Julie Horowitz, and Martha Kongsgaard) met with leaders of the U.S. IWG-OA and other agency leaders in Washington D.C.
- Oct 2015 – The PCC sends letter to U.S IWG-OA suggesting strong collaboration on OA.
- Nov 2015 – Positive Response from the U.S. IWG-OA sent to PCC.
- Jan 2016 – PCC outlines specific plans for collaboration to the the U.S. IWG-OA.
- April 2016 – U.S. IWG-OA responds to PCC with modest adjustments to the PCC plan.

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Recommendations

- Develop an inventory of OA-relevant, federal and non-federal chemical and biological observing assets on the West Coast, including British Columbia, and engaging on key management questions than can be addressed with current and planned future observing assets.
- Have a few point people from the IWG-OA and the West Coast states work as a task force team to reach out to state, university, tribal, and federal staff to further develop the inventory.
- Conduct a workshop attended and funded by US and Canadian federal agencies, IOOS, California, Oregon, Washington, and British Columbia to identify key management questions which can inform current and future observing assets, and facilitating an enhanced partnership with IOOS.
- Develop a national dialogue related to the potential application of Clean Water Act programs (regulatory and non-regulatory) to acidification in coastal waters. EPA hopes that the PCC will engage in this dialogue.