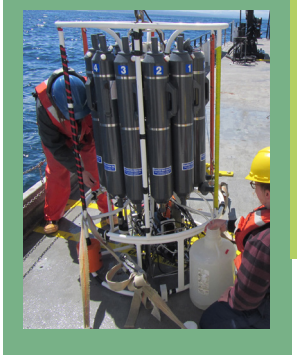
Oregon Ocean Acidification and Hypoxia

Action Plan

2019 - 2025



About this Document

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

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

For electronic copies of Oregon's Action Plan visit the OAH Council's website:
oregonocean.info/index.php/ocean-acidification

For printed copies of Oregon's Action Plan please contact:
Oregon Department of Fish and Wildlife • Marine Resources Program
2040 Marine Science Drive • Newport, OR 97365 • (541) 867-4741

KATE BROWN
Governor

August 19, 2019

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

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

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

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

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

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

Sincerely,

Kate Brown

Governor Kate Brown

GKB:jm,kl

254 STATE CAPITOL, SALEM OR 97301-4047 (503) 378-3111 FAX (503) 378-8970
WWW.GOVERNOR.OREGON.GOV

This document was prepared for the State of Oregon by the Oregon Coordinating Council on Ocean Acidification and Hypoxia, whose membership is:

Dr. John Barth, Co-Chair
Oregon State University

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

Frank Barcellos
Department of Agriculture

Jennifer Wigal
Department of Environmental Quality

Andy Lanier
Department of Land Conservation & Development

Dr. James Sumich
Oregon Ocean Science Trust

Dr. Shelby Walker
Oregon Sea Grant

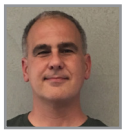
Fran Recht
Conservation Representative

Al Pazar
Fishing Representative

Liu Xin
Shellfish Industry Representative

Dr. Aaron Galloway
University of Oregon

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



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

Oregon Coordinating Council on Ocean Acidification and Hypoxia

Contents

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

Photo Credits - photos used in this report are open access and available for public use, as provided by: Oregon Department of Fish and Wildlife, Oregon Department of Transportation, Oregon Department of Parks and Recreation, Partnership for the Interdisciplinary Studies of Coastal Oceans, Oregon Sea Grant

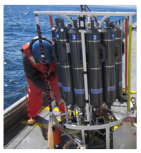
Graphic Credits - several graphics in this action plan were purchased or used with permission from the Integration and Application Network, University of Maryland Center for Environmental Science (ian.umces.edu/imagelibrary/)

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_2 and other causes of OAH

- Enhance local and global communication networks working on CO_2 reduction
- Support research on effective and efficient ways to reduce excess CO_2 and OAH stressors
- Implement measures to reduce excess CO_2 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

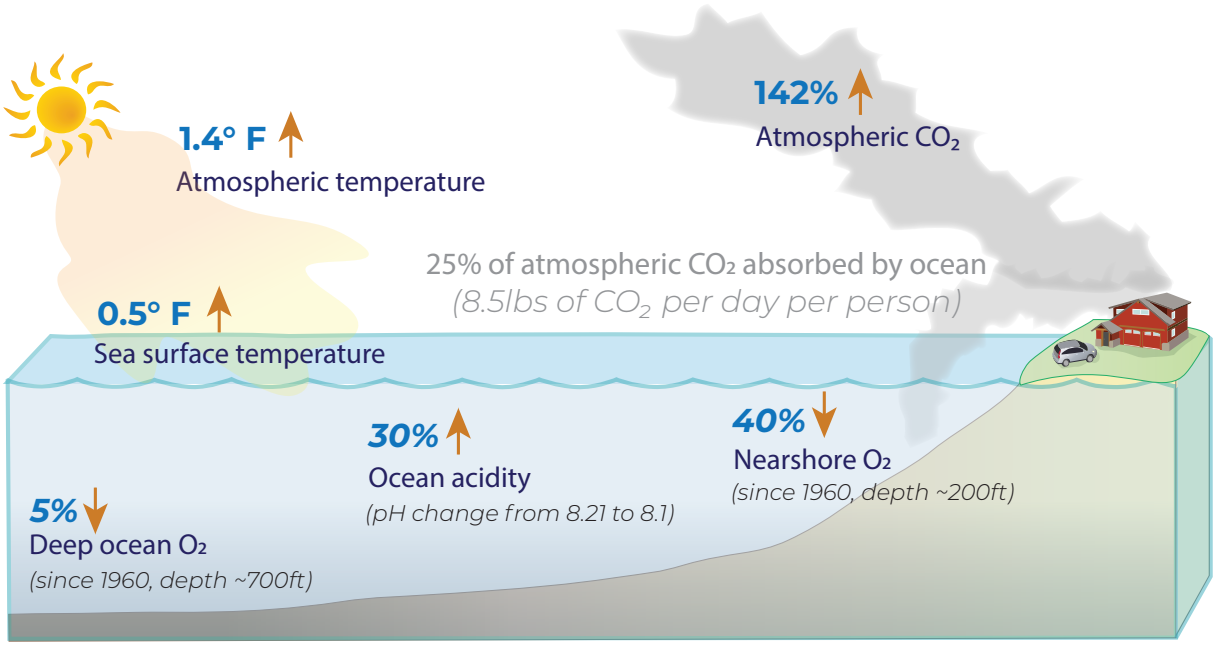
Why is this OAH Action Plan Needed?

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_2 and other greenhouse gases.**

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

Ocean Change since the Industrial Revolution *(Late 1800s)*



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

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

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

oregonocean.info/index.php/ocean-acidification

What is at risk in Oregon?

> ***"The cost of inaction to me is about how it is going to become a lot harder to address ocean acidification and hypoxia the longer we wait. Over time I think that we are going to start to erode what were good options as the ecosystems change. Then it becomes a situation of "coulda, woulda, shoulda"***
>
> Dr. Francis Chan
> Department of Integrative Biology, Oregon State University

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

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

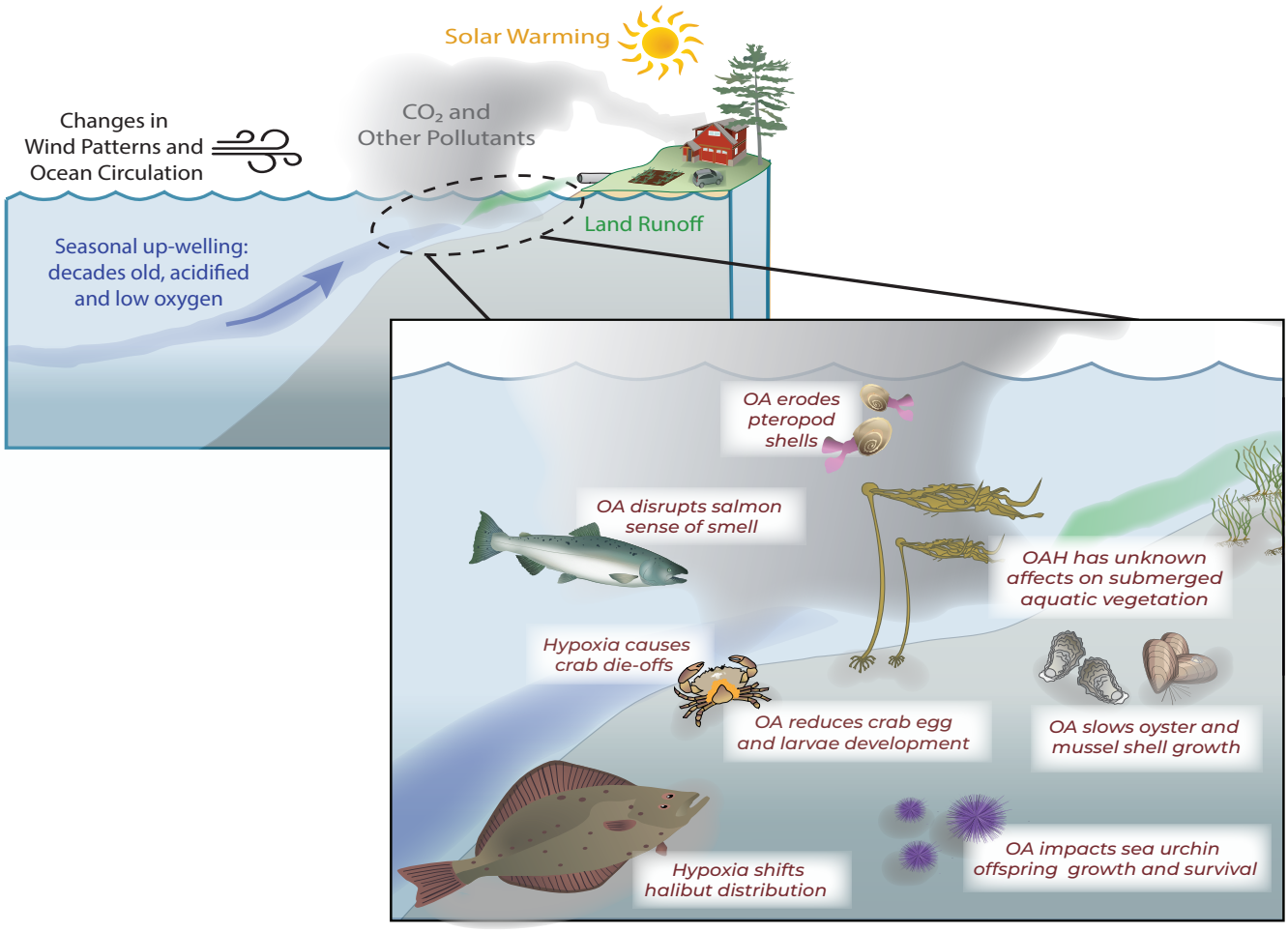
Fossil fuel combustion and related accumulation of **carbon dioxide (CO_2)** and other greenhouse gases has led to climate change, ocean acidification and ocean deoxygenation (hypoxia). The earth's oceans have absorbed 30% of the excess CO_2 produced from fossil fuel combustion since the Industrial Revolution (mid 1800s). When absorbed by seawater, CO_2 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_2 and OAH stressors simultaneously (see **Appendix B** for a description of Oregon's actions of managing CO_2 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_2) 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_2) 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_2 emissions than ocean acidification."

Charlie Plybon
Ocean Policy Coordinator, Oregon Surfrider

VISION **Oregon measurably has reduced carbon dioxide (CO_2) 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_2 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_2 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_2 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_2 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_2 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_2 from marine waters through technological means, sequestration, or bioremediation (e.g., culture and harvest kelp, thus removing CO_2 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. E**stablish research priorities to identify effective measures to remove excess CO_2 from marine waters through technological means, sequestration, or bioremediation (e.g., culture and harvest kelp, thus removing CO_2 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_2 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.

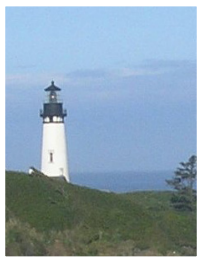
- The OAH Council develops communications evaluation tools to assess the OAH Council's outreach efforts and inform future outreach activities.
  (Start: 2021-2023 and continuing)

- 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.

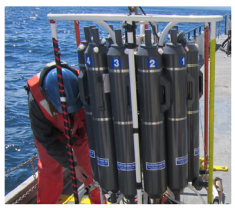
OAH Action Plan progress will be evaluated by the OAH Council based on the following factors:

- 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

Funding and Timeline

*Oregon OAH Action Plan - **Appendix A***

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

Start Year	Action	Step	Estimated Funding Needs
2019	2	1. The OAH Council works with the Governor's Natural Resource Office to establish regular communication and coordination pathways with state agencies and other State entities to address excess CO_2 and OAH stressors locally and globally.	--
	4	1. 1. The OAH Council convenes an advisory working group with regional education/ outreach specialists to identify OAH outreach needs.	--
	5	1. 1. Governor issues a 2019 policy, directing relevant state agencies to consider work they are doing and their plans to address OAH priorities in the context of this Action Plan: Agencies document both existing and needed programs and regulations.	--
	5	1. 2. Agencies propose anticipated needs in biennial agency budget development process, starting with agency budget proposals for the 2021-2023 biennium.	
	5	2. Governor's Natural Resources Office provides leadership, coordination, and policy guidance to agencies on OAH action priorities.	--
2019 - 2020	1	1. 1. Re-establish oceanographic monitoring to complement an historical time-series in Yaquina Bay.	*$50K-$200K (biennial costs)*
2019 - 2021	4	1. 2. The OAH Council develops a communications plan and outreach materials to meet the needs of diverse stakeholders and provide solutions-oriented messages on OAH science and impacts.	*$50K-$150K (onetime costs)*
2019 - 2025	4	2. 3. The OAH Council provides information in a variety of forms to impacted audiences including policy makers, at-risk industries, and coastal communities.	--
2020	4	2. 1. The OAH Council reports to the Oregon legislature on recommended OAH actions, through a biennial report (see step 1).	--
	4	2. 2. The OAH Council convenes "State of OAH" workshop for communities on OAH science, impacts, and solutions with policy makers as well as communities and at-risk industries.	*$25K-$100K (per workshop)*
2020 - 2023	3	1. 1. Allocate state funding for competitive grants and/or match to identify how to achieve ecosystem and economic resilience for Oregon.	*$200K-$300K (per project)*
	3	2. 1. Allocate state funding to support data collection, synthesis, and modeling to inform strategies that promote OAH resilient ecosystems: Develop maps to address the following information needs.	*$50K-$150K (onetime costs)*
	3	2. 2. Allocate state funding to support data collection, synthesis, and modeling to inform strategies that promote OAH resilient ecosystems: competitive grants and/or match to conduct ecosystem modeling.	*$200K-$400K (per project)*

Year	Action	Step	Estimated Funding Needs
2021	1	2. 1. Conduct a workshop to determine priority biological metrics for monitoring in Oregon coastal waters, including consideration of research results from regional partners.	*$25K-$100K (onetime costs)*
	3	1. 2. Industry and academics support continued research of resilient shellfish aquaculture strains.	*$200K-$600K (biennial costs)*
	5	1. 2. The OAH Council incorporates agencies' reports into ongoing development of recommendations to the State.	--
2021 - 2023	1	1. 2. Co-locate OAH oceanographic monitoring (intertidal and subtidal) alongside existing Marine Reserves biological sampling to leverage Oregon's existing research investments in Marine Reserves.	*$300K-$500K (biennial costs)*
	1	1. 3. Provide sustained funding for OAH oceanographic monitoring in Tillamook Bay.	*$50K-$100K (biennial costs)*
	1	1. 4. Support the maintenance of existing and installation of new climate grade OAH instruments in communities and at-risk industry locations.	*$100K-$200K (biennial costs)*
	1	2. 3. Augment on-going funding for the Newport Hydrographic Line to add biological and chemical OAH monitoring sensors and analysis to get the most value out of this existing monitoring program.	*$50K-$200K (biennial costs)*
	2	2. Fund competitive grants; funds could be used for match to attract additional investment or for full implementation); use outcomes to inform decision-making and future investments.	*$200K-$300K (per project)*
	2	3. Relevant state agencies implement measures to reduce excess CO_2 and OAH stressors.	*TBD*
	4	3. 1. The OAH Council develops communications evaluation tools to assess the OAH Council's outreach efforts and inform future outreach activities.	*$25K-$75K (onetime costs)*
2021 - 2025	5	3. State agencies implement measures to fill gaps, as described in agency OAH planning, in alignment with the Oregon Climate Adaptation Framework (2010), and with guidance from the Governor's Natural Resources Office.	*TBD*
2023	4	3. 2. The OAH Council revises outreach efforts and materials based on evaluation.	*$25K-$50K (onetime costs)*
2023 - 2024	1	2. 3. Augment Oregon Department of Fish and Wildlife's (ODFW) Shellfish assessment team to increase frequency and spatial scale of shellfish and submerged aquatic vegetation (SAV, e.g., eelgrasses) observations.	*$400K-$550K (biennial costs)*
	3	3. Agencies will develop Best Management Practices (BMPs), based on current ecosystem and economic research (as determined in Step 1) focused on Oregon's estuaries and nearshore.	*TBD*

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

oregonocean.info/index.php/ocean-acidification

Carbon and Climate Policies

*Oregon OAH Action Plan - **Appendix B***

The Oregon OAH Action Plan identifies problems and develops solutions to ocean acidification and hypoxia, a challenging consequence of global climate change attributable to anthropogenic greenhouse gas emissions. While Oregon's carbon footprint is only part of the global problem, Oregon is working to address emissions in a variety of ways that complement and reinforce our work on OAH. While the OAH Council developed the recommendations that led to this OAH Action Plan, other Oregon entities have the expertise on CO_2 directly. This appendix briefly describes the entities and responsibilities in Oregon (outside of the OAH Council process), that are addressing CO_2 adaptation and mitigation.

Oregon has taken great strides to manage CO_2 emissions, understand the effects of climate change on our ecosystem and economy, and provide leadership across the West Coast and the globe on CO_2 emissions policy.

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

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

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

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

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

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

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

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

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

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

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

oregonocean.info/index.php/ocean-acidification

Action Plan Development Process

Oregon OAH Action Plan - ***Appendix C***

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

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

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

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

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

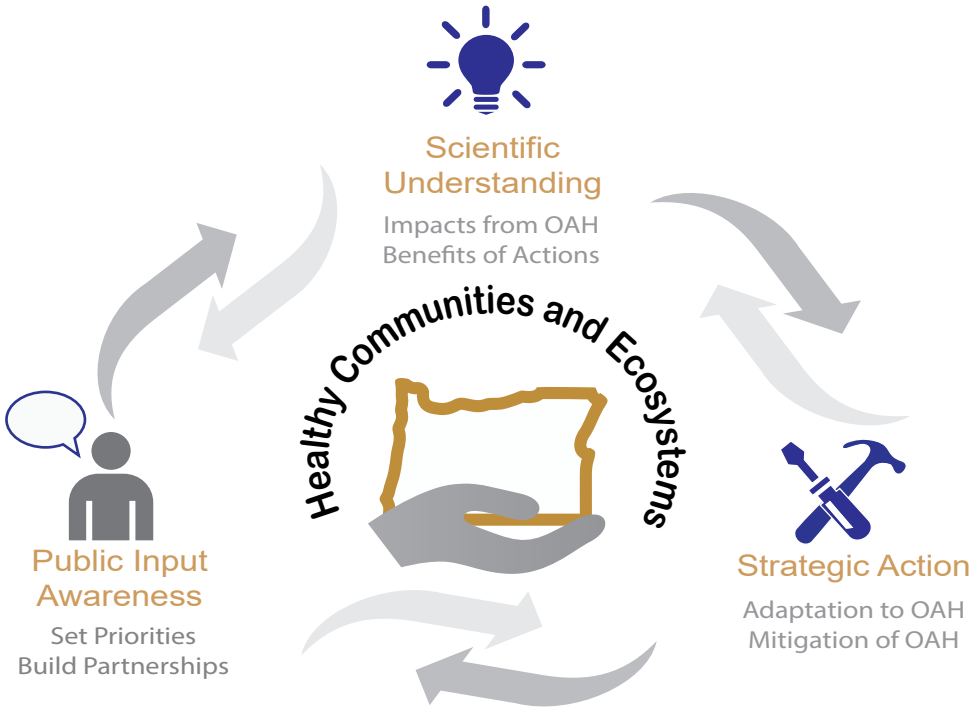
Oregon OAH Council and 2018 Report

(January 2018 – September 2018)

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

Prioritization of OAH Actions
(December 2019)

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



Oregon OAH Community Survey
(February 2019 – April 2019)

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

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

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

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

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

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

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

Draft OAH Action Plan Public Comment Period

(June 2019 – July 2019)

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

RECORDED WEBINARS OCCURRED ON:

June 11th 6:00pm – 8:00pm
In person at Oregon Department of Fish and Wildlife, Newport, and remote

June 14th 10:00am – 12:00pm
In person at Oregon State University, Corvallis, and remote

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

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

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

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.

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

oregonocean.info/index.php/ocean-acidification

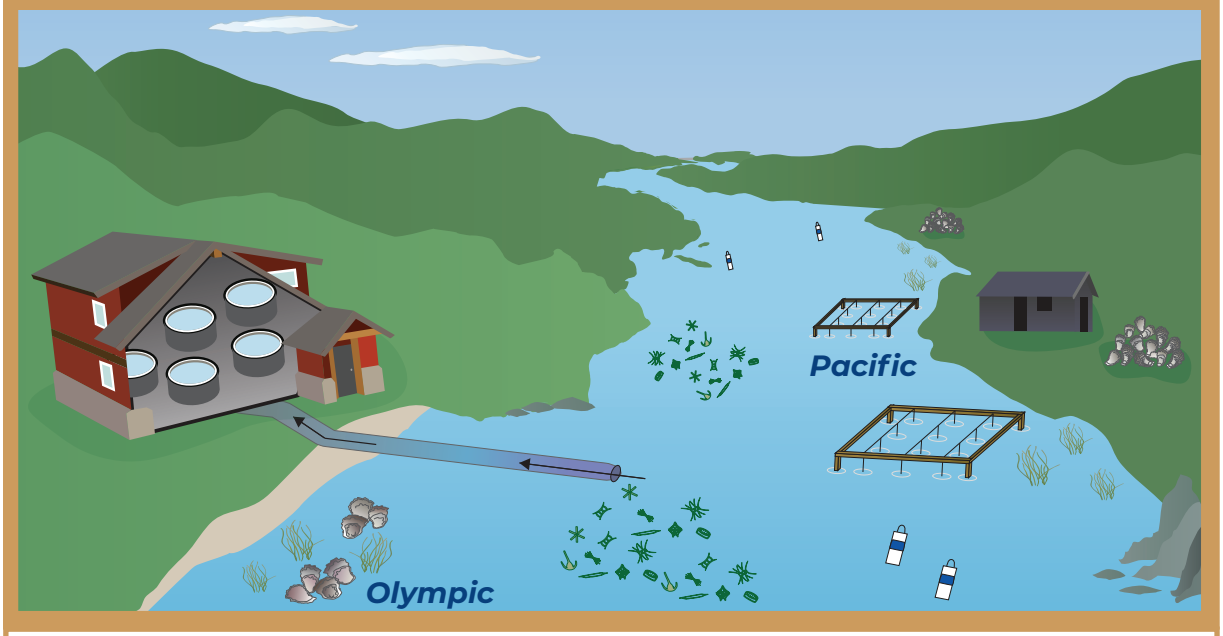
Oregon's Coordinating Council on
Ocean Acidification and Hypoxia

Species Spotlight

Olympic and Pacific Oysters

Ocean Acidification (OA) and Hypoxia (H) are harmful to ocean life and the economic stability of the Oregonians who rely on a healthy ocean. Olympic oysters (native) and Pacific oysters (cultured) provide important ecological and industry opportunities throughout coastal Oregon.

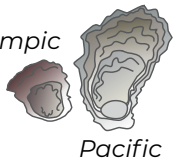
What is at risk?



Habitat Effects

Eelgrass, habitat for Olympic and Pacific oysters, may buffer short term effects of OAH through photosynthesis (absorbing CO_2 and releasing oxygen).

Cumulative Effects



Small changes in pH make a large difference in growth conditions, which could affect Olympic and Pacific oysters throughout their life.

Direct Effects

Larval growth and calcium carbonate shell formation in Olympic and Pacific oysters are lowered by OA.

Hatchery Effects

Pumped seawater used in hatcheries now must be chemically modified to reduce the effects of OAH on larval Pacific oysters.

Foodweb Effects

Species shifts in phytoplankton, feed for Olympic and Pacific oysters, may occur with changing ocean conditions.

Economic Effects

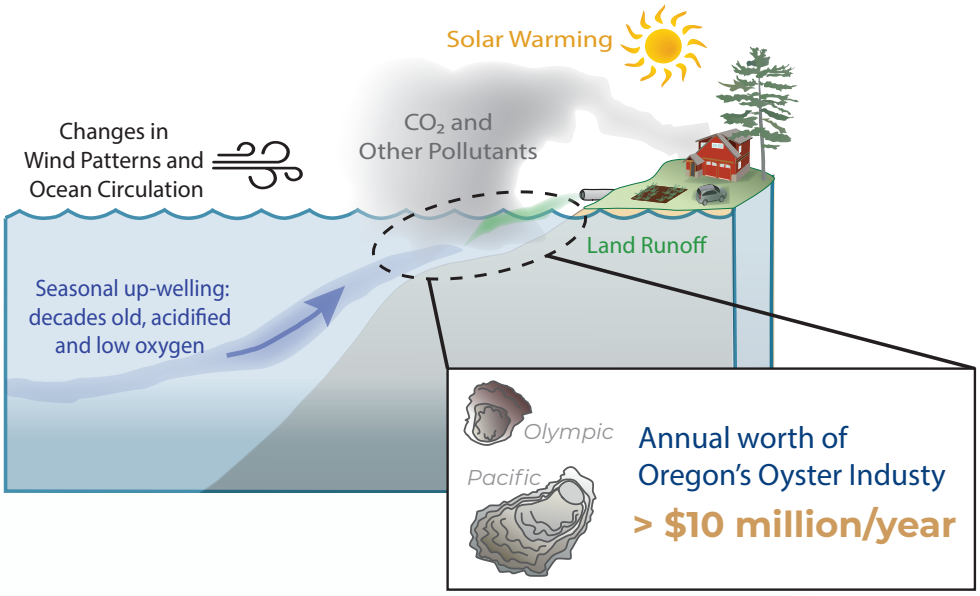
With declining larval supplies, Pacific oyster farmers may experience declines in production.

What is OAH?

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_2 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!**



The earth's oceans have absorbed 30% of the excess CO_2 produced from fossil fuel combustion since the Industrial Revolution (mid 1800s). When absorbed by seawater, CO_2 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.

Support Action!

Ocean Acidification and Hypoxia (OAH) will not stop on its own, and actions must be taken by regional and national governments, communities, and scientists now in order to address the growing problems. Through coordination and collaboration, such as through the **Oregon OAH Action Plan**, Oregon will be able to adapt and mitigate the effects of OAH. Solutions are needed to help Oregon's wild fisheries and marine resources withstand the projected changes in OAH.

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

oregonocean.info/index.php/ocean-acidification

Oregon's Coordinating Council on Ocean Acidification and Hypoxia

Species Spotlight

Salmon

Ocean Acidification (OA) and Hypoxia (H) are harmful to ocean life and the economic stability of the Oregonians who rely on a healthy ocean. Salmon are one of the favorite pursuits of Oregon's recreational and commercial anglers, as well as being an essential cultural resource Northwest tribes.

What is at risk?

Habitat Effects

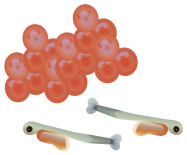
Changes in OAH can not only affect oceans but are also experienced in estuarine and river environments.

These environmental effects have carryover into all aspects of the Salmon life cycle.

Foodweb Effects

Pteropods (marine snails) are key prey, whose shells are sensitive to OA and are pitted by increased acidity.

Cumulative Effects



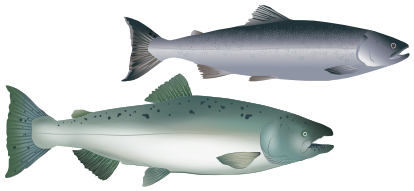
Early Salmon life stages' survival could be altered as a result of material diet changes due to OAH.

Direct Effects

Juveniles may experience reduced growth rates, which can increase the risk of predation.

Sensory Effects

Signaling in brains can be disrupted, causing fish to possibly not recognize prey, predators, or migration cues.



Economic Effects

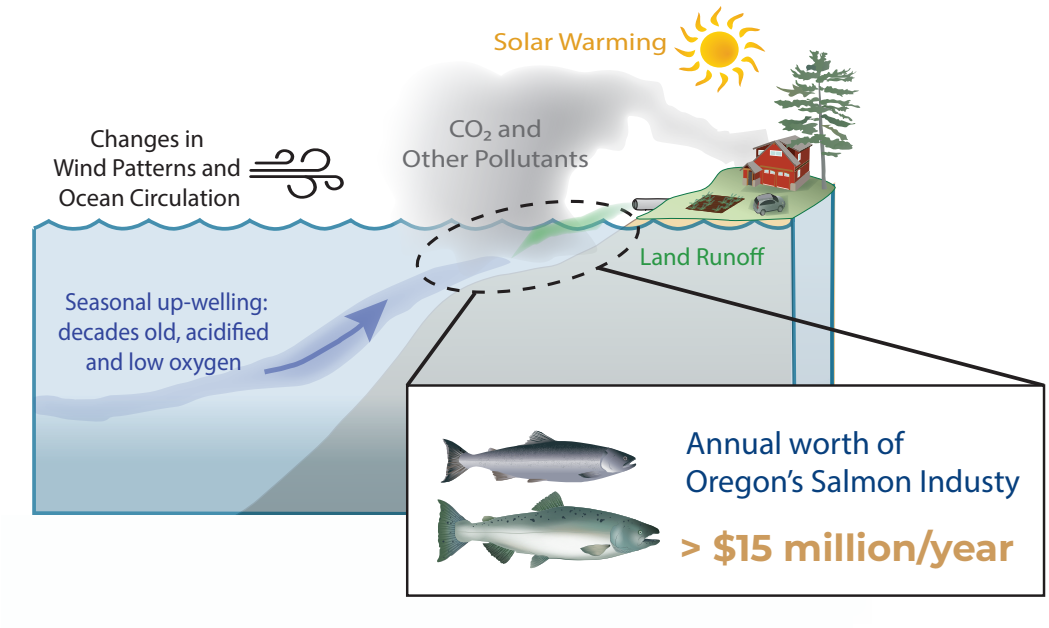
Fisheries managers and researchers are not certain how OAH effects may compound across Salmon life stages and on habitats, or if there will be any effects on commercial and recreational Salmon harvests.

What is OAH?

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_2 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!**



The earth's oceans have absorbed 30% of the excess CO_2 produced from fossil fuel combustion since the Industrial Revolution (mid 1800s). When absorbed by seawater, CO_2 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.

Support Action!

Ocean Acidification and Hypoxia (OAH) will not stop on its own, and actions must be taken by regional and national governments, communities, and scientists now in order to address the growing problems. Through coordination and collaboration, such as through the **Oregon OAH Action Plan**, Oregon will be able to adapt and mitigate the effects of OAH. Solutions are needed to help Oregon's wild fisheries and marine resources withstand the projected changes in OAH.

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

oregonocean.info/index.php/ocean-acidification

Oregon's Coordinating Council on
Ocean Acidification and Hypoxia

Species Spotlight

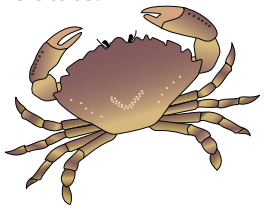
Dungeness Crab

Ocean Acidification (OA) and Hypoxia (H) are harmful to ocean life and the economic stability of the Oregonians who rely on a healthy ocean. The Dungeness crab fishery is one of Oregon's highest harvest values commercial fisheries, and is an iconic pastime for recreational harvesters.

What is at risk?

Economic Effects

Overall declines in harvest levels, resulting in possible economic and recreational losses throughout the State.



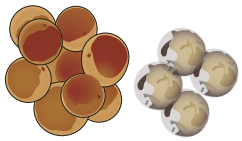
Foodweb Effects

Declines in food (such as clams and mussels) affect crab health.

Habitat Effects

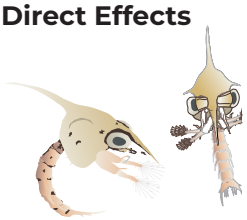
Eelgrass is an important habitat for crabs, and may buffer short term effects of OAH through photosynthesis (absorbing CO_2 and releasing oxygen).

Cumulative Effects



Poor ocean conditions are likely to lead to lower productivity.

Direct Effects



Larval growth and shell formation out of chitin (a calcium carbonate compound) can also be affected by lower acidity.

Sensory Effects

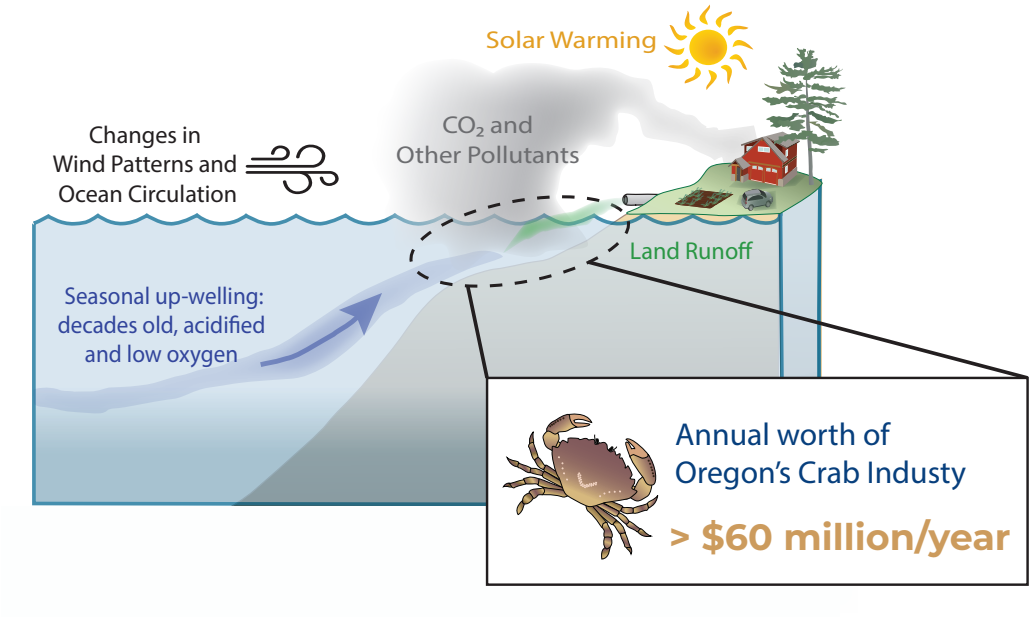
Behavior maybe affected by changing cues, due to altered chemical signaling (peptide production) needed for juvenile settlement.

What is OAH?

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_2 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!**



The earth's oceans have absorbed 30% of the excess CO_2 produced from fossil fuel combustion since the Industrial Revolution (mid 1800s). When absorbed by seawater, CO_2 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.

Support Action!

Ocean Acidification and Hypoxia (OAH) will not stop on its own, and actions must be taken by regional and national governments, communities, and scientists now in order to address the growing problems. Through coordination and collaboration, such as through the **Oregon OAH Action Plan**, Oregon will be able to adapt and mitigate the effects of OAH. Solutions are needed to help Oregon's wild fisheries and marine resources withstand the projected changes in OAH.

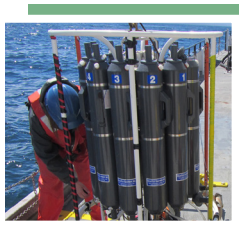
To learn more about OAH science, impacts, and solutions, please visit the Oregon OAH Council's website:

oregonocean.info/index.php/ocean-acidification

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

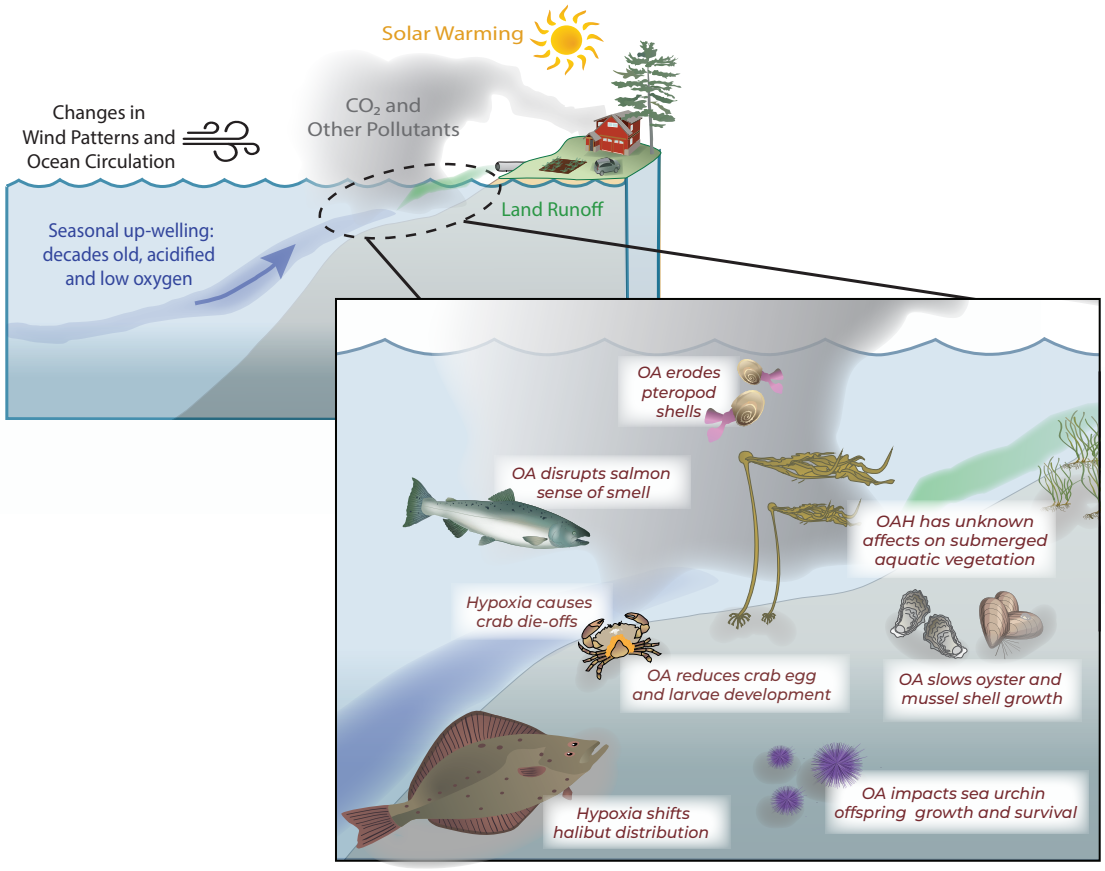
Encourage and Participate in Public Processes

- 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

Why is the Oregon OAH Action Plan Needed?

Oregonians have always treasured the ocean's bounty and natural beauty. But our ocean's resources are at risk. Fossil fuel combustion and related accumulation of carbon dioxide (CO_2) and other greenhouse gases has led to climate change, ocean acidification, and ocean hypoxia that threaten our future reliance on ocean resources. Crab, salmon, oysters, halibut, and prey species that feed ocean life have already shown vulnerability.

Climate and other human drivers of ocean change ...



... impacts economically and ecologically important marine species.

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.

Graphic Credits - several graphics in this document were purchased from or used courtesy of the Integration and Application Network, University of Maryland Center for Environmental Science (ian.umces.edu/imagelibrary/)

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

oregonocean.info/index.php/ocean-acidification

Research Needs

The Oregon Ocean Acidification and Hypoxia (OAH) Action Plan identifies ways that Oregonians can make a difference to slow OAH impacts and adapt to the changes we are already seeing. This abbreviated list of research actions from the OAH Action Plan was prioritized by the OAH Council. This list is meant to be a starting place to help guide researchers and funding groups on what the OAH Council thinks are top priorities for the state of Oregon. Additional research needs and priorities will be developed as needed.

Here are the top RESEARCH ACTIONS that can make a difference

Advance Scientific Understanding

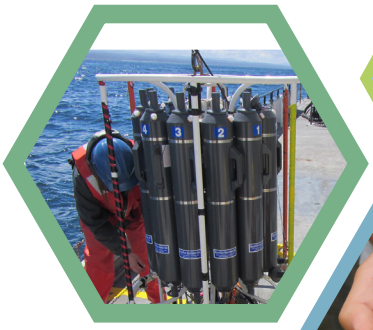
- Re-establish OAH monitoring in Yaquina Bay
- Co-locate existing Marine Reserves sampling with new OAH intertidal and subtidal OAH monitoring
- Add biological and chemical OAH monitoring to the Newport Hydrographic Line
- Sustain OAH monitoring in Tillamook Bay
- Maintain and support new OAH instruments within communities and alongside at-risk industries
- Provide a workshop to prioritize biological monitoring metrics for OAH
- Conduct a socio-economic vulnerability assessments of Oregon's vulnerabilities to OAH

Reduce Causes

- Develop effective and efficient ways to reduce excess CO_2 and OAH stressors

Create Resilience

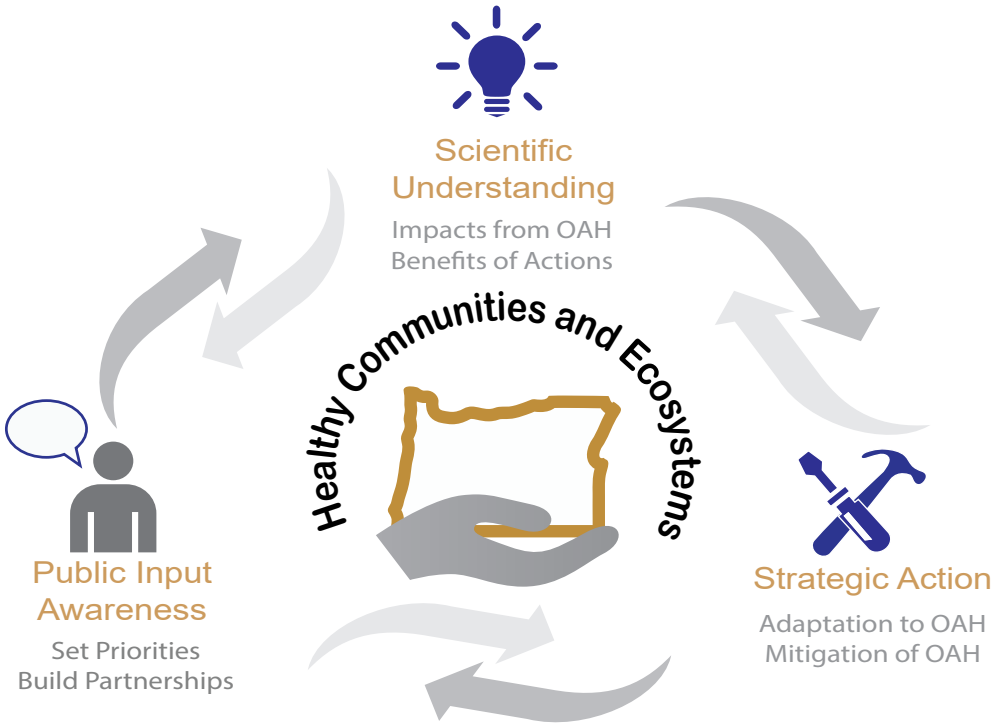
- Identify strategies to restore, protect, and sustain: (1) Nursery habitat for valuable shellfish, (2) Submerged Aquatic Vegetation (SAV) and native shellfish, (3) Oregon's water quality, (4) Life history stages of OAH vulnerable marine species, (5) Economic resilience in coastal communities and marine industries
- Research of resilient shellfish aquaculture strains
- Develop maps to that promote resilience in: (1) SAV and native oyster core distribution areas, (2) Priority areas for habitat restoration and protection
- Conduct an ecosystem modeling of SAV, and hydrodynamic and biogeochemical processes to inform: (1) Regions considered for blue carbon and/or carbon mitigation offsets, (2) Aquaculture practices in Oregon's bays and estuaries



Why is the Oregon OAH Action Plan Needed?

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_2 and OAH stressors simultaneously recommends will take time to implement. 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.

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