



**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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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
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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)**.

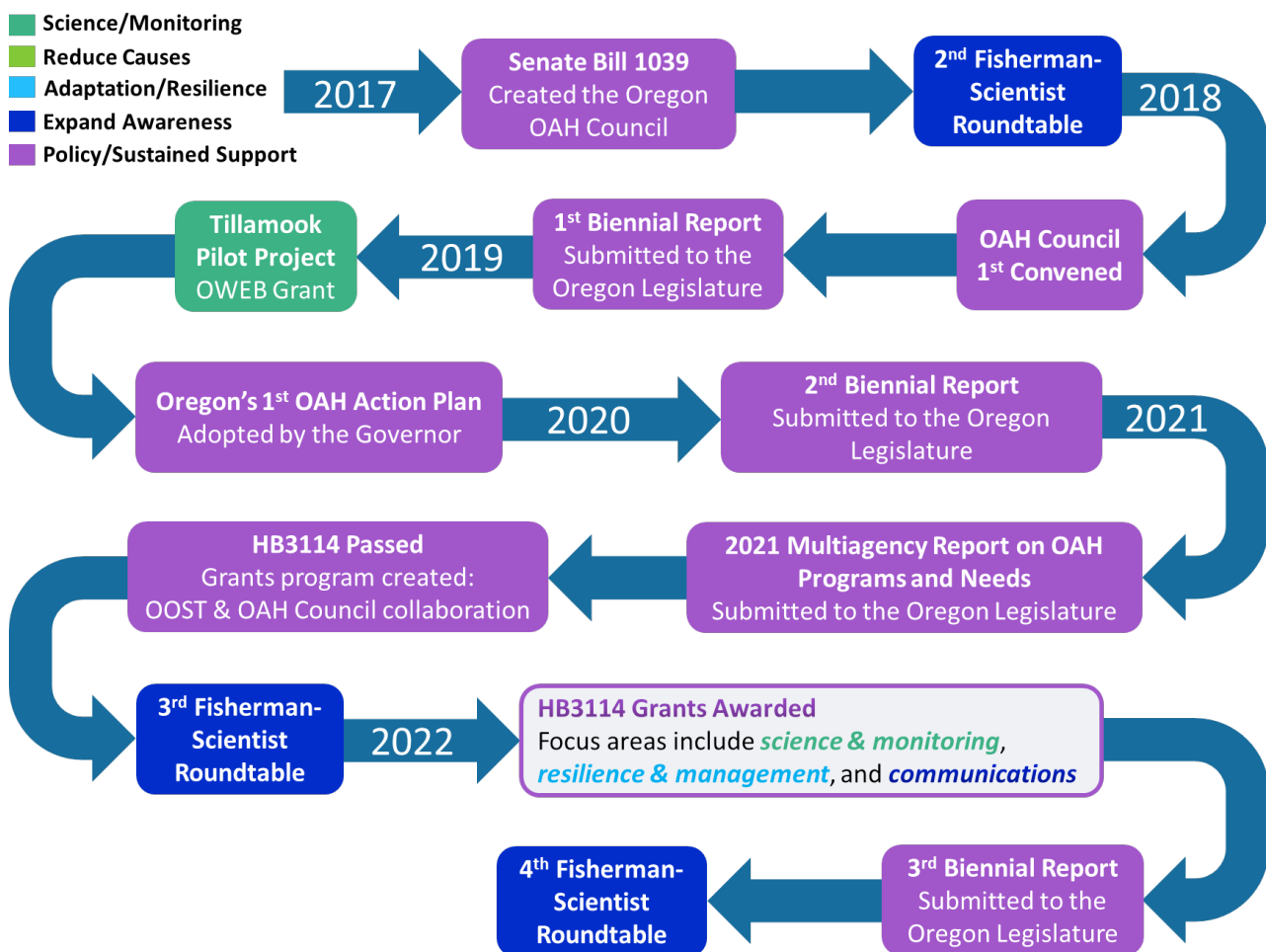


Figure 1. Timeline of events since the Oregon OAH Council was created in 2017 through 2022. The five color-coded phrases are the primary action items identified in Oregon’s first ever OAH action plan (**Appendix A**).

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.**

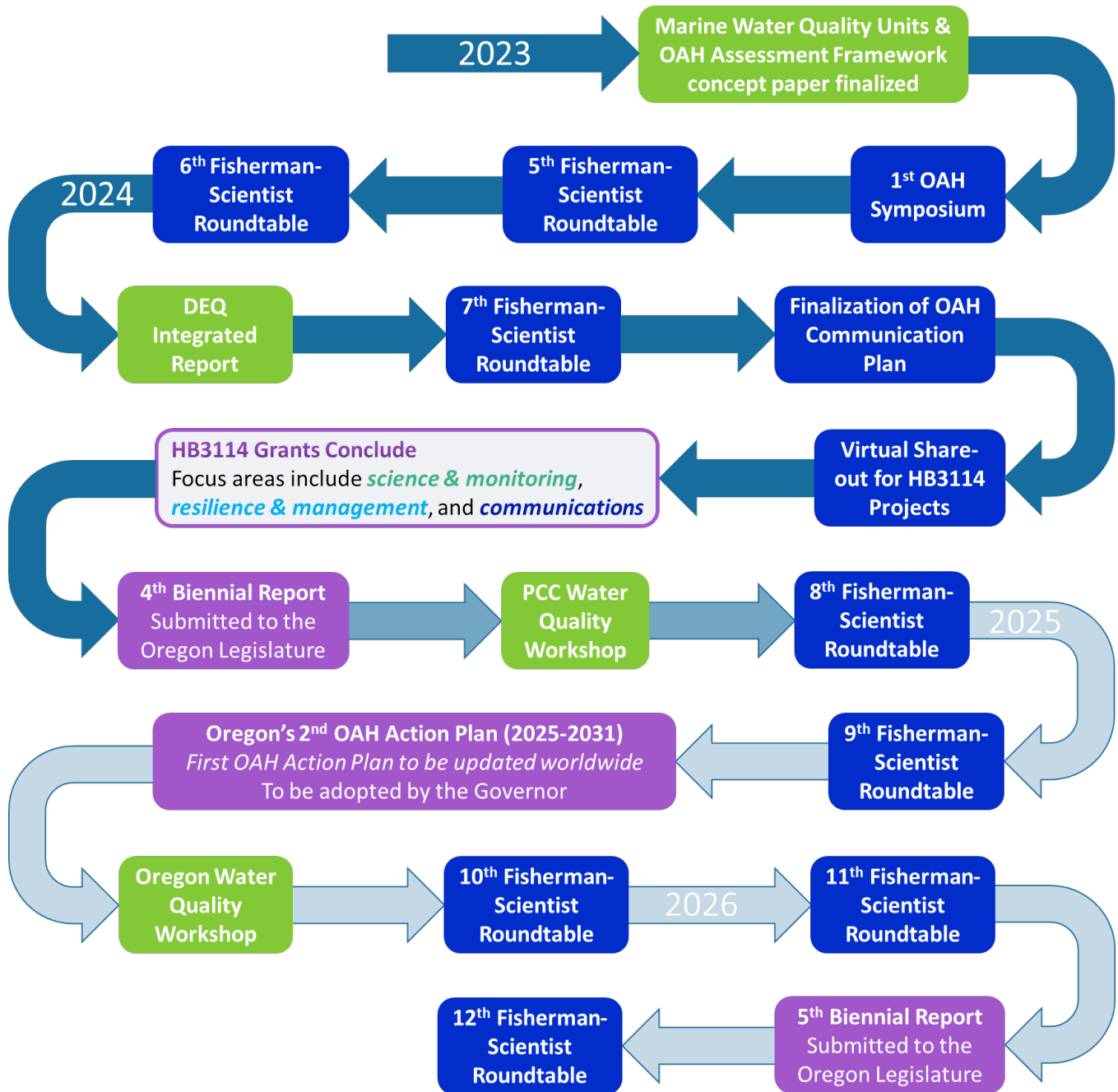


Figure 2. Timeline of Oregon OAH Council events from 2023 and planned through 2026.

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.

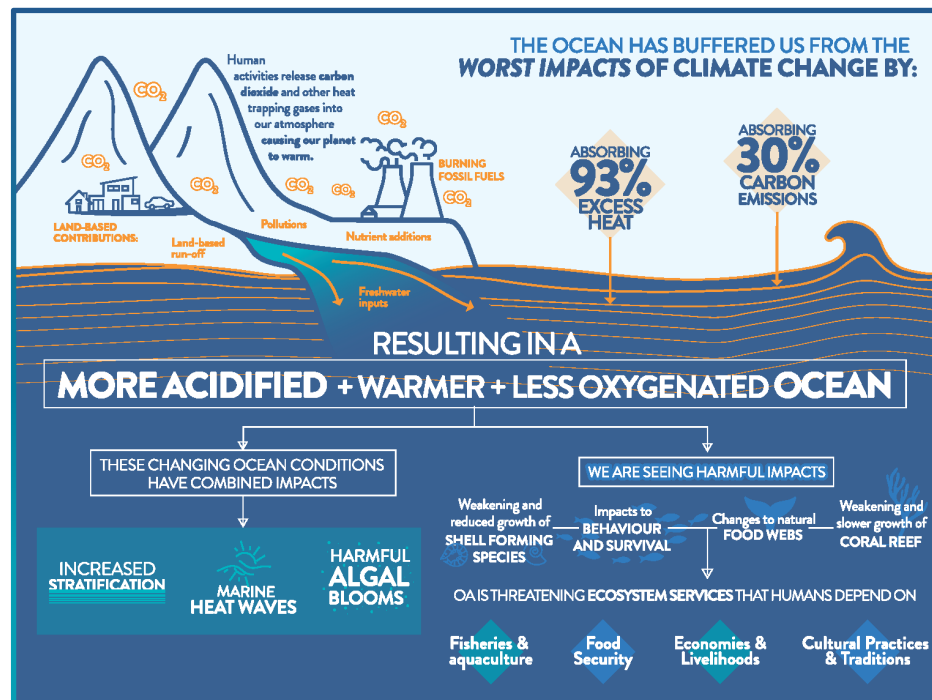


Figure 3. Global impacts of climate change on the marine environment, highlighting the climate connections between the ocean, land, and atmosphere. *Graphic Credit: sourced from the OA Alliance.*

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.

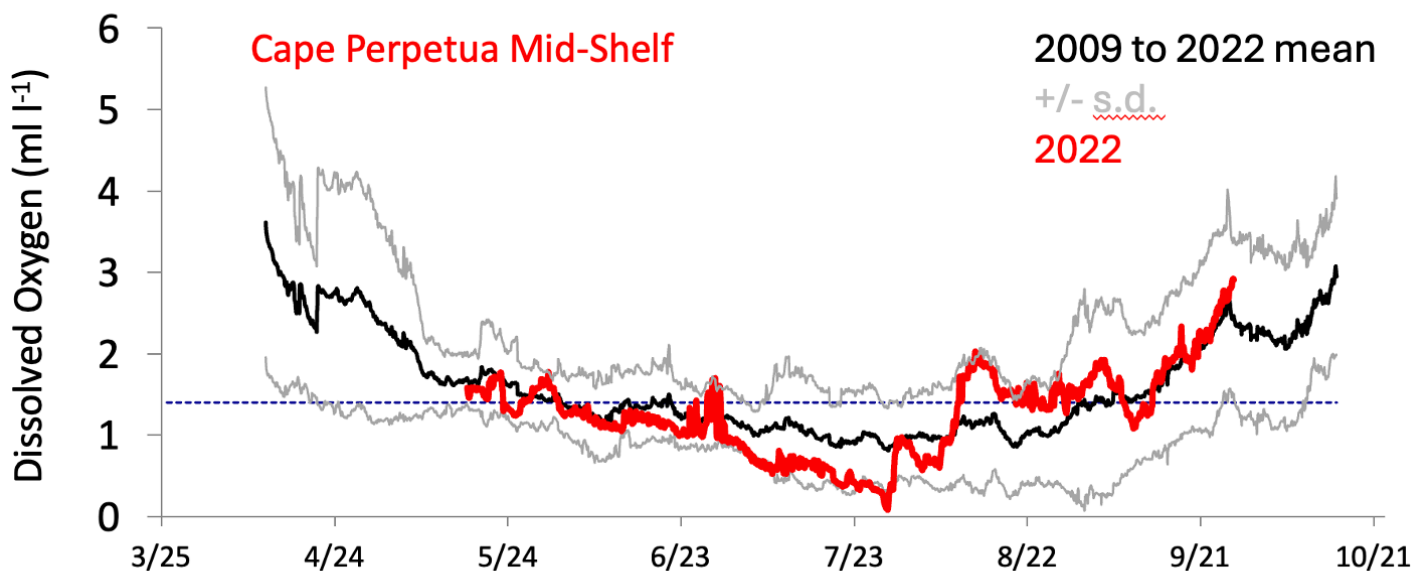


Figure 5. Dissolved oxygen concentration observed at the Cape Perpetua Marine Reserve. Red bold line indicates concentration in 2022. Black line shows the average conditions over 2009-2022 with grey lines indicating one standard deviation (s.d.) of the mean. Hypoxic conditions are indicated by the dashed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

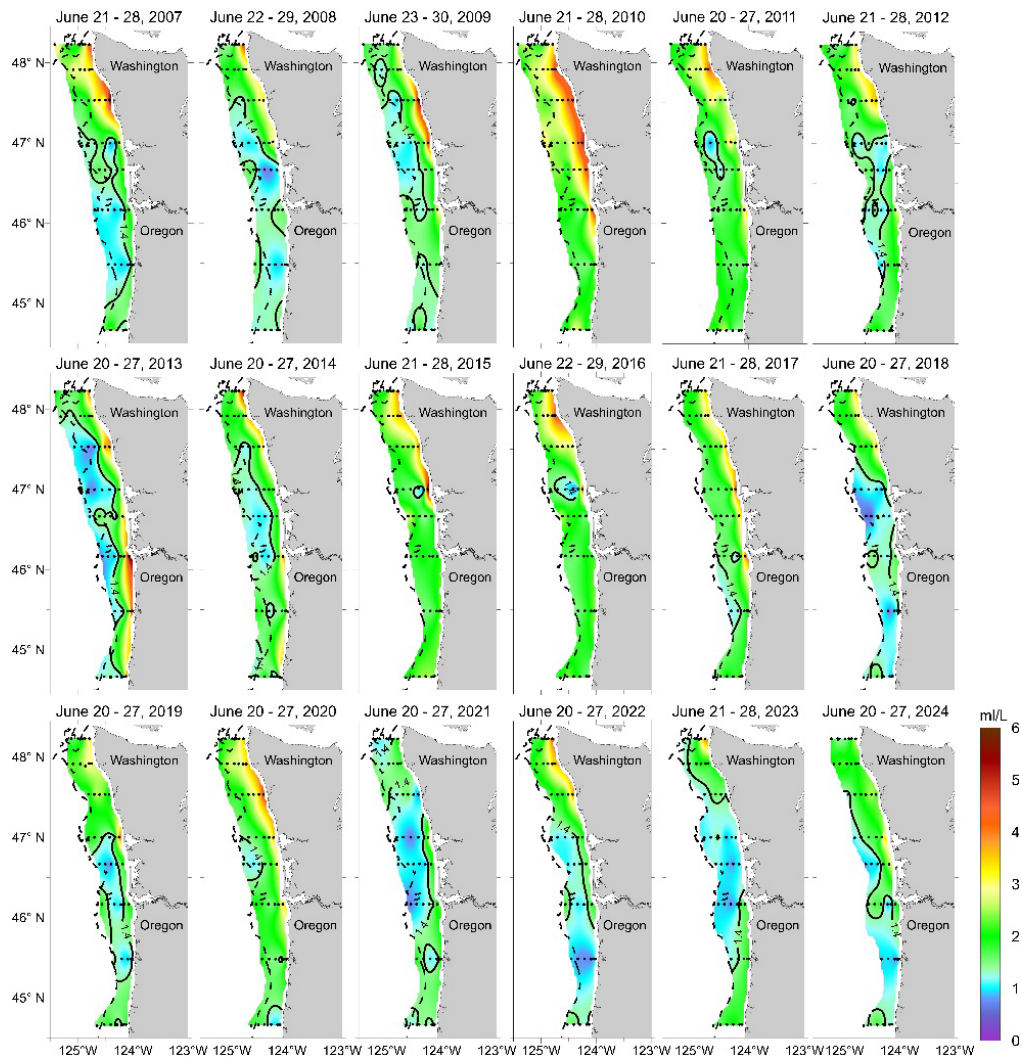


Figure 6. Near-bottom dissolved oxygen concentrations observed in ship-based surveys conducted in coastal Washington and Oregon during mid to late June over the last 10 years. Hypoxic waters below a threshold of 1.4 ml/L are bounded by a thick black line. Credit NOAA Fisheries, <https://www.fisheries.noaa.gov/west-coast/science-data/local-physical-indicators#hyp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

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**.



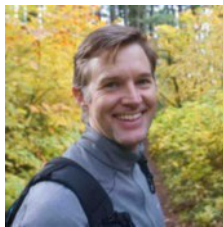
DR. LAURIE JURANEK
Council Co-Chair
Oregon State University



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:



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

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

