

# 3

## **Recommended Strategies and Actions to Address Ocean Acidification**



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Oysters from Washington. Photo credit: Marc Dewey

The strategies and actions recommended by the Panel in 2012 reflected the need for action across a range of areas. In the 2017 review, no new focus areas were identified. Instead, recommendations were made to update actions and add new actions to address emerging questions, changes in knowledge, or clarify action intent. These changes are discussed in detail in the following chapters.

The table below includes a complete list of strategies and actions Washington needs to pursue to address ocean acidification. New and updated actions identified from the 2017 efforts are called out; for reference, the revisions to updated actions are underlined. Key Early Actions (KEAs) are actions designated as essential next steps for reducing the risks associated with ocean acidification as identified by the Panel. Progress toward all recommendations is strongly urged, however.

Reduce Emissions of Carbon Dioxide (Chapter 4)	
Take action to reduce global, national, and local emissions of carbon dioxide (Strategy 4.1)	Work with international, national, and regional partners to advocate for a comprehensive strategy to reduce carbon dioxide emissions (Action 4.1.1) [KEA]
	<b>Updated Action:</b> Implement additional actions <u>to reduce carbon emissions</u> where such actions would reduce acidification of Washington's marine waters (Action 4.1.2)
	<b>Updated Action:</b> <u>Explore relationships between local air emissions and elevated regional atmospheric carbon dioxide through observations and modeling. Use numerical models to evaluate scenarios of elevated regional atmospheric carbon dioxide. Take actions to reduce local air emissions that are shown to contribute significantly to acidification.</u> (Action 4.1.3)
	Enlist key leaders and policymakers to act as ambassadors advocating for carbon dioxide emissions reductions and protection of Washington's marine resources from acidification (Action 4.1.4)

Share significant findings and progress on reducing carbon emissions (Strategy 4.2)	<b>New Action:</b> Identify and share key findings from reducing emissions of carbon dioxide with ocean acidification communicators to support outreach and communication efforts designed to raise public awareness of ocean acidification. (Action 4.2.1) [Related to Action 8.1.6]
<b>Reduce Local Land-Based Contributions to Ocean Acidification (Chapter 5)</b>	
Strengthen and augment existing pollutant reduction actions to reduce nutrients and organic carbon (Strategy 5.1)	<b>Updated Action:</b> Implement, <u>support, and enforce existing and effective nutrient, sediment, and organic carbon reduction programs</u> in locations where these pollutants are causing or contributing to multiple water quality problems (Action 5.1.1) [KEA]
	<b>Updated Action:</b> Support and reinforce current planning efforts and programs that address the impacts of nutrients, <u>sediment loading</u> , and organic carbon (Action 5.1.2) [KEA]
	<b>Updated Action:</b> <u>Support research efforts for developing water quality criteria relevant to ocean acidification in collaboration with new and existing monitoring efforts</u> (Action 5.1.3)
	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)
Impose stringent controls to reduce and limit nutrients and organic carbon from sources that are contributing significantly to acidification of Washington's marine waters (Strategy 5.2)	<b>Updated Action:</b> If it is scientifically determined that nutrients from sewage systems are contributing to local acidification, <u>identify opportunities to reduce stress on or improve treatment of sewage systems</u> (Action 5.2.1)
	If determined necessary based on scientific data, reduce nutrient loading and organic carbon from point source discharges (5.2.2)
	<b>New Action:</b> If determined necessary based on scientific data, establish new programs to reduce nutrient, sediment, and organic carbon loading from nonpoint sources (Action 5.2.3)
<b>New Strategy:</b> Share significant findings and progress on local land-based contributions actions (Strategy 5.3)	<b>New Action:</b> Identify and share key findings from local land-based contributions actions with ocean acidification communicators to support outreach and communication efforts designed to raise public awareness of ocean acidification (Action 5.3.1) [Related to Action 8.1.6]
<b>Increase Our Ability to Adapt and Remediate the Impacts of Ocean Acidification (Chapter 6)</b>	
Remediate seawater chemistry (Strategy 6.1)	<b>Updated Action:</b> Develop <u>land and aquatic</u> vegetation-based systems of remediation for use in upland habitats and in shellfish areas (Action 6.1.1) [KEA]
	Maintain and expand shellfish production to support healthy marine waters (Action 6.1.2)
	Study the use of shells in targeted marine areas to remediate impacts of local acidification on shellfish (Action 6.1.3)
	<b>New Action:</b> Identify and support research and implementation of activities to increase the marine ecosystem's ability to preserve carbon stored in sediments and capture and store additional carbon from atmospheric sources (Action 6.1.4)

	<p><b>New Action:</b> In watersheds where models show land-based pollution contributes to local acidification, implement macroalgae recycling programs between local shellfish farms and terrestrial farms (Action 6.1.5)</p>
Increase the capacity of resource managers and the shellfish industry to adapt to ocean acidification (Strategy 6.2)	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]
	Expand the deployment of instruments and chemical monitoring to post-hatchery shellfish facilities and farms (Action 6.2.2)
	Investigate and develop commercial-scale water treatment methods or hatchery designs to protect larvae from corrosive seawater (Action 6.2.3) [KEA]
	Develop and incorporate acidification indicators and thresholds to guide adaptive action for species and places (Action 6.2.4)
	<b>New Action:</b> Investigate the relationship between ocean acidification resistance in shellfish and feed quantity and quality, to assess potential to strengthen shellfish through adjusted feeding regimes (Action 6.2.5)
Enhance resilience of native and cultivated shellfish populations and ecosystems on which they depend (Strategy 6.3)	Preserve Washington’s existing native sea grass and kelp populations and, where possible, restore these populations (Action 6.3.1)
	Identify, protect, and manage refuges for organisms vulnerable to OA and other stressors (Action 6.3.2) [KEA]
	Support restoration and conservation of native oysters (Action 6.3.3)
	Use conservation hatchery techniques to maintain the genetic diversity of native shellfish species (Action 6.3.4)
	Investigate genetic mechanisms and selective breeding approaches for acidification tolerance in shellfish and other vulnerable marine species (Action 6.3.5)
	<b>New Action:</b> Identify and protect intertidal and nearshore habitats that currently support, or will support in the future due to sea level rise, organisms vulnerable to ocean acidification, and those that mitigate ocean acidification impacts (Action 6.3.6)
	<b>New Action:</b> Review and evaluate current regulations governing the culture and harvest of aquatic vegetation and develop recommendations for regulatory changes, if needed (Action 6.3.7)
<b>New Strategy:</b> Share significant findings and progress on adaptation and remediation actions (Strategy 6.4)	<b>New Action:</b> Identify and share a summary of key findings from adaptation and remediation actions with ocean acidification communicators to support outreach and communications efforts designed to raise public awareness of ocean acidification (Action 6.4.1) [Related to Action 8.1.6]

## Invest in Washington's Ability to Monitor and Investigate the Effects of Ocean Acidification (Chapter 7)

Understand the status and trends of ocean acidification in Washington's marine waters (Strategy 7.1)	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]
	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)
Identify factors that contribute to ocean acidification in Washington's marine waters and estimate the relative contribution of each (Strategy 7.2)	<b>Updated Action:</b> Quantify key natural and human-influenced processes that contribute to acidification based on estimates of sources, sinks, and transfer rates of carbon and nitrogen (Action 7.2.1) [KEA]
	Develop new models or refine existing models to include biogeochemical processes of importance to ocean acidification (Action 7.2.2)
Characterize biological responses of local species to ocean acidification and associated stressors (Strategy 7.3)	Determine the association between water and sediment chemistry and shellfish production in hatcheries and in the natural environment (Action 7.3.1) [KEA]
	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]
	Conduct field studies to characterize the effects of ocean acidification, alone and in combination with other stressors, on local species (Action 7.3.3)
Build capabilities for short-term forecasting and long-term prediction of ocean acidification (Strategy 7.4)	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]
	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 response to predicted ocean acidification conditions (Action 7.4.2)
	Enhance the ability to model the response of organisms and populations to ocean acidification to improve our understanding of biological responses (Action 7.4.3)
<b>New Strategy:</b> Coordinate and leverage resources among monitoring and investigation efforts (Strategy 7.5)	<b>New Action:</b> Support coordination at the state level to capitalize on existing data and efforts for monitoring ocean acidification (Action 7.5.1)
	<b>New Action:</b> Support co-location of observational resources and coordinate lab and field efforts for mutual benefit (Action 7.5.2)
<b>New Strategy:</b> Share significant findings and progress on monitoring and investigations actions (Strategy 7.6)	<b>New Action:</b> Identify and share key findings from monitoring and investigations actions with ocean acidification communicators to support outreach and communications efforts designed to raise public awareness of ocean acidification (Action 7.5.1) [Related to Action 8.1.6]

## Inform, Educate, and Engage Stakeholders, the Public, and Decision Makers in Addressing Ocean Acidification (Chapter 8)

Share information showing that ocean acidification is a real and recognized problem in Washington state (Strategy 8.1)	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 stakeholders, 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)
	<b>Updated Action:</b> Provide a forum for agricultural, forestry, business, and other stakeholders to engage with coastal resource users and managers in developing and implementing solutions (Action 8.1.4) [KEA]
	<b>New Action:</b> Raise awareness of available ocean acidification tools and resources (Action 8.1.5)
	<b>New Action:</b> Develop and periodically update an ocean acidification outreach and communications strategy and an annual list of key messages and key findings (Action 8.1.6)
Increase ocean acidification literacy (Strategy 8.2)	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)

## Maintain a Sustainable and Coordinated Focus on Ocean Acidification (Chapter 9)

Ensure effective and efficient multi-agency coordination and collaboration (Strategy 9.1)	<b>Updated Action:</b> <u>Continue to coordinate, through the Marine Resources Advisory Council,</u> implementation of the Panel's recommendations with other ocean and coastal actions (Action 9.1.1) [KEA]
	<b>Updated Action:</b> <u>Continue operation of the Washington Ocean Acidification Center as the state's ocean acidification science coordination team to promote scientific collaboration across agencies and organizations, and connect ocean acidification science to adaption and policy needs</u> (Action 9.1.2) [KEA]
	<b>New Action:</b> Coordinate Washington's efforts to address ocean acidification with those of other regional, domestic, and international groups (Action 9.1.3)