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I. List of Council members

Oregon Coordinating Council on Ocean Acidification and Hypoxia

Council Co-chairs

Dr. Caren Braby	Department of Fish & Wildlife - Marine Resources Program Manager
Dr. John Barth	Oregon State University - Director of the initiative for integrative Marine Studies

Council Members

Frank Barcellos	Department of Agriculture
Karen Tarnow	Department of Environmental Quality
Andy Lanier	Department of Land Conservation & Development

Appointed by the executive director of the Oregon Ocean Science Trust

Dr. James Sumich	Ocean Science Trust
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Appointed by the director of the Sea Grant College

Dr. Shelby Walker	Oregon Sea Grant
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Appointed by the Ocean Policy Advisory Council

Fran Recht	Conservation Organization
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Appointed by the State Fish and Wildlife Commission

Al Pazar	Fishing Representative
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Appointed by the State Board of Agriculture

Liu Xin	Shellfish Industry Representative
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Appointed by the scientific and technical advisory committee to the Ocean Policy Advisory Council

Dr. Aaron Galloway	University of Oregon
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Appointed by the State Fish and Wildlife Commission, in consultation with the Commission on Indian Services

John Schaefer	Confederated Tribes of the Coos, Lower Umpqua & Siuslaw Indians
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Governor's Representative

Dr. Kristen Sheeran	Climate and Energy Policy Advisor to Governor Kate Brown
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II. Letter from the Co-Chairs

III. Letter from Francis Chan – Blue Ribbon Panel Co-chair

IV. Executive Summary

V. Introduction

Problem Statement:

Oregonians care about and rely on the ocean for food and for social, cultural, and economic purposes. Living ocean resources are at risk from Ocean Acidification and Hypoxia (OAH) and other atmospheric-carbon related changing ocean conditions.

Solution:

To sustain Oregon's marine-based food supply and our cultural and economic well-being, the OAH Council recommends taking action to understand, adapt to, and mitigate OAH.

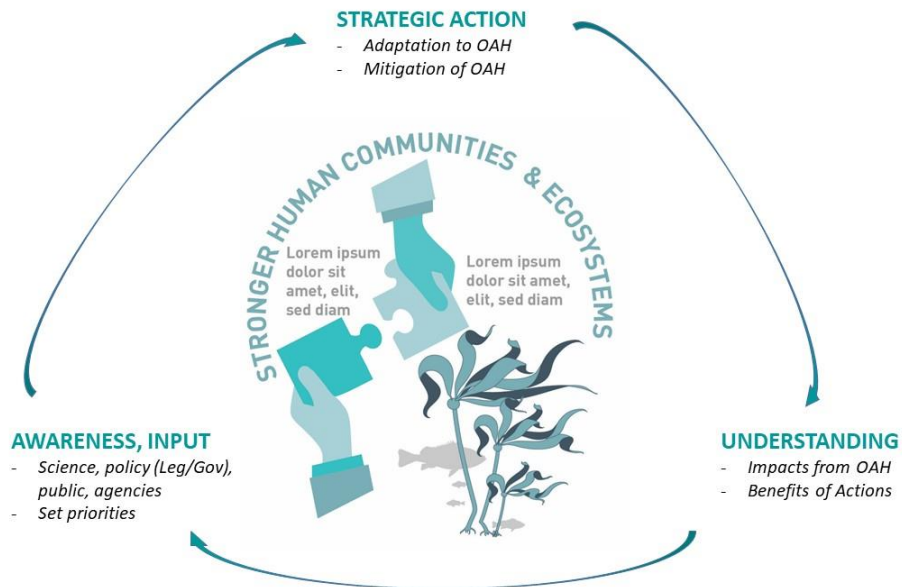
OAH Council Purpose, Need, Process and Timeline:

- Purpose and Need
 - History of OAH impacts on WC/Oregon – oysters, recent years (2014-present) – The Blob, El Nino, HABs in crab/clams. Estuaries/Nearshore/Marine species & habitats. Cultural and economic foundations of the coastal communities and Oregon traditions.
 - Figure__: Oregon's Timeline in Responding to OAH (from oysters – OAH Science Panel 2016)
 - Oregon's leadership on the WC OAH SP. Brief description of recommendations, highlight SP take-homes:
 - Scientific understanding increases the management options available.
 - More options likely means choices among more and less punitive management responses
 - Acting now/soon increases the management options available.
 - Figure__: WC OAH SP findings (or road map?)
 - Legislative acknowledgment of needed action: OAH Council bill (SB 1039)
 - Request from Governor Kate Brown (build Oregon OAH Action Plan)
- Council Process (2017-2018)
 - Council members,
 - 1st convening,
 - development of recommendations,
 - Figure__: Council Process Diagram
 - Guiding principles:
 - Use/retool existing management systems (regulations) rather than create new management systems (regulations), if possible
 - Consider funding streams to support extra capacity, as necessary
 - Make recommendations that leverage collaborations and partners, rather than create (government) silos.
 - There are other groups in the State that are working on ocean issues, carbon dioxide and climate; the OAH Council strives to be in complementary alignment with these groups, and not be redundant unnecessarily

- Timeline for the OAH Council is long (no sunset) but time is short to act; set short-term priorities quickly to make fast progress, and long-term priorities, for a sustained approach to addressing OAH impacts.
 - Strive for both ecosystem and socio-economic (human community) strengthening; they are inter-related and both are essential to Oregon.
 - The OAH Council should develop a well-developed set of recommendations as a starting point, that will benefit from input from the Legislature, the Governor, and Oregonians. Together, this will chart a course for the future.
- 1st report (“starting point”) due in September 2018
- Oregon OAH Action Plan Process (2018-2019)
 - Legislative/Governor’s office feedback on priorities
 - Public process on priorities
 - OAH Council finalizes “Oregon OAH Action Plan” (June 2019) for Governor adoption
 - Figure__ : Oregon’s Timeline in Responding to OAH (Legislative Action/OAH Council 2017 – to Oregon OAH Action Plan 2019 – to funding prioritization 2021)
- Subsequent process for recommendations/OAH Council
 - Governor, Agencies, Legislature use 2018 OAH Council recommendations and 2019 OAH Action Plan to develop policy/budget/research/analysis priorities during 2019-2021 biennium, and implement policy/budget priorities & spending starting in 2021-2023.
- Long-term – no sunset for OAH Council, on-going iterations of “Understanding → Adaptation/Mitigation” recommendations.

Figure __. COUNCIL PROCESS DIAGRAM:

Depicting the process that the Oregon Coordinating Council on OAH took to reach recommendations and actions.



VI. Legislative Mandate at Work

Senate Bill 1039 (quick reference guide):

Table ____. Crosswalk of Senate Bill Enrolled 1039 legislative text and OAH Coordinating Council Report Recommendations

SB 1039		OAH Council Report Section	Page
Sec 1	<i>General legislative findings and declarations</i>	Executive Summary	#
Sec 2.(1)	<i>Council establishment and makeup</i>	Council Members and Affiliations	#
Sec 2. (2 - 8)	<i>Terms of service and operating framework</i>	Appendix ____	#
		Appendix ____	#
Sec 3. (1) (a) (A – B)	<i>Review and utilize relevant scientifically supported information</i>	Connections to Past Regional and State Science Initiatives	#
Sec 3. (1) (b) (A-G)	<i>Identify actions and initiatives</i>	Council Recommendations : Themes	#
		Connections of State Agencies to OAH	#
		Appendix ____	#
Sec 3. (1) (c)	<i>Advise and assist the State agencies in coordinating and conducting actions and initiatives</i>	Connections of State Agencies to OAH	#
Sec 3. (2) (a-c)	<i>Develop a Socioeconomic Vulnerability to Ocean Acidification Report</i>	Council Recommendations : Themes	#
		Continuing Work of the Council	#
Sec 3. (3) (a-c)	<i>Recommendations for the Oregon Ocean Science Trust, State agencies, academia, or other organizations</i>	Council Recommendations : Themes	#
Sec 3. (4)	<i>Biennial report to the Legislative Assembly and the Ocean Policy Advisory Council</i>	Appendix ____	#
		Continuing Work of the Council	#
Sec 3. (5)	<i>Agencies assistance to the coordinating council</i>	Appendix ____	#
		Connections of State Agencies to OAH	#

Senate Bill 1039:

**Sponsored by Senators ROBLAN, KRUSE
79th OREGON LEGISLATIVE ASSEMBLY
AN ACT**

Relating to ocean chemistry.

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

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

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

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

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

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

Whereas Oregon's coastal communities and economies are important to this state and are dependent on a thriving marine ecosystem; and

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

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

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

Whereas an Oregon Ocean Acidification and Hypoxia Center of Excellence is explicitly identified in the Oregon State University Marine Studies Initiative Strategic Plan as a possible center of excellence to be housed in the Marine Studies Initiative to leverage and build upon existing state contributions to ocean acidification and hypoxia research; and

Whereas the Ocean Policy Advisory Council and the Oregon Ocean Science Trust have identified ocean acidification as a priority issue for Oregon; and

Whereas the West Coast Ocean Acidification and Hypoxia Science Panel, comprised of eminent scientists from Oregon and other west coast jurisdictions, working in collaboration with ocean management counterparts in Oregon, Washington, California and British Columbia, recently issued recommendations and associated specific actions that can be implemented immediately to respond to ocean acidification and hypoxia; now, therefore,

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

SECTION 1. The Legislative Assembly finds and declares that ocean acidification and hypoxia severely endanger the state's commercially and culturally significant ocean resources. The Legislative Assembly therefore declares it to be the policy of the state to ensure a coordinated, effective response to ocean acidification and hypoxia. To facilitate efforts that are coordinated and effective, it is the state's policy to

support ocean acidification and hypoxia actions and initiatives that are developed through close collaborations between federal, state and local agencies, academic institutions and commercial industries, among others.

SECTION 2.

(1) The Oregon Coordinating Council on Ocean Acidification and Hypoxia is established, consisting of 13 members as follows:

- (a) The Governor or the Governor's designee;
- (b) The director of an initiative for integrative marine studies at Oregon State University or the director's designee;
- (c) The State Fish and Wildlife Director or the director's designee;
- (d) The Director of Agriculture or the director's designee;
- (e) The Director of the Department of Environmental Quality or the director's designee;
- (f) The Director of the Department of Land Conservation and Development or the director's designee; and
- (g) Seven members appointed in consultation with the Governor's office as follows:
 - (A) One member representing the Oregon Ocean Science Trust, appointed by the executive director of the Oregon Ocean Science Trust;
 - (B) One member representing the Sea Grant College of Oregon State University, appointed by the director of the Sea Grant College;
 - (C) One member representing a conservation organization, appointed by the Ocean Policy Advisory Council;
 - (D) One member representing fishing interests, appointed by the State Fish and Wildlife Commission;
 - (E) One member representing the shellfish mariculture industry, appointed by the State Board of Agriculture;
 - (F) One member representing the academic research community with relevant expertise, appointed by the scientific and technical advisory committee to the Ocean Policy Advisory Council; and
 - (G) One member representing the interests of federally recognized Oregon Indian tribes, appointed by the State Fish and Wildlife Commission in consultation with the Commission on Indian Services.

(2)(a) The term of office of each member of the coordinating council appointed under subsection (1)(g) of this section is four years, but a member serves at the pleasure of the appointing authority. The terms must be staggered so that no more than two terms end each year.

(b) Before the expiration of the term of a member, the appointing authority, in consultation with the Governor, shall appoint a successor to take office upon the date of that expiration. A member is eligible for reappointment. If there is a vacancy for any cause, the appointing authority, in consultation with the Governor, shall make an appointment to become immediately effective for the unexpired term.

(3) The State Fish and Wildlife Director or the director's designee and the director of an initiative for integrative marine studies at Oregon State University or the director's designee shall serve as cochairpersons of the coordinating council.

- (4) A majority of the members of the coordinating council constitutes a quorum for the transaction of business.
- (5) The coordinating council shall meet at times and places specified by the call of the chairpersons or of a majority of the members of the coordinating council.
- (6) The coordinating council may adopt rules as necessary for the operation of the coordinating council.
- (7) The members of the coordinating council are not entitled to compensation but are entitled to expenses as provided in ORS 292.495. Claims for expenses incurred in performing functions of the coordinating council shall be paid out of funds appropriated to the State Department of Fish and Wildlife for purposes of the coordinating council.
- (8) The State Department of Fish and Wildlife shall provide staff support to the coordinating council.

SECTION 3.

- (1) The Oregon Coordinating Council on Ocean Acidification and Hypoxia shall:
 - (a) Review and utilize relevant, scientifically supported information, including the recommendations of the West Coast Ocean Acidification and Hypoxia Science Panel and other available information, reports and studies, to:
 - (A) Identify research and monitoring activities necessary to better understand the changing ocean chemistry and the potential impacts of ocean acidification and hypoxia; and
 - (B) Recommend prioritized state actions to address ocean acidification and hypoxia;
 - (b) Identify actions and initiatives to address Oregon's vulnerabilities to ocean acidification and hypoxia that may include, but need not be limited to:
 - (A) Developing optimal strategies for mitigating the effects of ocean acidification and hypoxia;
 - (B) Taking steps to strengthen existing scientific monitoring, research and analysis regarding the effects and trends in ocean acidification and hypoxia;
 - (C) Identifying habitats that are particularly vulnerable to corrosive sea water, including areas experiencing multiple stressors such as hypoxia, sedimentation and harmful algae blooms;
 - (D) Identifying the socioeconomic and ecosystem impacts of intensifying ocean acidification;
 - (E) Taking steps to increase public awareness of the science and impacts of ocean acidification and hypoxia;
 - (F) Developing a long-term ocean acidification and hypoxia coordination strategy among state agencies, academia, the federal government and industry; or
 - (G) Leveraging opportunities for research partnerships with academia, tribes and the commercial fishing industry, in order to advance the understanding of ocean acidification and hypoxia in Oregon; and
 - (c) Advise and assist the State Department of Fish and Wildlife and all other represented public agencies in coordinating and carrying out, as directed by the agencies' governing bodies, the actions and initiatives identified under paragraph (b) of this subsection.

(2) The coordinating council may develop a Socioeconomic Vulnerability to Ocean Acidification Report. A report developed under this subsection may include, but need not be limited to, information identifying:

- (a) Coastal communities in this state that may be impacted by ocean acidification;
- (b) The impacts of ocean acidification and hypoxia on the communities identified under paragraph (a) of this subsection; or
- (c) The gaps in understanding that exist regarding the impacts of ocean acidification and hypoxia on economically or commercially important species, particularly species that support commercial, recreational and tribal fisheries and shellfish aquaculture in this state.

(3) The coordinating council may develop recommendations for the Oregon Ocean Science Trust, state agencies, academia or other organizations on high-priority, strategic research that may be done to address gaps that exist in the understanding of ocean acidification and hypoxia. Strategic research recommendations developed by the coordinating council may include, but need not be limited to, research related to:

- (a) The impacts of ocean acidification and hypoxia on marine organisms and the marine ecosystem;
- (b) The economic impacts of ocean acidification and hypoxia on communities in this state; or
- (c) Developing adaptation and mitigation strategies for conserving and enhancing the resilience of marine organisms and ecosystems for future use and enjoyment by Oregonians and visitors to this state.

(4) The coordinating council shall submit a biennial report to the Legislative Assembly and to the Ocean Policy Advisory Council by September 15 of each even-numbered year on the coordinating council's activities and recommendations.

(5) All agencies of state government, as defined in ORS 174.111, are requested to assist the coordinating council in the performance of its duties and, to the extent permitted by laws relating to confidentiality, to furnish such information and advice as the members of the coordinating council consider necessary to perform their duties.

SECTION 4. Notwithstanding any other provision of law, the General Fund appropriation made to the State Department of Fish and Wildlife, Fish Division, by section 1 (1), chapter 544, Oregon Laws 2017 (Enrolled House Bill 5010), for the biennium beginning July 1, 2017, is increased by \$162,286 for the purpose of implementing sections 2 and 3 of this 2017 Act.

VII. Recommendations

OAH Council recommendations were developed through a careful review of the legislative mandate (per Senate Bill 1039), ocean acidification and hypoxia (OAH) plans developed by other entities (US States, Nations), review of existing process/activities in Oregon, and identification of opportunities for action. Potential opportunities for action were explored and identified through the convening of OAH Council working groups, each comprised of a subset of Council members. After each working group developed a set of potential recommendations, all were integrated into a single set of recommendations organized around themes, which were further refined and adopted by the Council as a whole. The OAH Council has developed recommendations in five thematic areas:

Theme 1: Scientific Understanding, Data Gaps and Information Needs



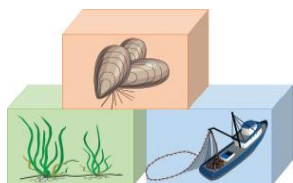
The OAH Council recognizes that rigorous management options must take into account scientifically sound information and data. Through scientific understanding of ecosystem and socio-economic impacts and solutions, Oregon will have more diverse management options in facing OAH impacts, and those options will dwindle as time passes if action is not taken.

Theme 2: Reducing Causes of OAH



The OAH Council recognizes that increasing atmospheric carbon dioxide from fossil fuel combustion is a direct cause of increasing OAH and that there are other factors that exacerbate OAH impacts. Both carbon management and OAH management will provide positive impacts on Oregon's ability to face OAH impacts today and into the future.

Theme 3: Building Adaptation and Resilience



The OAH Council recognizes that weaker ecosystems and weaker socio-economic infrastructure makes additional stresses more difficult to withstand. Building adaptation and resilience strategies for both ecosystem and socio-economic infrastructure will help Oregon face OAH impacts that will be experienced throughout the state.

Theme 4: Expanding Awareness



The OAH Council recognizes that Oregonians want to be informed about scientific information, and management options, and have much to share to shape implementation of management decisions. Developing information and communications strategies to raise awareness and motivate input is critical to Oregon's success in facing OAH impacts.

Theme 5: Commit Resources to Implement

The OAH Council recognizes that some of the recommendations included herein can be incorporated into Oregon's current management framework, through coordination and redirecting existing agency staff. Many of the recommendations require additional capacity, which may come from a variety of sources, and additional policy guidance to implement.

Within each theme, the OAH Council identifies high-level recommendations, each of which is further described by more specific actions, as described below.

Table __. Senate Bill Enrolled 1039 Section 3 legislative text, as related to OAH Council thematic areas for recommendations.

SB 1039		<i>Council Recommendations</i>			
		T1	T2	T3	T4
Sec 3. (1) (b) (A)	<i>Developing optimal strategies for mitigation</i>				
Sec 3. (1) (b) (B)	<i>Strengthening existing scientific monitoring, research and analysis</i>				
Sec 3. (1) (b) (C)	<i>Identifying habitats vulnerable to corrosive sea water</i>				
Sec 3. (1) (b) (D)	<i>Identifying the socioeconomic and ecosystem impacts</i>				
Sec 3. (1) (b) (E)	<i>Steps to increase public awareness of the science</i>				
Sec 3. (1) (b) (F)	<i>Developing long-term coordination strategy</i>				
Sec 3. (1) (b) (G)	<i>Leveraging opportunities for research partnerships</i>				

THEME 1: Build Scientific Understanding, Data, and Information Needs

Identify and develop information critical for Oregon to understand, adapt to, and mitigate OAH impacts.

Recommendation 1.1: Expand and maintain a robust monitoring network that captures OAH oceanographic trends (e.g., pH, pCO₂ and/or alkalinity, oxygen, temperature, salinity, nutrient loads) and biological responses to OAH (e.g., productivity, abundance, distribution), through collaborative efforts in the State and West Coast region. **(Sec 3.1.a; Sec 3.1.b.B/G; Sec 3.3.a-c)**

Action 1.1.a. Support strategic augmentation of Oregon's monitoring network, by conducting oceanographic modeling validations and gaps analyses to identify and to aid in the development of an Oregon-wide model of OAH vulnerability and trends.

- a. Improve information from oceanographic modeling by working with oceanographic modelers (e.g., Live Ocean project) to further develop longer-term annual, multi-year, and decadal scale West Coast OAH projections that can be used by industry and managers.
- b. Evaluate the West Coast OAH Monitoring Inventory (Pacific Coast Collaborative, 2018) to identify gaps in West Coast oceanographic monitoring coverage (e.g., oceanographic model evaluation, gaps analysis).
- c. Maintain the West Coast regional OAH monitoring inventory so that it continues to reflect the robustness of oceanographic monitoring inventory and the continued validation of regional models.
- d. Determine if physical and chemical instrumentation in the Oregon Marine Reserves would be beneficial to gaining an increased understanding of how OAH affects Oregon's marine resources and ecosystems.

Action 1.1.b. Reinstate an oceanographic monitoring station for Yaquina Bay, Oregon's third largest estuary systems for Pacific oyster production.

- a. Collaboratively develop and maintain a station in Yaquina Bay, in conjunction with academic institutions, Yaquina shellfish industry, and State agencies. This is the oyster production estuary that does not currently have oceanographic instrumentation. Build on and leverage the historical USEPA data set from Yaquina Bay, when establishing the monitoring site and database.

Action 1.1.c. Develop and support vessel-based OAH monitoring data collection in Oregon.

- a. Identify the oceanographic metrics, instrumentation packages including scale and accuracy considerations, and collaborators (e.g., fishery participants, research vessels) that would be beneficial for Oregon understanding the spatiotemporal patterns in OAH.
- b. Build a program to deploy vessel-based monitoring instruments on vessels, including instrument calibration, maintenance, data management (e.g., processing/storage/public access).

Action 1.1.d. Support continued funding of the “Newport Line” (biweekly monitoring of chemical, physical, and biological metrics; currently funded by NOAA), a tremendous monitoring asset and keystone of our understanding of biological response to OAH in the West Coast and Oregon, an asset that has been vulnerable in past Federal budget cycles.

Action 1.1.e. Develop and implement biological indices, proxies, and model systems to track the biological responses to OAH, and inform State natural resource management (e.g., Territorial Sea Planning). Facilitate and utilize previous research and observations by academics, agencies, and stakeholders.

- a. Prioritize the use of model organisms and metrics that are feasible for a wide range of user and observer interests.
- b. Prioritize the use of model organisms that are meaningful to Oregon ecosystem, socio-economic traditions and values.
- c. Facilitate collaborative data collection and sharing by academics, monitoring groups, as well as State and Federal agency managers.
- d. Consider Oregon’s Marine Reserves sites relative to OAH hotspots and refuges, to inform future decisions about OAH resilience.

Recommendation 1.2: Develop an OAH research plan for Oregon, to be implemented in collaboration with partners, which includes characterizing OAH vulnerabilities and adaptation/resilience strategies for Oregon ecosystem and socio-economic assets. **(Sec 3.1.a and Sec 3.1.b.A/B/G; Sec 3.1.b.D, Sec 3.2.a-c)**

Action 1.2.a. Identify Oregon’s commercially, recreationally and culturally important species that are likely, or are demonstrated, to be affected by increasing OAH. Conduct a vulnerability assessment of high-priority species and identify research priorities to characterize species responses to OAH.

- a. Fisheries species include: clams, Dungeness crab, pink shrimp, halibut, rockfish, urchins, etc.
- b. Cultured species include: Pacific oysters.
- c. Ecosystem species include: mussels, abalone, native oysters, kelps, seagrasses, etc.
- d. Public health concern species include: Harmful Algal Blooms (HABs)

Action 1.2.b. Identify Oregon’s communities and industries that are at risk and/or vulnerable to OAH impacts. Conduct a socio-economic vulnerability assessment and identify research priorities to characterize socio-economic responses to OAH.

Action 1.2.c. Support research needed to identify effective mitigation for ecosystem and socio-economic vulnerabilities discovered from **Action 1.2.a and 1.2.b.** above.

- a. Continue State support for research priorities for Oregon's oyster industry, including projects such as seed development by the Molluscan Broodstock Program (MBP) at Oregon State University.
- b. Other research needed, as identified.

Action 1.2.d. Establish research priorities to determine the benefits of conserving and restoring Oregon's submerged aquatic vegetation (SAVs), in building ecosystem and socio-economic resilience.

- a. Determine resilience/mitigation benefits of SAV protection and restoration for Oregon's coastal ecosystems and human communities. If so, build protection/restoration of SAVs into existing and new management frameworks (**reference Theme 3, Recommendation 3.1 and 3.2**).

Action 1.2.e. Determine if native oyster restoration promotes short term OAH buffering through estuary shell bed restoration and long term carbon removal through shell carbon burial and/or other ecosystem resilience benefits.

Recommendation 1.3. Establish research priorities and information needs for developing carbon mitigation solutions (e.g., carbon removal engineering, carbon sequestration) and OAH mitigation strategies (e.g., reduce pollutants that exacerbate OAH) to reduce ecosystem and socio-economic impacts and build resilience. (**Sec 3.1.b.F**)

Action 1.3.a. Identify research priorities to remove carbon from ocean waters.

Action 1.3.b. Identify research priorities to characterize the potential for marine habitats and species to help achieve carbon sequestration and management goals. Support academic research to characterize potential benefits.

- a. "Blue carbon" long term sequestration of CO₂ in Oregon.
- b. Kelp aquaculture in contained systems to remove CO₂ from ocean waters.

Action 1.3.c. Assess water pollution information needs, to facilitate reductions in water pollutants that amplify or exacerbate OAH (i.e., mitigate pollutants that exacerbate OAH, including biological loading), **as described in Recommendation 2.3.**

- a. Characterize local pollution sources (e.g., water/land based outfalls, scale and source), to inform local and state management of water pollution. Support DEQ to produce periodic summary reports for coastal watersheds, to provide information on locations and magnitudes of water pollutants that are likely to exacerbate OAH in estuaries and nearshore. Identify missing data and/or regulations that need to be addressed to control land-based sources of OAH exacerbating pollutants.

- b. Characterize point source discharge impacts (i.e., amplitudes and distribution of plume extent) on surrounding estuarine and marine environments.
- c. Identify and characterize biological and/or decomposition loading of water bodies that exacerbate OAH conditions (e.g., at sea fish processing, sewage discharge) and other non-characterized sources (e.g., road runoff into watersheds), and their impacts on surrounding ecosystems and communities.

THEME 2: Reduce Causes of OAH

Develop a coordinated approach in the State for carbon dioxide and OAH management and mitigation, and implement strategies to reduce factors that exacerbate OAH.

Recommendation 2.1. Develop and maintain aligned strategies to reduce anthropogenic causes of OAH; coordinate between carbon dioxide and OAH management and mitigation efforts in the State and regionally. **(Sec 3.1.b.F)**

Action 2.1.a. Strengthen coordination among the OAH Council, State agencies, and other State government entities (e.g., Oregon Global Warming Commission, Governor's cabinets) that inform carbon management and mitigation activities to include local and State and regional scales.

Recommendation 2.2. Develop and maintain collaborations with Federal programs and non-governmental institutions, to share the best available science to inform and support Oregon's carbon dioxide and OAH management and mitigation activities.

Action 2.2.a. Build collaborations to share data and information

- a. USEPA Partnership to access data and information products.

Action 2.2.b. Leverage national and regional programs, infrastructure, and funds that address environmental quality to help promote in-State actions to follow "best practices", to comply with existing laws, and to make permanent improvements in water quality management.

- a. Encourage and incentivize local voluntary with State outreach and extension programs to focus on local and individual decisions that make a difference.

Recommendation 2.3. Reduce water pollutants that are co-stressors of OAH **(pursuant to findings from Action 1.3.c)**, to mitigate water pollutants that amplify or exacerbate OAH.

Action 2.3.a. Enhance enforcement of state agency programs to ensure that existing water quality regulations are leading to stated water quality standards. Conduct audits by 3rd party enterprises to evaluate success.

Action 2.3.b. Reduce identifiable water pollution sources through State regulatory reform of allowed state water uses, wastewater and storm water treatment requirements, and other actions to prevent and reduce water quality issues exacerbating coastal OAH.

Action 2.3.c. Promote consideration of OAH in local water quality enforcement and permitting decisions, as an issue of concern and point to review. Activities include agriculture, forestry, sewage treatment systems, septic systems.

- a. Support upgrades to sewer treatment for coastal municipalities for use of advanced treatment technologies on sewage treatment systems to mitigate local water quality impacts.
- b. Encourage septic system inspections by local governments and municipalities to reduce the potential for water pollution.
- c. Assure Goal 5 – safe harbors requirements (i.e., 50’ riparian set back buffers) are applied and enforced, especially along river systems with outflows into OAH sensitive coastal ecosystems and communities.

THEME 3: Promote Adaptation and Resilience of Marine Resources

Support activities and initiatives that promote adaptation to and build resilience of Oregon's human communities and ecosystems, to increasing OAH conditions.

Recommendation 3.1: Incorporate OAH considerations into the existing decision-making framework to build resilience in Oregon's human communities and ecosystems, as supported by best available science **identified in Action 1.2.d. (Sec 3.3.c)**

Action 3.1.a. Identify opportunities to incorporate OAH resilience into current and future management actions, as well as to streamline and minimize cost of management response, by conducting an inventory of Oregon State agency management processes that are relevant to OAH. **(Sec 3.1.a)**

- a. State Agencies examples, with selected agency responsibilities:
 - a. Department of Land Conservation and Development (DLCD) – land use and ocean planning; statewide planning goals (e.g., Goals 5, 17, 18, 19 - Coastal Zone Management).
 - b. Department of State Lands (DSL) – state lands leasing, including in state submerged waters; impacts of leasing to submerged aquatic vegetation, marsh, riparian buffers.
 - c. Department of Environmental Quality (DEQ) - water quality planning
 - d. Oregon Department of Agriculture (ODA) - food safety management (HABs), aquaculture practices improvement (not as a mitigation for OAH); oyster lease impact on SAVs
 - i. Oregon Department of Fish and Wildlife (ODFW) – emerging fisheries and resilient fishing communities; Oregon Ocean Monitoring Group (OOMG) - monitoring network for oceanography and biological response; Guidance to State permitting decisions on fish and wildlife impacts
- b. Non-agency State entities:
 - a. Global Warming Commission (GWC) - inclusion of ocean considerations in policy recommendations and activities
 - b. Oregon Ocean Science Trust (OOST) – inclusion of OAH in coordinate nearshore research priorities
 - c. Ocean Policy Advisory Council (OPAC) – Territorial Sea Planning
 - d. Science and Technical Advisory Committee (STAC) – research, monitoring, science efforts evaluation

Action 3.1.b. Anticipate specific management and regulatory decision-making processes, into which OAH resilience considerations can be incorporated.

- a. Rocky Shore/Territorial Sea Plan review process (OPAC; 2019)
- b. Marine Reserves Program review process (Legislature; 2023)

- c. Oregon's Coastal Nonpoint Control Program - Coastal Zone Act Reauthorization (DEQ/EPA/NOAA) (timeline 2019)

Recommendation 3.2: Support new OAH resilience initiatives to sustain Oregon's habitats, species, and human communities, thereby supporting Oregon's ecosystem health and socio-economic reliance on living marine resources. (**Sec 3.1.b**)

Action 3.2.a. Promote SAVs conservation and restoration strategies and opportunities, as supported by best available science as **outlined in Action 1.2.d**.

- a. Short-term buffering of acidified waters and sequestration of carbon.
- b. General ecosystem services provided by SAVs to promote resilience; includes provision of nursery habitat for many fisheries species targets, promotion of biodiversity, forage and predator avoidance.

Action 3.2.b. Promote native ecosystem resilience in management decisions, as supported by best available science and **outlined in Recommendation 1.2**.

- a. Work with relevant Oregon state agencies to increase current preservation efforts of current and new native oysters' beds in state waters. The native oyster is a species that is more resilient to OAH impacts and a key member of healthy estuary communities.
- b. Other native species, including top predators.

THEME 4: Raise Awareness of OAH Science, Impacts, and Solutions

Identify and advance opportunities to raise awareness of OAH science, impacts, and mitigation solutions.

Recommendation 4.1: Develop communications and awareness strategies on OAH science, impacts, and solutions (long-term; e.g., 10-year plans), working collaboratively with partners.
(Sec 3.1.b.F)

Action 4.1.a. Formulate an Oregon OAH “communications needs assessment” based on what information is already known and what information is needed or desired by Oregonians.

- a. Informal surveys – use “comment books” as a “free thought” exercise for the public to write questions or concerns.
- b. Formal surveys – to be provided throughout Oregon.

Action 4.1.b. Establish the link in public opinion between OAH and other climate issues

- a. Collaboration with other commissions and working groups including the Oregon Global Warming Commission.

Action 4.1.c. Build a foundation of positive, solutions-oriented messaging on OAH science, impacts and solutions. Messages should include: simple, positive, local connections, actions for individuals and for government.

- a. Connect education and outreach actions with audience values – including monetary gains and savings, personal time, outdoor recreation.
- b. Build in estimates of OAH economic impacts at local and regional levels, into OAH outreach documentation and materials (**reference Action 1.2.b**).
- c. Develop environmental messaging on OAH that is similar in style to those developed for other environmental messaging that was successful (e.g., protecting the ozone, reducing acid rain).

Action 4.1.d. Create an information resource and outreach library for the OAH Council and others, that highlights OAH science, impacts and solutions, using a positive messages strategy.

- a. Facilitate public conversations with key facts and summaries of the OAH issue (e.g., convene discussion panel, write articles).
- b. Developing digital resources (e.g., web portal) for outreach materials (e.g., one-pagers, curricula), and a centralized repository of hands on kits.
- c. Standardized “Roadshow”: Prepared PowerPoint slides and one pagers for use by state agencies and the OAH Council.

Action 4.1.e. Encourage informal education opportunities through State wide outreach events – informal conversations with the general public.

- a. Partner with informal venues (e.g., Hatfield Marine Science Center Visitor Center, Charleston Marine Life Center, Oregon Museum of Science and Industry, Creative Minds Learning Centers) to develop and showcase exhibits on OAH.
- b. Working with industry to provide informal experiential opportunities for general public.
- c. Exhibit general OAH materials at community events (e.g., OSU marine science days, Oregon Aquarium's Our Oceans Day, State Fair, State of the Coast).

Action 4.1.f. Build evaluation tools, to determine how to improve and refine communications strategies.

Recommendation 4.2. Increase awareness and dispel misconceptions of OAH science, impacts, and solutions by building specialized informational materials and reaching specific audiences.
(Sec 3.1.b.E)

Action 4.2.a. Audience: K-12 school educators and students; "Next generation" engagement with local based school curriculum development-in alignment curriculum standards.

- a. Encourage the state legislature to continue funding of OAH STEM curriculum supplies in public schools and after-school education programs.
- b. Work with the Department of Education to incorporate OAH science into Oregon State education standards at elementary, middle, and/or high school education levels (e.g., Next Generation Science Standards (NGSS), common core).
- c. Teacher training programs – Promote teacher training and long-term training strategies on OAH issues.
- d. Help educators develop, adapt, and/or implement curricula on OAH and associated climate issues for primary, secondary, and higher education.

Action 4.2.b. Audience: Policy makers and legislative staff; inform policy actions with increased knowledge.

- a. Participate in legislative days, with clear messages on OAH science, impacts, and mitigation strategies.
- b. Provide "field trip" opportunities for legislative staff to visit science laboratories and industry sites (e.g., fishing boats, shellfish farms).
- c. Provide "science in Salem" opportunities, outside of legislative days, where hands-on information is brought to the legislative offices of state agencies and other state government offices.
- d. Encourage the appointment of funded positions in State agencies with dedicated focus on oceans, including local impacts of OAH and local actions to combat OA within government and resource management at every level.

Action 4.2.c. Audience: Media; Utilize the “Public Arena” – information access, media “take homes”.

- a. Develop visuals and clear messages for media to use.
- b. Develop an OAH media strategy, with clear timeframes and measured messaging outcomes with positive messages.

Action 4.2.d. Audience: At-risk industries and professions; communication with industries affected by OAH to strengthen cultural values of healthy and sustainable seafood and seafood industry.

- a. Convene specialists and/or industry representatives across industries and regions using round tables and workshops.
- b. Engagement with seafood processors and food industry (e.g., chefs and restaurants).
- c. Work with existing industry associations and science partnerships to develop unified messages and communication strategies on OAH.

Action 4.2.e. Audience: Local governments to help with “best practices” and decision-making for water quality (**reference Action 2.3.c.**).

Action 4.2.f. Audience: Academics and researchers; communicate research needs, considering a list of needs, a seminar series to facilitate information exchange and other methods. Materials to help strengthen State-Research cooperation (**reference Recommendation 5.3**)

- a. Raise awareness and communicate research needs to scientific and granting community.
- b. Developing a seminar series, by academic and management presenters for both community members and academics audiences.
- c. Attend national conferences and workshops with a unified message and informational handouts to provide information on Oregon OAH priorities. Communicate research priorities to regional partners (e.g., OOST, Sea Grant, academics)
- d. Communicate research priorities to National partners (e.g., NOAA – aquaculture and OA; NSF – biological and chemical oceanography, funding of moorings, UNOLS vessel time; EPA – land sea interactions, USDA – aquaculture) as well as to Oregon’s Congressional delegation, and Congressional Committees.

THEME 5: Commit Resources to Implement

Support a sustained, long-term approach to addressing OAH: policy declaration, funding for actions that require additional capacity, and reinforcement of Oregon's intellectual capital to meet future challenges.

Recommendation 5.1. Develop State policy on carbon dioxide and OAH management, to align and guide agency priorities and programs starting in 2019. Continue carbon dioxide and OAH management and mitigation efforts in the State.

Recommendation 5.2. Diversify funding sources that can be used to implement Oregon's science, adaptation, and mitigation goals. **(Sec 3.1.a)**

Action 5.1.a. As the State develops new revenue streams from mitigation requirements (e.g., fees from carbon management, development of mitigation banking, water pollution), consider allocation of mitigation funds to invest in OAH resilience strategies.

- a. Identify communities, regions, and research topics/programs which would benefit most from funding.

Action 5.1.b. Support State science funding entities that provide grant funds to OAH science and response.

- a. Oregon Watershed Enhancement Board (OWEB)
- b. The Oregon Ocean Science Trust (OOST)

Action 5.1.c. Facilitate the acquisition of outside sources of funding to meet the State's needs.

- a. Support funding for Oregon Sea Grant, NOAA programs for OAH science and response.
- b. Create an OAH funding library that could be used to support OAH recommendations and actions.
- c. Ensure the OOST and similar entities have the institutional framework to take in outside funds and redistribute, to fund State priorities.

Recommendation 5.3. Reinforce State-researcher collaboration and cooperation. Support integration of OAH research priorities into planning for academic institutions. **(Sec 3.1.b.A/B/E, Sec 3.3.a-c)**

Action 5.3.a. Invest in Oregon's intellectual capacity on OAH issues by supporting prioritization of OAH by Oregon universities, including research, education, and outreach. Include priorities for development and training on OAH instrumentation technologies.

- a. Support the ongoing development of an OAH instrumentation hands on workshop by the University of Oregon.

Action 5.3.b. Strengthen student/young professional academic training programs specific to OAH in Oregon to tackle specific OAH needs for the State, and requests from the OAH Council.

- a. Establish Oregon OAH fellowship program, to be collaboratively supervised by OOST, OAH Council (through the OSU and ODFW co-chairs), to address changing ocean conditions priorities, relative to biological monitoring.

VIII. Connections of Oregon Agency Responsibilities to OAH

Oregon Department of Fish and Wildlife

Oregon Department of Agriculture

Oregon Department of Environmental Quality

Oregon Department of Land Conservation and Development

IX. Continued work of the OAH Council

- Need sustained approach to addressing OAH. Staffing, funding to agencies, researchers, and/or others for implementation of OR-OAH-AP, continuation of the OAH Council, funding of the OOST.
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X. Definitions

OAH

Understanding

Adapting

Mitigating

Oceanographic monitoring – includes chem/phys/biol metrics

Chemical metrics:

Physical metrics:

Biological metrics:

Marine resources: species, habitats from brackish waters to open ocean

SAVs – eelgrass, seagrass, kelp, seaweeds (marsh?)

Water pollutants (that exacerbate OAH) – co2 from fossil fuel combustion, biological loading (sewage, road runoff, processing waste).

XI. References/Literature Cited

WC OAH SP report

OPC reports on HABs, SAVs, Fisheries and OAH Climate
BRP 2012 and 2017

XII. Appendix A: Council Member Biographies

Short 250 word bio

Picture

XIII. Appendix B: Council Procedures

XIV. Appendix C: Council Meeting Summaries

Council meetings

Working group meetings

List of guest presenters/invited subject matter experts

XV. Appendix D: Communication and Outreach

List of outreach events

Written summaries of actions