



# The Oregon Coordinating Council on Ocean Acidification and Hypoxia



**THIRD BIENNIAL REPORT**  
*September 15, 2022*



*Submitted by the Oregon Coordinating Council on Ocean Acidification and Hypoxia*



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# Letter from the OAH Council Co-Chairs

Over the past four and a half years, the Oregon Coordinating Council on Ocean Acidification and Hypoxia (OAH) has been implementing the legislature's vision of this Council, serving as a diverse stakeholder group that provides science-based recommendations to the State about our changing ocean. The legislature prioritized the creation of this Council after years of emerging problems related to OAH in the oyster aquaculture industry and a growing recognition of similar problems facing many of our wild stocks. The ocean is an integral part of Oregon's past, present and – with care – our future, as a source of food, recreation, solace, economic and cultural identity, and vitality. We benefit from maintaining healthy coastal habitats, the ocean intimately shapes the inland climate, moderates drought and extreme heat, and can help buffer against storm waves and tides. Yet, the ocean is showing signs of impacts related to fossil fuel combustion, elevation of carbon dioxide in the atmosphere, and the resulting broad impacts on weather, ocean conditions, temperature, and productivity. The various symptoms are complex, but we know that ocean acidification and hypoxia (low oxygen) are both profound elements of the big picture. The OAH Council's work to understand and strategize how to address these problems is timely, the importance also increases year-by-year, as we learn more about the challenges facing us and the need to adapt to change and build resilience for future generations.

Certainly, this report is a retrospective on the OAH Council's work over the past two years, as requested by the legislature in our origin legislation, Senate Bill 1039. It is also an interim report, providing an update on Oregon's implementation of the Oregon OAH Action Plan, adopted in 2019 (**Appendix A**). Importantly, this report is a communication tool between the OAH Council and the public, sharing the status, stories, and progress on adaptation, mitigation, and ocean change resilience efforts. Our public is not only Oregonians, but also the region, the nation and the international community that are likewise concerned with and working to find solutions to the changes we face globally. The United States' recent decisions to re-join the Paris Accord and to become a member of the International Alliance to Combat Ocean Acidification (OA Alliance), reaffirm that the problems we see in Oregon are concerning at the highest levels of government. Lastly, this report is an important refocusing document for the Council, highlighting what we have achieved, and what we have still to do in implementing the 2019-2025 Action Plan.

We have achieved much over the past two years, including these highlights:

- *Improved understanding, by convening scientific experts on OAH*
- *Improved monitoring regionally, by facilitating the installation of equipment in Oregon, and coordinating with regional partners on the West Coast monitoring network*
- *Raised awareness about problems and solutions by participating in and convening workshops, roundtables, and conferences, notably including the fishing community*
- *Coordinated within the State agency family on authorities and strategic planning related to climate and ocean change*
- *Provided leadership in the State and with other governments on OAH policy, science, and action*
- *Operationalized House Bill 3114 (2021) funding for 11 different projects in science, monitoring, and communications, in collaboration with the Oregon Ocean Science Trust*

Yet, we have much to do. With three years remaining in our 6-year Action Plan, we will continue to implement the priorities of the legislature and Council, as we have the ability and resources to do so. OAH will be a challenge for decades to come, making the institutionalization of adaptive resilience and mitigation a critical short-term goal for fisheries, aquaculture, coastal communities, and resource managers. Durable funding and capacity are needed to fully integrate the recommendations into the work of agencies and partner organizations.

Serving as Co-Chairs of this Council is a sobering responsibility that we take very seriously. We are grateful for the opportunity to build a brighter future for Oregon.

Sincerely,

**Laurie Juranek, PhD**



Associate Professor  
College of Earth, Ocean, and Atmospheric Sciences  
Oregon State University

**Caren Braby, PhD**



Marine Resources Program Manager  
Oregon Department of Fish and Wildlife

## House Bill 3114

On June 22, 2021, the Oregon legislature passed House Bill (HB) 3114 (**Appendix B**), representing a historic investment in Oregon's efforts to combat ocean acidification and hypoxia. With some direct appropriations to existing work groups at Oregon State University and Oregon Department of Fish and Wildlife, the bulk of the \$1.9 million, one-time investment, was distributed through competitive grants led by the Oregon Ocean Science Trust (OOST). This was the first OOST "request for proposals" or RFP process, since the Trust was created by the legislature in 2013. All projects funded by the legislation were identified in the 2019-2025 Oregon OAH Action Plan (**Appendix A**), and are particularly aligned with outcomes in three of the five Action Plan thematic areas:

**Theme 1: Ocean and Estuarine Monitoring**

**Theme 3: Adaption and Resilience – Applied Research and Management**

**Theme 4: Raising Awareness – Communications Planning for OAH**

More specifically, the projects are designed to advance scientific understanding of OAH impacts, mitigate the effects of OAH on Oregon's coastal resources and community livelihoods, and increase community understanding of these changes and threats, so Oregonians can best adapt to changes that are already occurring. Each of the funded projects are described in this report (*pages 10-19*).

As specified in HB3114, the OAH Council worked closely with the OOST over a nine-month period to design and run the inaugural grant program, with all awards announced in April 2022 for work that will continue through 2024. During the grant period, the OAH Council will meet with grantees and showcase their ongoing work in public venues, as their work progresses. For more information on the specific projects and teams doing this work, see the Ocean Science Trust website: [oregonoceanscience.com](http://oregonoceanscience.com)

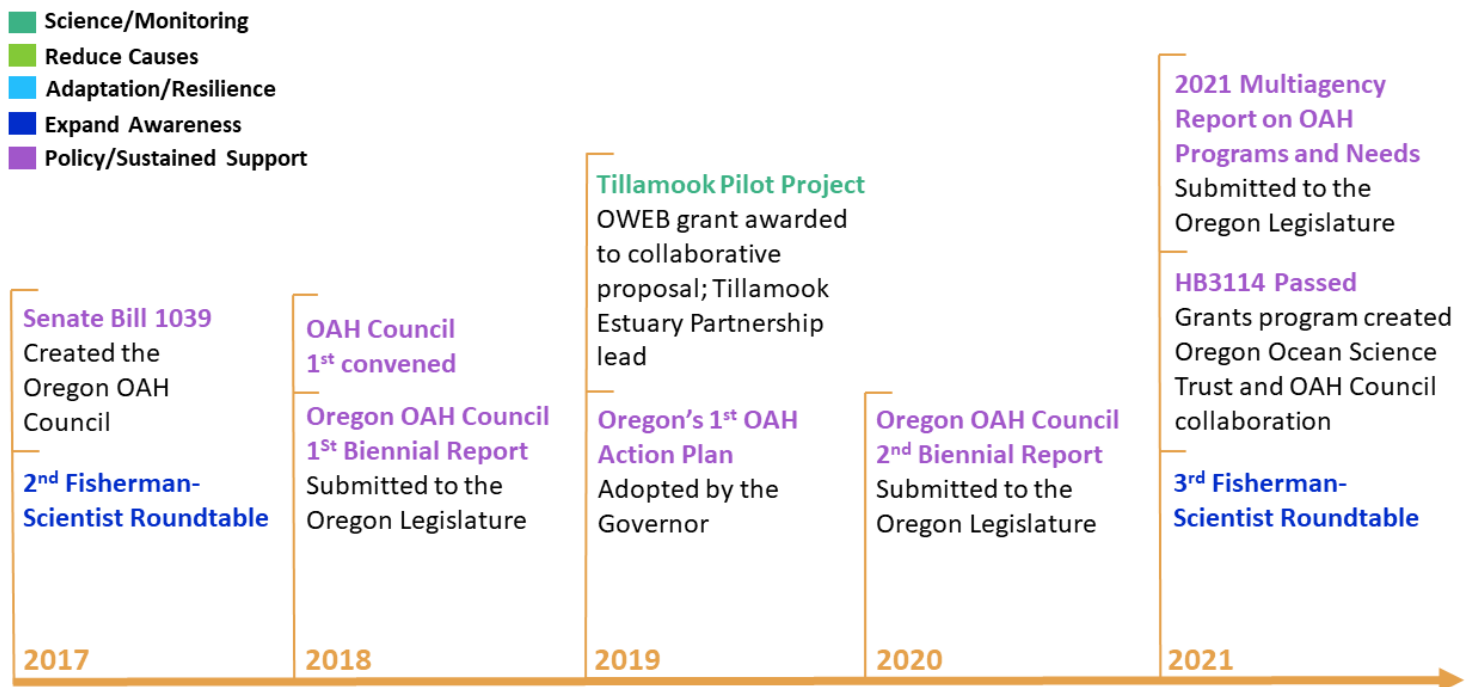
# Executive Summary



## 3<sup>rd</sup> Biennial Report to the Legislature and Ocean Policy Advisory Council *Submitted by the Oregon Coordinating Council on Ocean Acidification and Hypoxia*

Oregon was one of the first places in the world to experience the direct impacts of ocean acidification and hypoxia (OAH). Hypoxia (low oxygen) events are now predictable each summer. The steady increase in acidification is approaching or meeting levels that are problematic not only for oysters, but for crab, mussels, urchins, salmon, rockfish, and other species that Oregonians care deeply about. Since its creation in 2017, the Oregon Coordinating Council on OAH has worked to understand, mitigate, adapt to, communicate, and strengthen Oregon’s response to these changing ocean conditions and associated negative impacts (**Figure 1**).

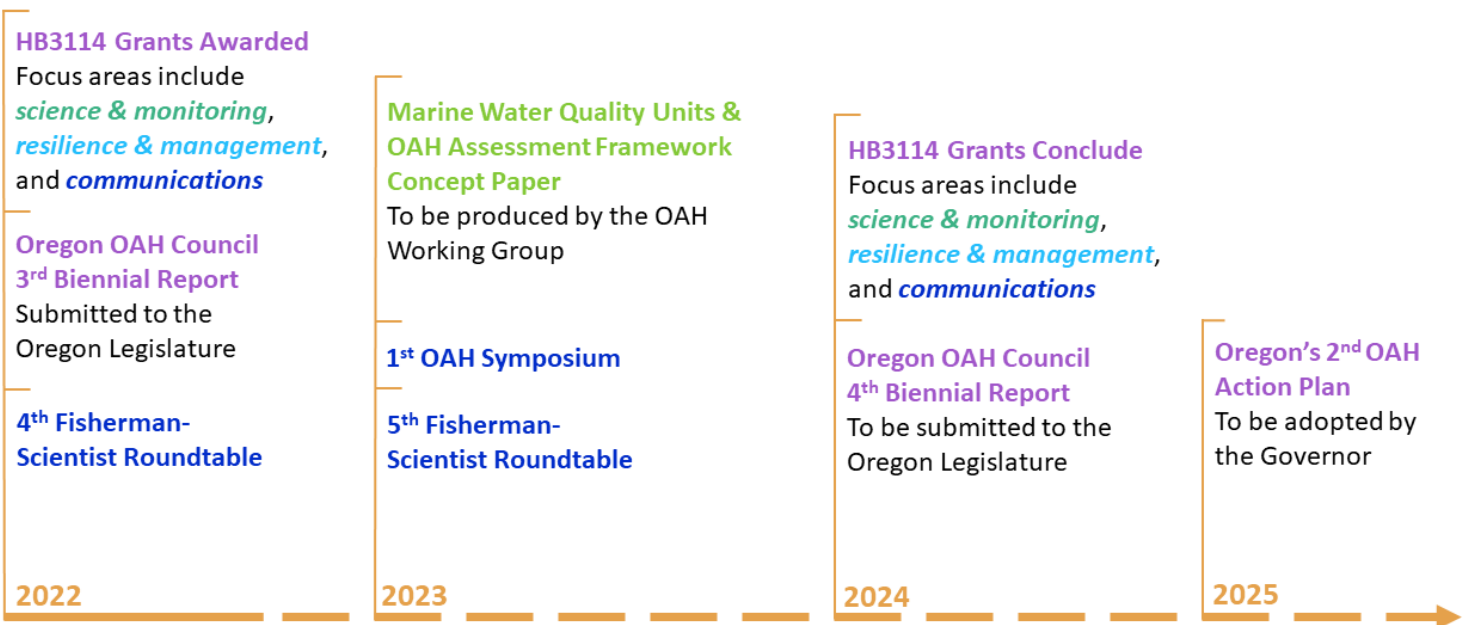
Over the last two years, the Council invested significant time on two objectives: 1) exploring the ability of state agencies to address ocean change, as described in the **Multiagency Report on OAH (2021)** and 2) awarding funding per the **Oregon legislature investment in OAH through House Bill 3114 (2021)**. The Multiagency Report outlines the existing authorities, roles, and potential contributions for eight of Oregon’s state agencies that have a nexus with ocean change management. Passage of HB3114 marked the largest Oregon legislative investment in OAH initiatives as well as the first funding to be received by the Oregon Ocean Science Trust (OOST) for distribution through a competitive grants program. The projects funded by HB3114 have been OAH Council priorities since its inception (as described in the 2018 Report to the legislature); the OAH Council collaborated closely with the OOST to help create the grants program and ensure that rigorous projects, aligned with Oregon’s needs, were funded.



**Figure 1.** Timeline of events since the Oregon OAH Council was created in 2017, as planned through 2025.

HB3114 provided an unequivocal leap forward in facilitating the achievement of multiple benchmarks recommended by the OAH Council, and the Council has made significant progress in achieving other Action Plan goals. Of critical importance, the OAH Council has played a key role in building up Oregon’s OAH monitoring network to document ocean trends (with a goal of distinguishing between natural variability and long-term change), which will in turn will be used in ocean management. Over the last four years, the OAH Council has helped establish monitoring programs in two of Oregon’s most important bays, Tillamook and Yaquina, standing by the leadership from the partner institutions who founded these sites, the Tillamook Estuary Partnership and Hatfield Marine Science Center. Supported by competitive grant awards from the Oregon Watershed Enhancement Board (OWEB) and the OOST (from HB3114), these two sites now have a solid foundation and start of a long-term monitoring program, although both are in need of long-term funding to continue. **These long-term monitoring investments by the State will provide vital information about changes in Oregon’s coastal ecosystems.**

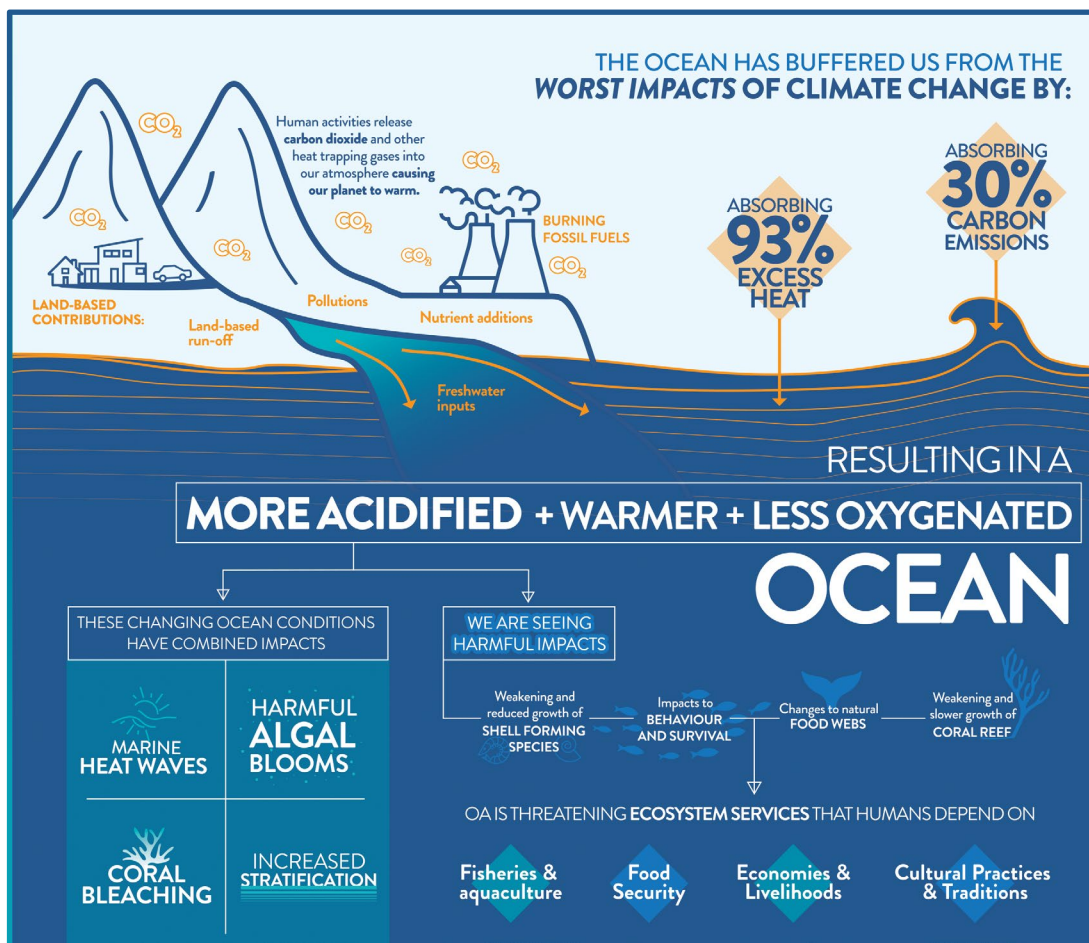
Additionally, the OAH Council continues facilitating events to increase collaboration between fishermen, who are out on the water every day, and scientists, who have the academic skills to rigorously document change. Convening fisherman-scientist roundtables, hosting OAH sessions at conferences, and building a pilot project communications app (for mobile devices) to connect fishermen and scientists are contributions by the OAH Council, helping raise awareness and fostering collaboration. Over the next two years, the OAH Council will continue with these and other projects aimed at improving monitoring, awareness, and collaboration. The Council will work to achieve best outcomes from HB3114-funded projects, working closely with the OOST grant recipient that is tasked with creating an Oregon OAH Communications Plan. To highlight OOST project results and synergies, the OAH Council will also initiate and host an annual OAH symposium. As the next two-year period draws to a close, the OAH Council will look further in the future and start strategic planning for Oregon’s 2<sup>nd</sup> OAH Action Plan (2025-2031). **These coordination efforts will lead to better-informed science and solutions to OAH impacts, while communications and planning efforts will keep Oregon moving forward and making progress on changing ocean conditions, preparing Oregon for the future.**



## How is the ocean affected by CO<sub>2</sub>?

The ocean covers more than 70% of the planet and is essential to the planet’s climate, productivity, human survival, and livelihood (**Figure 2**). The ocean absorbs and accumulates carbon dioxide (CO<sub>2</sub>) and heat from the atmosphere, causing chemical and thermal changes. When dissolved in seawater, CO<sub>2</sub> undergoes a chemical reaction that lowers the pH (making it more acidified). This has been shown to disrupt shell formation in some calcifying organisms, including well-known species like oysters and crabs, and lesser-known species such as sea butterflies (“pteropods”). Previously considered to be periodic or rare, hypoxia events are now part of our annual patterns and observations – like wildfire seasons on land – and may be increasing not only in frequency but also in severity. These events are a particular focus of current scientific research due to the potential impacts on some of Oregon’s most commercially important species, like crab and halibut. These simultaneously occurring processes (OA and H) are inextricably linked and represent collectively a multiple stressor challenge for marine species, ecosystems, and human communities.

Since the industrial revolution, there has been a **1.1 trillion-ton increase in atmospheric CO<sub>2</sub>** from fossil fuel combustion with a global atmospheric temperature increase of 2° Fahrenheit (1° Celsius). The Oregon Governor and legislature have both taken steps to set greenhouse gas emission reduction goals. Relative to 1990 levels, these goals currently aim for a 45% reduction by 2030, and 80% reduction by 2050. Under existing policies, Oregon’s current trajectories are **not on track with the State’s GHG emissions reduction goals**.



**Figure 2.** Global impacts of ocean acidification on the marine environment, highlighting the climate relationship between the ocean, land, and atmosphere. *Graphic Credit: sourced from the OA Alliance.*

## Oregon's OAH Action Plan & achievements

Adopted by Governor Brown in 2019, Oregon's OAH Action Plan is a 6-year roadmap that outlines the State's efforts to address OAH from 2019-2025 (**Appendix A**). As a founding member, Oregon submitted the Action Plan to the International Alliance to Combat Ocean Acidification (OA Alliance), demonstrating to the international community how local actions are beneficial and can support the global efforts of combating climate and ocean change.

During the past two-year period, the Council completed or facilitated achievement of numerous benchmarks recommended by the Council in the 2020 Biennial Report. **Figure 3 summarizes the five thematic areas of the Action Plan, with details of the Council's successes in the last two years in facilitating OAH science & monitoring, reducing causes, adaptation & resilience, awareness, and building support:**



**Figure 3.** Diagram summarizing the Oregon OAH Action Plan themes (2019-2025), and Oregon's achievements over the last two-year period (2020-2022).



## 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)***

Strategic enhancement of the State’s robust ocean monitoring network will help us better track the extent and severity of ocean change at a local level. While global monitoring efforts are helpful in understanding large-scale change, they are not useful in telling us how severe ocean change is in one area of Oregon compared to another. However, we know that there are differences within Oregon, and a monitoring network will help us quantify differences and identify areas that are most vulnerable to and at risk from ocean change. Additionally, data from a strong monitoring network will help us better understand the causes as well as predict the frequency and severity of changing ocean conditions. Fostering a greater understanding could be important in focusing management decisions and resources in the places that most need it. Predictions of oceanic change and effective management responses will only be possible if we sufficiently understand OAH trends.

In the recent past, monitoring of changing ocean conditions has led to key management outcomes at the local scale. For example, in 2007, Oregon’s Whiskey Creek Shellfish Hatchery and Oregon State University researchers worked hand-in-hand to discover why larval oysters were failing to grow. Monitoring led to the understanding that ocean acidification was the root cause and directed hatchery management practices to mitigate acidified waters. This partnership created practical solutions for continuing successful oyster hatchery production in the face of increasingly acidified conditions of Oregon’s ocean waters.

# Current Project Highlights

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

To address the need for increased OAH monitoring, this project aims to better understand where and for how long OA events will persist under different climate conditions in intertidal regions. It also documents changes in the chemical state of the ocean and connectiveness between the inner continental shelf and the intertidal zone in different coastal regions. State support now means that Oregon has the longest record of intertidal OA exposure on the West Coast. This is enabled by a network of coastal residents who work directly with OSU researchers to keep up with observations and make Oregon's marine reserves a legacy resource for detecting, tracking, and communicating changes in our coastal ocean. **This research will foster a greater understanding of sense of place, ocean change, and its status in marine reserves as well as leverage existing research investments in marine reserves.**

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

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

Long-term monitoring data from Cape Perpetua Marine Reserve has served as a backbone of OAH observations in Oregon. This project continues decade-long monitoring efforts in the region by sustaining crucial time-series observations of OAH throughout Cape Perpetua. The researchers will develop a community supported OAH monitoring program by engaging fishing industry partners and utilizing existing partnerships and technology from the National Oceanic and Atmospheric Science Administration (NOAA) and awards from the National Science Foundation. State support has been essential and timely as dissolved oxygen levels dropped precipitously in August 2022, resulting in reports of Dungeness crab mortality from fishermen. State support has also resulted in expanded partnerships with Oregon's commercial fishermen who deployed sensors in waters adjacent to marine reserves that are providing crucial observations. **Aiming to increase OAH monitoring across the State, these efforts set the precedent for long-term OAH monitoring across Oregon's marine reserves.**

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

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

The Newport Hydrographic Line (NHL) is a series of oceanographic sampling locations that run west from Newport, Oregon, where a NOAA-OSU collaboration has been collecting chemical, physical, and biological information for over 20 years, sampling every two weeks. This project leverages a long-standing federally (NOAA) supported ocean survey program at OSU's Cooperative Institute for Marine Ecosystem and Resources Studies to enhance a crucially needed understanding of how OAH will affect the coastal-ocean food web. Oregon's coastal-ocean food web sustains the growth of high value species such as juvenile salmon and larval Dungeness crabs. State support through HB3114 will enhance OAH monitoring at the NHL, augmenting observations of the coastal-ocean food web in concert with measurements of changing ocean conditions. These enhanced observations will also be valuable in the State's efforts to define water quality criteria and assess future impairment. **This project leverages Oregon's collaborative marine research community to understand and plan for a more resilient coastal ocean.**

*Francis Chan (OSU), HB3114-OSU Project 1 (ongoing)*

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

This project is focused on collecting a series of oceanographic data from Yaquina Bay, Oregon including climate-grade temperature, salinity, dissolved oxygen, turbidity, conductivity, total algae, chlorophyll a, CDOM, pCO<sub>2</sub>, and TCO<sub>2</sub> time series data. These data will be collected at the newly constructed Hatfield Marine Science Center (HMSC) Climate Monitoring Station and shared near real-time via a public exhibit in the Oregon Sea Grant Visitor Center. Necessary oceanographic monitoring instrumentation has been ordered with a goal of having them on hand by the fall of 2022, with a space designed and designated specifically for collecting OA data. The research team is in the process of devising ideas for the public exhibit, developing communication strategies, and discussing ways to incorporate an OAH theme into other HMSC visitor center exhibits. **This project establishes a long-term OAH monitoring station in Yaquina Bay, a high-priority to strengthen Oregon's monitoring network, and will expose the public to scientific data collected in real-time through the HMSC visitor's center.**

*Bob Cowen (OSU), HB3114-OOST Project 3 (2022-2025)*

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

Oregon's bays are where river and ocean waters meet, mix, and create a special ecosystem that provides habitat and nursery grounds for many species. Rich eelgrass beds are particularly important and are thought to provide protection from changing ocean conditions and buffer from physical storms and chemical extremes. This project builds on previous research, using existing and publicly available data to develop a biochemical ecosystem model that will explore the interaction of ecological and hydrodynamic factors in delivering or mitigating OAH vulnerabilities. Once the model is developed and validated, eelgrass vulnerability to OAH, the potential future absence of eelgrass, and resulting OAH extremes in response to climate change will also be explored. **The results of this project will help us understand the interactions among OAH vulnerability, eelgrass abundance, climate change, and hydrography of Coos Bay.**

*Tarang Khangaonkar (University of Washington), HB3114-OOST Project 4 (2022-2024)*

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

Often, Oregon's estuaries include ports that act as cultural and economic centers on the coast. They are productive and beloved habitats that support recreational activities, fishing and mariculture, and nursery grounds for many species. The ODFW Shellfish and Estuary Assessment of Coastal Oregon (SEACOR) team was established in 2008 to document the shellfish and habitat of Oregon's estuaries and has been actively assessing these areas since. This additional one-time funding allows the team to double its effort during the 2022 field season, increasing the frequency of assessments and providing timely data during the current legislatively created Tillamook Bay clam management process (Senate Bill 1025; 2019). Under routine funding levels, the team is able to visit each of Oregon's estuaries once every ten years to conduct clam stock assessments and eelgrass bed mapping. **This project bolsters a long-term data series, including both biological and oceanographic measures in Tillamook Bay, one of Oregon's highest-priority locations for understanding ocean change.**

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

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

After massive losses of young oysters by mariculture businesses in 2007, a collaboration between Whiskey Creek Shellfish Hatchery and Oregon State University revealed that acidified waters, not disease as originally suspected, was to blame. Coastal waters are used by shellfish hatcheries to rear young oysters, but these waters are becoming too corrosive for this delicate life stage. This necessitates careful monitoring and adjustment of water conditions in rearing tanks. In 2009, Dr. Burke Hales developed the “Burke-O-Lator.” This instrument measures pCO<sub>2</sub> and dissolved inorganic carbon (DIC) at oyster hatcheries, such as the Whiskey Creek Shellfish Hatchery (WCSH), so that they can carefully control water chemistry in their facilities. HB3114 supports the ongoing long-term monitoring efforts at WCSH, including system maintenance, water sampling, and data analysis. To date, WCSH appears to be experiencing some of the highest observed CO<sub>2</sub> levels since monitoring began. **OA monitoring at WCSH is critical in order to maintain adequate water quality in the facility, to avoid problems previously experienced, and to support the continuation of Oregon’s production of juvenile oysters.**  
*Burke Hales (OSU), HB3114-OSU Project 2 (ongoing)*

### ***Ecological spotlight: Submerged aquatic vegetation (SAV)***

#### **What is SAV?**

SAV are rooted aquatic plants and seaweeds that grow underwater such as flowering seagrasses or kelp. On the Oregon coast, eelgrass beds are found throughout the State’s 22 major estuaries, while kelp forests form in cold, nutrient-rich water along the coast.

#### **Why are SAV important?**

SAV can provide water quality benefits, cultural resources, shoreline protection, nutrient cycling, and habitat that promotes biodiversity. Eelgrass beds serve as nursery habitat for many of Oregon’s commercially important species of fish and shellfish. Kelp forests support a range of species, from small zooplankton and forage fish to large marine mammals and seabirds. One acre of SAV is estimated to house up to 40,000 fish and 50 million invertebrates.

#### **What are the threats to SAV?**

A reduction in SAV habitat imposes additional challenges to the resilience of Oregon’s coastal marine ecosystems. Major contributors to the decline in SAV include climate change, warming water, harmful algal blooms, sea level rise, sedimentation, pollution, coastal development, and predator loss in the kelp forests.

#### **How do SAV interact with OAH?**

Considered an important source of “blue carbon”, these aquatic plants absorb CO<sub>2</sub> and release oxygen through photosynthesis. ***Promoting the restoration of SAV may serve as an important natural buffer against extreme ocean change and increase coastal resilience and sustainability.***



## Implementing the OAH Action Plan

### *Theme 2: Reduce Causes*

#### *Action: Develop and integrate strategies to reduce causes of excess carbon dioxide (CO<sub>2</sub>) and ocean acidification and hypoxia (OAH)*

Oregon is developing frameworks for action that reduce causes and co-stressors of OAH. It is a long-term goal of the OAH Council and the State of Oregon (per Executive Order No. 20-04 and Senate Bill 1025) that Oregon reduce CO<sub>2</sub> and greenhouse gas emissions and stressors to create a pathway towards a sustainable future. Governing bodies have committed to reducing causes of excess CO<sub>2</sub> and OAH through the development of policy initiatives that reduce greenhouse gas emissions while improving air and water quality. For example, the State is phasing in the implementation of clean fuel standards and clean fuel credits for electrification and is considering other ways to decrease our reliance on fossil fuel combustion. Efforts to reduce OAH impacts are integral to the health of coastal industries, such as tourism and fisheries, given that Oregon's natural resources are heavily dependent on the health of coastal and inland systems.

# Current Project Highlight

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

Per the Federal Clean Water Act (CWA) responsibilities, the Oregon Department of Environmental Quality (DEQ) is required to assess the condition of Oregon's waters and document water quality in the biennial Integrated Report, filed with the U.S. Environmental Protection Agency. In the 2020 Integrated Report, DEQ listed Oregon territorial (coastal) waters as an area of potential concern (category 3B) for ocean acidification and for hypoxia. A category 3B listing indicates that there is cause for concern, but either data and/or methods to assess data are insufficient to determine impairment.

Since that time, and consistent with publicly-vetted agency workload priorities, DEQ formed a technical workgroup to assist with developing science-based methodologies for assessing both ocean acidification and hypoxia. The technical workgroup is comprised of researchers from academic and scientific institutions, agency staff from USEPA, ODFW, and other subject matter experts who are recommending the appropriate and most meaningful metrics to employ for assessing potential water quality impairments. The OAH Council played an important role in identifying this work as a priority, assisting with identifying technical group participants, securing a Sea Grant fellow to support the workgroup, and participating on the technical group. Based upon input from the technical workgroup, DEQ will conduct a separate peer review process of the draft methodologies and also consider peer review comments in its adoption of new or revised assessment methodologies for future Integrated Reports.

**Developing OAH water quality criteria and assessment methodologies are critical management tools for Oregon to accurately assess, adapt to and/or mitigate ocean change. Multi-state and multi-agency participation in this process is likely to provide an important model for other states engaging in similar work.**



## 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***

To support Oregon’s thriving marine habitats and economies through current and future ocean changes, State agencies and local governments work to promote OAH resilience in management decisions. The OAH Council envisions continued collaboration between Oregonians, agencies, and industry members to identify and conserve Oregon’s commercially, recreationally, culturally, and ecologically relevant species. Building strong collaboration among key stakeholders is imperative to maximize resilience for the State’s natural resources.

By supporting community-driven climate resilience and adaptation measures, Oregonians from vulnerable coastal communities and industries will become part of the solution to help mitigate OAH impacts. For example, Oregon is leading the way by becoming the first U.S. state to integrate the benefits of blue carbon and submerged aquatic vegetation in coastal habitats, which help offset the cumulative impacts of climate change. The OAH Council continues its commitment to facilitating alignment and collaboration in the State on OAH and climate issues. However, the likelihood of future resilience to the impacts OAH is dependent upon continued and timely action.

# 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 study evaluates environmental interactions between shellfish and submerged aquatic vegetation (SAV), and how these interact with Oregon's existing policies, regulations, and management strategies. It also aims to identify how stakeholder groups perceive and envision the combined management of shellfish and SAV, and how these perspectives can be integrated into a best management practice (BMP) framework. The research team is working with existing information (established BMPs and study results) as well as building an advisory group with participants from across Oregon to guide the project. **This project will improve our understanding of how SAV can protect Oregon's shellfish, better inform management of estuarine habitats, and improve BMPs.**

*Melissa Ward (San Diego State University), HB3114-OOST Project 5 (2022-2024)*

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

This study, based in Yaquina Bay, examines the growth and composition of shells and tissue in native Olympia oysters, employing a method used for studying slow ecological processes. Additionally, the study will measure carbonate chemistry, salinity, temperature, and food quantity/quality throughout the bay. Environmental data will be synthesized to identify timescales and processes to understand the underlying causes and effects on Olympia oyster fitness, growth, and survival. These data will contribute to building a statistical growth model based on environmental variables. Researchers have conducted early boat survey work, trialed their flow-through seawater system, deployed juvenile Olympia and Pacific oysters at five sites throughout Yaquina Bay, and have conducted two successful surveys of surface water PCO<sub>2</sub>. **This project will further inform our understanding of oyster growth and survival under different environmental variables such as food quantity/quality and OA. Using this data, the scientific community will better understand oyster lifecycles in a changing ocean.**

*George Waldbusser (OSU), HB3114-OOST Project 6 (2022-2024)*

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## *Effects of OAH on Pacific oyster larvae* (OAH Action Plan Step 3.1)

This project investigates the effects of OAH on Pacific oyster larvae from select families derived from the Molluscan Broodstock Program (MBP) at Hatfield Science Center. Oysters that are most resistant to OAH impacts will be made available to the Whiskey Creek Hatchery in Netarts Bay. Researchers are currently building flow-through systems to expose larvae to consistent OAH conditions and expect to be finished by the end of 2022. Parent broodstock oysters have been genotyped and selected to produce larvae for the experiment in 2023. **This research contributes to the development of oyster strains that are more resilient to ocean stressors, including OAH. If successful, oyster farms would be able to maintain their production and avoid widespread die-offs in the future.**

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

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## Implementing the OAH Action Plan

### ***Theme 4: Expand Public Awareness***

#### ***Action: Communicate ocean acidification and hypoxia (OAH) science, impacts, and solutions to raise awareness and support decision-making***

Public awareness is key to unlocking broad engagement and creative problem-solving for tough issues. As such, the OAH Council has set a goal for increasing communication and accessibility of information on OAH science and policy to empower coastal communities to take part in building a more robust future. This future can only occur through clear, strategic communications that resonate with multiple stakeholder groups. Additionally, as Oregon continues to experience the impacts from OAH, it is vital that we acknowledge equity and environmental justice concerns related to ocean change in our actions and our communications. Many underserved communities in rural and urban centers are expected to be disproportionately impacted by climate and ocean change due to limited access to resources and information.

Community resilience relies upon understanding where vulnerabilities lie, then taking action to decrease those vulnerabilities through strategic planning and mitigation. We can benefit from complementing scientific knowledge with traditional ecological knowledge and experiential knowledge from those who are regularly out on the ocean. By fostering diverse partnerships of engaged and informed individuals (who understand OAH science, and are well-informed on mitigation, adaptation, and resiliency options), Oregon will stand on the best foundation in combating negative impacts from our changing ocean.

# Current Project Highlights

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

Ocean change is both complex to understand and communicate effectively. Success lies in the artful and simple extraction of essential information into digestible, factual units. This project engages a professional communications team to help Oregon talk about the science, problems, and potential solutions for ocean change in a way that motivates action and change. Using working groups and pilot-testing, the communications team is developing messages for targeted audiences, measurable success metrics, and a communications toolkit for the OAH Council and interested partners to use in communicating our work. The team will create an implementation plan outlining how to use these messages locally, regionally, and statewide. To date, the team has conducted front-end interviews and workshops with the OAH Council and working groups. **This project will help the OAH Council raise awareness about OAH through solutions-oriented messaging.**

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

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

Oregon Sea Grant, OSU, ODFW, and (starting in 2021) the OAH Council have hosted four Fishmen-Scientist OAH Roundtable sessions to facilitate a dialog about our changing ocean and support research collaborations that can generate an improved understanding of science and trends in Oregon. These roundtables have spurred multiple collaborative research projects, resulting in lasting relationships and benefits. Conversations at the 2021 and 2022 roundtable sessions resulted in a pilot-project effort to build a mobile device “Fishermen’s App”, which will allow fishermen and recreationalists to document their observations of unusual sightings at sea and share with their peers, scientists, and managers on shore. ODFW hosted a Sea Grant Summer Scholar in 2022 to begin a pilot project on this app. **Fisherman-scientist roundtables provide a communication channel to convey real-time changes in our ocean, particularly between at-risk industry leaders and scientists. Out of these roundtables, we are scoping a Fishermen’s app that could propel research forward by providing real-time insight into changes in ocean conditions.**

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## **State of the Coast panel discussions** (OAH Action Plan Steps 4.2)

The annual coastal meeting “State of the Coast” engages interested coastal community members in “hot topics” during an ocean-focused day of talks, workshops, and networking. Ranging from science to art to food, the meeting is cross-disciplinary and provides a great opportunity to gain new perspectives on current problems. The OAH Council has hosted sessions at both State of the Coast meetings during this biennial period. In 2020, the Council hosted a session on communicating the risks and impacts of OAH and climate change in ways that connect with Oregonians’ personal experiences. In 2021, the OAH Council brought commercial fishermen together in a facilitated panel discussion to share their observations on ocean change, the challenges they face, information needs, and ideas for collaboration. **These panels provided OAH information to impacted audiences including at-risk industries and coastal communities.**

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## Implementing the OAH Action Plan

# *Theme 5: Build Sustained Support*

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

Developing a long-term OAH coordination strategy among state agencies, academia, the federal government, and industries is central to Oregon’s ongoing success in combating ocean change and OAH. Leadership by the State’s elected officials has been invaluable for setting OAH science and monitoring goals as well as decision-making on policy issues. In turn, this leadership has been valuable regionally and nationally, providing a model for other governments. Oregon’s commitment to strong science-informed climate and ocean change policy has been demonstrated by directed funding under HB3114 to better understand OAH, mitigate its impacts, and increase ecological and economic resilience. There is no one-size-fits-all solution, and the advancement of scientific underpinnings of successful management will help us strategically design and implement solutions. Utilizing what we have learned and implementing scientific knowledge into proactive management programs requires adaptive effort and collaboration among numerous State and federal agencies.

# Current Project Highlight

## *2021 Multiagency Report on Ocean Acidification and Hypoxia (OAH) Programs and Needs* (OAH Action Plan Steps 5.1, 5.3)

To combat the near and long-term effects of OAH, it is essential that relevant state agencies have the authority to develop clearly defined goals and strategies to achieve Oregon’s adaptation and mitigation of climate and ocean change. These strategies will benefit community, economic, and ecosystem resilience. While OAH strategies have been incorporated into some aspects of agency planning processes, the 2021 Multiagency Report on Ocean Acidification and Hypoxia (OAH) Programs and Needs (the Report) is a landmark and novel collaboration among eight state agencies to describe existing and potential opportunities to integrate OAH into the day-to-day work of state agency programs. Specifically, the Report includes a section for each agency, addressing the following:

### *1. Authority and nexus with climate/ocean change*

A description of agency authorities, responsibilities and key policies that relate to OAH Program

### *2. Elements that relate to climate/ocean change and OAH Action Plan goals*

A description of current management strategies for each agency that relate to OAH

### *3. Opportunities for augmenting programs and actions*

An evaluation of potential enhancements in agency capacity to further prioritize OAH adaptation into agency programs and activities. Potential augmentation in science, monitoring, reducing stressors, resilience, education/outreach, and policy/regulation improvements.

For the OAH Council and eight Oregon agencies, the Report is an integral step in recognizing the State’s long-term goals to reduce OAH stressors and the importance of creating a pathway to socio-economic resilience. The ODFW Co-Chair of the Council led the development of the Report, orchestrating the thematic content, coordination, and collaboration among agencies. The Report identifies priority potential opportunities that would better prepare the State for future ocean change, thereby describing a potential roadmap to advancing Oregon’s climate and ocean change preparation. Additional information about progress on initiatives from the 2021 Multiagency Report on OAH Programs and Needs can be found in **Appendix C**.

**The OAH Council promotes an effective and efficient use of State resources through collaboration with sister agencies. By clearly articulating agency roles, programs and opportunities, the multiagency report approach promotes vital and well-coordinated OAH action, minimizing redundancy within state programs.**



# Noteworthy Milestones



*Increased OAH awareness has led to growing regional, national, and international mitigation efforts. The actions showcased here are of particular note for the State of Oregon, the West Coast (including British Columbia), and the nation to combat the ecosystem and socio-economic effects of OAH. In a recent milestone, the **U.S. has become a member of the International Alliance to Combat Ocean Acidification (OA Alliance)**, an international association of governments that are committed to addressing OA.*

## *Around Oregon*

***\*Oregon Climate Change Research Institute - Fifth Oregon Climate Assessment (2021):*** This biennial report disseminated the latest climate science and climate change effects on Oregon’s natural and human systems. Written by over 30 authors in state agencies, academia, and tribal groups, the Assessment discusses natural hazards of climate change and strategies to adapt to climate-related challenges. A chapter on ocean change reviews observed and potential impacts of ocean acidification and its impacts on local species.

***\*Oregon Climate Adaptation Framework (2021):*** This framework, updating and expanding an initial effort from 2010, is the product of public input and the work of 25 state agencies, with the goal of guiding state leadership and staff decision-making on response to climate change. The 4 OAH Council agencies served on the interagency working group and contributed to ocean change content that best reflects Oregon coastal communities’ unique needs for climate adaptation. The report urges the state to integrate climate and ocean change work into agency programs and business in a transformative, coordinated, and efficient manner. This second revision of the Oregon Climate Adaptation Framework outlines guiding principles to adapt and mitigate climate change, presents necessary administration actions, and describes collaborative strategies for state agencies to implement.

***Oregon Global Warming Commission (OGWC) – Natural and Working Lands Report (2021):*** This report recommended net carbon sequestration and storage goals for Oregon’s natural and working lands, in response to Executive Order 20-40. The OGWC stresses that natural and working lands must be a part of climate change action and can lead Oregon to becoming net carbon neutral. Specifically, the Report emphasizes the preservation and restoration of forested tidal wetlands due to their carbon storage potential and other ecosystem services. Following the OGWC recommendations would make Oregon a leader in carbon sequestration policy.

## *Around the region, nation, and globe*

***California Ocean Science Trust: Enhancing California’s Ocean Acidification and Hypoxia Monitoring Network (2020):*** This report by the California Ocean Protection Council Ocean Acidification and Hypoxia Task Force (Task Force); identifies ocean acidification as a key management priority for California. The Task Force recommends

increasing connections between chemical and biological OAH monitoring, improving OAH models, and adding monitoring effort into less represented areas.

**California Current Integrated Ecosystem Assessment (2022):** This annual report documents the connected and changing California Current Ecosystem by describing its biology, climate, physical, and social conditions. NOAA scientists and collaborators who work on the U.S. West Coast produce this report to support ecosystem-based management. This year's report highlighted widespread near-bottom hypoxia and upwelling that occurred in 2021 from Oregon to Washington.

**\*Pacific Coast Collaborative (PCC) – Climate Resilience on the Pacific Coast: Framework for Collaborative Action (2021):** PCC member governments of British Columbia, Washington, Oregon, and California created this framework to provide a climate resilience roadmap for the region. Emphasizing actions for regional resilience, the Framework recommends five near-term priorities including mainstreaming climate resilience into public processes and decision-making, utilizing natural and working lands for carbon sequestration, and analyzing the economic impacts of climate change and resilience.

**Cooperative Institute for Climate, Ocean, and Ecosystems Studies – Annual Report (2021):** This report highlights research projects, employees, and yearly activities from the Cooperative Institute for Climate, Ocean, and Ecosystems Studies (CICOES). CICOES promotes research collaboration between NOAA, the University of Washington, the University of Alaska Fairbanks, and Oregon State University.

**\*Coastal Management Journal (CMJ) Special Issue on Ocean Acidification (2021):** This special edition of CMJ has contributions from OA Alliance members, including an article by Oregon OAH Council Co-Chairs and staff on collaboration. The special edition details the partnerships made by a variety of state governments to increase scientific data and monitoring, disseminate information, and initiate political action.

**NOAA Ocean, Coastal, and Great Lakes Acidification Research Plan 2020 – 2029:** Created by nearly 70 federal researchers and academic partners, this plan includes regional and national research priorities, outlines current acidification research, and guides future science to understand the ecosystem-related impacts to commercial activities, subsistence and recreational fishing, tourism, and other social identifiers. This plan is in furtherance of the Federal Ocean Acidification Research and Monitoring (FOARAM) Act of 2009.

**\*International Alliance to Combat Ocean Acidification (OA Alliance) – Highlights, Impacts, and Progress Report (2021):** This annual report celebrates major achievements, details actions that supported climate-ocean leadership for members, and outlines the OA Alliance's objectives for the next three years. 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.

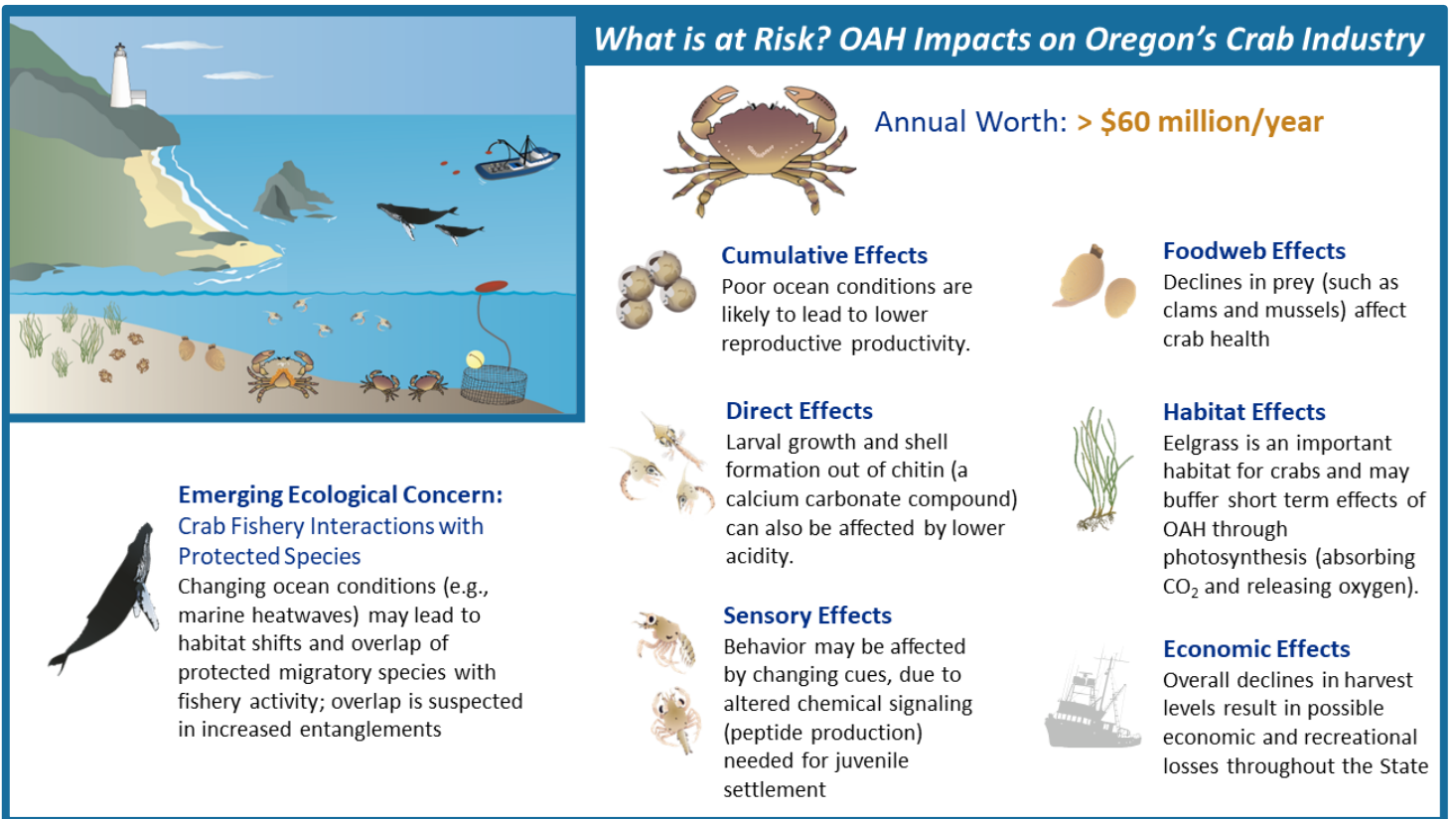
**The CHIPS and Science Act Subtitle E: Coastal and Ocean Acidification Research and Innovation (2022):** This Congressional Act reauthorizes the FOARAM Act through Fiscal Year (FY) 2027. After a lapse in FY 2012, NOAA will receive \$120.5 million, and the National Science Foundation will receive \$20 billion for OA-related activities from 2023-2027. This provision expands the definition of ocean acidification to include estuaries and defines coastal acidification to recognize mechanisms that cause changes in aquatic chemistry. This act will increase our understanding of the socioeconomic effects of ocean acidification and coastal acidification.

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

# Ocean Status Update

The ocean’s surface waters are currently at the lowest pH level (acidification) they have been in 23,000 years (World Meteorological Organization, 2021). In order to remain resilient as the impacts of climate and ocean change unfold, we must continue to act and do so through partnerships, coordination, and use of the best available science. This Ocean Status Update is intended to provide insight into the latest trends and science in OAH. Oregon’s cultural and economic history are strongly tied to the marine ecosystem, yet ocean change is occurring at a rate faster than our ability to understand and respond. Human communities and ocean industries will remain susceptible to the ongoing ecological and biological impacts of ocean acidification and hypoxia until we fully understand what is happening and how to address it.

Oregonians feel a strong connection to the ocean via the species that we have come to associate with a healthy ocean, that we rely on in our fisheries, and that are iconic to our way of life. Dungeness crab is a great example of a species that has been central to Oregon’s socio-economic activity and vitality for decades. **Figure 4** summarizes multiple ways that Dungeness crab are vulnerable to and/or impacted by ocean change, including impacts on crab biology, habitat, fishery economics, and ocean ecology. An emerging concern about crab fishery gear entanglements has led to a new understanding of how this complex management issue has come about, at least in part, due to ocean change (marine heatwaves) causing greater fishery overlap with federally protected migratory whale species in recent years.



**Figure 4.** The ecological, biological, and economic impacts of OAH on Oregon’s top marine fishery. Graphic image credits: Integration and Application Network ([ian.umces.edu/media-library](http://ian.umces.edu/media-library)).

**Table 1.** Species of concern in Oregon and status of our knowledge on their response to OAH. Peer-reviewed literature sources were evaluated to draw conclusions on **vulnerability** (impacts impair species function), **resilience** (impacts do not affect species function), **mixed response** (impacts are inconclusive between sources), or **data needed** (there is insufficient literature to draw a conclusion). Referenced literature is from the West Coast or California Current Region.



**Fisheries & Mariculture Species**

	Ocean Acidification					Ocean Hypoxia				
	● Vulnerable ● Resilient ● Mixed Response ○ Data Needed									
	Calcification	Reproduction, Growth, & Development	Physiology	Behavior	Survival	Reproduction, Growth, & Development	Physiology	Behavior	Survival	
<b>Shellfish</b>										
Dungeness crab	●	●	●	●	○	●	●	●	●	
Pink shrimp	○	○	○	○	○	○	○	○	○	
Red sea urchin	○	●	○	○	○	○	○	○	○	
Pacific oysters	●	●	○	○	○	○	○	○	○	
Olympia oysters	○	○	○	○	○	●	○	○	●	
<b>Groundfish</b>										
Black rockfish		○	○	○	○	○	○	○	○	
Copper rockfish		●	●	●	○	○	●	●	●	
Blue rockfish		●	●	●	○	○	●	○	○	
Cabazon		○	○	○	○	○	●	●	○	
Lingcod		○	○	○	○	●	●	○	○	
Sablefish		○	○	○	○	●	●	●	○	
Pacific whiting		○	○	○	○	○	○	●	○	
Pacific halibut		○	○	○	○	○	○	○	○	
<b>Salmon</b>										
Coho		○	○	○	○	●	●	●	●	
Chinook		○	○	○	○	●	●	●	●	
Steelhead		○	○	○	○	●	●	○	●	
<b>Tuna</b>										
Albacore		○	○	○	○	○	○	○	○	

**Other Key Species**

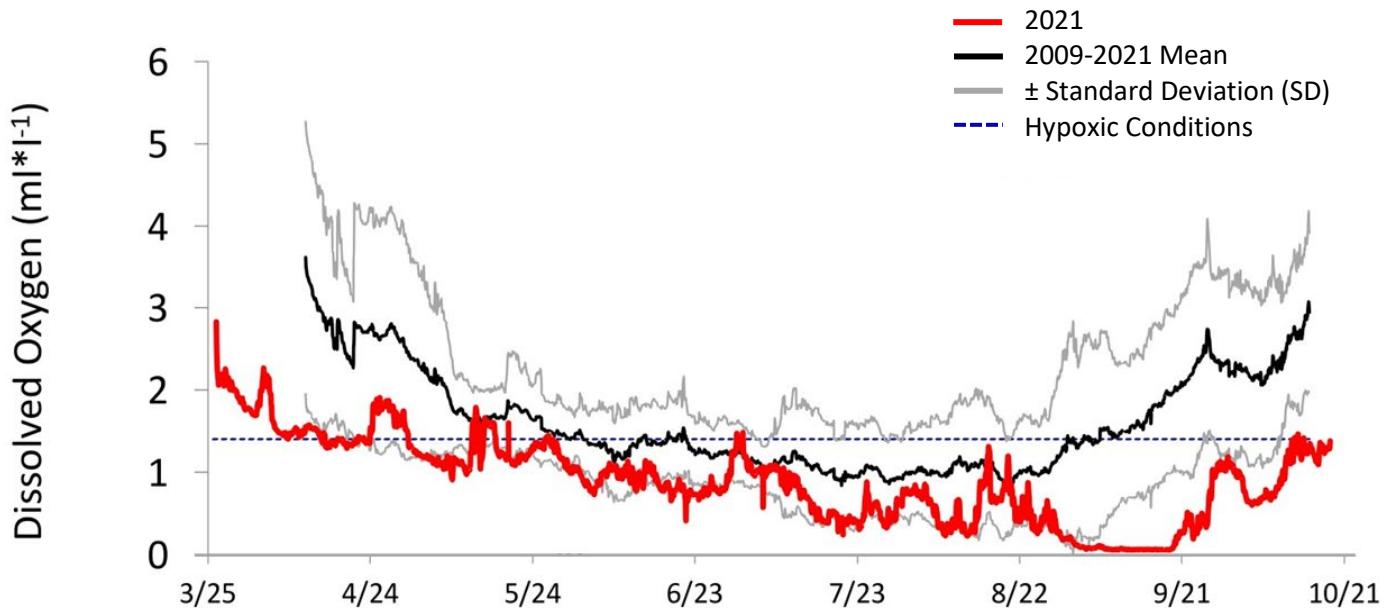
Pacific herring		○	○	○	○	●	○	●	○
Market squid		●	○	○	○	●	●	●	○
Krill	○	●	●	○	○	●	●	●	○
Pteropods	●	○	○	○	●	○	○	○	●
Red abalone	○	●	○	○	●	●	●	○	●
California mussels	●	●	●	○	○	○	●	○	●

## Ocean hypoxia

The Oregon coast has historically experienced annual hypoxic events near the sea floor and deeper areas of the continental shelf due to seasonal upwelling which brings water that is low in pH and oxygen from the deep ocean into nearshore waters in the summer. Like a forest wildfire season, Oregon's coastal marine ecosystems experience a "hypoxia season," which is linked to the timing of seasonal coastal upwelling. The intensity of hypoxic seasons is variable in that some years will be more severe than others. Oceans continue to absorb CO<sub>2</sub>, and upper ocean surface temperatures are rising. In turn, hypoxic events are exacerbated, leading to increased frequency, severity, and duration of OAH conditions that impact Oregon's ecological, cultural, and economic resources.

In the spring of 2021, a very early onset of spring upwelling triggered a hypoxia season and

stimulated early phytoplankton blooms (**Figure 5**). When the blooms die, sink, and decompose, they consume oxygen and release CO<sub>2</sub>, further intensifying OAH beyond the low values brought up by upwelling from the deep ocean. The long duration of an upwelling season, or an increase in upwelling intensity due to prevailing wind patterns, can cause a particularly strong drawdown of oxygen and low pH in bottom waters. This increases the potential for widespread "dead zones" when deep dwelling species that are stationary, or cannot quickly escape, perish due to oxygen deprivation. During the 2021 season, hypoxic water was detected only six miles offshore from Oregon and Washington. By mid-summer, the hypoxic water spanned 8,000 square miles and observed oxygen levels near zero; making it the earliest and longest hypoxic event compared to previous records.

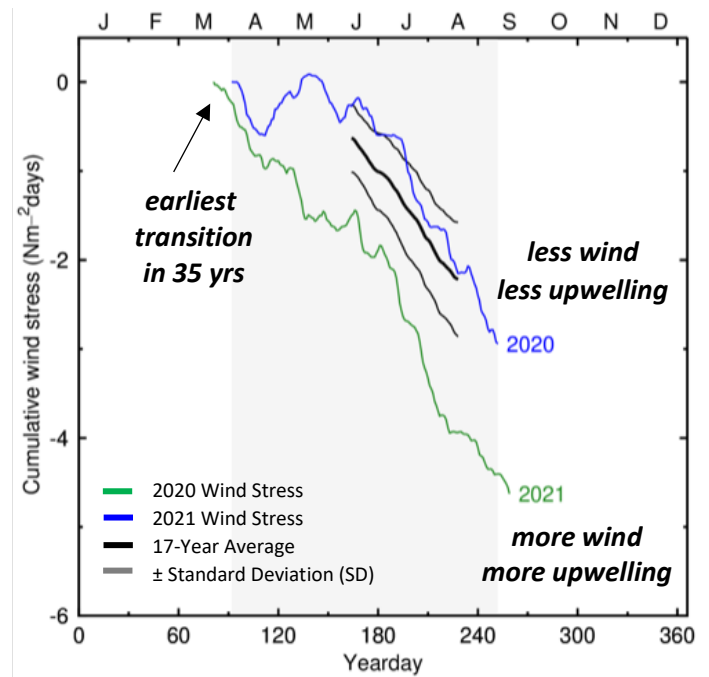


**Figure 5.** Dissolved oxygen concentration collected at Cape Perpetua Marine Reserve in 2021 (red) compared to 2009-2021 mean (black) ± standard deviation (grey) from March to October. Hypoxia is defined as waters with oxygen concentrations <1.4ml/L (blue), and is observed during the coastal upwelling season, especially during June-September. Credit: Francis Chan (OSU).

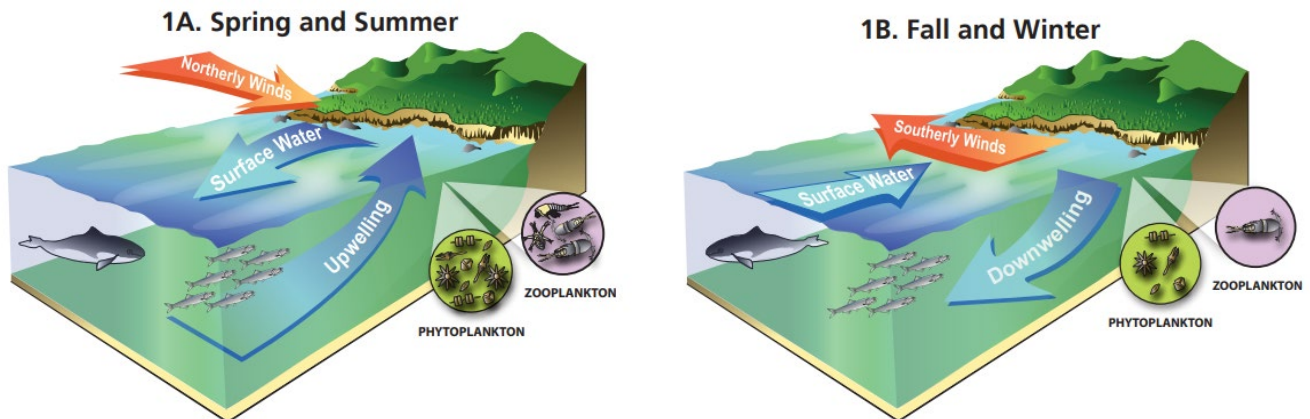
## Coastal upwelling

The process of coastal upwelling is initiated when strong winds blow southward (“northerly winds”) along the Oregon coast from April to September. Cool, nutrient-rich, CO<sub>2</sub>-rich, and oxygen-poor deep water from offshore is brought up to shallower depths on the continental shelf. This process stimulates phytoplankton blooms that form the base of the marine food web and contribute to Oregon’s productive fisheries. The onset of an upwelling season is marked by the spring transition, which represents the shift from predominantly northward moving winds in winter to southward moving winds in spring (**Figure 6**).

Ocean conditions that lead to hypoxia – including wind stress – vary year to year (**Figure 7**). In 2021, the shift to northerly winds in March initiated the earliest spring transition in 35 years. The long upwelling season duration resulted in the earliest recorded hypoxia season and caused widespread concern regarding the implications for coastal economies, especially for the Dungeness crab fishery. In a rare occurrence, low oxygen conditions also spread north into Canadian waters. Changing wind patterns and warming further exacerbate hypoxia due to increased stratification in the water column. When winds decrease (or “relax”), as they did several times in 2021, the upward movement of deeper water is subdued, which causes waters to become stagnant and intensifies the accumulation of low oxygen and high CO<sub>2</sub>. These intense upwelling-driven hypoxia events can disrupt fisheries, stock assessments, and can cause habitat shifts in a substantial number of Oregon’s marine species.



**Figure 7.** Comparison of annual coastal upwelling trends on the Oregon coast, showing extreme 2021 conditions compared to 2020 and the previous 17-year average ( $\pm$  SD). The spring transition is indicated by the start of each trendline at  $y=0$ . Upwelling intensity for a given year is indicated by consistent negative (southward moving) wind stress (steeper line slope). Periods of relaxation where hypoxia could be particularly bad are indicated by periods of minimal change in wind stress, which causes water to become stagnant. Credit: Jack Barth and Steven Pierce (OSU).



**Figure 6.** Transition process of seasonal coastal upwelling between A) Spring and Summer and B) Fall and Winter. Graphic Credit: Greg Krutzikowsky (ODFW).

# Moving Forward

## OAH Council benchmarks for 2022-2024

The projects on these two pages indicate the priorities for the OAH Council over the next two year period, from 2022-2024. These align with the OAH Action Plan, the Multiagency Report, and HB3114 funded projects.

### Research & monitoring projects

Action Plan step; in-progress projects	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"> <li>• <b>OAH monitoring at marine reserves</b> (HB3114-OOST Project 1-2)</li> <li>• <b>OAH monitoring in Yaquina Bay</b> (HB3114-OOST Project 3)</li> <li>• <b>Whiskey Creek monitoring program</b> (HB3114-OSU Project 2)</li> </ul>	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"> <li>• <b>Newport Hydrographic Line</b> (HB3114-OSU Project 1)</li> <li>• <b>Water Quality/Eelgrass, Coos Bay</b> (HB3114-OOST Project 4)</li> <li>• <b>Shellfish/Estuary Assessment</b> (HB3114-ODFW Project 1)</li> </ul>	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"> <li>• <b>SAV, shellfish, management</b> (HB3114-OOST Project 5)</li> <li>• <b>OAH-resilient oyster broodstock</b> (HB3114-OSU Project 3)</li> </ul>	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"> <li>• <b>Olympia oyster growth in Yaquina Bay</b> (HB3114-OOST Project 6)</li> </ul>	3.2	No
<p>“Develop Best Management Practices (BMPs) based on current ecosystem and economic research focused on Oregon’s estuaries and nearshore”</p> <ul style="list-style-type: none"> <li>• <b>SAV, shellfish, management</b> (HB3114-OOST Project 5)</li> </ul>	3.3	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"> <li>• <b>Continue participating in water quality criteria and development coordination</b></li> </ul>	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"> <li>• <b>Continue coordination on initiatives under the 2021 OAH Multiagency Report</b></li> </ul>	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 state holders and provide solutions-oriented messages on OAH science and impacts”</p> <ul style="list-style-type: none"> <li>• <b>Pathways Collaborative planning</b> (HB3114-OOST Project 7)</li> </ul>	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"> <li>• <b>OAH Symposium</b> (2023)</li> <li>• <b>Fisherman-Scientist Roundtables</b> (2023, 2024)</li> </ul>	4.2	Yes

## Long-term goals

The most apparent, long-term goals of the OAH Council include strategic planning and preparation for the 2025-2031 OAH Action Plan, 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 2022 OAH Report, this diverse body has completed 3 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 D**.



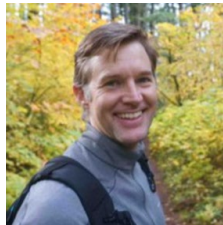
**DR. LAURIE JURANEK**  
Council Co-Chair  
Oregon State University



**DR. CAREN BRABY**  
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. CHRISTINE MOFFITT**  
Oregon Ocean Science Trust



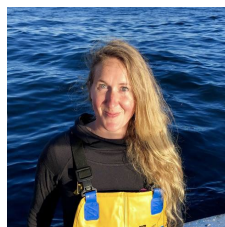
**DR. KARINA NIELSEN**  
Oregon Sea Grant



**FRAN RECHT**  
Conservation Organization Representative



**BOB KEMP**  
Fishing Representative



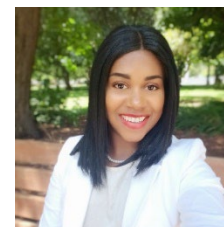
**KRISTEN PENNER**  
Shellfish Industry Representative



**DR. JESSICA MILLER**  
Academic Representative



**JOHN SCHAEFER**  
Tribal Government Representative



**AMIRA STREETER**  
Governor's Office Representative



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

*Dr. Jack Barth (OSU Co-Chair), 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-D

## **Appendix B: House Bill 3114**

## **Appendix C: Progress on initiatives from the 2021 Multiagency Report on OAH Programs and Needs**

## **Appendix D: OAH Council member biographies**

**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*



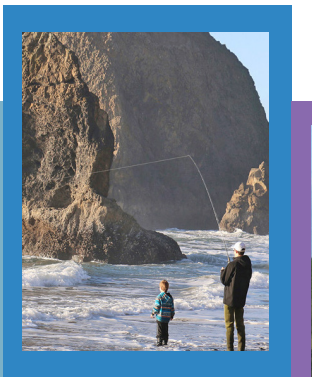
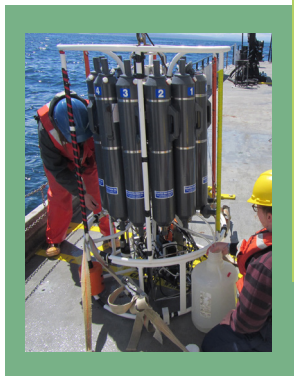
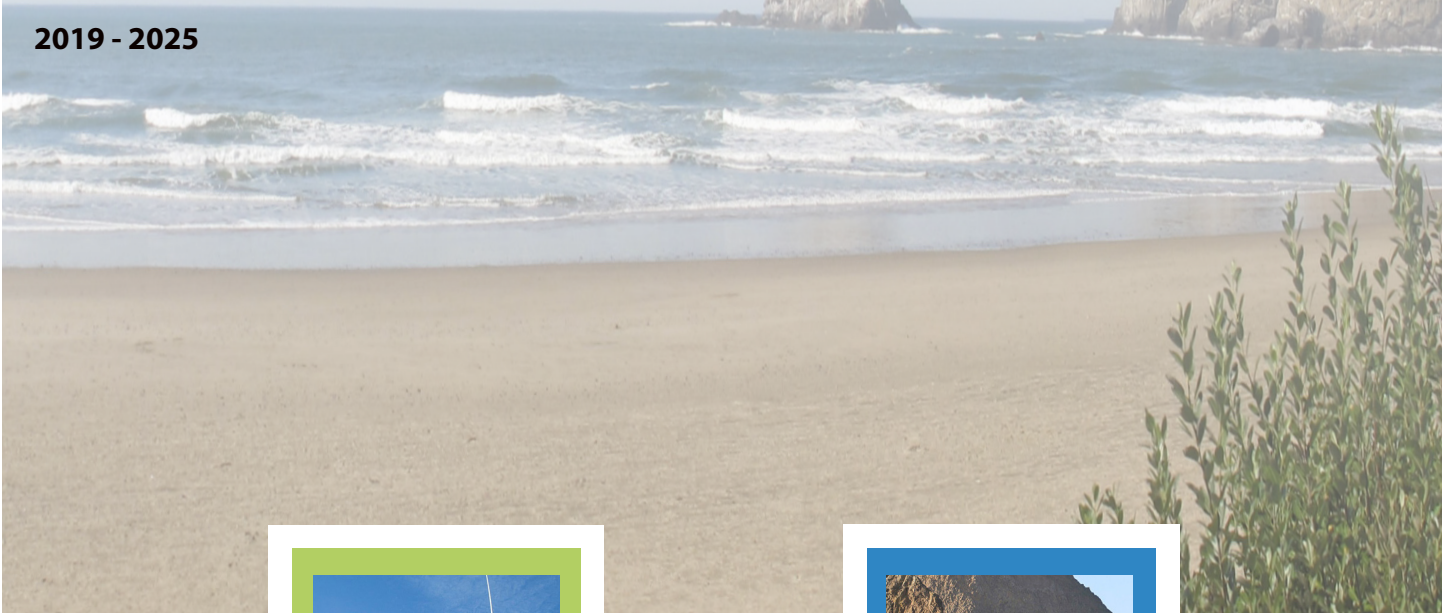
The Oregon Coordinating Council on  
Ocean Acidification and Hypoxia  
**SECOND BIENNIAL REPORT APPENDICES**





# *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](http://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

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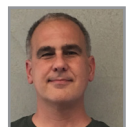
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**Oregon Coordinating Council on  
Ocean Acidification and Hypoxia**

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## 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](http://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 CO<sub>2</sub> and other causes of OAH

- Enhance local and global communication networks working on CO<sub>2</sub> reduction
- Support research on effective and efficient ways to reduce excess CO<sub>2</sub> and OAH stressors
- Implement measures to reduce excess CO<sub>2</sub> 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

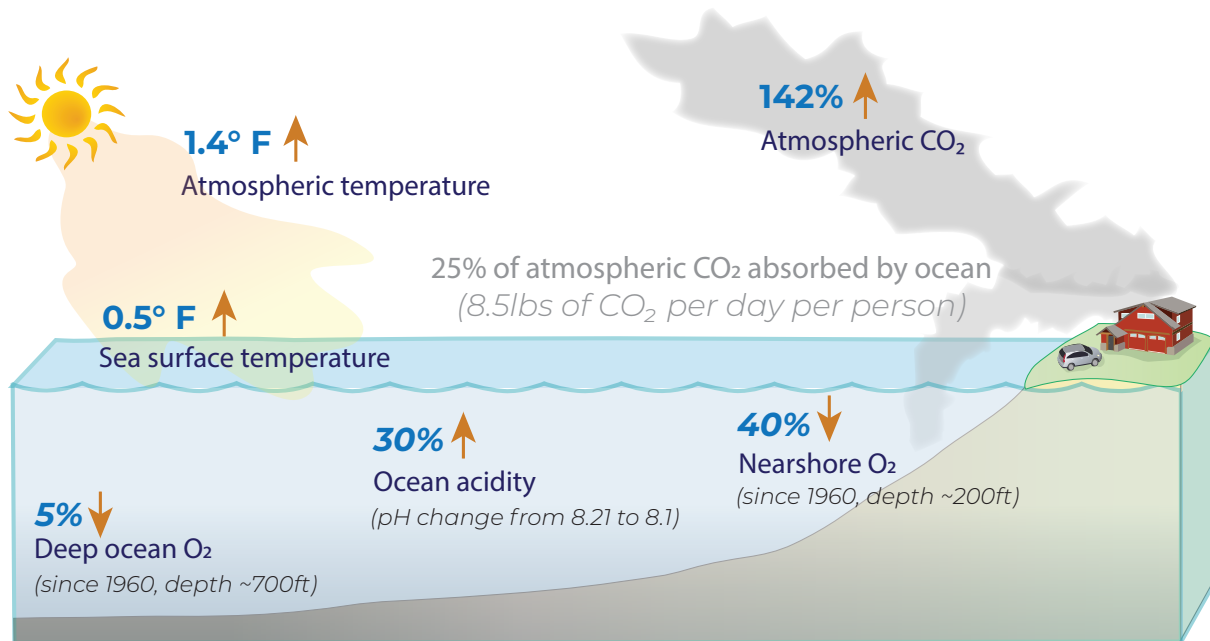
## Why is this OAH Action Plan Needed?

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 CO<sub>2</sub> 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](https://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?**

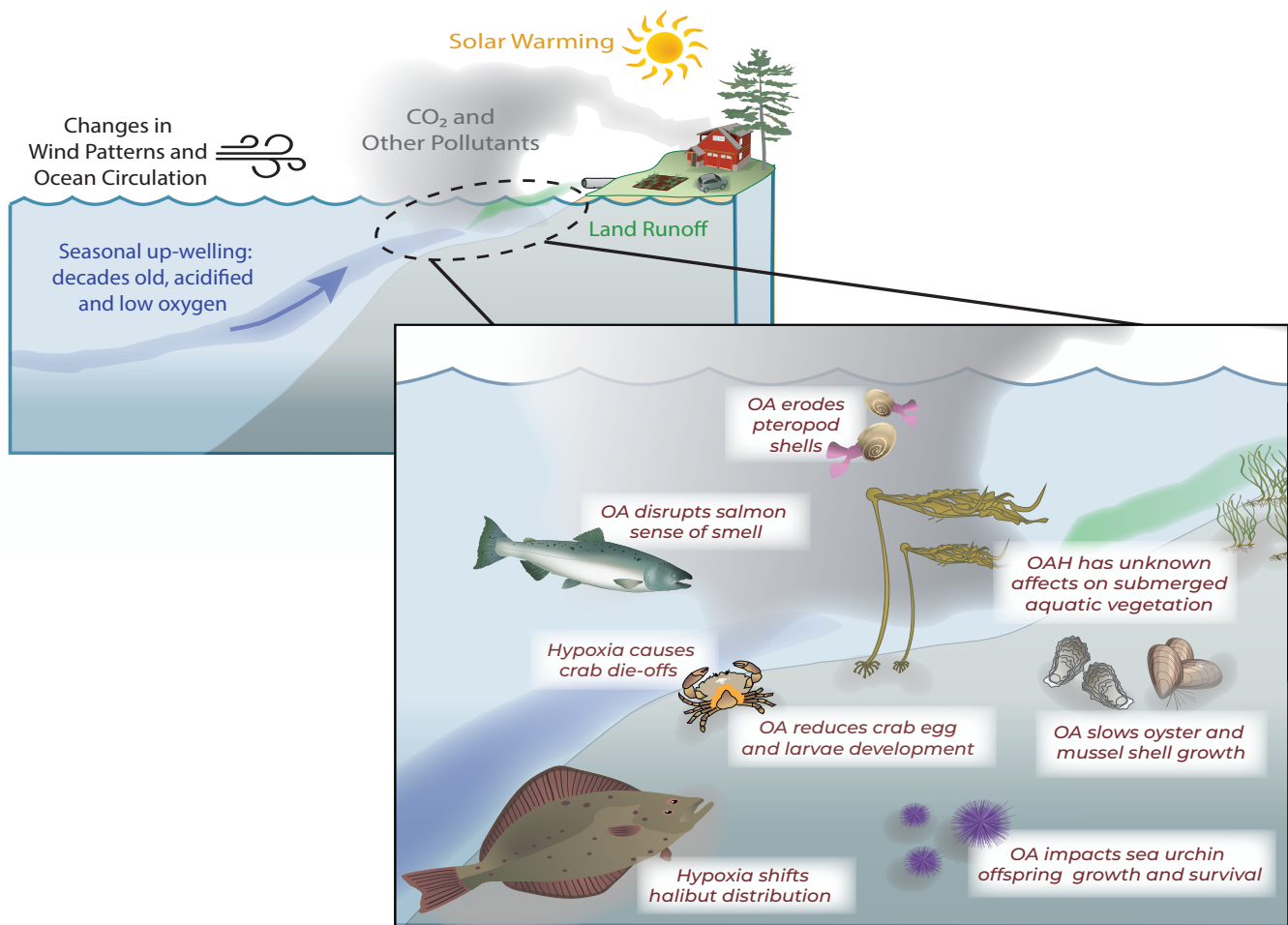
Fossil fuel combustion and related accumulation of **carbon dioxide (CO<sub>2</sub>)** and other greenhouse gases has led to climate change, ocean acidification and ocean deoxygenation (hypoxia). The earth’s oceans have absorbed 30% of the excess CO<sub>2</sub> produced from fossil fuel combustion since the Industrial Revolution (mid 1800s). When absorbed by seawater, CO<sub>2</sub> 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 CO<sub>2</sub> and OAH stressors simultaneously (see **Appendix B** for a description of Oregon’s actions of managing CO<sub>2</sub> 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 (CO<sub>2</sub>) 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).

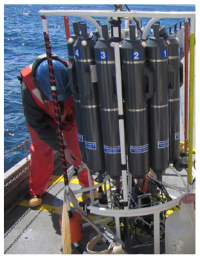
**Steps:** Specific measures to implement the action, including who will implement the step. Order of steps are not necessarily an implication of time sequence.

**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 (CO<sub>2</sub>) 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 CO<sub>2</sub> emissions than ocean acidification.”*

Charlie Plybon  
Ocean Policy Coordinator, Oregon Surfrider

### **VISION**

**Oregon measurably has reduced carbon dioxide (CO<sub>2</sub>) 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 CO<sub>2</sub> 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 CO<sub>2</sub> 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 CO<sub>2</sub> 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 CO<sub>2</sub> 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 CO<sub>2</sub> 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 CO<sub>2</sub> from marine waters through technological means, sequestration, or bioremediation (e.g., culture and harvest kelp, thus removing CO<sub>2</sub> 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 CO<sub>2</sub> from marine waters through technological means, sequestration, or bioremediation (e.g., culture and harvest kelp, thus removing CO<sub>2</sub> 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 CO<sub>2</sub> 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>

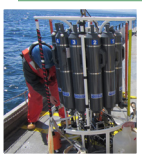


# Executive Summary

## 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 CO<sub>2</sub> and other causes of OAH

- Enhance local and global communication networks working on CO<sub>2</sub> reduction
- Support research on effective and efficient ways to reduce excess CO<sub>2</sub> and OAH stressors
- Implement measures to reduce excess CO<sub>2</sub> and OAH stressors in Oregon



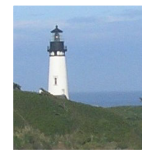
#### 3) Support resilience to OAH in Oregon's ecosystems and communities

- 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

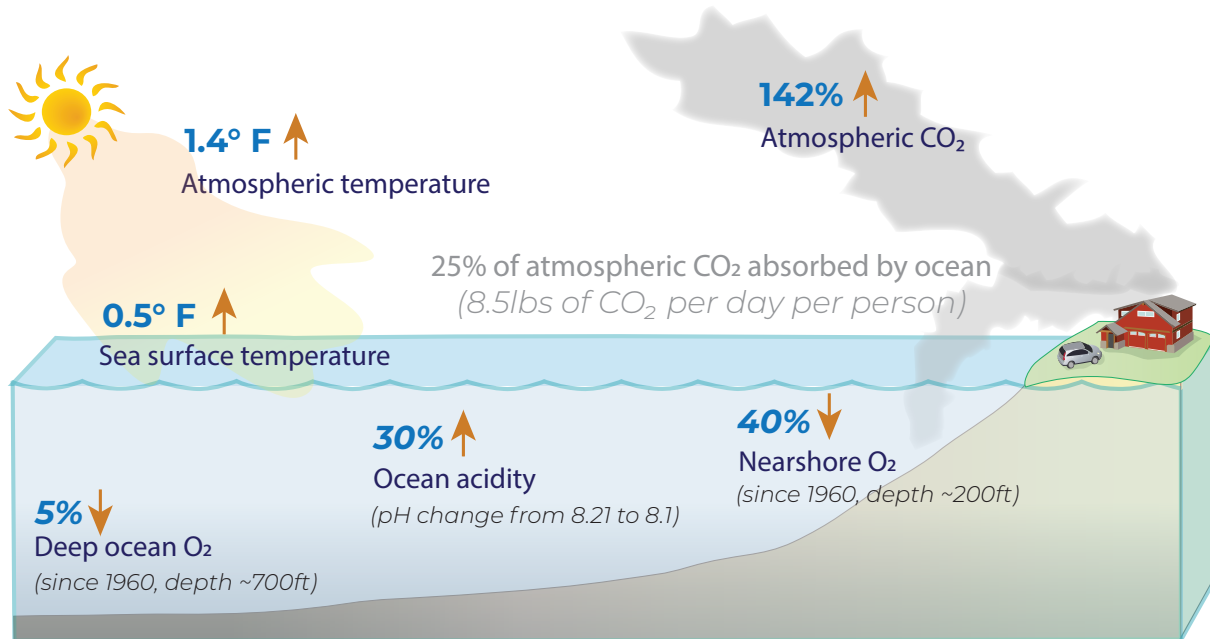
## Why is this OAH Action Plan Needed?

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 CO<sub>2</sub> 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](http://oregonocean.info/index.php/ocean-acidification)

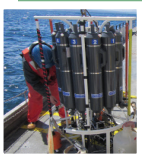


# Resumen Ejecutivo

## 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 CO<sub>2</sub> y otras causas de la AOH

- Mejorar las redes de comunicación locales y globales que trabajan en la reducción de CO<sub>2</sub>
- Apoyar la investigación de manera efectiva y eficiente para reducir el exceso de CO<sub>2</sub> y los factores estresantes de la AOH
- Implementar medidas para reducir el exceso de CO<sub>2</sub> 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

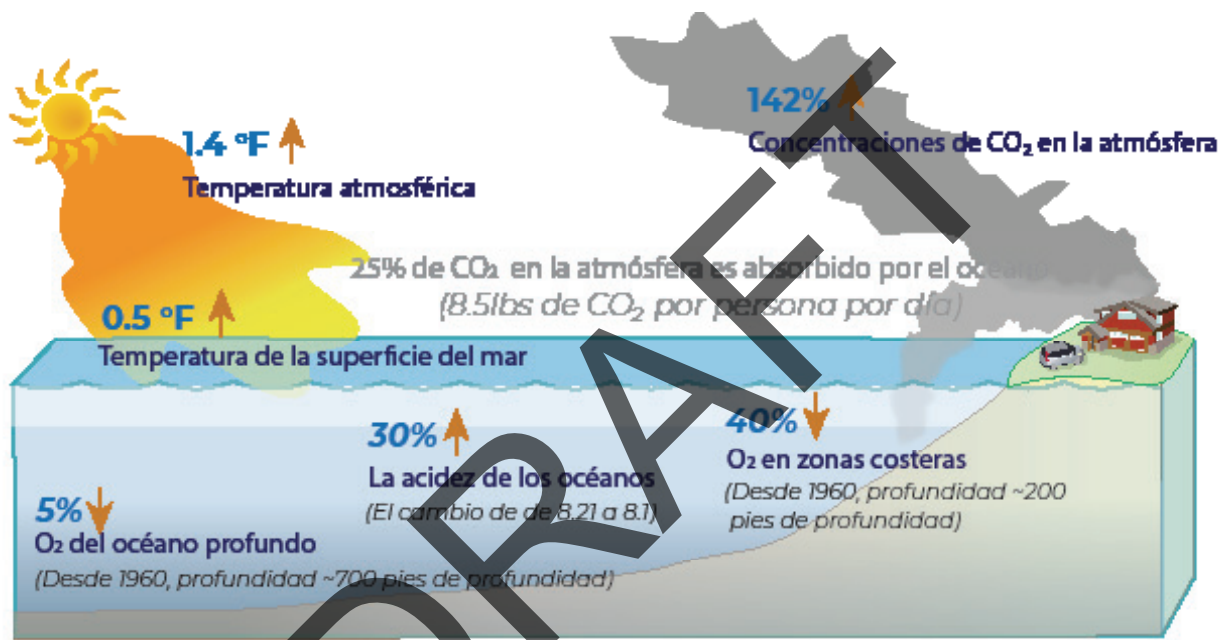
## ¿Por qué necesitamos este Plan de Acción sobre la AOH?

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 CO<sub>2</sub> 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.

**Créditos de la Imagen** - Varios gráficos en este documento fueron comprados o usadas a la cortesía de la Integración y Red de Aplicaciones, El Centro de Ciencias Ambientales de la Universidad de Maryland ([ian.umces.edu/imagelibrary/](http://ian.umces.edu/imagelibrary/))



**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](http://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 <sub>2</sub> 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 <sub>2</sub> 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](http://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 CO<sub>2</sub> directly. This appendix briefly describes the entities and responsibilities in Oregon (outside of the OAH Council process), that are addressing CO<sub>2</sub> adaptation and mitigation.

**Oregon has taken great strides to manage CO<sub>2</sub> emissions, understand the effects of climate change on our ecosystem and economy, and provide leadership across the West Coast and the globe on CO<sub>2</sub> 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](http://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

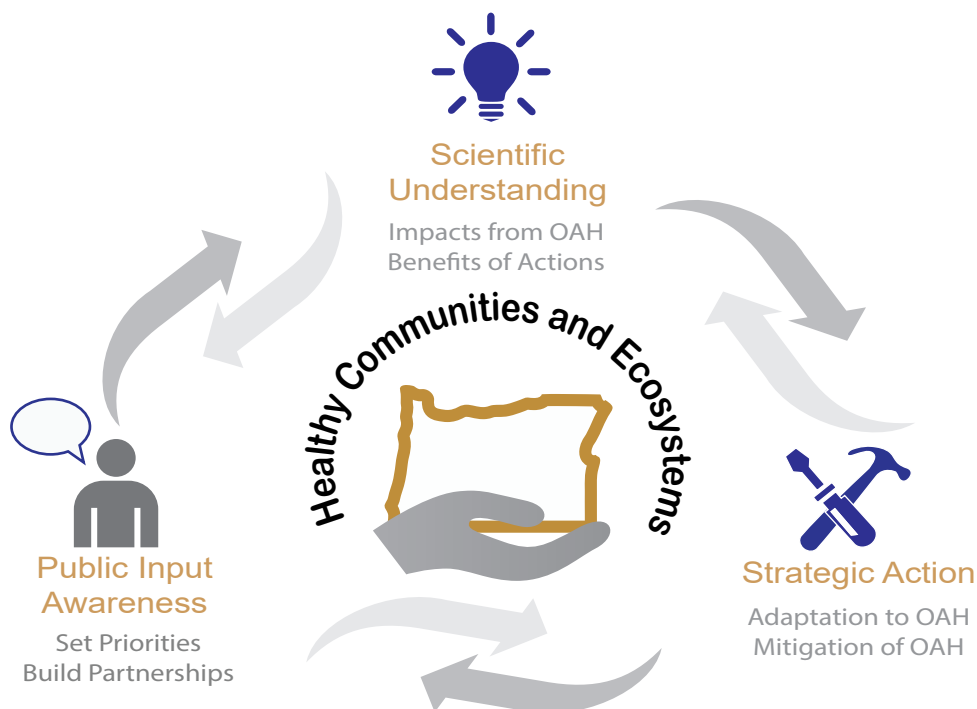
*(January 2018 – September 2018)*

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.

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

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# Appendix C

## Progress on Initiatives from 2021 Multiagency OAH Report

*The Multiagency Report on Ocean Acidification and Hypoxia (OAH) Programs and Needs (Feb 2021)* outlines existing programs and potential new initiatives to address OAH impacts for each of 8 Oregon state agencies. This report classifies agency programs and initiatives by themes in the Oregon OAH Action Plan, including *advance scientific understanding*, *reduce causes of OAH*, *create resilience and adaptation*, *raise awareness*, and *build sustained support*. More specifically, each agency described 1) *Agency authority and nexus with climate and ocean change*, 2) *Program elements that relate to climate and ocean change*, and 3) *Opportunities for augmenting agency programs and actions (initiatives)*.

*This appendix provides a brief review of the content of the [multiagency report](#), along with recent updates from each agency on progress made in launching initiatives, since early in 2021.*





## *Oregon Department of Fish and Wildlife*

### **Authority and nexus in climate and ocean change:**

The Oregon Department of Fish and Wildlife (ODFW) manages and protects Oregon's biological resources and acts as an authority on Oregon's diverse ecosystems, habitats, harvested species, non-harvested species, and the Endangered Species Act.

### **Program elements that relate to climate and ocean change:**

ODFW monitors Oregon's local ocean ecosystems and fish stocks, mitigates the impacts of ocean and coastal development, and addresses changing ocean conditions for fisheries and coastal communities. ODFW also communicates with the public about key ocean issues, including Ocean Acidification and Hypoxia, and coordinates adaptation and mitigation management actions in light of current and future climate changes.

### **Opportunities for augmenting agency programs and actions:**

ODFW aims to expand monitoring efforts for shellfish, harmful algal blooms (HAB), and nearshore biological change. The agency also intends to hire a climate-resilient fisheries specialist to develop and execute resilience strategies and a Climate Change Coordinator to develop and execute communications and outreach strategies.

### **Progress to date on initiatives:**

ODFW has made progress on all 5 initiatives listed in the Report, either in implementing new work or identifying and pursuing funding to begin the initiatives, with particular success in two initiatives related to ocean monitoring. First, augmentation of the shellfish assessment team was realized for a two-year period with funding from HB3114; the assessment team was in the field during 2022 in Tillamook Bay collecting co-located biological and oceanographic information that will be added to Oregon's long-term estuary ecology data sets. Second, ODFW has received a separate one-year grant from NANOOS, the regional ocean observing data portal, to conduct harmful algal bloom (HABs) sampling during 2023. ODFW will continue to seek long-term funding for HABs sampling, including strong potential through Recovering America's Wildlife Act (RAWA), if that passes Congress, as expected.

ODFW has also made some progress with the remaining 3 initiatives, including climate communications capacity, adding a nearshore biological change assessment team, and adding a climate-resilient fisheries management specialist. All three of these initiatives have been prioritized by the Department in strategic planning for RAWA funding and in policy option packages that will be considered by the Governor for inclusion in the Governor's Recommended Budget expected later this year. Together, these 3 initiatives would help ODFW raise awareness of climate and ocean change issues and solutions, greatly increase ODFW's ability to monitor nearshore species populations (both for documenting change and for fisheries management) and help ODFW build climate and ocean change strategies and resilience into our ocean fisheries management approach.



**Authority and nexus in climate and ocean change:**

The work of the Department of Land Conservation and Development (DLCD) impacts greenhouse gas emissions (GHGs) through planning, policy development, technical guidance for cities and counties, and implementing the state's ocean resources management framework.

**Program elements that relate to climate and ocean change:**

DLCD provides ocean and coastal services to coastal communities through Oregon's federally approved coastal zone management program. They also give technical expertise on transportation, growth management, natural hazards, climate change mitigation, and property rights as well as technical assistance to local governments and state agencies on urban and natural resource issues. DLCD also supports external communication, such as the Oregon Ocean Information Website.

**Opportunities for augmenting agency programs and actions:**

DLCD aims to assess OAH regarding the regulation and permitting of fish waste, incorporate an ecosystem evaluation framework into the Territorial Sea Plan, expand public web content about OAH, collaborate with local governments to strengthen OAH planning efforts, and revise Statewide Land Use Planning Goal to address climate change.

**Progress to date on initiatives:**

DLCD is participating in DEQ's OAH Water Quality working groups to discuss the establishment of state water quality standards that will form the basis for understanding ocean water quality health thresholds. Once adopted, those health measures can be used in federal consistency reviews of water quality discharge permits into state waters. Future efforts to incorporate an ecosystem evaluation framework into the Territorial Sea Plan will be informed by such work. DLCD continues to support the OAH Council website and communication efforts, continuing to leverage shared resources of DLCD and ODFW. Numerous projects are currently ongoing in collaboration with local governments to strengthen OAH planning, including completion of the adoption of Climate Friendly and Equitable Communities development rules which strengthen Oregon's system transportation and housing planning capacity. In 2021, DLCD coordinated the adoption of the new Oregon State Climate Change Adaptation Framework, a 10-year update that include more than 20 state agencies. A project to scope out the needs for incorporating climate change into the Statewide Land Use Planning Goals was initiated. DLCD is finalizing (after adoption by the Land Conservation and Development Commission) the Rocky Habitat Management Strategy. The Strategy recognizes the value of submerged aquatic vegetation (SAV) and limits disturbance to those habitats in the territorial sea and rocky intertidal zones via the adoption of new policies (Policies I, J, K, Q and R).

### Authority and nexus in climate and ocean change:

The Department of Environmental Quality (DEQ) administers state and federal laws designed to limit air, water, and land pollution to protect public health and the environment.

### Program elements that relate to climate and ocean change:

The DEQ Air Quality Division implements a variety of programs to reduce GHG emissions, communicate environment and climate science to the public, and coordinate with local, regional, and national levels to improve climate and environmental policy. The Water Quality Division has a variety of programs that support OAH monitoring, prevention and mitigation efforts, and is responsible for implementing Clean Water Act regulations to reduce pollution and establish restoration plans for waters not meeting water quality standards.

### Opportunities for augmenting agency programs and actions:

DEQ aims to establish and implement a greenhouse gas cap and reduce program, develop methodology to assess marine water quality for OAH, continue the Tillamook Bay Estuarine Monitoring Project, and increase capacity for TMDL development and implementation efforts. Providing secondary co-benefits to OAH, DEQ intends to address factors contributing to disapproval of coastal nonpoint program (CZARA), improve HAB prevention and risk reduction efforts, increase capacity for issuance and enforcement of wastewater permits, maintain DEQ Laboratory Infrastructure, and re-establish an onsite septic system repair/replace loan program.

### Progress to date on initiatives:

The department has made progress on multiple initiatives described in the 2021 report. DEQ established the Climate Protection Program (CPP), in accordance with Executive Order 20-04, to dramatically reduce and cap greenhouse gas emissions in Oregon over the next thirty years. Starting in 2022, the CPP sets a limit or “cap” on fossil fuel greenhouse gas emissions in residential and commercial settings using a best available emissions reduction approach. DEQ convened a technical workgroup to assist with and provide recommendations toward the development of OAH assessment methodologies. These recommendations will be used to develop a more robust assessment of marine dissolved oxygen and OA as part of the 2024 Integrated Report. DEQ was awarded a two-year Oregon Watershed Enhancement Board grant to study OAH in Tillamook Bay in coordination with Tillamook Estuaries Partnership (TEP). Collected data will be included in the Ambient Water Quality Monitoring System database, and a summary of results is set to be available in early 2023. Thanks to collaborations with the U.S. Environmental Protection Agency and TEP, long-term monitoring in Tillamook Bay will continue for the foreseeable future at the Garibaldi site. The 2021 Legislature established four new positions at the agency to develop and implement watershed restoration plans (TMDLs) for areas not meeting water quality standards. DEQ and DLCD, in coordination with other state natural resource agencies, have restarted discussions with the EPA and NOAA to address CZARA interim management measures and forestry gaps so federal agencies can approve Oregon’s coastal nonpoint program and fully restore associated grant funding. CyanoHAB monitoring and analytical testing capacity has been expanded to improve CyanoHAB detection and response efforts across the state. In partnership with Craft3, DEQ re-established the Onsite Loan Program and launched a new Onsite Financial Assistance Program that allocates funds to community partners to address failing septic systems in Oregon.

**Authority and nexus in climate and ocean change:**

The Oregon Department of Agriculture (ODA) Natural Resource Program is responsible for the development and implementation of management plans to prevent and control water pollution from agricultural activities and industries. They ensure cooperation from Oregon's local farmers and ranchers in order to ensure riparian and landscape conditions attain ODA's water quality standards and meet the agricultural pollutant load allocations assigned by DEQ.

**Program elements that relate to climate and ocean change:**

A primary initiative of ODA is to prevent and control agricultural water pollution, and is accomplished through multiple research, monitoring, and management actions. ODA completes the inspection and certification of shellfish mariculture and seafood with respect to changing ocean conditions and harmful algal blooms, considers and protects eelgrasses and native oyster beds when siting shellfish farm locations, and coordinates with multi-agency and stakeholder taskforces, councils, and groups to address ocean and climate change.

**Opportunities for augmenting agency programs and actions:**

ODA aims to expand research efforts to increase agricultural carbon sequestration and soil health in partnership with Oregon State University (OSU). The agency continues to implement ODA's climate change plan, expand water quality improvement work in strategic areas, improve early detection and rapid response to invasive aquatic species, and assist the shellfish industry in the development of new shellfish aquaculture sites.

**Progress to date on initiatives:**

Work is in progress to meet ODA's goal in the expansion of agricultural carbon sequestration and soil health. ODA entered into a contract agreement with OSU to study the Lower Umatilla Basin Groundwater Management Area (LUGBWMA), which aims to inform governing bodies of the hydrologic make-up of the LUGBWMA using existing data and its aquifer structure. ODA hired a soil health specialist to support the goals of the Fertilizer Program by supporting outcomes that 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.



## Department of State Lands

### Authority and nexus in climate and ocean change:

The Department of State Lands (DSL) Aquatic Resource Management Program conserves, restores, and protects Oregon's state waters and the ecosystem services they provide.

### Program elements that relate to climate and ocean change:

DSL implements research on coastal and estuarine regions to understand, adapt to, and mitigate OAH impacts. They support activities and initiatives that promote adaptation and resilience to OAH conditions, conduct research and education partnerships that support OAH research priorities, and develop policy to support OAH action.

### Opportunities for augmenting agency programs and actions:

DSL aims to support monitoring efforts at South Slough National Estuarine Research Reserve. The goal of these efforts is to develop a further understanding of OAH causes and impacts, support visiting researchers studying submerged aquatic vegetation (SAV) and continue monitoring and mapping eelgrass in South Slough. DSL is also focused on utilizing research to improve conservation efforts for salt marshes and eelgrasses, working to understand carbon sequestration potential of estuarine habitats, incorporating best available information into current DSL policies, and continuing to provide staff resources to state-wide ocean policy management efforts.

### Progress to date on initiatives:

In order to advance OAH monitoring, South Slough National Estuarine Research Reserve (SSNERR) collaborated on two OAH studies. These studies included a doctoral research project investigating the relationship between OAH and macrophytes, and a HB3114 – Oregon Ocean Science Trust (OOST) project focused on evaluating the interaction of water quality and eelgrass in Coos Bay. SSNERR is currently collaborating, providing support, and contributing data to ten research projects focused on eelgrass (*Zostera marina*) that contribute to increased eelgrass monitoring and mapping efforts. Similarly, SSNERR has conducted intertidal eelgrass abundance monitoring at four sites between 2004-2022, and is undergoing pilot projects to assess optimal eelgrass restoration methods and the feasibility of using Unmanned Aerial Vehicles (UAV) to map eelgrass beds. In collaboration with the CTCLUSI and the Coquille Indian Tribe, SSNERR conducted water quality monitoring at ten sites from 1995-2022, where a subset of the water quality network is managed through the NERRS System-Wide Monitoring Program and NANOOS. In March 2022, SSNERR also hosted an information exchange for the DSL Aquatic Resource Management Program's quarterly planning and policy meeting, which is hosted to share current reserve science and stewardship restoration project updates. DSL continues to provide staff resources to state-wide ocean policy management efforts including their work with SSNERR, hiring an Ocean Cable Policy Specialist to work with DLCD, and providing administrative support to the OOST.



## *Oregon Department of Forestry*

### **Authority and nexus in climate and ocean change:**

The Oregon Department of Forestry (ODF) commits to maintaining long-term water quality goals on non-federal forestland, which affects Oregon's coastal and oceanic landscape and marine ecosystems.

### **Program elements that relate to climate and ocean change:**

ODF ensures the long-term vitality of the state's forested ecosystems through science, monitoring, and carbon mitigation and storage. They also coordinate with additional state agencies on research, policy direction, and project implementation.

### **Opportunities for augmenting agency programs and actions:**

The goal of ODF is to complete and implement an aquatic habitat centric Habitat Conservation Plan (HCP) for State Forest lands and analyze riparian structure and function in western Oregon.

### **Progress to date on initiatives:**

Currently, ODF is modifying Oregon's forestry rules to aid in the creation of a Habitat Conservation Plan (HCP) that will meet the issuance criteria of an Incidental Take Permit under the Endangered Species Act. 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 were 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 updating the PFA are available for public comment as of September 1<sup>st</sup>, 2022, and is open for 30 days. When the comment period closes, the rules will go before the Board of Forestry on October 26, 2022, to be considered for final adoption. ODF staff will seek approval of the draft proposed HCP by the Board of Forestry in November 2022 and then present a proposed draft to the federal agencies by December 31, 2022.

Staff will prepare the final HCP and obtain the incidental take permit no later than December 31, 2027. ODF is no longer interested in creating a Forest Carbon Offset Program, preferring to allow the private sector to continue to grow and fill that space.

### **Authority and nexus in climate and ocean change:**

The Oregon Health Authority (OHA) seeks to understand the socioeconomic vulnerabilities associated with OAH and supports activities and initiatives that promote adaptation and resilience.

### **Program elements that relate to climate and ocean change:**

OHA is focused on reducing climate-related health risks while promoting Oregon community resilience. They also coordinate with academic institutions and state agencies regarding OAH socioeconomic impacts.

### **Opportunities for augmenting agency programs and actions:**

OHA aims to promote climate mitigation efforts that maximize health co-benefits, advance equitable climate adaptation through local, state, and tribal government collaborations, and expand environmental health capacity in the public health system. The steps will assist in identifying and addressing emerging threats to environmental health, as well as fostering a greater understanding of the effect on mental health. Lastly, OHA is focused on identifying the role of social resilience regarding a community's capacity to adapt and has incorporated increasing climate-resilience of local communities as a strategy in OHA's State Health Improvement Plan, *Healthier Together Oregon*.

### **Progress to date on initiatives:**

Currently, OHA is working to promote climate mitigation efforts that maximize health co-benefits by collaborating with the DEQ Climate Protection Program, Oregon Global Warming Commission Transformational Integrated Greenhouse Gas Emissions Reduction (TIGHGER) Project, and DLCD Climate-Friendly and Equitable Communities Rulemaking initiatives. The 2021 legislature adopted a budget for OHA in House Bill 5024 (HB5024) that included funding specifically for the public health system, comprised of local county public health authorities, Tribal health departments, community based organizations, and OHA to develop plans and strategies to build community resilience to climate risks. With its funding OHA has hired or will hire four additional climate specialists and data analysts to expand environmental health capacity in the public health system and deliver technical assistance to partners. To increase understanding of mental health effects on individuals, OHA published a study on Climate Change Impacts to Youth Mental Health in Oregon.

### Authority and nexus in climate and ocean change:

The Oregon Department of Energy (ODOE) is focused on the reduction of greenhouse gas (GHG) emissions that occur as a result of Oregon's use of energy, while also educating and raising awareness of the impacts and risks of climate change.

### Program elements that relate to climate and ocean change:

ODOE plays a vital role in energy education through a biennial legislative report, which includes information on energy's role in producing GHG emissions. The agency also produces the Oregon Global Warming Commission Reports that, among other things, track and evaluate the economic, environmental, health, and social impacts of climate change. ODOE also supports the development of efficient energy measures, the reduction of energy demand, cleaner energy technology, and policy initiatives.

### Opportunities for augmenting agency programs and actions:

ODOE aims to continue education on energy efficiency, clean energy, and climate change. They also aim to continue research and planning relating to climate change, and to continue administering programs that support energy efficiency and cleaner supplies of energy.

### Progress to date on initiatives:

The Oregon Department of Energy (ODOE) continues to make progress in the program areas it identified in the 2021 Multiagency OAH Report. As one high-profile example, the Oregon Global Warming Commission (staffed by ODOE) expects to complete its Transformational Integrated Greenhouse Gas Emission Reduction (TIGHGER) Plan work by the end of 2022. The TIGHGER Plan aims 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.

Since the 2021 Multiagency OAH Report, recent legislation has bolstered ODOE's work in identified program areas through new studies and additional incentive programs. The Floating Offshore Wind Study identifies the benefits and challenges of integrating up to 3 GW of floating offshore wind into Oregon's electric grid by 2030 (published September 15, 2022). The Renewable Hydrogen Study will report on potential benefits of, and barriers to, production and use of renewable hydrogen in Oregon (expected by November 15, 2022). In addition, the Small-Scale Renewable Energy Projects Study will examine opportunities to encourage the development of small-scale and community-based renewable energy projects that can contribute to economic growth and local energy resilience (expected by September 30, 2022). Furthermore, the Energy Efficient Wildfire Rebuilding Incentive, the Heat Pump Incentive Programs, the Community Renewable Energy Grant Program, and the Rural & Agricultural Energy Audit Program have allowed ODOE to amplify its work in identified program areas.

# Appendix D



## 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 2022 OAH Report, has completed three 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. During the past two years, the Council welcomed a new Council co-chair and seven new members. 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 an Associate 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 biogeochemical processes in the ocean. She enjoys working on complex oceanographic data sets and collaborating across disciplines with physical oceanographers and marine microbial ecologists.

#### Dr. CAREN BRABY – Oregon Department of Fish and Wildlife



Caren Braby provides strategic leadership on all things ‘ocean’ within the state of Oregon and across the West Coast, as the Manager of the Marine Resources Program for the Oregon Department of Fish and Wildlife. Her work is grounded in both fishery and ecosystem issues and is directed at facilitating and inspiring stewardship of ocean resources from the estuaries to the high seas. Caren and her staff build partnerships with industry, academic researchers, tribal governments, agencies, stakeholders, and elected officials to collaboratively define, and achieve, both economic and ecosystem resilience. In particular, changing ocean conditions (particularly OAH) have become focal points for Caren’s work over the past seven years. Caren received a Ph.D. in Biological Sciences from Stanford University in 2004.

# 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.

### **DR. CHRISTINE MOFFITT - Oregon Ocean Science Trust**



Christine retired to the Oregon Coast at Coos Bay after an active career in higher education and aquatic sciences research in the Pacific Northwest. She has held leadership positions in numerous scientific review boards, professional societies, and non-profit organizations. Currently, she serves as a member of the Oregon Sea Grant Advisory Board, the Oregon Invasive Species Council, the Oregon Ocean Science Trust, as well as a suite of local and regional organizations. She holds a Ph.D. in Fisheries Science from the University of Massachusetts, Amherst, a MA from Smith College, and BA from the University of California Santa Cruz. She is a strong supporter of science-based engagement and collaborative processes to increase understanding and communication regarding the challenges of coastal resources and communities.

### **DR. KARINA NIELSEN - Oregon Sea Grant**



Karina Nielsen is the director of the Oregon Sea Grant (OSG) program based at Oregon State University. OSG 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 on the board 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, 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.

### **JOHN SCHAEFER - Tribal Government Representative**



John Schaefer earned his B.S. degree from Oregon State University in biology and has acted as the water protection specialist and biologist for the Confederated Tribes of the Coos, Lower Umpqua & Siuslaw Indians (CTCLUSI) since 2015. As part of the Department of Natural Resources & Culture team, John represents the CTCLUSI natural resource interests at local stakeholder meetings and watershed councils. Prior to working for the tribes, John was shellfish biologist for ODFW for over ten years. He is a Coos Tribal member with interests in first foods and other cultural resources and is dedicated to preserving natural resources and creating local adaptation actions, in light of changing ocean conditions from OAH.

### **AMIRA STREETER - Governor’s Office Representative**



Amira Streeter is a member of the Governor’s Office Natural resources Team where she serves as the Natural Resources Policy Advisor. Her policy portfolio includes issues regarding agriculture, air and land quality, fish and wildlife, geology, sustainability, and environmental justice. She has extensive experience in policy, collaborative problem solving, and community engagement and empowerment. Before working in Governor Brown’s office, Amira built her career in the private and non-profit sectors. She holds a JD with certificates in environmental and natural resource law from Lewis & Clark University and bachelor’s degrees in Environmental Science and Dance from Skidmore College.