



**The Oregon Coordinating Council on
Ocean Acidification and Hypoxia**



FOURTH BIENNIAL REPORT
October 1, 2024



Submitted by the Oregon Coordinating Council on Ocean Acidification and Hypoxia



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Table of Contents

Letter from the OAH Council Co-Chairs	4
Executive Summary	6
What has been accomplished, and what is to come?	6
How is the ocean affected by CO ₂ and hypoxia?	8
Oregon’s OAH Action Plan & achievements	9
Implementing the OAH Action Plan	10
Theme 1: Advance Scientific Understanding	10
Theme 2: Reduce Causes.....	14
Theme 3: Create Resilience	16
Theme 4: Expand Public Awareness.....	18
Theme 5: Build Sustained Support.....	20
Noteworthy Milestones	24
Ocean Status Update	28
Moving Forward	30
Oregon’s OAH Council Members	32
Appendices: Table of Contents	33

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Letter from the OAH Council Co-Chairs

The coastal ocean is cornerstone to many Oregonians' identities. While the use and enjoyment of ocean resources varies between individuals, the protection and enhancement of ocean resources for future generations is a common value. Since its inception in 2017, the Oregon Coordinating Council on Ocean Acidification and Hypoxia (OAH) has been the key entity highlighting the dramatic changes Oregon's ocean is experiencing from climate change, investigating the impacts these changes are having on individuals, organizations, businesses, Tribes and other affected parties, and taking actions to support adaptation and mitigation. The Council draws on the broad expertise of its members to ensure that our actions and recommendations are science-based and represent the needs and desires of all Oregonians. Ocean acidification and hypoxia, as well as marine heatwaves, have already disrupted our region's economic use and recreational enjoyment of the ocean, and these impacts are projected to increase in the future. For those appreciating the ocean from the shore, rising sea levels will change beaches and affect coastal infrastructure. For those reliant on seafood, harvesting will require extensive adaptive management as species move, and consumers will need to adapt to new products as fisheries change. In all these issues, the OAH council is a nexus, bringing together experts and decision makers to understand the science, the impacts, and potential consequences for communities now and in the future.

Over the past biennium, the OAH Council has been deeply engaged in community and capacity building to further our readiness and response for ocean change. Members of the OAH Council continue to lead the nation and world in research and policy on ocean change, with presence on regional, national, and international boards (e.g. Ocean Decades Program, Ocean Acidification Alliance and the Pacific Coast Collaborative). The OAH Council continues to strengthen its relationship with the Oregon Global Warming Commission, recently rebranded as the Oregon Climate Action Commission (OCAC). Additionally, the council has continued to host Fishermen-Scientist Roundtables. Recognizing their value, the council has increased meeting frequency to twice a year. These events are now highly anticipated by both scientists and fishermen alike and have resulted in productive collaborations among previously disconnected stakeholder groups.

In our first action plan, we highlighted 5 core action areas where Oregon can continue to prepare and plan for additional changes associated with OAH. These 5 can briefly be summarized as **increasing understanding**, **mitigating causes**, **adaptation**, **communication**, and **strengthening capacity and response through policy**. Over the last biennium, we have continued to make measurable progress in these key areas, as illustrated by these highlights:

- *Conducted essential OAH monitoring projects and surveys at sea, in estuaries, and at aquaculture facilities to better understand OAH at a local level (Funded through House Bill 3114)*
- *Coordinated with Oregon Department of Environmental Quality to provide evidence that supports policy decisions with respect to OAH impairment within Oregon's territorial waters*
- *Coordinated with California, Washington, and British Columbia partners to establish best practices for regulating and monitoring OA water quality impacts*
- *Conducted research projects focused on monitoring and improving the resilience of Olympia and Pacific oyster fisheries and habitat (Funded through House Bill 3114)*

- *Funded (through House Bill 3114) a project that developed science-based recommendations for co-managing submerged aquatic vegetation and shellfish fisheries*
- *Raised awareness about problems and solutions by participating in and convening workshops, roundtables, and OAH Symposia, notably including the fishing community*
- *Completed Oregon's first OAH Communication Plan (funded through House Bill 3114)*
- *Coordinated within the State agency family on strategic planning related to climate and ocean change*
- *Provided leadership in the State and with other governments on OAH policy, science, and action*

The OAH council plans to continue our critical work in readying Oregon's response to the impacts of ocean acidification and hypoxia to our livelihoods and Oregon's vital coastal economy. We will update Oregon's OAH Action plan with an outlook for 2025-2031. This action plan will continue Oregon's national leadership as the first update to an OAH action plan conducted by any national or subnational body. We will also focus efforts on identifying critical needs to advance Oregon's detection and response capabilities. Emerging needs for the next biennium include:

- 1) Replacing critical infrastructure at Cape Perpetua to maintain our longest time series of hypoxia monitoring in Oregon, which is a critical source of information and asset to management.
- 2) Implementing the OAH Council's communication plan to raise awareness of the harmful effects of ocean change and actions that can be taken to reduce them.
- 3) Increasing observations of nearshore ocean conditions and species to quantify how our ocean is changing and enable natural resource agencies to adapt their management to better protect these resources.
- 4) Supporting the implementation of DEQ's work to assess and potentially list nearshore waters as imperiled.
- 5) Continue monitoring and research on Oregon's submerged aquatic vegetation to understand how these important ecosystems are changing and their potential to sequester carbon.

Climate change is the paramount challenge of our time and responding to it requires immediate action. The effects of climate change will dominate natural resource science and policy for generations to come. As Co-chairs of Oregon's OAH Council we take our responsibility very seriously and will continue to advance the best available science to guide policy and action to increase Oregon's resilience to changing ocean conditions.

Laurie Juranek, PhD



*Professor
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Leif Rasmuson, PhD



*Marine Fisheries Research Project Leader
Oregon Department of Fish and Wildlife*

Executive Summary



4th Biennial Report to the Legislature and Ocean Policy Advisory Council Submitted by the Oregon Coordinating Council on Ocean Acidification and Hypoxia

What has been accomplished, and what is to come?

Oregon and its coastal communities rely heavily on healthy ocean ecosystems that support thriving wild fisheries (e.g., Dungeness crab, pink shrimp, salmon, and rockfish), oyster aquaculture, and a strong tourist economy. However, these industries – and the communities that depend upon them – are negatively impacted by intensifying ocean acidification and hypoxia (low oxygen) in the waters off Oregon’s coast. This intensification of ocean acidification and hypoxia (OAH) is one of a suite of climate change effects in the ocean caused by anthropogenic carbon emissions. To address these threats to Oregon’s people and coasts, the Oregon Coordinating Council on Ocean Acidification and Hypoxia (OAH Council) has been working to **understand**, **mitigate**, **adapt to**, **communicate about**, and **strengthen Oregon’s capacity and response to** ocean change (**Figure 1**).

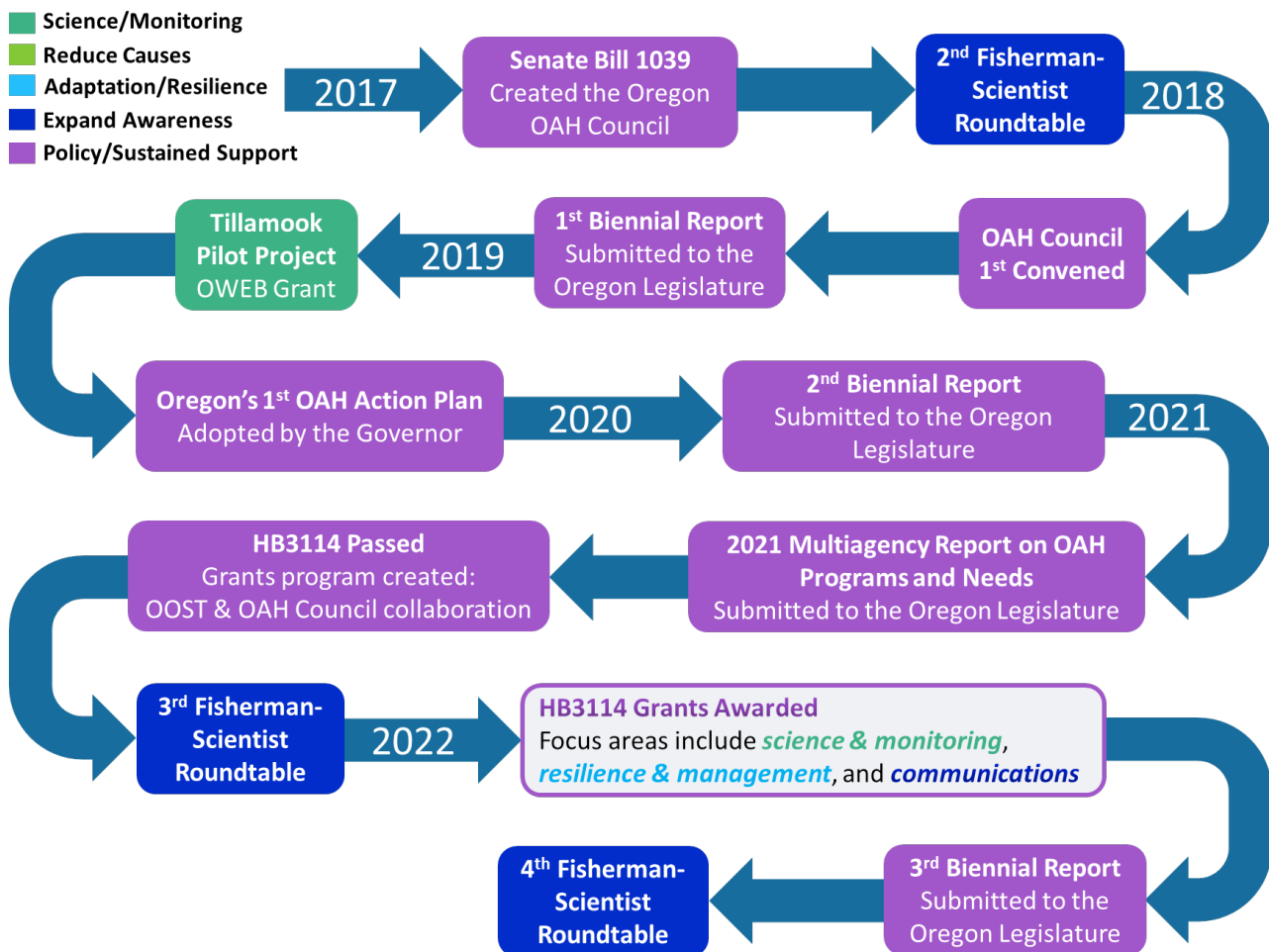


Figure 1. Timeline of events since the Oregon OAH Council was created in 2017 through 2022. The five color-coded phrases are the primary action items identified in Oregon’s first ever OAH action plan (**Appendix A**).

Over the last two years, the OAH Council has continued to build capacity and communication among multiple interested groups: 1) hosted the first OAH Symposium showcasing **monitoring**, **resilience-building**, and **communication** projects funded by HB 3114; 2) contributed to an integrated report on the quality of Oregon’s surface waters that proposes designating two ocean areas impaired by OAH or OA for the first time in the history of the United States; 3) hosted fishermen-scientist roundtable meetings, which have led to better-informed science, resource management, and solutions to minimize the effects of OAH; and 4) facilitated knowledge-sharing and synthesis via report-outs from the HB3114 projects, providing key insights to Oregon’s changing coastal ecosystem (**Figure 2**). Over the next two years, the OAH Council will continue to focus on increasing knowledge and best-practice information exchange via fishermen-scientist roundtable meetings and will develop Oregon’s 2nd OAH Action Plan (2025-2031). **This will be the first OAH Action Plan in the world to be updated, so Oregon continues to lead the way in addressing ocean change.**

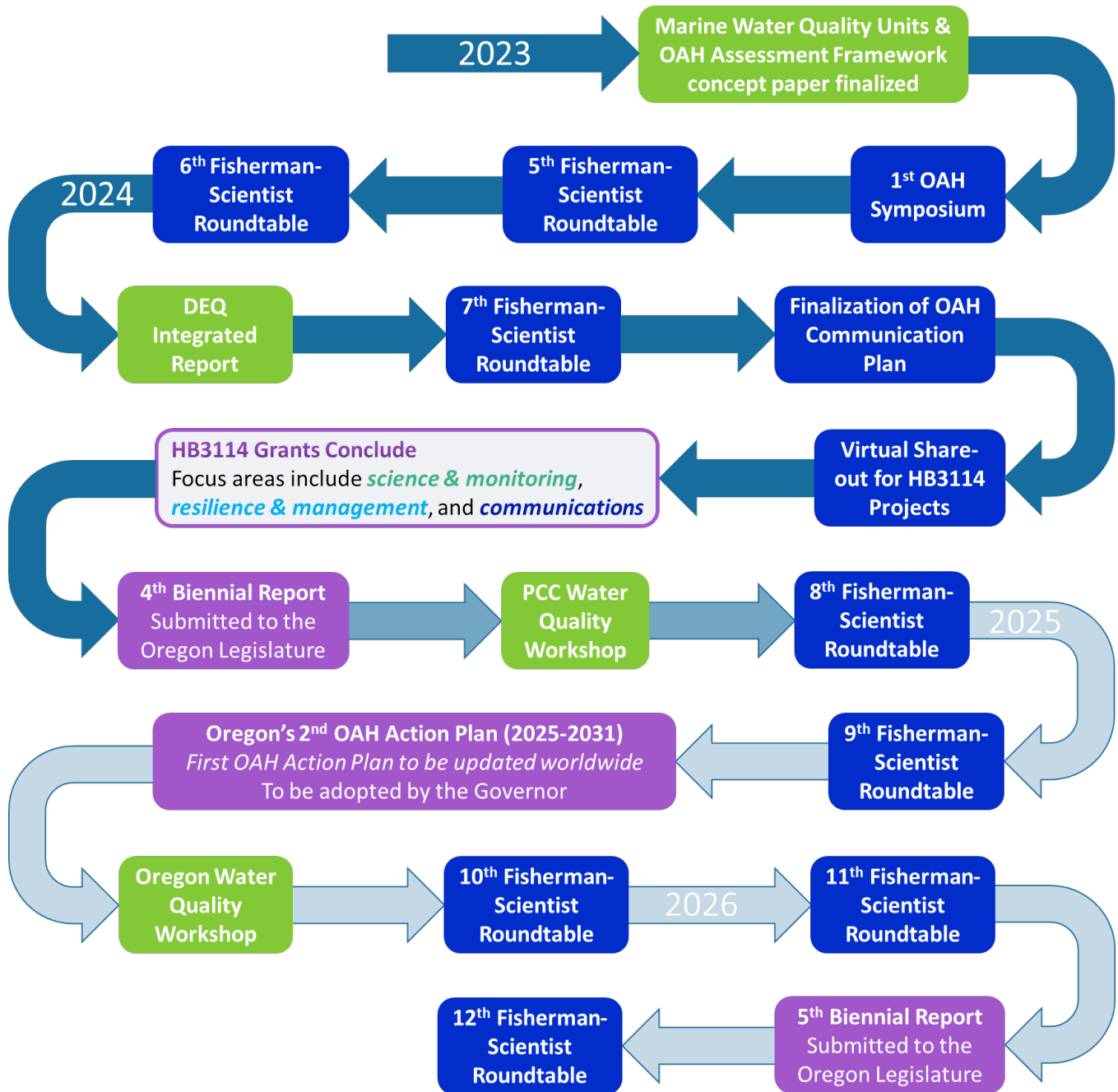


Figure 2. Timeline of Oregon OAH Council events from 2023 and planned through 2026.

How is the ocean affected by CO₂ and hypoxia?

The ocean has absorbed roughly 90% of the heat and 30% of the CO₂ associated with industrial emissions and climate change. Therefore, the ocean plays a critical role in regulating a stable climate and buffering against further change. However, absorption of CO₂ causes chemical reactions to take place in the ocean which lower the pH of the water (called ocean acidification). This change in ocean chemistry makes it more difficult for organisms to form shells and impacts fish survival, which negatively impacts food webs and fisheries. A warming climate that is enhancing upwelling-favorable winds may also be driving increasingly widespread and longer duration of hypoxic (low oxygen) events along the Oregon coast.

Oregon is particularly sensitive to ocean acidification and hypoxia due to coastal upwelling that brings high nutrient, high CO₂ and low oxygen waters to our nearshore each summer. The waters off Oregon are naturally extraordinarily productive due to northern summer winds that drive coastal upwelling – a process that forces surface waters offshore and brings deep ocean water to the surface. These “cold and old” waters are naturally high in CO₂ and low in oxygen since they have been sequestered at depth where biological respiration and decomposition increase CO₂ and decrease oxygen. The CO₂ concentrations are further increased by additional uptake of anthropogenic CO₂ emissions, which when added to this already high CO₂ water, can cause extremes in ocean pH that are harmful to certain organisms, particularly those that form shells.

These deep, upwelled waters that are rich in nutrients, low in oxygen, and high in CO₂ also promote large blooms of phytoplankton. The strength and frequency of winds from the north is increasing with climate change, likely leading to larger phytoplankton blooms. When these blooms die, they decay as they sink to the bottom, consuming oxygen in the process. Since the decay occurs in already low oxygen water, the process uses up most of the remaining oxygen and creates hypoxic or sometimes anoxic (no oxygen) zones.

Ocean acidification and hypoxia pose a multi-stressor challenge for marine organisms and coastal communities (**Figure 3**). Understanding the linkage between the effects of anthropogenic climate change and natural processes is critical. Thus, it is essential we monitor and study our ocean to respond to these changes.

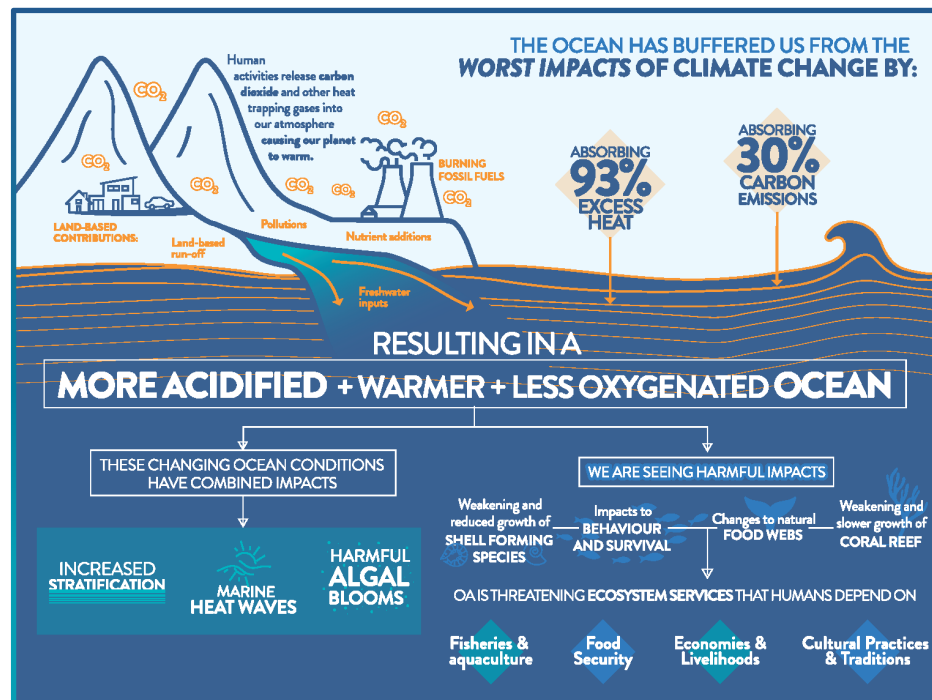


Figure 3. Global impacts of climate change on the marine environment, highlighting the climate connections between the ocean, land, and atmosphere. *Graphic Credit: sourced from the OA Alliance.*

Oregon's OAH Action Plan & achievements

Governor Brown adopted Oregon's first OAH Action Plan in 2019. This action plan was developed to lay out a roadmap of actions to address OAH for the next 6 years (2019-2025; **Appendix A**). Oregon was one of the first states to submit an OAH Action plan to the International Alliance to Combat Ocean Acidification (OA Alliance), which established our commitment to local actions that can help address the larger global issues of climate and ocean change.

Over the last two years, the OAH Council has facilitated or completed many of the actions and achievements recommended in their 2022 Biennial Report and the OAH Action Plan **including OAH science & monitoring, reducing causes, adaptation & resilience, awareness, and building support (Figure 4).**



Figure 4. Oregon OAH Action Plan themes (2019-2025) and achievements between 2023-2024.



Implementing the OAH Action Plan

Theme 1: Advance Scientific Understanding

Action: Invest in Oregon’s monitoring network to document oceanographic and biological conditions, and the socio-economic vulnerabilities relating to ocean acidification and hypoxia (OAH)

Increasing the spatial and temporal resolution of Oregon’s ocean monitoring program will ensure that our understanding of ocean change accounts for all the nuances we know exist throughout Oregon’s water and across seasons. This requires frequent observations in the state-managed nearshore waters from Washington to California. We will be unable to effectively account for how the ocean is changing near each of the highly unique coastal communities without a complete observing network that represents all of Oregon’s waters. Alternatively, a complete set of observations will allow agencies to develop region-specific adaptive management plans for natural resources such as water quality and fisheries. Ultimately, increasing observations will allow us to forecast ocean changes throughout the region, which in turn, will allow us to promote resiliency in decision-making and inform our adaptive management.

Recently, scientists and fishermen have been able to collaborate on monitoring ocean conditions. This not only increases the scale and resolution of our observations, but it also increases awareness within the fleet about OAH. Funded by HB3114, Oregon State University researchers have worked to develop sensors that can be added to crab pots to measure dissolved oxygen levels. Fishermen benefit from immediately knowing if conditions are hypoxic where they are fishing (increasing the efficiency of their gear), and scientists benefit from knowing the extent of the hypoxic zones. This, like many other partnerships between science and industry, illustrates the immense benefits we experience when industry and science work together.

Current Project Highlights

Intertidal ocean acidification monitoring in Oregon's marine reserves (OAH Action Plan Step 1.1)

Research in Oregon's coastal waters was instrumental in establishing the linkage between a warming ocean and the intensification of hypoxia. In concert with the realization that ocean acidification was already impairing the state's shellfish industry, Oregon has been recognized as ground zero for the challenges of ocean climate and carbon changes. Simultaneously, we were at risk of losing our long-term observations crucial for detecting trends and tipping points, as well as quantifying exposure to OAH stressors in state waters that are essential for interpretations of fishery and marine reserve fish survey data.

Funding from HB3114 allowed us to sustain our most important hypoxia time series (begun in 2003) and make OAH measurements in (or just outside of) marine reserves. The latter was achieved through partnership with ODFW and crab fishermen. Through these partnerships, we now have strong clarity on the geography of exposure to OAH stressors across our state's marine reserves and the recognition of those reserves as sentinel sites for detecting and tracking ocean change. Without this funding, we would have missed the return of anoxia to the central Oregon Coast. OAH exposure is too dynamic and consequential for marine life and fisheries to leave our ocean vastly under-monitored. Support from HB3114 was also instrumental in allowing an OSU-led regional effort to leverage federal funding opportunities in ocean climate science. This includes \$4.2 million to develop management options to support the climate and OA-resilience of the Dungeness crab fishery, and another \$1.2 million for an OSU-industry partnership to bring operational ocean monitoring technologies to the commercial and charter crab fleet.

Francis Chan (OSU), HB3114-OOST Project 1 (2022-2024)

Subtidal OAH monitoring in Oregon's marine reserves (OAH Action Plan Step 1.1)

Oregon's rocky shores are iconic habitats where many generations of Oregonians experience the biodiversity that our coastal oceans hold. These habitats are also where the global problem of ocean acidification makes landfall. Summertime upwelling winds bring waters to nearshore areas where human CO₂ emissions accentuate the challenges of low pH stress. Initial research indicated that this vulnerability is unlikely to be evenly distributed along our coast. Without place-based monitoring, the exposure of Oregon's marine reserves to changing ocean stressors would be unknown. Funding from HB3114 has allowed us to sustain measurements of pH and temperature in marine reserves through a network of partners that include The Nature Conservancy, Friends of Cape Falcon Marine Reserve, Friends of Otter Rock, Redfish Rocks Community, Surfrider, and others.

We now have a clear understanding of the geography of OAH exposure that persists across years, with hotspots of exposure in the central coast and a refuge from the most severe low pH stress in the Port Orford region. We also have robust measurements of just how severe ocean acidification stress can be in rocky shore habitats due to frequent exposure to waters that are corrosive to carbonate minerals found in many intertidal organisms. The data collected to date serves as reference points to document OAH exposure in State waters as Oregon considers questions of water quality impairment under the Clean Water act. The data also serves as a baseline as we try to understand the potential for tipping points in exposure to not just OAH but multiple accompanying climate stressors. HB3114's support of this project has allowed the training of students who can be part of an ocean climate technology workforce. Perhaps most importantly, these students will be part of a landscape of community-engaged science and solutions building in the face of rapid ocean changes.

Francis Chan (OSU), HB3114-OOST Project 2 (2022-2024)

Enhanced OAH sampling on the Newport Hydrographic Line (OAH Action Plan Step 1.2)

The Newport Hydrographic Line (a line of survey stations running East-West out of Yaquina Bay) time series is key to understanding the connectivity between changes in ocean- climate and ecosystem structure and function. The 25+ year time series provides fortnightly to monthly data collected on the continental shelf and slope off Newport, OR. Oxygen profile data have been collected since 2006 to monitor OAH. With the addition of HB3114 funding, monthly water samples are also being collected to establish a baseline of carbonate chemistry in Oregon's nearshore waters. These near-bottom samples have been collected since February 2023 from three nearshore stations.

2023 was the first year since 2016 where near bottom hypoxic water was not observed on the continental shelf. Although the waters were not hypoxic, the carbonate chemistry measurements showed the inner shelf bottom waters became corrosive with respect to aragonite ($\Omega < 1$) in July, 2023. Ω is a metric that signals the dissolution of aragonite, which is important for many calcifying organisms. **In collaboration with researchers from CA and WA, we are developing a guide to the best practices for OA biological monitoring.**

Francis Chan (OSU) and Jennifer Fisher (NOAA), HB3114-OSU Project 1 (ongoing)

Hatfield Marine Science Center climate monitoring station (OAH Action Plan Step 1.1)

Oregon State University's (OSU) Hatfield Marine Science Center (HMSC) is utilizing HB3114 funds to create a robust long-term ocean acidification and hypoxia (OAH) monitoring site on the HMSC campus located on Oregon's Yaquina Bay. The HMSC dock is a significant estuarine research reference site with a historic monitoring effort. However, many of these vital monitoring programs have lapsed, struggled with data gaps, or have inaccessible data due to a lack of resources. When complete, the HMSC Climate Monitoring Station will fill these vital OAH data gaps by collecting a comprehensive suite of parameters creating a stable long-term data collection and dissemination system accessible to managers, researchers, and the public in an interactive exhibit in our visitor's center. We are also optimizing our data architecture with other estuary sampling efforts up and down the coast enabling us to compare data over a wide geographic scale. **The data collected at the HMSC Climate Monitoring Station will create a baseline OAH dataset to track ecosystem shifts, inform management decisions in Oregon's critical estuaries, and improve public data literacy and estuary health awareness for the more than 150,000 annual visitors to HMSC.**

Bob Cowen and Cinamon Moffett (OSU), HB3114-OOST Project 3 (2022-2025)

Evaluating the interaction of water quality and eelgrass in Coos Bay, Oregon using a biophysical model (OAH Action Plan Step 1.2)

Seagrasses, including eelgrass *Zostera marina*, are thought to mitigate ocean acidification and hypoxia (OAH) in estuaries. However, the scales at which mitigation is realized are not fully understood. Multiple approaches have been used to investigate the influence of seagrass on pH and dissolved oxygen, but few have attempted to do so at estuary-wide scales. We are leveraging existing information to build a biophysical model of Oregon's Coos Bay estuary. Initially, the model is being used to explore how eelgrass abundance impacts OAH. Model development is ongoing, but initial results suggest that dissolved oxygen and pH are elevated in simulations with high eelgrass abundance. Due to interacting biological and hydrological factors, the OAH mitigation by eelgrass in Coos Bay is spatially and temporally limited. **Once finalized, the model can help guide eelgrass conservation and restoration and can evaluate other ecosystem scale processes that impact Coos Bay, including coastal development and climate change.**

Tarang Khangaonkar and Caitlin Magel (University of Washington), HB3114-OOST Project 4 (2022-2024)

Estuary shellfish and habitat surveys (OAH Action Plan Step 1.2)

Project 1: Increased staffing for the ODFW Shellfish and Estuarine Habitat of coastal Oregon (SEACOR) project

The increased staffing for SEACOR supported an additional field team for the 2022-2023 field seasons. This increased sampling efficiency and areal coverage for Tillamook Bay Estuary Assessment during those field seasons, and it included both intertidal (2022-2023) and subtidal (2023) sampling. Ocean Acidification can negatively impact shellfish populations, so these samples are key to detecting change for stock assessments. The results of the survey were used to update the stock estimates of recreationally and commercially important bay clam populations of Tillamook Bay, last sampled in 2010-2012. The updated stock assessments were used by ODFW to adjust the quotas for the intertidal and sub-tidal (dive) clam fisheries. **The results of the assessment were also shared with the legislatively mandated Tillamook Bay Clam Advisory Committee (TBCAC) and were used, in part, to generate the 31 TBCAC recommendations that were presented to the Oregon legislature by ODFW in December 2023.**

Project 2: Estuary Mapping

The second component of HB 3114 funding was for estuary mapping. The ODFW Shellfish Program purchased 2 new DJI Uncrewed Aircraft Systems (UAS). These included UAS with standard (RGB) and Multispectral camera systems. UAS flights were flown in Tillamook Bay in 2023 using both camera systems in areas of the bay with known beds of the native eelgrass, *Zostera marina*, a protected habitat in Oregon estuaries. These flights produced high-resolution habitat maps of eelgrass and unvegetated areas in Tillamook Bay. The new multispectral imaging systems tested during these flights show potential for rapid mapping of estuarine vegetation such as eelgrass. **Imagery from these flights has already been used by ODFW to address emerging management issues such as permit reviews for proposed shellfish aquaculture activities.**

Tony D'Andrea (ODFW), HB3114-ODFW Project 1 (2022-2023)

Ocean acidification monitoring at Whiskey Creek Shellfish Hatchery (OAH Action Plan Step 1.1)

OSU researchers have continued the monitoring program at Whiskey Creek Shellfish Hatchery (WCSH) for the time between this and the last OAH Biennial Report. **Continued high-resolution measurement of the full carbonate system in hatchery intake waters from Netarts Bay has allowed WCSH managers to adaptively target favorable conditions for culture activities. Additionally, this monitoring has allowed WCSH staff to buffer waters with sub-optimal chemical conditions after receiving advice on the appropriate mineral selection from OSU researchers.** Continued operating software and system hardware maintenance have developed the autonomous analyzer (the 'Burke-o-Lator') into a far more stable and robust system than the previous prototype system from approximately a decade ago that revolutionized shellfish aquaculture's response to OA. OSU researchers have had a NOAA-funded partnership with WCSH that sprung from this historical collaboration to explore more proactive approaches, both in alkalizing hatchery waters and in performing the necessary organismal-response incubations to assess the environmental impacts of alkalization.

Burke Hales (OSU), HB3114-OSU Project 2 (ongoing)



Implementing the OAH Action Plan

Theme 2: Reduce Causes

Action: Develop and integrate strategies to reduce causes of excess carbon dioxide (CO₂) and ocean acidification and hypoxia (OAH)

Reducing the causes of OAH is essential to protecting the resources that sustain the industries that are central to Oregon’s coastal communities. Notably, the OAH Council and the State of Oregon have had the long-term goal of reducing CO₂, greenhouse emissions, and other co-stressors of OAH to help ensure a sustainable future (per Executive Order No. 20-04 and Senate Bill 1025 and House Bill 2021). Oregon has been taking actions to achieve this goal by implementing policies that reduce emissions and improve air and water quality. An example is the “Climate Resilience Package” Governor Kotek signed into law in 2023 (House Bills 3409 and 3630). This pair of House Bills focuses on nature-based climate solutions through natural and working lands and cleaner energy through more affordable and efficient building heating and cooling, electric vehicle rebates, and solar installation rebates.

Current Project Highlight

Clean Water Act water quality program & criteria development (OAH Action Plan Step 2.2, 2.3)

Every two years, the Oregon Department of Environmental Quality (DEQ) creates the Integrated Report, a comprehensive evaluation of Oregon's surface waters. In 2022, in consultation with [a technical workgroup of OAH experts](#), DEQ's Integrated Report Team developed methodologies to assess impairment of narrative water quality criteria relevant to marine waters: Oregon's narrative biocriteria (ocean acidification assessment) and marine dissolved oxygen criteria (hypoxia assessment). Both ocean acidification and hypoxia methodologies include an approach that uses multiple lines of evidence to assess water quality impact with a comparison to natural background conditions. For the purposes of the Integrated Report, Oregon marine waters are defined as the area from the shore to three miles out into the Pacific Ocean, and do not include estuaries.

In applying the ocean acidification and hypoxia methodology using the data and tools available for the 2024 assessment, DEQ has identified one ocean area (Cape Foulweather to Siltcoos River) as impaired for OAH, and one area (mouth of the Columbia River to Cape Lookout) as impaired for ocean acidification only. These proposed impairments are now reflected on DEQ's draft 2024 Integrated Report - 303(d) list of Impaired Waters needing a Management Plan (typically a Total Maximum Daily Load). This is the first time an ocean area has been listed as impaired for ocean acidification in the United States. **By identifying these stressors to marine life as pollution to be regulated under the Clean Water Act, DEQ's goal is to work collaboratively with existing state programs and with the scientific community to increase coastal resilience and develop tools and approaches to better understand and mitigate the effects of OAH and changing ocean conditions at the state level.**

Rian vanden Hooff (DEQ)

West Coast Water Quality Modeling and Ocean Acidification: Practitioners Meeting (OAH Action Plan Step 2.3)

The OAH Council also engages with regional entities on water quality and management issues to reduce OAH causes. Members of the OAH Council will attend the water quality modeling and management meeting focused on ocean acidification currently being planned by the Pacific Coast Collaborative's (PCC) OAH Working Group for November 2024. The meeting will gather ocean acidification experts and state and provincial water quality practitioners to **discuss regional OAH observations and hydrodynamic models to better inform coastal resource management across the Pacific US and Canadian coastlines.**



Implementing the OAH Action Plan

Theme 3: Create Resilience

Action: Support activities and initiatives that promote adaptation and resilience to ocean acidification and hypoxia (OAH) for Oregon’s human communities and ecosystems

Adaptation and resilience allow coastal communities to continue to thrive as marine industries are threatened by ocean change. A strategic way of fostering resilience is to promote community-driven adaptation measures because these integrate the insights and efforts of coastal residents into our collective response. Some examples of adaptative strategies in Oregon’s coastal communities are the ongoing blue carbon and submerged aquatic vegetation habitat protection and restoration projects that could help offset the carbon emissions that lead to climate change. The OAH Council continues to serve as a facilitator in aligning and coordinating these efforts across our state, ensuring a unified approach to addressing pressing environmental challenges. As we move forward, it is paramount that we continue to prioritize and support these critical activities by taking timely and impactful action to encourage resilience in Oregon’s marine resources and coastal communities.

Current Project Highlights

Science-based best management practices for co-management of Oregon submerged aquatic vegetation (SAV) and shellfish (OAH Action Plan Steps 3.1, 3.3)

This project developed science-based co-management recommendations for submerged aquatic vegetation (SAV) and shellfish in Oregon. These were developed through literature review, in person interviews, online surveys, and a two-day workshop, aiming to understand points and places of co-management opportunity or contention. Through these efforts, care was taken to incorporate diverse perspectives from user groups including scientists, managers, regulators, aquaculture operators, Tribal representatives, and conservation practitioners. Information from these processes was coalesced into a mapping tool currently available online, showing user group specific perceptions of SAV and shellfish co-management opportunities and challenges. This mapping tool can also be used to visualize spatially explicit overlaps between commercial shellfish harvest areas, recreational shellfish harvest areas, SAV habitat, and key management boundaries. **More in-depth recommendations and guidance such as priority scientific needs, considerations for shellfish harvest practices, improved communication, and trust between key players, among many more, can be found in the final report.** *Melissa Ward (SDSU) and Brian Katz (OSU), HB3114-OOST Project 5 (2022-2024)*

Olympia oyster growth and survival with climate change (OAH Action Plan Steps 3.1, 3.2)

To understand climate and ocean acidification impacts on Olympia oysters, the research team ran a ‘space for time’ study in Yaquina Bay, utilizing environmental variations through the estuary to compare with oyster growth. Five locations were established in 2022, and data has been collected on environmental conditions and oyster growth over the past two years. As many as 200 Olympia oysters and 50 Pacific oysters have been at each location. The preliminary findings illustrate that the locations do have differing pH and temperature conditions and that oysters grow at differing rates. The largest and fastest growing 20% of Olympia oysters nearly doubled in growth within average summer water temperatures between 14-18°C; growth sharply declined in slightly warmer waters. Maximum growth was also at an average salinity of 25 ppt, with lower growth at both 20 and 30 ppt. The team will soon compare growth with CO₂ conditions and combine data into a more robust model. *George Waldbusser (OSU), HB3114-OOST Project 6 (2022-2024)*

Breeding Pacific oysters for resistance to the effects of ocean acidification (OA) (OAH Action Plan Step 3.1)

West coast oyster hatcheries, including the Whiskey Creek hatchery at Netarts Bay, have been severely impacted by the effects of upwelled acidified seawater. This results in reduced production of high-quality seed for oyster farmers. In this project, the research team developed a novel flow-through larval rearing system that allowed them to determine the effects of acidified seawater on larval performance and spat production under highly controlled conditions. They also carried out a selection experiment to determine if progeny from stressed parents (exposed to acidified water during the larval phase and heat stress during the adult phase) would out-perform progeny of non-stressed parents from the same families. **Results indicated that acidified seawater adversely affected larval growth and spat production; however, they were not able to detect an improvement in performance of larvae from stressed parents when exposed to OA conditions. Comparison of field performances of progeny from stressed and non-stressed parents is in progress.**

Chris Langdon (OSU), HB3114-OSU Project 3 (ongoing)



Implementing the OAH Action Plan

Theme 4: Expand Public Awareness

Action: Communicate ocean acidification and hypoxia science, impacts, and solutions to raise awareness and support decision-making

When tackling an issue as large as ocean change, it is important to have as many people working toward solutions as possible. This requires public engagement, community involvement, and education. The OAH council is striving to increase communication about OAH science and policy with all Oregonians and make information more readily available to the public.

By empowering coastal communities with knowledge, they can work alongside policy makers, resource managers, and scientists to ensure coastal communities are ready for the changing future. Ultimately, this will lead all parties to better understand vulnerabilities within the community. Using a diverse knowledge pool including traditional ecological knowledge and experiential knowledge from ocean users will ensure the plans to mitigate and respond to changing oceans are effective for all individuals. Understanding these vulnerabilities and mitigating them through strategic planning and action will lead to a more robust and resilient coastal communities for all Oregonians.

Current Project Highlights

Oregon OAH communications plan (OAH Action Plan Steps 4.1, 4.2, 4.3)

This project developed a communications toolkit and implementation plan that inspires key audiences to act to reduce the projected trajectory of ocean and climate change and build a more resilient future through OAH mitigation and adaptation planning and policy. Rooted in social science, these materials advance the ability of OAH scientists to communicate about their important work. Having identified key audiences and developed messaging relevant to those target groups, the OAH Council can now communicate more effectively about the science behind OAH and solutions to address the impacts on the livelihoods of Oregonians. These communications increase civic readiness, such that members of each target audience sector are prepared for legislative and/or community-based action when opportunities arise.

Pathways Collaborative, HB3114-OOST Project 7 (2022-2024)

Fisherman-scientist OAH roundtables & app (OAH Action Plan Steps 4.2)

During the last biennium, Oregon Sea Grant and the OAH Council have hosted 3 Fishermen-Scientist OAH Roundtable meetings. These meetings are a great way to facilitate dialog between the fishing industry and marine scientists about ocean change trends, potential research collaborations, and potential solutions to issues caused or exasperated by OAH impacts. One product that has come out of these meetings is an “Ocean Change” phone and tablet application. ODFW has been working with OSU students to develop this app and prepare it for beta-testing. The goal of the app is to have ocean users provide peers and scientists with real-time ocean change indicator information. This citizen science input would substantially expand the current ocean change monitoring effort, and there is already interest in including this data in NOAA’s Integrated Ecosystem Assessments in the future.

Oregon OAH Symposium (OAH Action Plan Steps 4.2)

The OAH Council hosted the first ever OAH Symposium in 2023. Progress updates from all HB3114-funded projects were presented for over 80 stakeholders, natural resource managers, journalists, and members of the public. An online recording of this symposium is available here: <https://tinyurl.com/OAHSymposium2023>. In 2024, the final results from these HB3114 projects were made available to the public via recorded presentations, which can be found here: <https://tinyurl.com/HB3114FinalVideos>. **This symposium was a great opportunity to increase public awareness of the scientific research and monitoring facilitated by the OAH Council.**



Implementing the OAH Action Plan

Theme 5: Build Sustained Support

Action: Mobilize agencies to address ocean acidification and hypoxia (OAH) priorities

Addressing ocean acidification, hypoxia, and their broader impacts demands a multifaceted approach that recognizes the necessity for ongoing scientific research, adaptive management strategies, and forward-thinking policy decisions. It is important to have effective coordination between state agencies, academia, federal agencies, and industries so we can achieve these goals and tackle these issues together. This collaboration ensures a cohesive and adaptive approach to safeguarding our oceans and coastal communities against the adverse effects of changing climate and ocean conditions. Prioritizing scientific rigor and fostering interagency collaboration paves the way for innovative solutions and resilient policies that can effectively mitigate and manage ocean acidification and its related impacts.

Additionally, legislators play a pivotal role in addressing the complex challenges posed by ocean change and the associated negative effects. Oregon's elected officials have demonstrated crucial leadership in both setting goals for advancing OAH science and monitoring and shaping policies to mitigate impacts. For example, the direct funding provided through HB3114 shows their commitment to enhance OAH monitoring capabilities, deepen scientific understanding, and bolster resilience against these changes.

Current Project Highlight

Progress on Initiatives from the 2021 Multiagency Report on Ocean Acidification and Hypoxia (OAH) Programs and Needs (OAH Action Plan Steps 5.1, 5.3)



Department of Land Conservation and Development (DLCD)'s Climate-Friendly and Equitable Communities (CFEC) program is a part of a larger partnership between the DLCD, Oregon Department of Transportation (ODOT), Oregon Department of Environmental Quality (DEQ), and Oregon Department of Energy (ODOE) to reduce greenhouse gas (GHG) emissions from the transportation sector. The agencies are partnering to reduce transportation-related emissions that seeks to align federal, state, and local efforts. The basis for the work plan is the Statewide Transportation Strategy: A 2050 Vision for Greenhouse Gas Reduction (STS). The STS is Oregon's carbon reduction roadmap for transportation and includes a variety of strategies for substantially reducing Greenhouse Gas emissions.

DLCD's CFEC program aims to reduce climate pollution, provide more transportation and housing choices, and promote more equitable land use planning outcomes. The program strengthens Oregon's transportation and housing planning in eight metro regions, where roughly two-thirds of Oregonians live. Since the department's governing commission adopted updated planning rules in 2022, DLCD has worked with 52 cities and counties to identify more areas to zone for walkable development, reduce arbitrary parking mandates, set performance measures, and update local transportation plans, development codes, and comprehensive land use plans. Much of the work is aimed at reducing how often and how far Oregonians must drive to meet their daily needs, thereby helping meet Oregon's pollution reduction policy and goals.



Oregon Department of Agriculture (ODA) is continuing to work toward their goal of **expanding agricultural carbon sequestration and soil health.** ODA entered into a contract

agreement with OSU to study the Lower Umatilla Basin Groundwater Management Area (LUGBWMA). The goal was to inform governing bodies of the hydrologic make-up of the LUGBWMA using existing data and its aquifer structure. This OSU study for the LUGBWMA has finished, and the full report is being drafted. ODA also hired a soil health specialist to help fulfill the goals of the Fertilizer Program by supporting outcomes to reduce erosion, enhance nutrient use efficiency, promote carbon sequestration on natural and working lands, and help the agriculture industry adapt to the ongoing effects of climate change. Unfortunately, funds for the soil health specialist were cut, and ODA lost this position. However, the Soil and Water Conservation Districts (with which the ODA work) promote soil health and carbon sequestration programs.



Department of Environmental Quality (DEQ) is updating its rulemaking on the **Climate Protection Program designed to dramatically reduce greenhouse gas emissions in Oregon over the next thirty years.** The Climate Protection Program sets a declining limit (or cap) on greenhouse gas emissions from fossil fuels used throughout Oregon, including diesel, gasoline,

natural gas, and propane used in transportation, residential, commercial and industrial settings. The program will also regulate site-specific greenhouse gas emissions at manufacturing facilities, such as emissions from industrial processes, with a best available emissions reductions approach.



Oregon Department of Fish and Wildlife (ODFW) continues to conduct extensive monitoring of oceanographic conditions in Oregon state waters, particularly within the Marine Reserves ([initiative 1](#)). ODFW also continues to monitor fisheries ([initiative 2](#)) with an extensive network of staff throughout Oregon’s coastal communities. To mitigate co-stressors, ([initiative 3](#)) ODFW was part of the implementation of 8 new Marine Gardens, Marine Research Areas, and Marine Conservation Areas under the territorial sea plan. ODFW has also been an important member of many blue carbon working groups ([initiative 3](#)). ODFW continues to excel in climate-ready fisheries management ([initiative 4](#)) by playing an important role at the Pacific Fisheries Management Council and conducting research on how hypoxia impacts Oregon’s fisheries. Climate-resilient communities and ecosystems ([initiative 5](#)) are being promoted by studying how the community perceives ocean change and the roll of management. Extensive communication ([initiative 6](#)) with the public has been ongoing through presentations, social media, and printed materials. Finally, ODFW continues to participate in many subnational, national, and international forums regarding ocean change.

Oregon Department of Forestry (ODF) has completed changes to Oregon’s forestry rules to aid in the creation



of an aquatic Habitat Conservation Plan (HCP) that will meet the issuance criteria of an Incidental Take Permit under the Endangered Species Act and issued by the federal agencies by 2027. Collectively, these agreements are known as the Private Forest Accord (PFA). The PFA and associated legislation came together early in the first quarter of 2022, which was documented and recorded in the PFA report. The associated legislation directed the department of forestry to adopt rules to revise the Forest Practices Act, develop an HCP, and apply for Incidental Take Permit (ITP) covering the identified aquatic species. The revised rules have been approved by the Board of Forestry and are now in place (exception for post disturbance logging). ODF staff will seek approval of the draft proposed HCP by the Board of Forestry soon in order to meet the December 31, 2027 HCP implementation deadline.

Staff are also coordinating with the Oregon Climate Action Commission and the four agencies identified in the Natural and Working Lands Fund legislation. The department’s efforts related to these funds are to increase implementation of the ODF Climate and Carbon Plan. **These funds are largely focused on increasing carbon sequestration, but they also provide a way for increasing forest adaptation and ensuring that Oregon’s forests remain as forests into the future through adaptation measures and increasing climate change technical support to landowners, land managers, and technical service providers.** Maintaining healthy forests and riparian areas will provide needed habitat and ecosystem services to fish and can support resiliency from OAH.



Oregon Health Authority (OHA), Tribal Health Departments, local (county) public health authorities (LPHAs) and community-based organizations (CBOs) form Oregon’s public health system, which is essential for delivering equity-centered public health services to communities across the state. Starting in 2021, successive Governor’s budgets and legislative appropriations have provided funds earmarked for public health modernization, including a priority on building climate resilience. This funding is strengthening OHA’s capacity to report on and provide partners technical assistance on climate and health work, as described in OHA’s annual Climate and Health in Oregon reports. Of note, this funding is resourcing 34 LPHAs (counties and multi-county health districts), 57 CBOs, and the Nine Federally Recognized Tribes of Oregon to begin to identify climate hazards and at-risk populations and then develop and implement protective strategies. Together with broader public health work advanced by OHA’s strategic goal to eliminate health inequities in Oregon by 2030 — and reflected in the recently issued OHA Strategic Plan (2024-27) — **these actions strive to improve the health status of people in Oregon adversely affected by ocean acidification and its attendant socioeconomic impacts to individuals and communities.**



Oregon Department of State Lands / South Slough National Estuarine Research Reserve (ODSL/SSNERR) has several funded collaborative research projects that prioritize monitoring in wetlands and sensitive habitats, including eelgrass and oyster beds, to understand long term impacts from stressors including ocean acidification, hypoxia, marine heat waves, and sea level rise. In addition, the Reserve added new exhibits to the Visitor's Center in 2024 that promote community outreach and education on climate change, OAH, and estuary habitat restoration and conservation.

Research projects include 1) evaluating the recovery potential of eelgrass from seed banks under ambient and warming conditions in the Coos estuary (2022-2024, NERRS Davidson fellow research), 2) a pilot eelgrass restoration project to understand elevation and planting season effect on survival of adult eelgrass transplants (2020-present, South Slough science), 3) communication and assessment of seagrass seed-based restoration techniques (2023-2024, NERRS Science Collaborative), 4) evaluating the interaction of water quality and eelgrass in the Coos estuary through a biophysical model to understand ocean acidification and hypoxia vulnerability (2022-2024, HB 3114), 5) Olympia oyster elevation mapping to understand how intertidal conditions limit their distribution from Canada to Mexico, 6) temperature and sediment dynamics of the Coos estuary and South Slough and effects on distribution of native oyster and eelgrass beds (2021-2024, NERRS Science Collaborative), and 7) partnership in the Northwest Association of Networked Ocean Observing System, which provides near real-time weather and water quality data for a wide variety of groups of people.



Oregon Department of Energy's (ODOE) climate policy team serves as primary staff to the Oregon Climate Action Commission (OCAC; formerly named the Oregon Global Warming Commission). The OCAC received a grant to develop a Transformational Integrated Greenhouse Gas Emission Reduction (TIGHGER) Plan for the State of Oregon. **The TIGHGER project was designed to advise the Governor and Legislature on the medium-term strategies for achieving the state's 2035 greenhouse gas emissions reduction goals, while continuing to grow Oregon's economy and enhancing equity and quality of life for all Oregonians.** The TIGHGER project presented a suite of decarbonization actions and combinations of actions needed to meet or exceed the state's GHG reduction target for 2035. The analysis identified sector-based opportunities and provided actionable information to reduce Greenhouse gas (GHG) emissions. The TIGHGER project was incorporated into the Oregon Climate Action Commission's Oregon Climate Action Roadmap to 2030, which presented a roadmap for meeting Oregon's statewide GHG emission reduction goals. Implementation of the Roadmap's recommendations should help mitigate the intensification of OAH.

Additionally, ODOE's Energy Development Services Division currently administers several grant and incentive programs to help Oregonians complete energy-saving and renewable energy projects through state-authorized incentive programs. These programs and incentives include the following: 1) the Solar + Storage Rebate Program for residential customers and low-income service providers in Oregon; 2) the Community Renewable Energy Grant Program, which provides competitive grants for planning and developing community renewable energy and energy resilience projects; 3) Heat pump incentives available through the Community Heat Pump Deployment Program and the Oregon Rental Homes Heat Pump Program; and 4) Energy Efficient Wildfire Rebuilding Incentives for rebuilding structures that were destroyed during the 2020 Labor Day fires.

2023 Oregon Ocean Science Trust (OOST) Strategic Meeting (OAH Action Plan Action Item 5)

In the fall of 2023, OOST hosted a strategic meeting with important groups of people from throughout Oregon including OAH council members. Presentations on the state of the coast, the work being done, and the needs were provided. Breakout groups discussed important research and monitoring needs throughout Oregon. These suggestions are being used by OOST in the coordination of their efforts going forward.

Noteworthy Milestones



Ongoing awareness of the impacts of OAH continues to lead to regional, national, and international mitigation efforts. Here we have highlighted some significant actions taken by the State of Oregon, the West Coast (including British Columbia), the nation, and the globe (International Alliance to Combat Ocean Acidification, of which the Oregon OAH Council is a part) to combat the ecosystem and socio-economic effects of OAH.

Around Oregon

***Oregon Department of Environmental Quality (DEQ) – Integrated Report (2024):** This report proposes classifying one ocean area as impaired for OAH and another area for OA. This is the first time an ocean area has been listed as impaired for OA in the United States. DEQ’s goal is to increase coastal resilience and mitigate the effects of OAH and changing ocean conditions on marine life and coastal communities. This report was supported and encouraged by the OAH Council (via previous Co-Chair, Caren Braby).

***Oregon Department of Environmental Quality (DEQ) – Climate Pollution Reduction Grant (2024-2029):** DEQ received \$197 million to support 12 measures to reduce greenhouse gas emissions from transportation, buildings, and waste materials identified in Oregon’s Priority Climate Action Plan. Some of the programs and projects that will be funded with this grant include electric vehicle rebates for lower-income households, support for medium and heavy-duty electric vehicle infrastructure, incentives for building energy-efficient housing, heat pump incentives, and food waste recovery infrastructure. The full grant workplan can be found here: <https://www.oregon.gov/deq/ghgp/Documents/cprgImpGrant.pdf>.

***Oregon Department of Land Conservation and Development (DLCD) – Part Three of the Oregon Territorial Sea Plan (TSP), The Rocky Habitat Management Strategy:** The update to the Territorial Sea Plan resulted in the designation of 8 new Rocky Habitat Management Sites and associated Submerged Aquatic Vegetation Protection Policies. This is the first update to the Rocky Habitat Management Strategy since 2000. These sites can be used for research, conservation, and public outreach and education. More information about this update and these sites can be found here: <https://www.oregonocean.info>.

Oregon Climate Action Commission (formerly the Oregon Global Warming Commission) – Roadmap to 2030 to Guide State Actions (2023): This report outlines extensive recommendations to inform state climate action and ensure that Oregon does not miss its next greenhouse gas goal. The Roadmap includes six overarching recommendations. (1) Support robust and continuous implementation of existing climate programs and regulations. (2) Adopt updated state greenhouse gas goals consistent with the best available science. (3) Advance a set of additional climate actions that can help Oregon meet an accelerated greenhouse gas emission reduction goal of 45 percent below 1990 levels by 2030. (4) Support further study and analysis to continue to guide effective climate action over time. (5) Strengthen governance and accountability for Oregon climate action. (6) Position Oregon to take full advantage of federal investments in climate action. The full report can be found here: <https://climate.oregon.gov/tighger>.

Around the region, nation, and globe

****The US State Department – The United States Ocean Acidification Action Plan (2023):*** This document highlights the nation’s leadership in reducing carbon emissions, investing in adaptive measures, and strengthening monitoring, research, and coordination research efforts. The Pacific Coast Collaborative’s OAH group (of which the Oregon OAH Council is a part) informed the development of this OA Action Plan. All members of the OA Alliance have committed to drafting a national OA Action Plan. The report can be found here: <https://www.state.gov/wp-content/uploads/2023/12/Ocean-Acidification-Action-Plan.pdf>.

The White House (Biden-Harris Administration) – Ocean Climate Action Plan (2023): This first-ever U.S. Ocean Climate Action Plan lays out the actions that need to be accomplished to achieve the following goals: 1) create a carbon-neutral future, 2) accelerate nature-based solutions, and 3) enhance community resilience to ocean change. The full plan can be found here: https://www.whitehouse.gov/wp-content/uploads/2023/03/Ocean-Climate-Action-Plan_Final.pdf.

White House - Bipartisan Infrastructure Law (2021): This law helped various federal agencies fund programs that will help combat ocean change. Some examples of funded projects are the Environment Protection Agency’s Gulf Hypoxia Program, the U.S. Department of Transportation Maritime Administration’s Port Infrastructure Development Program, and the National Ocean and Atmospheric Administration’s projects focused on habitat restoration, coastal resilience, and climate data. More on this law can be found here: <https://www.whitehouse.gov/build/guidebook/>.

White House - Inflation Reduction Act (2022): This act will help fund programs such as American-made clean energy technologies, air pollution reduction, cleaner and more efficient housing, climate-smart agriculture, nature-based solutions for climate mitigation and resilience, climate resilient communities, and more efficient and effective energy infrastructure permitting. For example, the funding from this Act will allow NOAA Fisheries to invest in Climate-Ready Fisheries, Tribal fish hatcheries, habitat restoration and fish passage, Arctic research, more efficient permitting, and facilities modernization, which will provide capacity for communities and fisheries to be more resilient and adapt to changing climate conditions. Read more on this act here: <https://www.whitehouse.gov/wp-content/uploads/2022/12/Inflation-Reduction-Act-Guidebook.pdf>.

NOAA marine carbon dioxide removal (mCDR) funding (2024): The NOAA Marine Carbon Dioxide Reduction (mCDR) program is a strategic initiative aimed at mitigating the impacts of ocean acidification and climate change through the reduction of carbon dioxide levels in marine environments. This program focuses on developing and implementing innovative methods to enhance the ocean's natural ability to absorb and store carbon dioxide, thereby contributing to global climate mitigation efforts. Key components of the NOAA mCDR program include (1) Research and Development, (2) Monitoring and Assessment, (3) Environmental Impact Studies, (4) Collaboration and Partnerships, (5) Policy and Management, and (6) Public Outreach and Education. Through these efforts, the NOAA mCDR program aims to significantly reduce atmospheric carbon dioxide levels, mitigate the effects of ocean acidification, and contribute to the broader goals of climate change mitigation and marine conservation.

Cooperative Institute for Climate, Ocean, and Ecosystems Studies – Annual Magazine (2023): This report highlights research projects, employees, and yearly activities from the Cooperative Institute for Climate, Ocean, and Ecosystem Studies (CICOES). CICOES promotes research collaboration between NOAA, the University of Washington, the University of Alaska Fairbanks, and Oregon State University. The full report can be found here: <https://cicoes.uw.edu/2023/12/22/our-2023-cicoes-magazine-is-now-available/>.

***California Current Integrated Ecosystem Assessment (2024):** NOAA Fisheries researchers and collaborators along the U.S. West Coast develop this annual report to document the connected and changing California Current Ecosystem to support ecosystem-based management. Some of the key takeaways from this year's report are that 2023 had the 4th largest marine heatwave on record, Harmful Algal Blooms (HABs) that delayed and closed fisheries, high crab megalopae returns, and intense periods of localized upwelling although overall upwelling was below average. Researchers were able to include experiential knowledge from fishermen in this report thanks for the OAH Council's Fishermen-Scientist Roundtable meetings. The full report can be found here: <https://www.integratedecosystemassessment.noaa.gov/regions/california-current>.

U.S. Geological Survey's Coastal Erosion Mitigation Program: This program focuses on understanding and addressing the processes contributing to coastal erosion in the United States. The researchers analyze coastal dynamics, develop predictive models, and assess the impacts of natural events and human activities on shoreline stability. The goal is to provide scientific data and tools to support effective coastal management strategies, minimize property damage, and protect natural resources and habitats along the coastlines. Through these efforts, the Coastal Erosion Mitigation Program aims to enhance the resilience of coastal communities, protect valuable coastal ecosystems, and ensure the sustainable use of coastal resources. The program's work is crucial in preparing for and adapting to the challenges posed by a changing climate and increasing coastal development.

***Pacific Coast Collaborative (PCC):** In October 2022, the PCC OA and Hypoxia Working Group hosted the West Coast OAH Symposium, bringing together state and provincial councils, steering committees, agencies, and ministries responsible for implementing OAH Action Plans over the next 5-10 years. The nearly 60 attendees came from a diverse assortment of academic institutions, monitoring networks, government programs, Tribal government and intergovernmental organizations, regional alliances, and international initiatives. The agenda focused on discussing strategies for implementing OAH Action Plan recommendations through an integrated climate and ocean policy framework.

***International Alliance to Combat Ocean Acidification (OA Alliance) – Highlights, Impacts, and Progress Report (2022 & 2023):** These annual reports celebrate major achievements, detail actions that supported climate-ocean leadership for members, and outline the OA Alliance's objectives. These objectives include the following: (1) support the development of OA Action Plans, (2) advance climate-ocean commitments and the use of science for policy decisions, (3) increase OA awareness through communication efforts, and (4) grow impact, increase partnerships, and strengthen initiative durability. The OA Alliance is an international group of governments, dedicated to taking urgent action to protect coastal communities and livelihoods from the threat of ocean acidification and other climate-ocean impacts. Oregon is a founding member. The full reports can be found here: <https://www.oaalliance.org/progress-reports>.

*** = The Oregon OAH Council contributed directly to achieving these milestones**

What is at Risk? OAH Impacts on Oregon's Nearshore Rockfish

More than 10 species of rockfish are commonly found in Oregon's nearshore waters. These rockfish live in a variety of habitats, but primarily prefer rocky reefs. They also support many recreational and commercial fisheries. This diverse group of fishes will have very different responses to Ocean Acidification and Hypoxia.

Economic Effects

The rockfish caught by fishers are changing their behavior on short time scales (due to hypoxic events) and longer time scales (due to changing ocean conditions). These shifts will affect fishers' ability to access and utilize this resource valued at nearly 20 million dollars.



Sensory Effects

Acidified ocean water increases anxiety and stress in juvenile rockfish.



Direct Effects

Changing conditions affect ear bone growth (an essential management tool), decrease ability to uptake oxygen, change ability to digest food, and alter fish behavior.



Food Web Effects

During hypoxic events, some rockfish move out of the area while others stay put. These changes — combined with shifting availability of prey — will impact food webs.



Habitat Effects

Animals like corals and sponges form structure on rocky reefs, which is important for rockfish. Hypoxia is often lethal to these animals since they cannot move.

Cumulative Effects

Rockfish species will each respond differently to these ocean changes — there will be winners and losers. Rockfish population and location changes will directly impact the coastal communities and cultural identities tied to these nearshore fisheries.

Artist: Emy Daniels



Oregon Coordinating Council on Ocean Acidification & Hypoxia



Marine Resources

Ocean Status Update

The work of the OAH Council continues to be informed by the best available science on ocean change in our region. Changing ocean conditions have caused significant impacts to socio-economic systems vital to Oregon’s economic and cultural values. Understanding these changes and their consequences for fisheries, coastal communities, and ecological systems is critical for identifying solutions, establishing best management practices, and maintaining resilience across all sectors.

Warming ocean temperatures are an increasing threat to Oregon’s coastal resources. Since the massive 2014-2016 marine heatwave known as “the blob”, warmer than usual temperatures have become a persistent summertime occurrence off Oregon’s coastline. In both 2022 and 2023, a marine heatwave developed offshore in the Northeast Pacific, building in intensity from spring until late summer with temperatures that were 2-3°C (4-5 °F) warmer than usual. These anomalously warm waters impinged along the Oregon coastline periodically through summer when typical upwelling conditions “relaxed” due to winds blowing from the south.

Marine heatwaves are creating additional challenges for Oregon coastal systems when coupled with other threats such as ocean hypoxia and acidification. The Oregon coast has historically experienced hypoxic events near the sea floor on the continental shelf. These hypoxic events are due to seasonal upwelling, which brings cold, acidified, low oxygen water from the deep ocean into nearshore waters each summer. Oregon’s coastal marine ecosystems routinely experience a summertime “hypoxia season,” which is linked to the timing of coastal upwelling (**Figure 5**). However, research indicates that, similar to the forest wildfire season that characterizes summer in our region, hypoxic conditions are becoming more frequent and extreme in recent years.

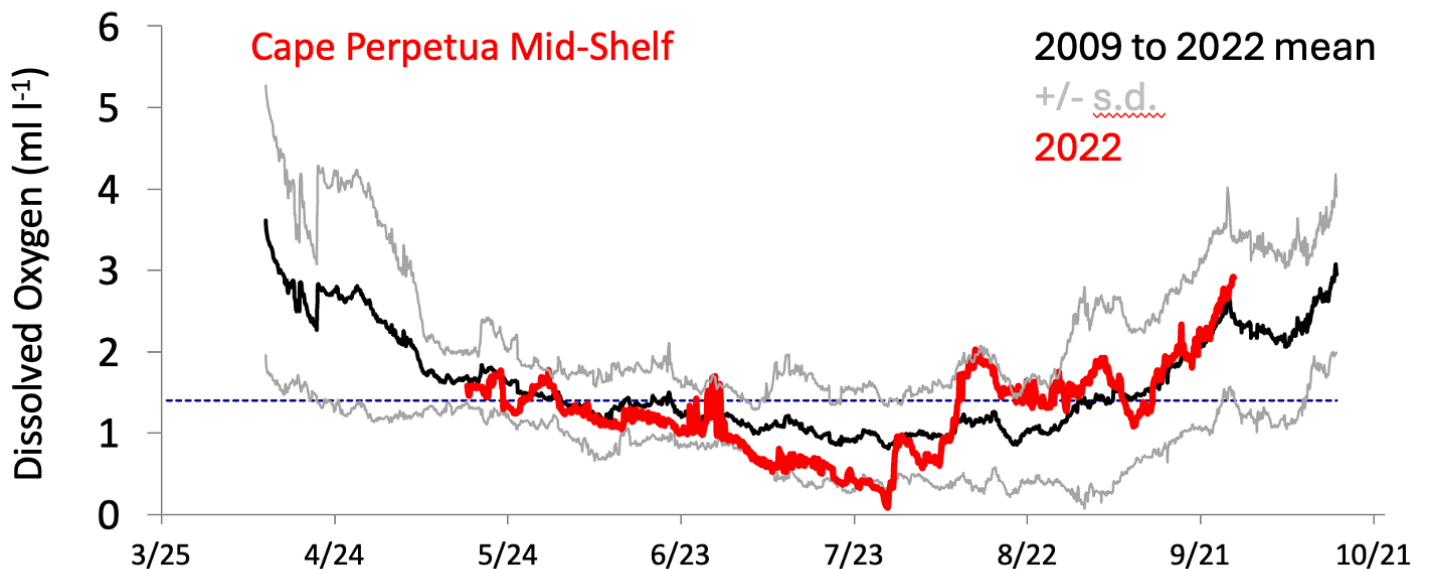


Figure 5. Dissolved oxygen concentration observed at the Cape Perpetua Marine Reserve. Red bold line indicates concentration in 2022. Black line shows the average conditions over 2009-2022 with grey lines indicating one standard deviation (s.d.) of the mean. Hypoxic conditions are indicated by the dashed horizontal line when oxygen concentration falls below 1.4 mL/L.

There is a balancing act between too much and not enough upwelling. Strong upwelling brings low oxygen, acidified waters to the surface but also pushes them rapidly offshore, keeping the system “flushed.” However, when strong upwelling is interspersed with periods of upwelling relaxation due to shifting wind patterns, the low oxygen water previously brought up by upwelling is trapped and can stagnate. In 2022, dissolved oxygen dipped to near zero outside of the Cape Perpetua Marine Reserve before rebounding in August (Figure 5). There were also frequent upwelling relaxation events and intrusions of warm offshore water throughout 2022. This extremely low near-bottom dissolved oxygen outside the marine reserve is likely related to stagnation episodes caused by the relaxed upwelling and intrusions of warm waters from offshore.

Observations from ship-based surveys in 2023 indicate that large swaths of the northern Oregon coast were below the hypoxic threshold (1.4 mL/L) by late June (**Figure 6**). These surveys, when compared to historical observations, illustrate the tremendous year-to-year variability in the spatial footprint and severity of low oxygen conditions along Oregon’s coastline. This variability also demonstrates the need for border-to-border observation arrays for monitoring the severity of these conditions and the associated coupled ecosystem and fisheries impacts.

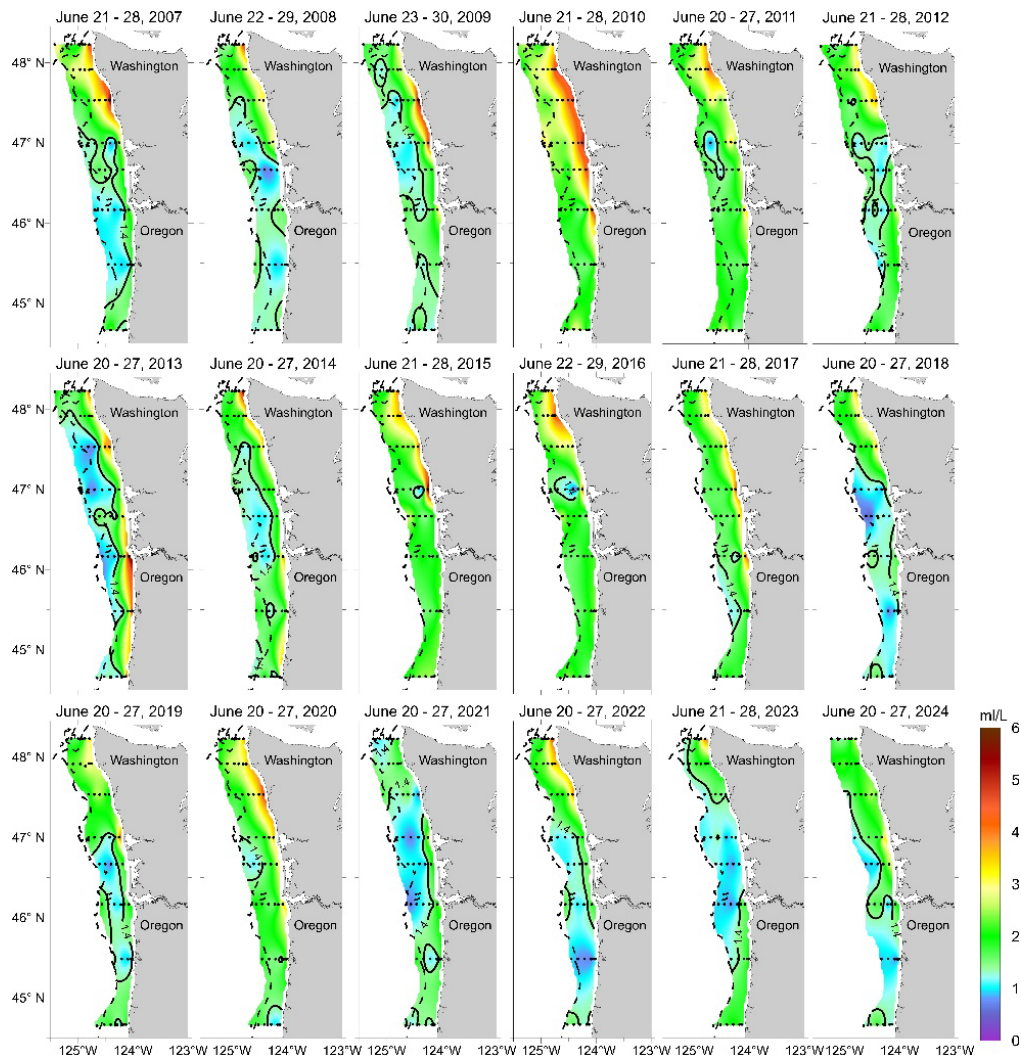


Figure 6. Near-bottom dissolved oxygen concentrations observed in ship-based surveys conducted in coastal Washington and Oregon during mid to late June over the last 10 years. Hypoxic waters below a threshold of 1.4 ml/L are bounded by a thick black line. Credit NOAA Fisheries, <https://www.fisheries.noaa.gov/west-coast/science-data/local-physical-indicators#hypoxia>.

Moving Forward

OAH Council benchmarks for 2024-2026

The projects on these two pages indicate the priorities for the OAH Council over the next two-year period, from 2024-2026. These align with the OAH Action Plan, the Multiagency Report, and HB3114 funded projects.

Research & monitoring projects

Action Plan step and projects to continue	Action Plan Reference	Funded after 2024?
<p>“Allocate state funding to use existing research reference sites and tools to enhance Oregon’s oceanographic monitoring network”</p> <ul style="list-style-type: none"> • Replace OAH mooring to continue monitoring at marine reserves (HB3114-OOST Project 1-2) • Add Harmful Algal Bloom imaging and CO₂ sensor instrumentation in Yaquina Bay (HB3114-OOST Project 3) • Establish additional monitoring sites along the Oregon coast similar to the Whiskey Creek program (HB3114-OSU Project 2) • Synoptic nearshore monitoring program • Continue additional ODFW SEACOR estuarine surveys (HB3114-ODFW Project 1) 	1.1	No
<p>“Allocate state funding to invest in monitoring of Oregon’s ocean life by implementing consistent monitoring of the biological response to OAH”</p> <ul style="list-style-type: none"> • Investigate OA impacts to biological communities through analysis of pteropod shell stability (HB3114-OSU Project 1) 	1.2	No
<p>“Identify strategies to restore, protect, and sustain native shellfish stocks and submerged aquatic vegetation (SAV) in Oregon’s estuaries and nearshore waters”</p> <ul style="list-style-type: none"> • Continue to select for OAH-resilient oyster broodstock (HB3114-OSU Project 3) 	3.1	No
<p>“Support data collection, synthesis, and modeling to inform strategies that promote OAH resilient ecosystems”</p> <ul style="list-style-type: none"> • Expand the Coos Bay estuary circulation model to include nutrients and run various climate scenarios (HB3114-OOST Project 5) • Develop spatial and time varying models, map carbonate chemistry, and conduct a process study to better attribute sources of CO₂ in native oysters in Yaquina Bay (HB3114-OOST Project 6) 	3.2	No

Coordination

Action Plan step; in-progress projects	Action Plan Reference	Funded after 2024?
<p>“Implement measures to reduce OAH stressors”</p> <ul style="list-style-type: none"> • Continue participating in water quality criteria and development coordination 	2.2, 2.3	N/A
<p>“Agencies document both existing and needed programs and regulations (including compliance) that address OAH impacts, adaptation, and mitigation”</p> <ul style="list-style-type: none"> • Continue coordination on initiatives under the 2021 OAH Multiagency Report 	5.1, 5.3	N/A

Communication

Action Plan step; in-progress projects	Action Plan Reference	Funded after 2024?
<p>“Build a communication plan and outreach materials to communicate OAH science, impacts, and solutions. Convene an advisory working group specialists to identify OAH outreach needs. Develop a communications plan that meets the needs of diverse stake holders and provide solutions-oriented messages on OAH science and impacts”</p> <ul style="list-style-type: none"> • Develop an implementation plan for the OAH Communication Plan created by HB3114-OOST Project 7 	4.1	No
<p>“Provide timely updates to the Legislature and affected communities in Oregon to inform decisions on how best to invest in OAH research, adaptation, mitigation”</p> <ul style="list-style-type: none"> • Fisherman-Scientist Roundtables (2025, 2026) 	4.2	No

Long-term goals

The most apparent, long-term goals of the OAH Council continue to include strategic planning and preparation for the 2025-2031 OAH Action Plan (this will be the first update to an OAH Action Plan in the world), assessing and securing funding for long-term OAH monitoring, and establishing marine water quality standards to prepare Oregon for the impacts of climate and ocean change.

Oregon's OAH Council Members

The Oregon Coordinating Council on Ocean Acidification and Hypoxia was convened by Senate Bill 1039 in 2017, which specified the 13 seats and representation of Oregon interests on the Council. Including this 2024 OAH Report, this diverse body has completed 4 biennial Reports to the Legislature and the first Oregon OAH Action Plan (**Appendix A**), since 2018. Additional information on the Council and its members can be found in **Appendix C**.



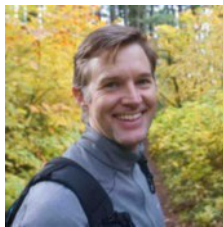
DR. LAURIE JURANEK
Council Co-Chair
Oregon State University



DR. LEIF RASMUSON
Council Co-Chair
Department of Fish and Wildlife



ALEX MANDERSON
Department of Agriculture



RIAN vanden HOOFF
Department of Environmental Quality



ANDY LANIER
Department of Land Conservation and Development



DR. KEITH WOLF
Oregon Ocean Science Trust



DR. KARINA NIELSEN
OregonSea Grant



FRAN RECHT
Conservation Organization Representative



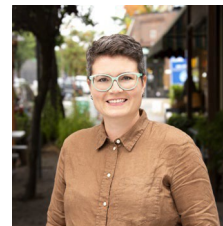
BOB KEMP
Fishing Representative



KRISTEN PENNER
Shellfish Industry Representative



DR. JESSICA MILLER
Academic Representative



KARIN POWER
Governor's Office Representative

VACANT
Tribal Government Representative

Thank you to past council members and staff that have contributed so much to the OAH Council's success:



Dr. Caren Braby (former ODFW Co-Chair), Dr. Jack Barth (former OSU Co-Chair), Jenny Koester, Dr. Christine Moffitt, John Schaefer, Frank Barcellos, Karen Tarnow, Jennifer Wigal, Dr. Jim Sumich, Dr. Shelby Walker, Dr. Aaron Galloway, Al Pazar, Brandii Holmdahl, Liu Xin, Dr. Kristen Sheeran, Daniel Sund, and Dr. Charlotte Regula-Whitefield

Appendices: Table of Contents

Appendix A: Oregon OAH Action Plan (2019-2025)

- Action Plan
- Action Plan Executive Summary (English and Spanish Versions)
- Action Plan Appendices A-C

Appendix B: House Bill 3114

Appendix C: OAH Council member biographies

Appendix D: List of Acronyms and Abbreviations

Submitted to the Oregon Legislature and the Oregon Ocean Policy Advisory Council

As directed by Oregon Senate Bill 1039 (passed in 2017)



APPENDIX A

The 2019 OAH Action Plan

- *Action Plan*
- *Action Plan Executive Summary (English and Spanish Versions)*
- *Action Plan Appendices A – D*



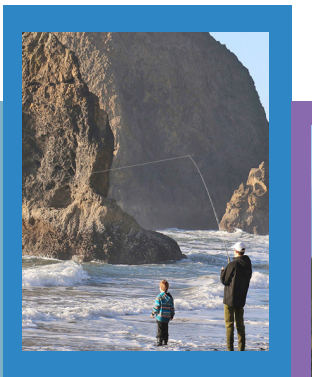
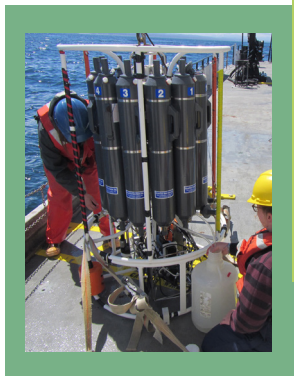
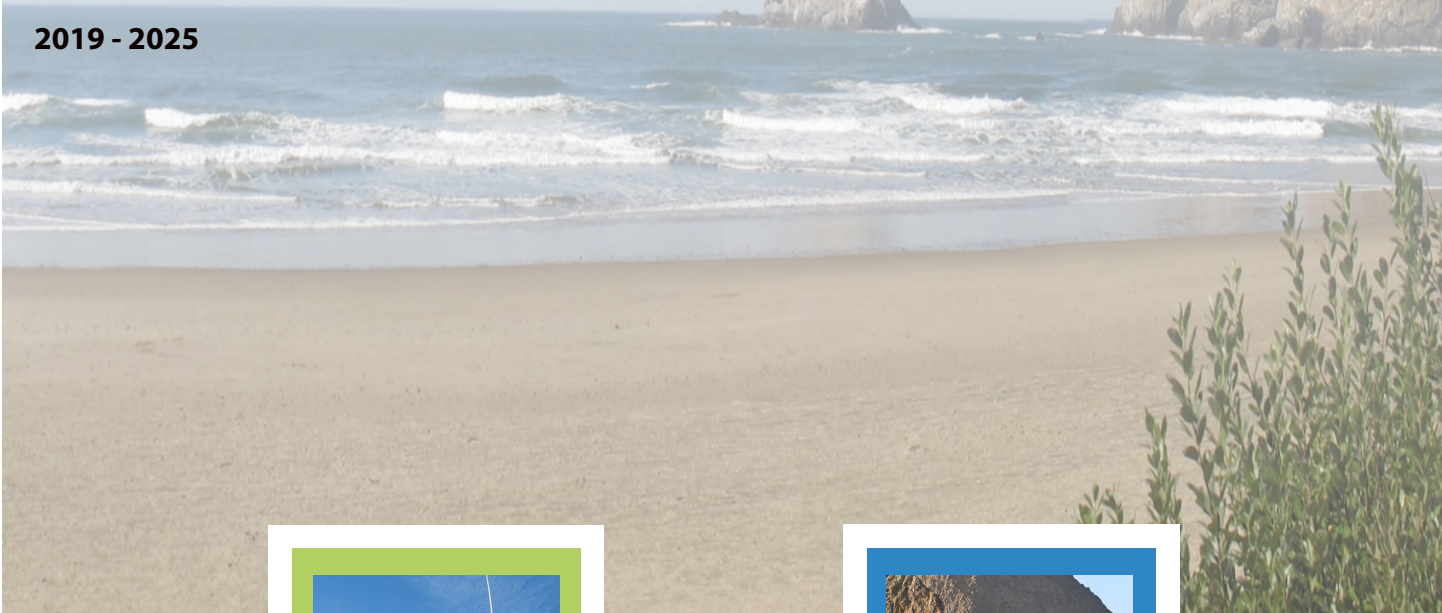
The Oregon Coordinating Council on
Ocean Acidification and Hypoxia
SECOND BIENNIAL REPORT APPENDICES





Oregon Ocean Acidification and Hypoxia **Action Plan**

2019 - 2025



About this Document

This ***Oregon Ocean Acidification and Hypoxia Action Plan*** was developed in recognition of the impacts that we see today, in hopes of minimizing the impacts for tomorrow, and to alter the trajectory of ocean changes for future generations - for Oregon, the Nation, and the world.

Oregon's OAH Action Plan, as adopted by Governor Brown, will guide Oregon's efforts and become Oregon's submission to the ***International Alliance to Combat Ocean Acidification***, and thus will be shared with the region and world. Because Oregon is one of the first states to feel the impacts of OAH, it is our hope that these actions can serve as a model for others to apply to their own geographical and political context. This work will also help demonstrate that local actions are meaningful in fighting the global challenges of climate and ocean changes.

For electronic copies of Oregon's Action Plan visit the OAH Council's website:

oregonocean.info/index.php/ocean-acidification

For printed copies of Oregon's Action Plan please contact:

Oregon Department of Fish and Wildlife • Marine Resources Program
2040 Marine Science Drive • Newport, OR 97365 • (541) 867-4741





KATE BROWN
Governor

August 19, 2019

Dear fellow members of the International Alliance to Combat Ocean Acidification:

With this letter, Oregon hereby presents the Ocean Acidification and Hypoxia Action Plan, as developed by the Oregon Ocean Acidification Coordination Council. Oregon endorses the Alliance's Global Call to Action, and commits to advance key goals that:

- Advance scientific understanding of ocean acidification.
- Reduce the causes of acidification.
- Protect the environment and coastal communities from the impacts of a changing ocean.
- Expand public awareness and understanding of acidification.
- Build sustained support for tackling this global problem.

This action plan is intended to provide guidance and policy directives to state agencies and local governments on the frontlines of combatting ocean acidification and hypoxia. I urge state agencies to consider and integrate the relevant recommendations within Oregon's Ocean Acidification and Hypoxia Action Plan into current management strategies by:

- Evaluating potential management and data gaps for ocean acidification and hypoxia,
- Incorporating funding needs for ocean acidification and hypoxia into 2021-2023 budgeting, and
- Promoting intra-agency communication and collaboration on projects and actions identified in the action plan.

Oregon is proud to submit our Ocean Acidification and Hypoxia Action Plan, and looks forward to leveraging current and future partnerships to combat the impacts of climate change on our lands, oceans, and people.

Sincerely,

Governor Kate Brown

GKB;jm,kl

**254 STATE CAPITOL, SALEM OR 97301-4047 (503) 378-3111 FAX (503) 378-8970
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This document was prepared for the State of Oregon by the Oregon Coordinating Council on Ocean Acidification and Hypoxia, whose membership is:

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Oregon State University



Dr. Caren Braby, Co-Chair
Department of Fish & Wildlife



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Department of Agriculture



Jennifer Wigal
Department of Environmental Quality



Andy Lanier
Department of Land Conservation
& Development



Dr. James Sumich
Oregon Ocean Science Trust



Dr. Shelby Walker
Oregon Sea Grant



Fran Recht
Conservation Representative



Al Pazar
Fishing Representative



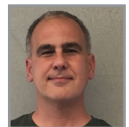
Liu Xin
Shellfish Industry Representative



Dr. Aaron Galloway
University of Oregon



John Schaefer
Confederated Tribes of the Coos,
Lower Umpqua & Siuslaw Indians



Dr. Kristen Sheeran, Ex-Officio
Governor's Natural Resources Office,
Governor Kate Brown



**Oregon Coordinating Council on
Ocean Acidification and Hypoxia**

Contents

Letter From Governor Kate Brown	3
Oregon Ocean Acidification and Hypoxia Council Membership	4
Executive Summary	6 - 7
What is at Risk?	8 - 9
Oregon's OAH Action Plan (2019-2025)	10 - 11
1. Advance Scientific Understanding	12 - 13
2. Reduce Causes	14 - 15
3. Create Resilience	16 - 17
4. Expand Public Awareness	18 - 19
5. Build Sustained Support	20 - 21
Evaluation	22
Get Involved	23

Electronic Appendices

- A.** Timeline and Funding Needs for Actions
- B.** Carbon and Climate Policies
- C.** Oregon's OAH Action Plan Development Process
- D.** Build Sustained Support – State of Oregon Agency Authorities
- E.** Oregon OAH Council Report (2018)

*For electronic copies of these appendices, visit the Council's website:
oregonocean.info/index.php/ocean-acidification*

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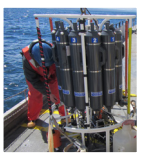


Executive Summary

Oregon OAH Action Plan

The Oregon Ocean Acidification and Hypoxia (OAH) Action Plan outlines actions that Oregon will take to adapt to and mitigate OAH impacts. Through this Action Plan, Oregon joins British Columbia, Washington, California, and other global partners in our commitment to building solutions for OAH impacts to better prepare for the future. Every action requires state leadership and resources to implement projects that lead to better understanding of OAH and to adaptation and mitigation steps. Broad partnerships with all Oregonians are essential to the success of this Action Plan.

Here are **5 ACTIONS** the State of Oregon has identified to address OAH impacts over the next six years



1) Advance scientific understanding to address OAH vulnerabilities

- Invest in Oregon's existing research sites and tools
- Invest in monitoring of ocean life
- Assess the socio-economic impacts of OAH in Oregon



2) Develop and use strategies to reduce causes of excess CO₂ and other causes of OAH

- Enhance local and global communication networks working on CO₂ reduction
- Support research on effective and efficient ways to reduce excess CO₂ and OAH stressors
- Implement measures to reduce excess CO₂ and OAH stressors in Oregon



3) Support resilience to OAH in Oregon's ecosystems and communities

- Support data collection, synthesis, and modeling
- Restore, protect, and sustain native shellfish stocks and submerged aquatic vegetation
- Develop Best Management Practices based on current ecosystem and economic research



4) Share OAH science, impacts, and solutions to raise awareness

- Build OAH communications plan and outreach materials
- Provide timely updates to Oregon's decision-makers and affected communities
- Evaluate the effectiveness of OAH communications



5) Build sustained support and mobilize agencies to address OAH

- Governor issues a 2019 policy to address Oregon's OAH priorities
- Leadership, coordination, and policy guidance by Governor's Natural Resource Office
- Oregon agencies work to fill gaps in State OAH efforts

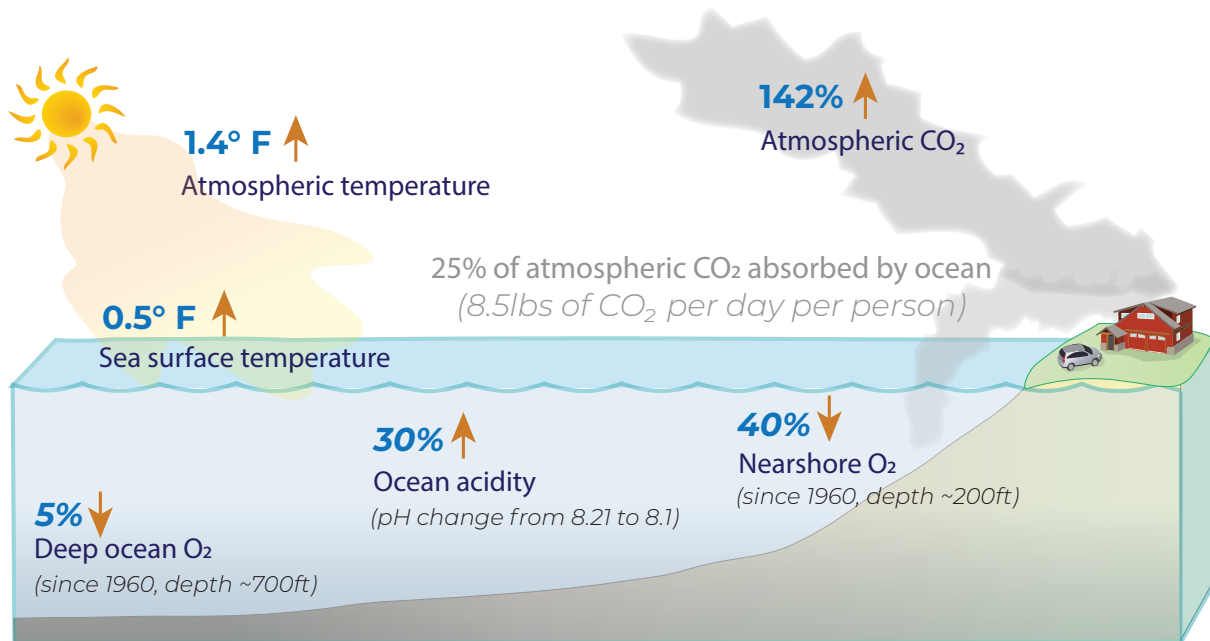
Why is this OAH Action Plan Needed?

Ocean acidification and hypoxia (OAH) are increasing, and are related to the same factor that is causing climate change.

The culprit? Fossil fuel combustion and related accumulation of CO₂ and other greenhouse gases.

The solution? Local actions will lead to a brighter future, for the oceans, its species and the communities that depend on them. We can and must act now!

Ocean Change since the Industrial Revolution (Late 1800s)



Referenced Data:

Pierce, S. D., J. A. Barth, R. K. Shearman and A. Y. Erofeev, 2012. Declining oxygen in the Northeast Pacific. *J. Phys. Oceanogr.*, 42, 495-501
Schmidtko, S., L. Stramma & M. Visbeck, 2017. Decline in global oceanic oxygen content during the past five decades. *Nature*, 542, 335-339
<https://earthobservatory.nasa.gov/world-of-change/DecadalTemp>
<https://www.epa.gov/climate-indicators/climate-change-indicators-sea-surface-temperature>

The Oregon OAH Action Plan identifies ways that our government and individual Oregonians can make a difference to slow these impacts and adapt to the changes we are already seeing. Ocean Acidification and Hypoxia (OAH) are harmful to ocean life and the economic stability of the Oregonians who rely on a healthy ocean.



To learn more about OAH science, impacts, and solutions, please visit the Oregon OAH Council's website:

oregonocean.info/index.php/ocean-acidification

What is at risk in Oregon?

“The cost of inaction to me is about how it is going to become a lot harder to address ocean acidification and hypoxia the longer we wait. Over time I think that we are going to start to erode what were good options as the ecosystems change. Then it becomes a situation of “coulda, woulda, shoulda”

Dr. Francis Chan

Department of Integrative Biology, Oregon State University

Oregon’s history is one of cultural and economic value in ocean and estuarine fisheries and in the natural beauty and bounty of the ocean – all of these rely on our healthy ocean communities. Salmon, halibut, Dungeness crab, razor clams, oysters, pink shrimp, lamprey, and rockfish have supported Oregon’s coastal economies for generations. Yet, Oregon’s ocean is changing, and each of these species has already shown signs of distress from ocean acidification and hypoxia (OAH).

Ocean acidification and hypoxia are increasing, and are related to the same factor that is causing climate change in our own human habitats. The culprit?

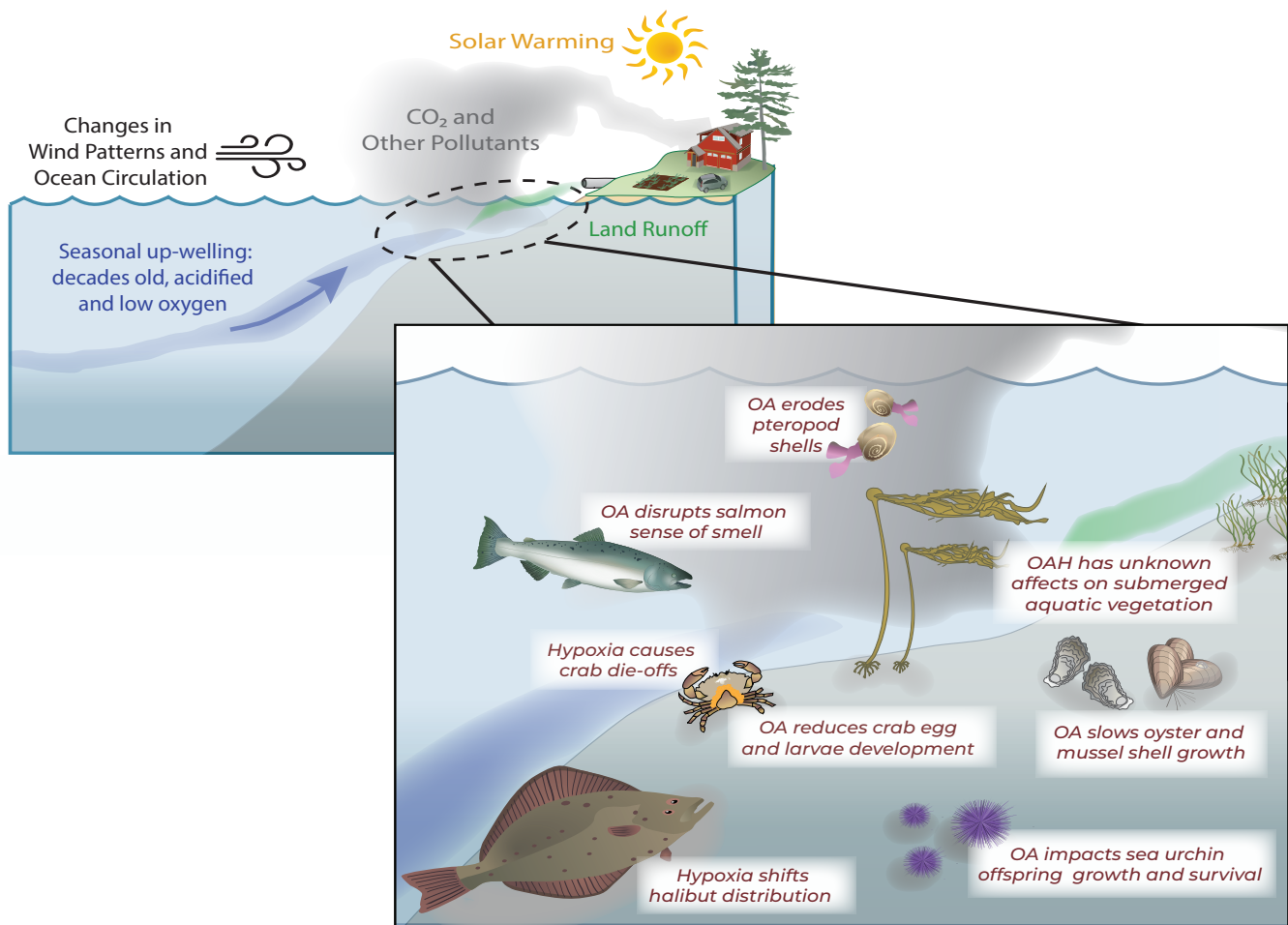
Fossil fuel combustion and related accumulation of **carbon dioxide (CO₂)** and other greenhouse gases has led to climate change, ocean acidification and ocean deoxygenation (hypoxia). The earth’s oceans have absorbed 30% of the excess CO₂ produced from fossil fuel combustion since the Industrial Revolution (mid 1800s). When absorbed by seawater, CO₂ undergoes chemical reactions that lower seawater pH (making it more acidic), and thus hampers shell formation in marine life. Hypoxia (low oxygen) conditions are also on the rise as a result of climate change, due to changing wind and weather patterns. This is leading to extended periods of hypoxia in some of Oregon’s coastal waters, impacting a wide range of marine animals from crabs to fish. This has led to major ecosystem and economic impacts, which are already reverberating through our tourism and seafood industries.

Oregon’s commitment to understand, actively adapt to, and mitigate OAH requires us to invest funding and time to build a more predictable future. Oregon’s approach to solving these problems requires addressing excess CO₂ and OAH stressors simultaneously (see **Appendix B** for a description of Oregon’s actions of managing CO₂ and climate change). To build the brightest future for the ocean and its species and the communities that depend on them, and despite uncertainty, we can and must act now in a pro-active way that will improve ecosystem outcomes for resilience, as a “no-regrets” strategy.

This Oregon OAH Action Plan recommends ways to invest in our future, to better adapt to and mitigate the problems we are already seeing, and which will worsen in the decades to come.

The results of increasing OAH have had far-reaching consequences, for both the ocean ecosystem and the economy, consequences that we, as a society, are only just beginning to understand and quantify. Shifting food webs, loss of fishery productivity and lost economic opportunities are just some of the many impacts we are expecting to see as a result of increasing OAH.

Climate and other human drivers of ocean change ...



... impacts economically and ecologically important marine species.

For more information see:

Oregon Climate Change Adaptation Framework. December 2010. <https://digital.osl.state.or.us/islandora/object/osl:4014>

Oregon OAH Action Plan (2019-2025)

“I think it is an obstacle that there are so many things changing in the environment, it is sometimes hard to make OAH a priority. But this should be a top priority - before we start to lose our shellfish, crab, salmon, and lamprey.”

Mark Healey
Marine Resource Manager, Coquille Tribe

This OAH Action Plan builds on the 2018 Report of the Oregon Coordinating Council on Ocean Acidification and Hypoxia, submitted to the Oregon Legislature and the Oregon Ocean Policy Advisory Council. The 2018 Report articulated 12 Recommendations and 38 Actions, organized under five Themes. Each of these actions are key to addressing OAH impacts at all levels, from science to policy, from education to adaptation. In creating this 6-year OAH Action Plan, the OAH Council considered the urgency of need, anticipated value of actions, and appropriate phasing of implementation steps for each action (see **Appendix C** for more detail on how the Report and Action Plan were developed).

It may not be possible to implement all actions immediately; this Action Plan articulates what needs to be addressed first. Below are 5 priority actions for Oregon.

- 1. Invest in Oregon’s monitoring network to document oceanographic and biologic conditions, and socio-economic vulnerabilities relating to OAH**
- 2. Develop and integrate strategies to reduce causes of excess carbon dioxide (CO₂) and Ocean Acidification and Hypoxia (OAH)**
- 3. Support activities and initiatives that promote adaptation and resilience to OAH, for Oregon’s human communities and ecosystems**
- 4. Communicate OAH science, impacts, and solutions to raise awareness and support decision-making**
- 5. Mobilize agencies to address OAH priorities**

Oregon joins our regional partners (British Columbia, Washington, and California) in describing our intent and commitment to action, to fulfill the state’s role in OAH and its solutions. For many years, the West Coast has provided critical leadership on OAH problem-solving, policy development, and supporting local actions to effect global change. Notably, the West Coast has conceived of and launched the International Alliance to Combat Ocean Acidification (OA Alliance). Oregon is a founding member of the OA Alliance, which has rapidly grown to a multi-national, multi-governmental collaborative body. The OA Alliance promotes voluntary government actions to address OAH, as part of our global responsibility to manage the problems from fossil fuel combustion.

Action Descriptions

With this document, Oregon fulfills our promise to global partners to develop and adopt an OAH Action Plan. For each of the five priority actions that are included in this OAH Action Plan, there are four distinct considerations for implementation that are described below.

Actions: Actions needed in order to achieve the vision.

Vision: The future Oregon we intend to create, as a result of the action(s).

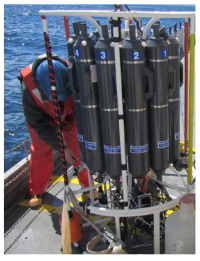
Steps: Specific measures to implement the action, including who will implement the step. Order of steps are not necessarily an implication of time sequence.

Timeline and funding needs: Within each step, the timelines are specified for the start year, or range of years, as well as the timeframe over which the step is anticipated to occur. In **Appendix A**, preliminary estimated funding needs are also provided, to indicate the scale of need for each action. All estimates are subject to further refinement as each action is implemented and specific budgets are developed.

Cross-Reference to the 2018 OAH Report: This text box, included at the bottom of each priority action section, lists the OAH Council Recommendations and Actions, as originally included in the September 2018 OAH Council Report, which would be implemented in whole or in part, by implementing the steps in this OAH Action Plan.



ACTION 1 - Invest in Oregon's monitoring network to document oceanographic and biologic conditions, and socio-economic vulnerabilities relating to Ocean Acidification and Hypoxia (OAH)



"I think that the best thing that we can really hope for now is to gather baseline data and gain a better understanding. I think we know what is causing Ocean Acidification and Hypoxia, but we need to know what the effects are going to be."

Bernie Lindley
Owner/Operator of F/V Sea Jay, Brookings, Oregon

VISION

Oregon has a robust monitoring network that produces long-term time series for physical, chemical, and biological properties of Oregon's nearshore ocean and estuaries. These data are used to understand Oregon's ecosystem and socio-economic vulnerabilities, to inform adaptation and mitigation efforts.

Step 1

Allocate state funding to use existing research reference sites and tools to enhance Oregon's oceanographic monitoring network.

- Re-establish oceanographic monitoring to complement an historical time-series in Yaquina Bay, an economic, research, and management hub for Oregon.
(Start: 2019-2020 and continuing)
- Co-locate OAH oceanographic monitoring (intertidal and subtidal) alongside existing Marine Reserves biological sampling to leverage Oregon's existing research investments in Marine Reserves.
(Start: 2021-2023 and continuing)
- Provide sustained funding for OAH oceanographic monitoring in Tillamook Bay, where a pilot program funded by Oregon Watershed Enhancement Board (OWEB) is providing baseline oceanographic observations for this Oregon hub of economic, research, and management activity.
(Start: 2021-2023 and continuing)
- Support the maintenance of existing and installation of new climate grade OAH instruments in communities and at-risk industry locations.
(Start: 2021-2023 and continuing)

Step 2 Allocate state funding to invest in monitoring of Oregon’s ocean life by implementing consistent monitoring of the biological response to OAH.

- Conduct a workshop to determine priority biological metrics for monitoring in Oregon coastal waters, including consideration of research results from regional partners.
(Start: 2021 and continuing)
- Augment on-going funding for the Newport Hydrographic Line to add biological and chemical OAH monitoring sensors and analysis to get the most value out of this existing monitoring program.
(Start: 2021-2023 and continuing)
- Augment Oregon Department of Fish and Wildlife’s (ODFW) Shellfish assessment team to increase frequency and spatial scale of shellfish and submerged aquatic vegetation (SAV) observations.
(Start: 2023-2024 and continuing)

Step 3 Allocate state funding to a socio-economic vulnerability assessment to determine Oregon’s vulnerabilities to OAH.

- Fund competitive grants and/or match (e.g. through the Oregon Ocean Science Trust), and use results to inform decision-making and investments.
(Start: 2021 – 2023 and continuing)

Cross-Reference to 2018 OAH Report

Action 1.1.a. Maintain and support oceanographic and biological monitoring at significant research reference sites that provide high value to Oregon due either to prior State investments, the geographic location and/or historical data collection activities at that site. **Action 5.2.a.** Continue and expand State support for science funding entities in Oregon that provide grant funds to OAH science and response (e.g., Oregon Watershed Enhancement Board, Oregon Ocean Science Trust (OOST)). **Action 5.2.b.** Ensure the OOST has the institutional structure needed to receive and redistribute funds to support the State’s OAH priorities. **Action 5.2.c.** Facilitate the acquisition of funding from a diversity of sources to address the State’s OAH priorities. **Action 4.2.d.** Academics and researchers: Communicate research needs to build OAH solutions, as identified by the OAH Council and the OAH Action Plan. **Action 5.3.a.** Maintain Oregon’s leadership role on OAH science by supporting prioritization of OAH research, education and outreach by Oregon universities. **Action 4.2.b.** At-risk industries and professions: Communicate with industries affected by OAH to strengthen cultural values of healthy and sustainable seafood and seafood industry and build relationships to strengthen collaborative solutions development. **Action 1.1.c.** Expand and implement monitoring to track the biological responses to OAH, to inform State natural resource decisions and management activities.

ACTION 2 - Develop and integrate strategies to reduce causes of excess carbon dioxide (CO₂) and Ocean Acidification and Hypoxia (OAH)



“Our oceans take a large brunt of the excess carbon. This is exactly what we should be relating climate change to and nothing can be more tied to CO₂ emissions than ocean acidification.”

Charlie Plybon
Ocean Policy Coordinator, Oregon Surfrider

VISION

Oregon measurably has reduced carbon dioxide (CO₂) emissions and Ocean Acidification and Hypoxia (OAH) stressors to achieve ecosystem and economic benefits for both ocean and inland systems.

Step 1

The OAH Council works with the Governor’s Natural Resource Office to establish regular communication and coordination pathways with state agencies and other State entities to address excess CO₂ and OAH stressors locally and globally.

(Start: 2019 and continuing)

- Relevant state agencies (see Appendix D for agency descriptions) include:
 - o Oregon Department of Fish and Wildlife (ODFW)
 - o Department of Land Conservation and Development (DLCD)
 - o Department of Environmental Quality (DEQ)
 - o Oregon Department of Agriculture (ODA)
 - o Department of State Lands (DSL)
 - o Oregon Department of Forestry (ODF)
 - o Oregon Health Authority (OHA)
 - o Oregon Department of Energy (ODOE)

- Other relevant state entities include:
 - o Oregon Ocean Science Trust (OOST)
 - o Oregon Watershed Enhancement Board (OWEB)
 - o Oregon Ocean Policy Advisory Council (OPAC)
 - o Oregon Global Warming Commission (OGWC)
 - o Oregon’s 4-year universities
- Relevant state entities (as described above) promote Oregon’s continued participation in organizations and collaborations working to reduce excess CO₂ and promote OAH adaptation and mitigation. Entities include:
 - o Pacific Coast Collaborative
 - o International Alliance to Combat Ocean Acidification
 - o West Coast Ocean Alliance (regional ocean partnership)

Step 2 **Allocate state funding to support scientific research leading to recommendations on effective and efficient ways to reduce excess CO₂ and OAH stressors.**

- Fund competitive grants (e.g. through the Oregon Ocean Science Trust, or through the Oregon Watershed Enhancement Board); use outcomes to inform decision-making and future investments.
(Start: 2021 – 2023 and continuing)

Step 3 **Relevant state agencies implement measures to reduce excess CO₂ and OAH stressors and encourages action, as identified in Step 2 and other relevant processes.**
(Start: 2021 and continuing)

Cross-Reference to 2018 OAH Report

Action 2.1.b. Strengthen communication and coordination on CO₂ and OAH management and mitigation among the OAH Council, State agencies, and other government entities (e.g., Oregon Global Warming Commission). **Action 5.2.a.** Continue and expand State support for science funding entities in Oregon that provide grant funds to OAH science and response (e.g., Oregon Watershed Enhancement Board (OWEB), Oregon Ocean Science Trust (OOST)). **Action 1.3.b.** Establish research priorities to identify effective measures to remove excess CO₂ from marine waters through technological means, sequestration, or bioremediation (e.g., culture and harvest kelp, thus removing CO₂ from local waters). **Action 5.2.b.** Ensure the Oregon Ocean Science Trust (OOST) has the institutional structure needed to receive and redistribute funds to support the State’s OAH priorities.

ACTION 3 - Support activities and initiatives that promote adaptation and resilience to Ocean Acidification and Hypoxia (OAH), for Oregon's human communities and ecosystems



“Impacts of Ocean Acidification on the shellfish industry was really the first time that an economic cost could be associated with acidified sea water. This was the first time people could put a price on the effects of Ocean Acidification.”

Dr. Chris Langdon
Oregon's Molluscan Broodstock Program

VISION

Oregon agencies and local governments promote Ocean Acidification and Hypoxia (OAH) resilience in management decisions, and Oregon's industries and communities work together to support thriving ecosystems and economic resilience to future changes.

Step 1

State agencies, in consultation with academia and industry, identify strategies to restore, protect, and sustain native shellfish stocks and submerged aquatic vegetation (SAV) in Oregon's estuaries and nearshore waters.

- Allocate state funding for competitive grants and/or match to identify how to achieve ecosystem and economic resilience for Oregon. Examples of project topics are listed below. *(Start: 2020-2023 and continuing)*
 - o Productivity of nursery habitat for economically valuable shellfish species
 - o Restoration and protection of submerged aquatic vegetation (SAV) and native shell fish that provide ecosystem services
 - o Restoration and protection of water quality throughout Oregon's estuaries and near shore
 - o Effects of OAH on marine organism life history to identify vulnerable species.
 - o Ability of Oregon's coastal communities and marine industries to achieve economic resilience to OAH

- Industry and academic support continued research of resilient shellfish aquaculture strains. *(Start: 2021 and continuing)*

Step 2 Allocate state funding to support data collection, synthesis, and modeling to inform strategies that promote OAH resilient ecosystems.
(Start: 2020-2023 and continuing)

- Develop maps to address the following information needs to promote resilience in decision-making in estuary and nearshore waters:
 - o SAV and native oyster core distribution areas – including historical and persistent regions
 - o Priority areas for habitat restoration and habitat protection
- Allocate state funding for competitive grants and/or match to conduct ecosystem modeling of estuary and nearshore ecosystems, including hydrodynamic and biogeochemical processes as well as SAV.
 - o Possible regions that could be considered for blue carbon and/or carbon mitigation offsets (if such programs are developed in Oregon)
 - o To inform aquaculture practices in Oregon's bays and estuaries

Step 3 Agencies will develop Best Management Practices (BMPs), based on current ecosystem and economic research (as determined in Step 1) focused on Oregon's estuaries and nearshore.

- Develop precautionary BMPs to ensure that coastal activities are sustainable and does not exacerbate OAH stressors. Examples of BMPs that might be developed are listed below.
(Start: 2023-2024 and continuing)
 - o Dredging
 - o Coastal development and infrastructure
 - o Aquaculture

Cross-Reference to 2018 OAH Report

Action 1.2.a. Develop and conduct an ecosystem vulnerability assessment to identify species vulnerable to OAH from among Oregon's commercially, recreationally, culturally, and ecologically important species. From this, identify research priorities for building adaptation and resilience strategies for species and species groups. **Action 1.2.d.** Establish research priorities to determine the benefits of conserving and restoring native species and vegetation in building ecosystem and socio-economic resilience. **Action 1.3.b.** Establish research priorities to identify effective measures to remove excess CO₂ from marine waters through technological means, sequestration, or bioremediation (e.g., culture and harvest kelp, thus removing CO₂ from local waters).

ACTION 4 - Communicate Ocean Acidification and Hypoxia (OAH) science, impacts, and solutions to raise awareness and support decision-making



“People must understand the root problem. Without that they may turn a blind eye to CO₂ emissions and only focus on understanding and documenting OAH, which is not enough.”

Catherine Corbett
Chief Scientist, Columbia River Estuary Partnership

VISION Policy-makers, agencies, and the public have information on Ocean Acidification and Hypoxia (OAH) science, impacts, and solutions. This information supports decision-making across the state and leads to publicly-supported approaches to OAH adaptation and mitigation.

Step 1 The OAH Council builds a communications plan and outreach materials to communicate OAH science, impacts, and solutions.

- The OAH Council convenes an advisory working group with regional education/outreach specialists to identify OAH outreach needs.
(Start: 2019 and continuing)
- The OAH Council develops a communications plan and outreach materials to meet the needs of diverse stakeholders and provide solutions-oriented messages on OAH science and impacts.
(Start: 2019-2021 and continuing)

Step 2 The OAH Council provides timely updates to Oregon Legislature, other policy-makers, and affected communities in Oregon to inform decisions on how best to invest in OAH research, adaptation, and mitigation.

- The OAH Council reports to the Oregon legislature on recommended OAH actions, through a biennial report (see step 1).
(Start: 2020 and continuing)
- The OAH Council convenes “State of OAH” workshops for communities on OAH science, impacts, and solutions with policy makers as well as communities and at-risk industries.
(Start: 2020 and continuing)

- The OAH Council provides information in a variety of forms to impacted audiences including policy makers, at-risk industries, and coastal communities.
(Start: 2019-2025 and continuing)

Step 3 **The OAH Council evaluates the effectiveness of OAH communication tools in filling information needs.**

- The OAH Council develops communications evaluation tools to assess the OAH Council's outreach efforts and inform future outreach activities.
(Start: 2021-2023 and continuing)
- The OAH Council revises outreach efforts and materials based on evaluation.
(Start: 2023 and continuing)

Cross-Reference to 2018 OAH Report

Action 4.2.b. At-risk industries and professions: Communicate with industries affected by OAH to strengthen cultural values of healthy and sustainable seafood and seafood industry and build relationships to strengthen collaborative solutions development. **Action 4.1.b.** Build solutions-oriented messages on OAH science, impacts and solutions. Messages should include: simple language, positive tone, local connections, and actions for individuals and governments. **Action 4.2.a.** Policy makers and legislative staff: Inform decision-makers on the science, impacts and solutions, to help them shape strategic policy decisions. **Action 4.1.c.** Create an information resource and outreach catalog for the OAH Council and others that highlights OAH science, impacts and solutions using the positive messages strategy.

ACTION 5 - Mobilize agencies to address Ocean Acidification and Hypoxia (OAH) priorities



“Functionally, without a policy framework that directs the natural resource agencies to work collectively on an issue, we are then isolated in our resource management and in our planning processes. We are then not collectively maximizing the progress we could be having on Ocean Acidification and Hypoxia.”

Davia Palmeri
Climate Change Policy Coordinator,
Oregon Department of Fish and Wildlife

VISION

Oregon state agencies have Ocean Acidification and Hypoxia (OAH) issues integrated into regular planning processes for budget, staffing, and management outcomes. Agencies have clear, defined goals to address projected ecosystem and economic impacts from OAH.

Step 1

Governor issues a 2019 policy, urges relevant state agencies to consider work they are doing and their plans to address OAH priorities in the context of this Action Plan.

- Agencies document both existing and needed programs and regulations (including compliance), that address OAH impacts, adaptation, and mitigation. Agencies report plans to address the gaps to the Legislature and Governor in February 2021.
(Start: 2019 and continuing)
- Agencies propose anticipated needs in biennial agency budget development process, starting with agency budget proposals for the 2021-2023 biennium.
(Start: July-December 2019 and continuing)
- The OAH Council incorporates agencies' reports into ongoing development of recommendations to the State on programs within and across agencies.
(Start: 2021 and continuing)

Relevant state agencies (see **Appendix D** for agency descriptions) include:

- o Oregon Department of Fish and Wildlife (ODFW)
- o Department of Land Conservation and Development (DLCD)
- o Department of Environmental Quality (DEQ)
- o Oregon Department of Agriculture (ODA)
- o Department of State Lands (DSL)
- o Oregon Department of Forestry (ODF)
- o Oregon Health Authority (OHA)
- o Oregon Department of Energy (ODOE)

Step 2 **Governor’s Natural Resources Office provides leadership, coordination, and policy guidance to agencies on OAH action priorities.**

- Expand expertise on ocean science and regulations within the Governor’s Natural Resource Office.
(Start: 2019 and continuing)

Step 3 **State agencies implement measures to fill gaps, as described in agency OAH planning (Step 1), in alignment with the Oregon Climate Adaptation Framework (2010), and with guidance from the Governor’s Natural Resources Office.**
(Start: 2021-2025 and continuing)

Cross-Reference to 2018 OAH Report

Action 5.1.a. Develop and implement policy, directing agencies to address OAH priorities in agency planning. **Action 3.1.a.** Conduct an inventory of Oregon State agency programs and authorities that are relevant to OAH; identify opportunities to incorporate OAH adaptation and resilience strategies into current and future management actions, including implementation of Statewide Planning Goals. **Action 3.1.b.** Anticipate specific management and regulatory decision-making processes, into which OAH adaptation and resilience strategies can be incorporated. **Action 5.1.b.** Prioritize staffing in the Governor’s Natural Resources Office to include expertise to provide leadership on ocean science and policy, to help guide and address OAH action priorities.

Evaluation

“One of the reasons I think monitoring is so important, is because a lot of the other OAH actions talk about strategies that we can implement to have an impact, mitigate bad responses, or try to make a resiliency strategy. Without having base monitoring, and the knowledge of the interactions in the ecosystems, it is going to be difficult to measure our success.”

York Johnson, North Coast Basin Coordinator
Oregon Department of Environmental Quality

The Oregon Coordinating Council on Ocean Acidification will review the status of this and subsequent Oregon OAH Action Plans in biennial reports to the Oregon Legislature, Oregon Ocean Policy Advisory Council (OPAC), and Governor (September of even years). Evaluation will inform the contents and focus of future recommendations by the OAH Council to Oregon.

OAH Action Plan progress will be evaluated by the OAH Council based on the following factors:

- Timely completion of identified actions
- Successful implementation of actions at achieving the vision and goals in this OAH Action Plan
- Achievement of criteria or benchmarks developed on a per action basis, as each is implemented
- Updated research priorities as they are identified

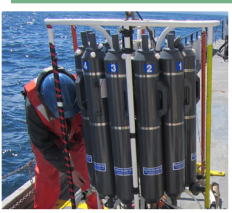




Take Action

The **Oregon Ocean Acidification and Hypoxia (OAH) Action Plan** outlines actions that Oregon will take to adapt to and mitigate OAH impacts. We need all Oregonians to help make a difference facing this global problem.

Here is how **YOU** can help make a difference



Help Monitor Ocean Change

- Establish local and regional community-based monitoring networks
- Join an existing research or management survey as a volunteer



Reduce Excess Carbon and Prevent OAH Stressors

- Plant and maintain trees and restore coastal habitats
- Support State regulatory and voluntary programs to improve water quality
- Be mindful of your personal carbon footprint and reduce where you can - food waste, water usage, home heating/cooling/lighting, and driving patterns



Build Resilience to Ocean Change

- Work with industry, managers, and researchers to develop OAH specific adaptation/mitigation steps
- Support sustainable and adaptable local coastal business growth as OAH impacts occur



Learn about OAH Science and Solutions

- Encourage local schools and universities to teach about OAH
- Attend science and policy lectures, speaker series, and outreach events
- Use your network to share information about OAH science, impacts, and solutions



Encourage and Participate in Public Processes

- Support your local communities, cities, or organization to join coalitions and formulate their own OAH Action Plans
- Speak with and organize letters to your state and local government representatives for OAH Action

*As requested by
Oregon's Governor Kate Brown*



Recommended Citation:

Oregon Governor's Natural Resource Office. Oregon Ocean Acidification and Hypoxia Action Plan 2019 - 2025. August 2019. URL: <https://www.oregonocean.info>

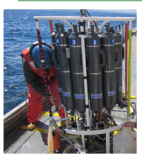


Executive Summary

Oregon OAH Action Plan

The Oregon Ocean Acidification and Hypoxia (OAH) Action Plan outlines actions that Oregon will take to adapt to and mitigate OAH impacts. Through this Action Plan, Oregon joins British Columbia, Washington, California, and other global partners in our commitment to building solutions for OAH impacts to better prepare for the future. Every action requires state leadership and resources to implement projects that lead to better understanding of OAH and to adaptation and mitigation steps. Broad partnerships with all Oregonians are essential to the success of this Action Plan.

Here are **5 ACTIONS** the State of Oregon has identified to address OAH impacts over the next six years



1) Advance scientific understanding to address OAH vulnerabilities

- Invest in Oregon's existing research sites and tools
- Invest in monitoring of ocean life
- Assess the socio-economic impacts of OAH in Oregon



2) Develop and use strategies to reduce causes of excess CO₂ and other causes of OAH

- Enhance local and global communication networks working on CO₂ reduction
- Support research on effective and efficient ways to reduce excess CO₂ and OAH stressors
- Implement measures to reduce excess CO₂ and OAH stressors in Oregon



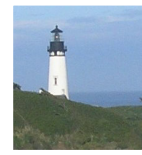
3) Support resilience to OAH in Oregon's ecosystems and communities

- Support data collection, synthesis, and modeling
- Restore, protect, and sustain native shellfish stocks and submerged aquatic vegetation
- Develop Best Management Practices based on current ecosystem and economic research



4) Share OAH science, impacts, and solutions to raise awareness

- Build OAH communications plan and outreach materials
- Provide timely updates to Oregon's decision-makers and affected communities
- Evaluate the effectiveness of OAH communications



5) Build sustained support and mobilize agencies to address OAH

- Governor issues a 2019 policy to address Oregon's OAH priorities
- Leadership, coordination, and policy guidance by Governor's Natural Resource Office
- Oregon agencies work to fill gaps in State OAH efforts

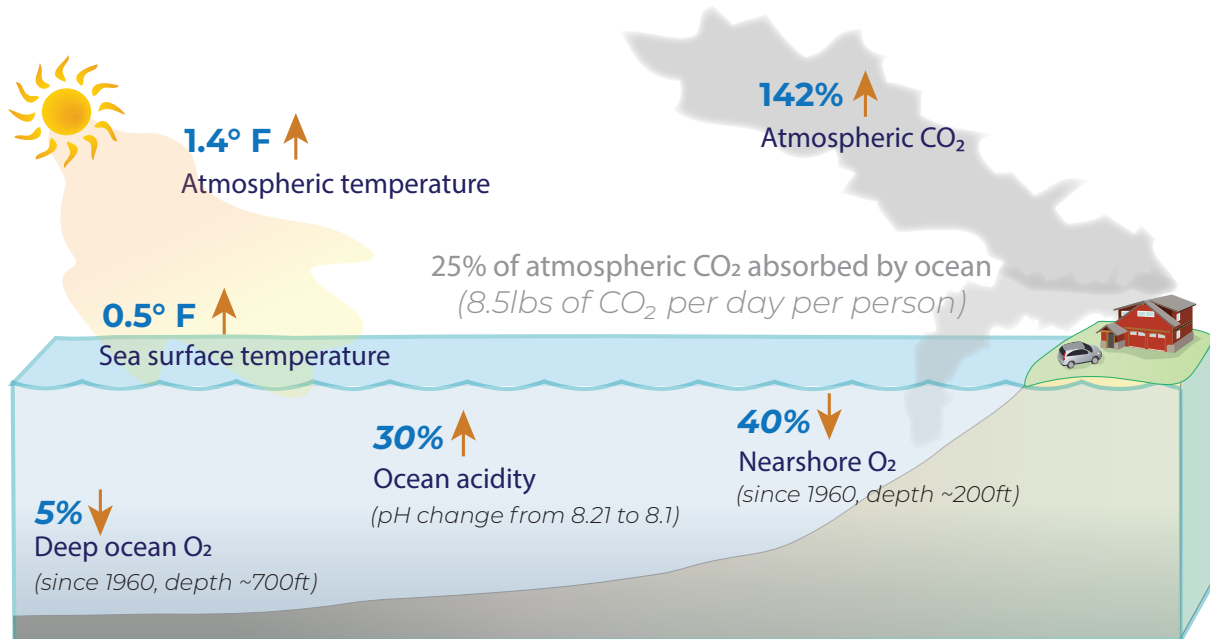
Why is this OAH Action Plan Needed?

Ocean acidification and hypoxia (OAH) are increasing, and are related to the same factor that is causing climate change.

The culprit? Fossil fuel combustion and related accumulation of CO₂ and other greenhouse gases.

The solution? Local actions will lead to a brighter future, for the oceans, its species and the communities that depend on them. We can and must act now!

Ocean Change since the Industrial Revolution (Late 1800s)



Referenced Data:

Pierce, S. D., J. A. Barth, R. K. Shearman and A. Y. Erofeev, 2012. Declining oxygen in the Northeast Pacific. *J. Phys. Oceanogr.*, 42, 495-501
Schmidtko, S., L. Stramma & M. Visbeck, 2017. Decline in global oceanic oxygen content during the past five decades. *Nature*, 542, 335-339
<https://earthobservatory.nasa.gov/world-of-change/DecadalTemp>
<https://www.epa.gov/climate-indicators/climate-change-indicators-sea-surface-temperature>

The Oregon OAH Action Plan identifies ways that our government and individual Oregonians can make a difference to slow these impacts and adapt to the changes we are already seeing. Ocean Acidification and Hypoxia (OAH) are harmful to ocean life and the economic stability of the Oregonians who rely on a healthy ocean.

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To learn more about OAH science, impacts, and solutions, please visit the Oregon OAH Council's website:

oregonocean.info/index.php/ocean-acidification

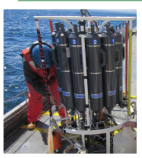


Resumen Ejecutivo

Plan de acción de la AOH de Oregón

El Plan de Acción de Oregón acerca la Acidificación Oceánica e Hipoxia (AOH) describe medidas que Oregón adoptará para adaptarse y así mitigar los impactos de la AOH. Con este Plan de Acción, Oregón se une a la Columbia Británica, Washington, California, y otros socios globales en nuestro compromiso a encontrar respuestas a los impactos de la AOH para prepararnos mejor para el futuro. Cada medida requiere tanto de liderazgo estatal como de recursos para la implementación de proyectos que conlleven a mejorar el entendimiento acerca de la acidificación oceánica e hipoxia, al igual que de los pasos a seguir para su adaptación y mitigación. Para alcanzar el éxito del Plan de Acción, es esencial contar con la amplia colaboración de todos los residentes de Oregón.

Aquí hay 5 MEDIDAS que el estado de Oregón ha identificado para hacer frente a los impactos de la Acidificación Oceánica e Hipoxia durante los próximos seis años



1) Avanzar el entendimiento científico para hacer frente a las vulnerabilidades de la AOH

- Invertir en los sitios y herramientas de investigación existentes en Oregón
- Invertir en el monitoreo de la vida oceánica
- Evaluar los impactos socioeconómicos de la AOH en Oregón



2) Desarrollar y usar estrategias para reducir las causas del exceso de CO₂ y otras causas de la AOH

- Mejorar las redes de comunicación locales y globales que trabajan en la reducción de CO₂
- Apoyar la investigación de manera efectiva y eficiente para reducir el exceso de CO₂ y los factores estresantes de la AOH
- Implementar medidas para reducir el exceso de CO₂ y los factores estresantes de la AOH en Oregón



3) Apoyar la resiliencia a la AOH en los ecosistemas y las comunidades de Oregón

- Apoyar la recopilación de datos, su síntesis y los elaboraciones de modelos
- Restaurar, proteger y conservar las poblaciones nativas de mariscos y la vegetación subacuática
- Desarrollar Mejores Prácticas mejores de Gestión basadas en la investigación actual del ecosistema y la economía



4) Divulgar la ciencia de la AOH, los impactos y las soluciones para fomentar la sensibilización

- Establecer un plan de comunicación acerca de la importancia de AOH y crear materiales de divulgación
- Proporcionar actualizaciones oportunas a los responsables de la toma de decisiones y a las comunidades afectadas de Oregón
- Evaluar la eficacia de la comunicación relacionada a sobre la AOH



5) Establecer el apoyo constante y movilizar agencias para hacer frente a la AOH

- Que en el 2019, el Gobernador proponga una política para hacerle frente a las prioridades de AOH en Oregón
- Que la oficina de Recursos Naturales del Gobernador brinde el liderazgo, la coordinación, y las directrices políticas
- Que las agencias de Oregón trabajen para llenar los vacíos encontrados en los esfuerzos del Estado relacionados con la AOH

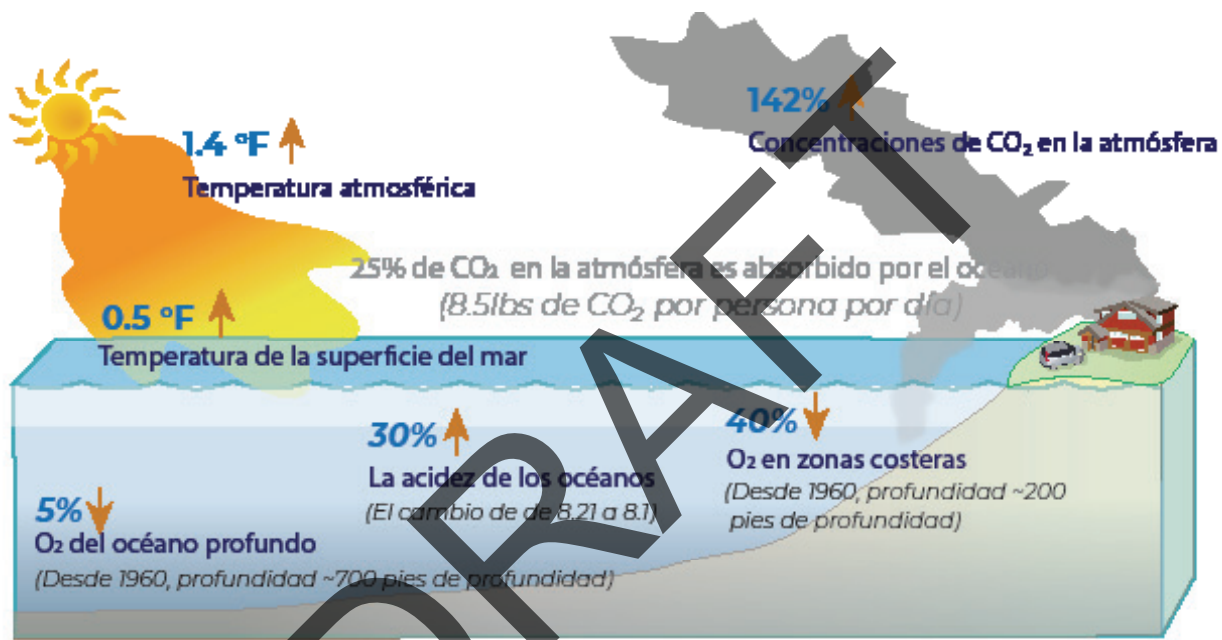
¿Por qué necesitamos este Plan de Acción sobre la AOH?

La Acidificación Oceánica e Hipoxia (AOH) están aumentando, y ellas están relacionadas con el mismo factor que está provocando el cambio climático.

¿Quién es el culpable? El consumo de combustibles fósiles y la respectiva acumulación de CO₂ al igual que otros gases de efecto invernadero.

¿La solución? Llevar a cabo medidas a nivel local conducirá a un futuro más favorable para los océanos, sus especies y las comunidades que dependen de ellos. ¡Podemos y debemos actuar ahora mismo!

Los cambios oceánicos desde la revolución industrial (Finales de los años 1800)



Referencia:

Pierce, S. D., J. A. Barth, R. K. Shearman and A. Y. Erofeev, 2012. Declining oxygen in the Northeast Pacific. *J. Phys. Oceanogr.*, 42, 495-501
Schmidt, S., L. Stramma & M. Visbeck, 2017. Decline in global oceanic oxygen content during the past five decades. *Nature*, 542, 335-339
<https://earthobservatory.nasa.gov/world-of-change/DecadalTemp>
<https://www.eopa.gov/climate-indicators/climate-change-indicators-sea-surface-temperature>

El Plan de Acción de Oregón sobre Acidificación Oceánica e Hipoxia identifica maneras que nuestro Gobierno y los Residentes de Oregón pueden llevar a cabo para tener una influencia decisiva y así reducir los impactos y a su vez, adaptarse a los cambios que estamos experimentando actualmente. La Acidificación Oceánica e Hipoxia (AOH) son dañinas no solo para la vida oceánica sino que también para la estabilidad económica de los residentes de Oregón que dependen de un ecosistema marino saludable.

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Para obtener mayor información acerca la ciencia de la AOH, los impactos, y las soluciones propuestas, por favor visite el sitio web del consejo de la AOH:

oregonocean.info/index.php/ocean-acidification



Funding and Timeline

Oregon OAH Action Plan - Appendix A

Below is a timeline and preliminary estimated funding needs for OAH Actions as outlined in this OAH Action Plan in the following Action Categories: 1. Advance scientific understanding, 2. Reduce Causes, 3. Create Resilience, 4. Expand Public Awareness, 5. Build Sustained Support. Values are ranges of preliminary estimates of costs for action, and were used to show the scale at which each action could be implemented. A dash (--) denotes actions for which there is uncertainty about whether there will be costs associated with the action, but costs may eventually be attributable to its implementation. TBD denotes funding needs yet to be determined (*no range set at this time*).

Start Year	Action	Step	Estimated Funding Needs
2019	2	1. The OAH Council works with the Governor's Natural Resource Office to establish regular communication and coordination pathways with state agencies and other State entities to address excess CO ₂ and OAH stressors locally and globally.	--
	4	1. 1. The OAH Council convenes an advisory working group with regional education/outreach specialists to identify OAH outreach needs.	--
	5	1. 1. Governor issues a 2019 policy, directing relevant state agencies to consider work they are doing and their plans to address OAH priorities in the context of this Action Plan: Agencies document both existing and needed programs and regulations.	--
	5	1. 2. Agencies propose anticipated needs in biennial agency budget development process, starting with agency budget proposals for the 2021-2023 biennium.	
	5	2. Governor's Natural Resources Office provides leadership, coordination, and policy guidance to agencies on OAH action priorities.	--
2019 - 2020	1	1. 1. Re-establish oceanographic monitoring to complement an historical time-series in Yaquina Bay.	\$50K-\$200K (biennial costs)
2019 - 2021	4	1. 2. The OAH Council develops a communications plan and outreach materials to meet the needs of diverse stakeholders and provide solutions-oriented messages on OAH science and impacts.	\$50K-\$150K (onetime costs)
2019 - 2025	4	2. 3. The OAH Council provides information in a variety of forms to impacted audiences including policy makers, at-risk industries, and coastal communities.	--
2020	4	2. 1. The OAH Council reports to the Oregon legislature on recommended OAH actions, through a biennial report (see step 1).	--
	4	2. 2. The OAH Council convenes "State of OAH" workshop for communities on OAH science, impacts, and solutions with policy makers as well as communities and at-risk industries.	\$25K-\$100K (per workshop)
2020 - 2023	3	1. 1. Allocate state funding for competitive grants and/or match to identify how to achieve ecosystem and economic resilience for Oregon.	\$200K-\$300K (per project)
	3	2. 1. Allocate state funding to support data collection, synthesis, and modeling to inform strategies that promote OAH resilient ecosystems: Develop maps to address the following information needs.	\$50K-\$150K (onetime costs)
	3	2. 2. Allocate state funding to support data collection, synthesis, and modeling to inform strategies that promote OAH resilient ecosystems: competitive grants and/or match to conduct ecosystem modeling.	\$200K-\$400K (per project)

Year	Action	Step	Estimated Funding Needs
2021	1	2. 1. Conduct a workshop to determine priority biological metrics for monitoring in Oregon coastal waters, including consideration of research results from regional partners.	\$25K-\$100K (onetime costs)
	3	1. 2. Industry and academics support continued research of resilient shellfish aquaculture strains.	\$200K-\$600K (biennial costs)
	5	1. 2. The OAH Council incorporates agencies' reports into ongoing development of recommendations to the State.	--
2021 - 2023	1	1. 2. Co-locate OAH oceanographic monitoring (intertidal and subtidal) alongside existing Marine Reserves biological sampling to leverage Oregon's existing research investments in Marine Reserves.	\$300K-\$500K (biennial costs)
	1	1. 3. Provide sustained funding for OAH oceanographic monitoring in Tillamook Bay.	\$50K-\$100K (biennial costs)
	1	1. 4. Support the maintenance of existing and installation of new climate grade OAH instruments in communities and at-risk industry locations.	\$100K-\$200K (biennial costs)
	1	2. 3. Augment on-going funding for the Newport Hydrographic Line to add biological and chemical OAH monitoring sensors and analysis to get the most value out of this existing monitoring program.	\$50K-\$200K (biennial costs)
	2	2. Fund competitive grants; funds could be used for match to attract additional investment or for full implementation); use outcomes to inform decision-making and future investments.	\$200K-\$300K (per project)
	2	3. Relevant state agencies implement measures to reduce excess CO ₂ and OAH stressors.	TBD
	4	3. 1. The OAH Council develops communications evaluation tools to assess the OAH Council's outreach efforts and inform future outreach activities.	\$25K-\$75K (onetime costs)
2021 - 2025	5	3. State agencies implement measures to fill gaps, as described in agency OAH planning, in alignment with the Oregon Climate Adaptation Framework (2010), and with guidance from the Governor's Natural Resources Office.	TBD
2023	4	3. 2. The OAH Council revises outreach efforts and materials based on evaluation.	\$25K-\$50K (onetime costs)
2023 - 2024	1	2. 3. Augment Oregon Department of Fish and Wildlife's (ODFW) Shellfish assessment team to increase frequency and spatial scale of shellfish and submerged aquatic vegetation (SAV, e.g., eelgrasses) observations.	\$400K-\$550K (biennial costs)
	3	3. Agencies will develop Best Management Practices (BMPs), based on current ecosystem and economic research (as determined in Step 1) focused on Oregon's estuaries and nearshore.	TBD



To learn more about OAH science, impacts, and solutions, please visit the Oregon OAH Council's website:

oregonocean.info/index.php/ocean-acidification



Carbon and Climate Policies

Oregon OAH Action Plan - Appendix B

The Oregon OAH Action Plan identifies problems and develops solutions to ocean acidification and hypoxia, a challenging consequence of global climate change attributable to anthropogenic greenhouse gas emissions. While Oregon's carbon footprint is only part of the global problem, Oregon is working to address emissions in a variety of ways that complement and reinforce our work on OAH. While the OAH Council developed the recommendations that led to this OAH Action Plan, other Oregon entities have the expertise on CO₂ directly. This appendix briefly describes the entities and responsibilities in Oregon (outside of the OAH Council process), that are addressing CO₂ adaptation and mitigation.

Oregon has taken great strides to manage CO₂ emissions, understand the effects of climate change on our ecosystem and economy, and provide leadership across the West Coast and the globe on CO₂ emissions policy.

Oregon Global Warming Commission (OGWC) was created by the Legislature in 2007 (HB3543) to track trends in [greenhouse gas emissions](#) and recommend ways to coordinate state and local efforts to reduce emissions in Oregon. In the past 12 years, the OGWC has produced several reports documenting state and regional actions on global warming impacts and existing greenhouse gas reduction policies. The commission consists of 25 members, 11 of which are voting members appointed by the Governor. Members include state agencies, NGOs, academics, and industry. Staff support for the commission is provided by the Oregon Department of Energy (ODOE).

Greenhouse Gas Emission Goals (2007) were set by the same bill that created the OGWC (HB3543). The emission goals commit Oregon to a 10% reduction from 1990 levels by 2020, and 75% reduction by 2050.

Oregon Climate Change Research Institute (OCCRI) was also created by the Legislature in 2007 to form a network of over 150 researchers from Oregon public universities and affiliated federal and state labs, to achieve a climate-prepared Northwest by cultivating informed communities and advancing the understanding of regional climate, impacts and adaptation. A representative of OCCRI holds one of the 11 voting seats on the OGWC and is responsible for providing technical assistance to the commission. The institute is administered by Oregon State University and also the National Oceanic and Atmospheric Administration's (NOAA) - Pacific Northwest Climate Impacts Research Consortium (CIRC), which is one of 11 Regional Integrated Sciences and Assessments (RISA) projects from around the United States.

Pacific Coast Collaborative (PCC) was created in 2008 by the Executive governments of the four West Coast jurisdictions: British Columbia, Washington, Oregon, and California. The goal of the PCC is to coordinate and promote Climate and Energy policies, aimed at dramatically reducing greenhouse gas emissions and creating a vibrant, low carbon regional economy. Key focus areas for the PCC have included clean energy buildings and transportation systems, food waste reduction management, and ocean acidification and hypoxia. By connecting governments (both regional and local) at the regional level the PCC facilitates collaboration on climate issues that cross borders and jurisdictional boundaries.

International Alliance to Combat Ocean Acidification (OA Alliance) was created through PCC collaboration in 2016, with Oregon as a founding member. The goal of the OA Alliance is to bring together international, regional, and local governments and organizations in order to encourage government action to mitigate and adapt to Ocean Acidification, in order to protect coastal communities and ecosystems. The OA Alliance currently has 42 member groups and governments developing their own OA Action Plans. Oregon's OAH Action Plan, as adopted by Governor Brown, becomes Oregon's submission to the OA Alliance, and thus will be shared with the region and world.

United States Climate Alliance is a bipartisan coalition of states formed in 2017 that are committed to honoring the 2015 Paris Agreement on climate change objectives and goals within their borders. Oregon is a founding member, and as a member has agreed to make steps to achieve the U.S. goal of reducing greenhouse gas emissions 26–28% from 2005 levels and targets of Clean Power Plan before 2025. This State-based Alliance has now become a platform for its members to further develop and strengthen their existing Climate policies, through sharing of information and best practices.

Oregon Climate Agenda (OCA) was developed in 2018 by Governor Kate Brown to create a roadmap to explain and implement Oregon's goals on carbon, climate change and ocean acidification and hypoxia. The OCA describes strategies to reduce carbon and GHG emissions, including:

- Implement market-based carbon program and create the Oregon Climate Authority to better align state programs and expertise to achieve the state's climate policy goals at the least possible cost, while protecting our manufacturing sector and mitigating impacts and providing opportunities for low-income and rural communities, communities of color, and Tribes.
- Hasten the pace of electrification of vehicles in Oregon by expanding electric vehicle infrastructure and incentives.
- Decarbonize the electricity sector by achieving the state's renewable energy targets, encouraging grid modernization and expand opportunities for residential, municipal, and commercial customers to access clean energy services.
- Maintain and strengthen strong energy efficiency investments in residential, commercial, industrial and agricultural sectors, expand the reach of energy efficiency programs to ensure all communities benefit, improve the energy efficiency of state building codes, and support world-leading industrial efficiency initiatives by Oregon's large industrial utility customers.
- Pursue climate solutions that benefit rural communities and Tribes, support working lands, and foster resilience to climate change.

Other Oregon Initiatives that relate to addressing carbon, climate change, and OAH:

- **Cleaner Air Oregon** (2018): rule making by the Oregon Department of Environmental Quality to set standards that regulate heavy metals and other toxic chemicals released by industrial facilities.
- **100 Year Water Vision** (2018): Oregon will steward its water resources to ensure clean and abundant water for our people, our economy and our environment, now and for future generations. Strategic investments and policies will result in resilient natural and built water systems across the state to support safe and healthy communities, vibrant local economies and a healthy environment.
- **Oregon Environmental Protection Act** (2019): solidifies protective federal clean air, water, and drinking water standards as a baseline for Oregon's rulemaking.



To learn more about OAH science, impacts, and solutions, please visit the Oregon OAH Council's website:

oregonocean.info/index.php/ocean-acidification



Action Plan Development Process

Oregon OAH Action Plan - Appendix C

In 2017, the Oregon Legislature created the Oregon Coordinating Council on Ocean Acidification and Hypoxia (OAH Council) with the passage of Oregon Senate Bill 1039. Through this action, the State committed both attention and resources toward understanding OAH science, impacts, and solutions. The Council began meeting in January 2018, and is comprised of agencies, stakeholders, Tribes, NGOs and the Governor's office. The OAH Council prides itself on leading an open and transparent process for developing recommendations for State actions.

As part of the OAH Council establishment, the following three guidelines were embraced:

UNDERSTANDING: The OAH Council developed an understanding of OAH science, how Oregon is impacted by increasing occurrence of OAH impacts, what other entities in Oregon and the West Coast are working on these issues.

RECOMMENDATIONS: The OAH Council identified action areas that are supported by all OAH Council members, drawing from personal and professional experience, OAH Council discussions, and presentations from subject matter experts.

CAPACITY: The OAH Council considered the various options of how the recommended action areas could ultimately be implemented.

Oregon OAH Council and 2018 Report

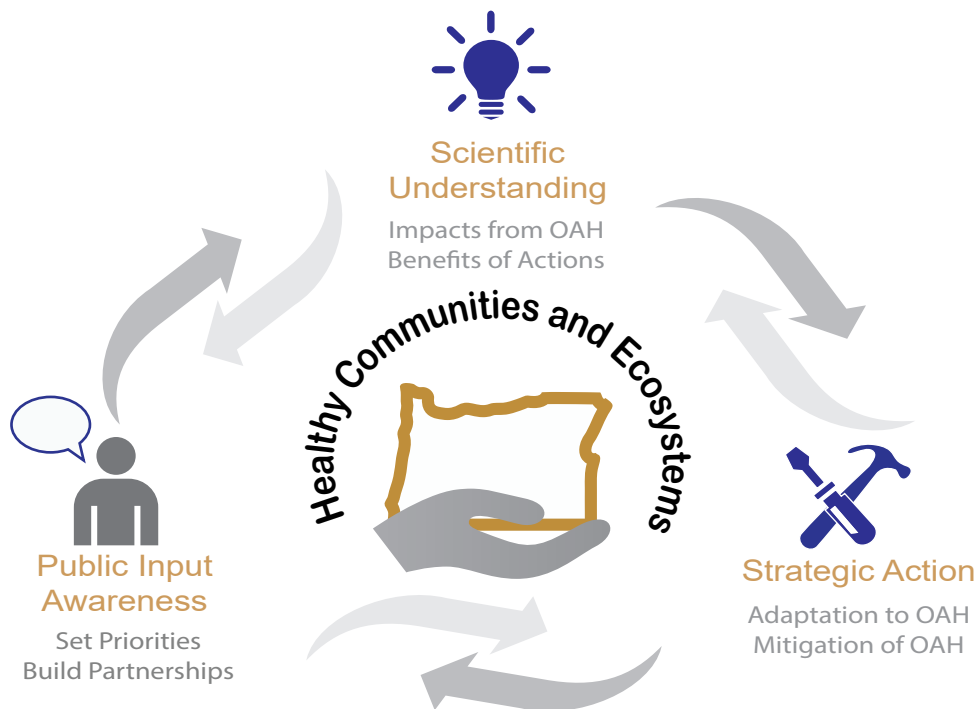
(January 2018 – September 2018)

To develop the OAH Council's first biennial report (submitted to the Oregon legislature on September 15, 2018), the OAH Council met monthly from January to August 2018. Working groups (comprised of a subset of OAH Council members) met between each OAH Council meeting from March-July 2018. All OAH Council and working group meetings were open to the public (including scheduled public comment periods), and followed Oregon's public meeting transparency guidelines. When the OAH Council was established, the Governor requested that the OAH Council draft Oregon's OAH Action Plan as part of Oregon's commitment to the International Alliance to Combat Ocean Acidification. The 2018 Report was intended to provide step 1, of the OAH Action Plan drafting process. In the OAH Council's 2018 Report, 12 recommendations with 38 nested actions were articulated as a comprehensive set of ideas for future actions. The intent is for OAH Council reports, to broadly inform decisions and management activities across entities, as capacity and opportunities are available, for all who are ready to take action to address OAH impacts and develop solutions. As part of finalizing the first OAH biennial report, the OAH Council members rated the relative value of each actions in the report, and elevated 7 actions to needing immediate attention (see **Table C1**). By articulating concerns and ideas for solutions-based actions, the OAH Council intended to generate broad discussions and activities that will help prepare Oregon for the next fifty years by stimulating actions now.

Prioritization of OAH Actions

(December 2019)

Building on the recommendations and actions developed in the September 2018 OAH report, the OAH Council members conducted a second prioritization exercise in October 2018 in order to reevaluate the rating of each report action. Careful deliberation and selections of actions by OAH Council members were based on urgency, anticipated impact, and pathway for implementation of each action (see **Table C1**). This reevaluation also considered public input on the 2018 Report.



Oregon OAH Community Survey

(February 2019 – April 2019)

In order to ensure that the OAH Council heard from as many diverse groups of Oregonians as possible, a community survey was also developed to aid in the development of the State's OAH Action Plan draft.

This survey was sent to 70 carefully selected people across Oregon and the region, and consisted of an online questionnaire and an optional 40 minute interview. Respondent groups included academics, State and Federal Agencies, Tribal organizations/governments, industry, and funding entities. Individuals were selected to participate because of their expertise and ability to help represent their colleagues' interests, concerns, and/or knowledge of OAH and how it will affect Oregon. The survey asked for participants' perceptions and opinions about Oregon's best opportunities to implement OAH mitigation and adaptation strategies.

Feedback from this survey was reviewed by the OAH Council and incorporated into the State's OAH Action Plan (see **Table C1**). Thirty-seven (37) individuals responded to the online survey (53% response rate) and 23 of these opted to participate in follow-up interviews (33% response rate).

From the interviews and online surveys there were three common themes that emerged:

INTERCONNECTION: This Action Plan should make clear the interconnection of actions and the State's needs.

LEVEL OF INFLUENCE: There is a sense of urgency that Oregon can and should act on local scales, while recognizing that OAH is also a global problem that requires global solutions. Respondents felt we need to communicate with all Oregonians, especially those who can be decision makers in their communities (business owners, policy makers, resource managers).

KNOWLEDGE GAPS: While we know a great deal about OAH Science, we still need more information to fully understand the OAH impacts to build solutions. Many felt that at this time they did not have access to all the information they need to address OAH within their community (i.e. on which to base local decisions). Two knowledge gaps that were repeatedly mentioned were 1) the need for more oceanographic monitoring of frequency and duration of OAH and 2) expanding our understanding of socio-economic impacts on Oregon communities.

Draft OAH Action Plan Public Comment Period

(June 2019 – July 2019)

At each meeting and webinar, the OAH Council has always welcomed public participation and comment and has used this feedback to guide OAH Council decisions throughout their processes. Formal public comment on the draft Oregon OAH Action Plan was open from June 10th through July 9th, 2019, which was widely advertised. As part of the public comment period, two webinars were held with both in-person and remote participation options. Each of these webinars was also recorded and the posted webinars, as well as all presented materials, are available on the OAH Council's website. Public input was taken as written or oral comments during and following the webinars, as well as via email, calls, or post throughout the public comment period.

RECORDED WEBINARS OCCURRED ON:

June 11th 6:00pm – 8:00pm

In person at Oregon Department of Fish and Wildlife, Newport, and remote

June 14th 10:00am – 12:00pm

In person at Oregon State University, Corvallis, and remote

Following formal public comment, the OAH Council and staff carefully reviewed all feedback and worked diligently to incorporate suggestions. The Council has taken a thoughtful and collaborative, science-based approach to developing recommendations, encouraging participation by all Oregonians in the crystallization of these ideas from the 2018 OAH Report, into the draft Oregon OAH Action Plan.

Table C1: Progression of actions to be included in the draft Oregon OAH Action Plan, as the Action Plan developed. Twenty (20) key actions were identified from the original 38, as described in the 2018 Report. **Bold red** font denotes the 5 key actions highlighted in the 2019 OAH Action Plan.

OAH Report Priorities <i>January - September 2018</i>	Prioritization Exercise <i>December 2018</i>	OAH Council Community survey <i>February - April 2019</i>	OAH Action Plan <i>June - July 2019</i>
1.1.a 1.1.c	1.1.a 1.1.c 1.1.b	1.2.b 1.2.d	1.1.a 1.1.c 1.2.b 1.2.c 1.3.b
2.1.b	2.1.a 2.1.b		2.1.a 2.1.b
3.2.a 3.2.b	3.2.a		3.1.a 3.2.a 3.2.b 3.1.b
4.2.a	4.2.a	4.1.b 4.2.b	4.1.a 4.1.b 4.2.a 4.2.b
5.1.a	5.2.a 5.2.b 5.2.c		5.1.a 5.1.b 5.2.a 5.2.b 5.2.c



To learn more about OAH science, impacts, and solutions, please visit the Oregon OAH Council's website:

oregonocean.info/index.php/ocean-acidification



Build Sustained Support

Oregon OAH Action Plan - Appendix D

This appendix lists each of the 8 State agencies who's authorities have the most direct nexus with OAH impacts, adaptation, and mitigation. Here, we outline issues that connect the agency authorities to the goals and priorities of the Oregon OAH Action Plan, that can serve as a starting point for agencies conducting evaluation of programs, regulations and compliance (as described in this Oregon OAH Action Plan, Action 5, Step 1). Additional authorities and nexus points may also be relevant.



Oregon Department of Fish and Wildlife

- emerging fisheries, resilient fishing communities, OAH research & monitoring
- Nexus with 2018 Report Recommendations: 1.1, 1.2, 3.2, 5.1**



Department of Land Conservation and Development

- ocean planning, coastal zone management, federal consistency, statewide planning goals, climate adaptation framework
- Nexus with 2018 Report Recommendations: 3.2, 1.2, 1.1, 5.1**



Department of Environmental Quality

- water quality planning, point and non-point source pollution, TMDLs
- Nexus with 2018 Report Recommendations: 2.2, 5.1**



Oregon Department of Agriculture

- food safety, aquaculture and agriculture permitting and practices
- Nexus with 2018 Report Recommendations: 2.2, 3.2, 5.1**



Department of State Lands

- submerged aquatic vegetation, removal/fill permitting, mitigation of development impacts, authorization of use of state-owned navigable waterways (includes estuaries and the territorial sea)
- Nexus with 2018 Report Recommendations: 3.2, 5.1**



Oregon Department of Forestry

- forested watersheds, carbon offset and mitigation, nonpoint source pollution on forested lands
- Nexus with 2018 Report Recommendations: 2.2, 5.1**



Oregon Health Authority

- impacted coastal communities
- Nexus with 2018 Report Recommendations: 3.1, 4.2, 5.1**



Oregon Department of Energy

- carbon mitigation framework, impacts on ecosystem and economics.
- Nexus with 2018 Report Recommendations: 1.1, 2.2, 5.1**

State of Oregon agency authorities

Below are examples of possible ways to incorporate OAH into agency planning, this list is not exclusive or comprehensive, and is meant as a starting place to help guide relevant agency planning.

Oregon Department of Fish and Wildlife (ODFW; OAH Co-Chair Member)

- Encourage development of emerging fisheries in federal and state waters, add socio-economic resilience in fisheries portfolios.
- Encourage monitoring and research on fisheries species distribution patterns, as a result of OAH (e.g., halibut distributions to hypoxia).
- Build OAH monitoring considerations into existing research and monitoring efforts/metrics.
- Continue coordination of the Oregon OAH Monitoring Group (OOMG) and OAH monitoring community in Oregon.

Department of Land Conservation and Development (DLCD; OAH Council Member)

- Consideration of OAH in the regulation and permitting of the at-sea processing of fish waste; ocean floor/space for projects such as open ocean aquaculture, windfarms, oil/mineral exploration, and other such uses that could stress ecosystems and exacerbate the regional impacts of OAH.
- Work with local governments to strength local planning efforts, particularly to OAH and the following planning goals: Oregon Statewide Planning Goals: 5 – Natural Resources, Scenic and Historic Areas, and Open Spaces, 17 – Coastal Shorelands, 18 – Beaches and Dunes, 19 – Ocean Resources, 16 - Estuary Management

Department of Environmental Quality (DEQ; OAH Council Member)

- Evaluate and update approaches within water quality programs to effectively address the control of pollutants relevant to causes of ocean acidification and hypoxia, especially near coastal regions and/or river basins that empty into coastal regions that are near OAH sensitive habitats/species/communities.
- Review approach to permits and for non-point sources to take into account coastal regions and/or river basins that empty into coastal regions that are near OAH sensitive habitats/species/communities.
- Prioritize and/or ensure that development of total maximum daily loads (TMDLs) in coastal basins also address nutrients and other relevant water quality goals.

Oregon Department of Agriculture (ODA; OAH Council Member)

- Consider the interplay between harmful algal blooms (HAB) biotoxins and OAH in crab, clam, and oyster testing and regulations.
- Improvement and regulation of aquaculture reporting standards – standard size of basket, production levels that can be used as monitoring metrics for the vulnerability of the aquaculture industry to the ongoing effects of OAH.
- Consider agricultural lands use and how to best promote water shed resilience and health, including through the use of incentive programs for land owners.

Department of State Lands (DSL)

- Saltmarsh preservation – prioritization of regions with the potential for carbon sequestration and/or that are within regions sensitive to OAH.
- Consider policy development to promote the protection, restoration, and maintenance of SAV's throughout coastal Oregon.
- Consideration of ecosystem resilience to withstand OAH projected changes, such as in permitting and mitigation measures for human development projects in Oregon estuaries and coastal areas.

Oregon Department of Forestry (ODF)

- Consideration of the regulatory ecosystem services (e.g., climate control, water, water quality) that forests provide to estuarine and nearshore from OAH stressors (e.g., warming temperature, toxic contaminants).
- Consideration of OAH causes and OAH stressors in carbon offset programs and mitigation and climate adaptation frameworks.
- Consideration of OAH stressors in annual meetings with other agencies on the sufficiency of forest practices regulations.
- Facilitate DEQ's work with the Oregon Departments of Forestry, USEPA, and NOAA to resolve concerns about the Coastal Non-point Pollution Control program with regard to forest practices on private lands.

Oregon Health Authority (OHA)

- Consideration of OAH impacted coastal communities and industries, designation of at-risk and impacted communities as a result of carbon mitigation programs.

Oregon Department of Energy (ODOE)

- Consideration of OAH causes and OAH stressors in regional carbon mitigation and climate adaptation frameworks.



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oregonocean.info/index.php/ocean-acidification

House Bill 3114

Sponsored by Representative GOMBERG, Senator ANDERSON, Representatives SMITH DB, WRIGHT (at the request of Oregon State University)

SUMMARY

The following summary is not prepared by the sponsors of the measure and is not a part of the body thereof subject to consideration by the Legislative Assembly. It is an editor's brief statement of the essential features of the measure **as introduced**.

Appropriates moneys from General Fund to Oregon Ocean Science Trust, State Department of Fish and Wildlife and Higher Education Coordinating Commission in certain amounts for certain purposes related to ocean chemistry.

Declares emergency, effective July 1, 2021.

A BILL FOR AN ACT

1 Relating to ocean chemistry; and declaring an emergency.

2 Whereas Oregon is an epicenter for the global manifestation of ocean acidification and hypoxia;
3 and
4

5 Whereas the natural seasonal process of upwelling transports corrosive waters into the
6 nearshore and estuaries, causing marine waters within this state's jurisdiction to be especially vul-
7 nerable to ocean acidification; and

8 Whereas ocean acidification, hypoxia and changes in ocean temperature are intensifying; and

9 Whereas Oregon has rich and vibrant wild marine fisheries, including shellfish fisheries; and

10 Whereas ocean acidification and hypoxia are known to cause mortality and reduced growth and
11 productivity in marine organisms, including in species that form the foundation of the marine food
12 web; and

13 Whereas negative impacts from ocean acidification, hypoxia or both have already been observed
14 in species that are commercially, culturally and economically important to this state, including
15 oysters, mussels and crabs; and

16 Whereas Oregon's coastal communities and economies are important to this state and are de-
17 pendent on a thriving marine ecosystem; and

18 Whereas ocean acidification and hypoxia severely endanger Oregon's commercially and cul-
19 turally significant ocean resources; and

20 Whereas Oregon has academic institutions with world-class expertise in ocean issues, including
21 ocean acidification and hypoxia; and

22 Whereas Oregon has played a leading role in fostering collaborative ocean acidification and
23 hypoxia monitoring, research and action; and

24 Whereas the partnerships between the shellfish industry and university scientists in this state
25 are an example to the nation for building innovative solutions to address ocean acidification and
26 hypoxia; and

27 Whereas the Ocean Policy Advisory Council has identified ocean acidification as a priority issue
28 for Oregon; and

29 Whereas the Oregon Ocean Science Trust has identified ocean acidification as a priority issue
30 for research and monitoring funding; and

NOTE: Matter in **boldfaced** type in an amended section is new; matter *[italic and bracketed]* is existing law to be omitted. New sections are in **boldfaced** type.

1 Whereas the Oregon Shellfish Task Force established under section 5, chapter 814, Oregon Laws
2 2015, and the Oregon Coordinating Council on Ocean Acidification and Hypoxia, through collab-
3 oration with Oregon stakeholders, have made recommendations to the Legislative Assembly on
4 strategic actions to address ocean acidification and hypoxia; and

5 Whereas strategic investments are necessary to address the risks and vulnerabilities caused by
6 ocean acidification and hypoxia that threaten the state's economy and ecosystems; now, therefore,

7 **Be It Enacted by the People of the State of Oregon:**

8 **SECTION 1. In addition to and not in lieu of any other appropriation, there is appropri-**
9 **ated to the Oregon Ocean Science Trust, for the biennium beginning July 1, 2021, out of the**
10 **General Fund, the amount of \$1,060,000, to be expended by the Oregon Ocean Science Trust,**
11 **in consultation with the Oregon Coordinating Council on Ocean Acidification and Hypoxia,**
12 **in the form of competitive grants as follows:**

13 (1) \$100,000 for intertidal ocean acidification and hypoxia monitoring at Oregon marine
14 reserves;

15 (2) \$300,000 for subtidal ocean acidification and hypoxia monitoring at Oregon marine
16 reserves;

17 (3) \$100,000 for ocean acidification and hypoxia monitoring at Yaquina Bay;

18 (4) \$140,000 for ecosystem modeling of submerged aquatic vegetation;

19 (5) \$25,000 to develop recommendations, through workshops or seminars, for maximizing
20 the abundance of wild shellfish, cultured shellfish and submerged aquatic vegetation in
21 estuaries in Oregon;

22 (6) \$150,000 to develop best management practices for conducting shellfish cultivation in
23 a manner that protects or promotes estuarine health;

24 (7) \$180,000 to fund a study on the life cycle impacts of ocean acidification and hypoxia
25 on shellfish species that are of importance to Oregon; and

26 (8) \$65,000 to develop a communications plan and strategy for outreach and education on
27 ocean acidification and hypoxia impacts, science and solutions.

28 **SECTION 2. In addition to and not in lieu of any other appropriation, there is appropri-**
29 **ated to the State Department of Fish and Wildlife, for the biennium beginning July 1, 2021,**
30 **out of the General Fund, the following amounts to be expended for the following purposes:**

31 (1) \$420,000 to be expended for the shellfish and estuarine assessment of coastal Oregon
32 project; and

33 (2) \$50,000 to be expended to conduct estuary mapping for long-term documentation of
34 ocean acidification and hypoxia impacts.

35 **SECTION 3. In addition to and not in lieu of any other appropriation, there is appropri-**
36 **ated to the Higher Education Coordinating Commission, for distribution to Oregon State**
37 **University, for the biennium beginning July 1, 2021, out of the General Fund, the following**
38 **amounts to be expended for the following purposes:**

39 (1) \$170,000 to be expended to support the Molluscan Broodstock Program at the Hatfield
40 Marine Science Center in conjunction with the Whiskey Creek Shellfish Hatchery;

41 (2) \$100,000 to be expended to support the work of the Cooperative Institute for Marine
42 Resources Studies in augmentation of sampling along the Newport Hydrographic Line in or-
43 der to support research on ocean acidification and hypoxia; and

44 (3) \$100,000 to be expended to support the work of the College of Earth, Ocean, and At-
45 mospheric Sciences in monitoring for ocean acidification using Burke-O-Lator systems.

1 **SECTION 4. This 2021 Act being necessary for the immediate preservation of the public**
2 **peace, health and safety, an emergency is declared to exist, and this 2021 Act takes effect**
3 **July 1, 2021.**

4

Appendix C



About the Oregon Coordinating Council on OAH

The Oregon Coordinating Council on Ocean Acidification and Hypoxia was convened by Senate Bill 1039 in 2017, which specified the 13 seats and representation of Oregon interests on the Council. This diverse body, with this 2024 OAH Report, has completed 4 biennial Reports to the Legislature and the first Oregon OAH Action Plan (Appendix B), since 2018. The OAH Council members serve on a voluntary appointment that bring together unique experiences and expertise to facilitate collaboration, inclusion, and diversity in the council's ongoing work. These members join from state agencies, universities, federal programs, industry representatives, Tribal governments, non-government organizations, and the Governor's office. The council's achievements continue to propel their efforts in building momentum for continued action and support as they continue moving forward under the Council's guiding Principles: *understand*, *recommend*, and *implement*.

Council Co-Chairs

DR. LAUREN (LAURIE) JURANEK - Oregon State University



Laurie Juranek is a Professor at Oregon State University in the College of Earth, Ocean, and Atmospheric Sciences (CEOAS). She received a Ph.D. in Chemical Oceanography in 2007 from the University of Washington, followed by a National Research Council postdoctoral fellowship with NOAA's Pacific Marine Environmental Laboratory pertaining to carbon cycling and ocean acidification. Her expertise is the use of dissolved gases, nutrients, inorganic carbon, and associated isotope tracers to understand aspects of ocean change.

DR. LEIF RASMUSON – Oregon Department of Fish and Wildlife



Leif Rasmuson runs the Marine Fisheries Research Project in the Marine Resources Program at the Oregon Department of Fish and Wildlife. Leif received his Ph.D. in Marine Biology in 2015 from the University of Oregon, followed by a postdoctoral position at the National Marine Fisheries Service's Southeast Fisheries Science Center. Leif has wide ranging experience from being a treaty shellfish biologist to developing physical oceanographic circulation models. He uses these experiences to help guide an extremely talented team of scientists at ODFW in conducting research to support sustainable fisheries management at the Pacific Fisheries Management Council.

Council Member Biographies

ALEX MANDERSON - Oregon Department of Agriculture



Alex is the Shellfish Specialist for the Oregon Department of Agriculture. He is responsible for implementing the internationally recognized National Shellfish Sanitation Program (NSSP) within Oregon. This program ensures that molluscan shellfish going into commerce are safe and wholesome. Alex also oversees Oregon's marine biotoxin monitoring program for both molluscan shellfish and Dungeness crab, shellfish and food processor licensing and inspection, and handling mariculture leasing applications on State owned tidelands within Oregon. Alex graduated from Massey University in New Zealand and has worked for ODA for the past 15 years. His interests in ocean acidification and hypoxia are from the perspective of the commercial shellfish and crab industry and their long-term resilience.

RIAN vanden HOOFF - Oregon Department of Environmental Quality



Rian is a Senior Policy Analyst for the Oregon DEQ, where he provides legislative policy, budget development and strategic guidance for DEQ's Water Quality Programs while working closely with stakeholders, elected officials, tribal governments, and other agencies. Prior to starting his current role in 2019, Rian's career background includes serving as DEQ's first Ballast Water Program and Invasive Species Management Coordinator and working as a marine and estuarine research faculty member at multiple west coast universities – including the Oregon Institute of Marine Biology (UO) and the Hatfield Marine Science Center (OSU) – where he focused on zooplankton community response to changing environmental conditions. He has received degrees in Environmental Science (B.Sc., University of Oregon) and Marine Ecology (M.Sc., San Francisco State University).

ANDY LANIER - Department of Land Conservation and Development



Andy Lanier is the Marine Affairs Coordinator with Oregon's federally approved Coastal Management Program. He holds a M.S. degree in Marine Resource Management from Oregon State University. Andy is the Co-Chair of the West Coast Ocean Data Portal and is a staffer to the Oregon Ocean Policy Advisory Council. Throughout his career he has been dedicated to promoting the inclusion of science-based considerations regarding ocean acidification and hypoxia into state management and policy.

VACANT - Tribal Government Representative

DR. KEITH WOLF - Oregon Ocean Science Trust



Dr. Keith Wolf is an appointed board member of the Oregon Ocean Science Trust through 2026. He has managed diverse environmental programs and divisions for over thirty years. He has developed and led multiple government, academic and private industry research and monitoring programs in the US and Canada. Recently, he co-led a global Environmental, Social, and Governance (ESG), Climate, and Sustainability Task Force across the Asia Pacific and Americas. At present, he holds a specialized Endangered Species Act contract position with the US Department of Commerce/NOAA Fisheries, where he is a member of the West Coast Climate Team and NOAA's Marine Carbon Dioxide Reduction working group. He is also supporting NOAA Sea Grant and the Administration's Climate-Ready-Workforce program funded by the landmark Inflation

Reduction Act legislation. He holds a bachelor's of science degree in Natural Resources Management, with certificates in Geographical Information Systems, Climate Scenario Planning, and Project Management from Sheppard University, Bellevue College, Pacific Lutheran University and Western Washington University. Later, he received a Ph.D. in Environmental Engineering with distinction where he innovated new technology and decision-support systems for environmental remote sensing systems.

DR. KARINA NIESEN – Oregon Sea Grant



Karina Nielsen is the director of the Oregon Sea Grant (OSG) program based at Oregon State University. OSG's mission is to promote discovery, understanding, and resilience for the coastal communities and ecosystems in Oregon. Karina also serves as an ex-officio council member of Oregon's Ocean Policy Advisory Council (OPAC), chair of the OPAC Science & Technical Advisory Committee, and board member of the California Ocean Science Trust. Previously she was the executive director of the Estuary & Ocean Science Center and a professor of biology at San Francisco State University and Sonoma State University. She earned her Ph.D. in Zoology from Oregon State University in 1998 and a B.S. in Biology from Brooklyn College, City University of New York in 1992.

FRAN RECHT - Conservation Organization Representative



Fran Recht is the Habitat Program Manager for the Pacific States Marine Fisheries Commission. In her position she acts to conserve and restore freshwater, estuarine and ocean habitats. She works by advancing policies and actions through work with collaborative, multiparty groups such as the Pacific Fishery Management Council, the Pacific Marine and Estuarine Fish Habitat Partnership, forest service stewardship groups, and local watershed councils. She also brings her academic background in biochemistry and marine resource management to this issue.

BOB KEMP - Fishing Representative



Bob Kemp has been fishing crab, salmon, and tuna for 35 years. Although he has had several careers throughout his life, fishing came easily thanks to his comfort around the ocean from an early age. Now, he owns his own operation and represents the fishing industry as the Newport Sea Grant Fisherman Representative, a Fisherman Representative at Science and Fisherman Exchange Meetings, and the secretary of the Newport Fisherman’s Crab Association. Previously, he served as the Fishing Representative to the Mid-Coast Watershed Council from 2000 to 2012. Throughout his career, he has been dedicated to providing his perspective and ocean observations to the scientific community.

KRISTEN PENNER - Shellfish Industry Representative



Kristen is a commercial fisherman participating in several of Oregon’s fisheries, including shellfish. She is also a Food Systems Consultant at Columbia Pacific Economic Development District of Oregon. Kristen is certified in Community Food Resource and Hub Management and Sustainable Food Enterprise Financial Planning and Management from the University of Vermont Continuing and Distance Education.

DR. JESSICA MILLER - Academic Representative



Jessica Miller is a Professor in Fisheries and Wildlife at OSU and a member of the Coastal Oregon Marine Experiment Station, stationed at the Hatfield Marine Science Center in Newport. She leads the Marine & Anadromous Fisheries Ecology Program and teaches an undergraduate and graduate course on the early life history of fishes. She is also OSU’s Project Director for the Living Marine Resources Cooperative Science Center, a NOAA-funded effort to promote underrepresented communities in marine science. Her research combines field and lab studies with biogeochemistry to address basic questions in marine and fisheries ecology that contribute to management and conservation efforts. She received a BA in Zoology from the University of Montana, a MS in Fisheries from University of Washington, and a PhD in Biology from the University of Oregon.

KARIN POWER - Governor’s Office Representative



Karin Power is the Governor’s Natural Resources and Climate Advisor, providing assistance on broader natural resource issues and focused efforts on climate and energy. Karin holds a J.D. from Lewis & Clark Law School with a Certificate in Environmental and Natural Resources Law, and she has worked for over ten years in water quality and quantity, habitat restoration, climate change policy, and sustainable business initiatives.

Appendix D

List of Acronyms and Abbreviations

CFEC	Climate-Friendly and Equitable Communities
CICOES	Cooperative Institute for Climate, Ocean, and Ecosystem Studies
CO ₂	Carbon dioxide
DEQ	Oregon Department of Environmental Quality
DLCD	Department of Land Conservation and Development
DO	Dissolved oxygen
GHG	Greenhouse gasses
HAB	Harmful Algal Bloom
HB3114	House Bill 3114
HCP	Habitat conservation plan
HMSC	Hatfield Marine Science Center
IPCC	Intergovernmental Panel on Climate Change
ITP	Incidental take permit
LUBGMA	Lower Umatilla Basin Groundwater Management Area
mCDR	Marine carbon removal
NANOOS	Northwest Association of Networked Ocean Observing Systems
NOAA	National Oceanic and Atmospheric Administration
OA	Ocean acidification
OAH	Ocean acidification and hypoxia
OCAC	Oregon Climate Action Commission
ODA	Oregon Department of Agriculture
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish and Wildlife
ODOE	Oregon Department of Energy
ODOT	Oregon Department of Transportation
OOST	Oregon Ocean Science Trust
ORKA	Oregon Kelp Alliance
OSU	Oregon State University
OWEB	Oregon Watershed Enhancement Board
PCC	Pacific Coast Collaborative
PFA	Private forest accord
RGB	Red, green, and blue
SAV	Submerged aquatic vegetation
SDSU	San Diego State University
SEACOR	Shellfish and Estuarine Assessment of Coastal Oregon
STS	Statewide Transportation Strategy
TSP	Oregon territorial sea plan
UAS	Unmanned aircraft system
WCSH	Whiskey Creek Shellfish Hatchery