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Ocean Acidification Policy: Applying the Lessons of Washington to California and Beyond

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OCEAN ACIDIFICATION POLICY: APPLYING THE LESSONS OF WASHINGTON TO CALIFORNIA AND BEYOND

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ABSTRACT: This Article aims to distill the lessons of Washington's experience with ocean acidification (OA) policy and apply them to the political framework that exists in California. More generally, this Article evaluates the political landscape in which OA policy is taking shape along the west coast of the United States and highlights elements of a political and policy strategy that would build current momentum on OA in California and elsewhere into a larger, more sustained policy infrastructure capable of addressing coastal issues of environmental resilience and water quality in the context of global change. It concludes by identifying some ways in which OA policy might benefit from action on—and constituencies for—the multiple interacting drivers of environmental change.[1]

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1. In gathering information in the fall of 2016, I had discussions with a cross-section of professionals in California and Washington, all of whom had significant histories of policy or scientific engagement on the issues. I distilled the respondents' comments and framed them against the backdrop of the major relevant laws and institutions governing environmental policy in the two states, referencing current legal and scientific literature only where necessary to support key points. Throughout, I have provided opinion about likely outcomes or trajectories of change; where I have done so, I have tried to make apparent the factual basis for this opinion.

My interviewees included Lisa Graumlich (Dean, University of Washington College of the Environment), Jan Newton (University of Washington and Co-Director, Washington Ocean Acidification Center), Terrie Klinger (University of Washington and Co-Director, Washington Ocean Acidification Center), Steve Weisberg (Southern California Coastal Water Research Project), Ali Boehm (Stanford University), Jen Phillips (California Ocean Protection Council), Meg Caldwell (David and Lucile Packard Foundation), Skyli McAfee (The Nature Conservancy, formerly Executive Director, California Ocean Science Trust), Cat Kuhlman (formerly Executive Director, California Ocean Protection Council and Deputy Secretary, Oceans and Coastal Policy), Terry Sawyer (Founding Partner, Hog Island Oyster Company), Ashley Erickson (Stanford University, Center for Ocean Solutions), and Jodie Toft (The Nature Conservancy, Washington). In addition, earlier drafts of this Article benefitted from comments by Matt Armsby (Resources Legacy Fund), Sarah Cooley and George Leonard (Ocean Conservancy), Steve Weisberg, and Emily Knight (California Ocean Science Trust). Note that the views expressed in this document do not necessarily reflect the views of individual interviewees, and neither do they necessarily represent consensus among interviewees. Rather, I have summarized trends in responses and overarching themes. Any errors are my own.

I. INTRODUCTION

Ocean acidification (OA) is the global change in the marine chemical environment—a significant decrease in pH, towards a more acidic state—that has resulted from humanity's CO_2 emissions over the course of the industrial era.[2] As with other large-scale ocean changes such as warming, sea-level rise, hypoxia, and shifts in species assemblages (including an increase in harmful algal blooms), OA will alter marine ecosystems and the associated services on which humans have come to depend.[3]

Recent years have seen a spike in OA science, leading directly

2. *See generally* J.-P. Gattuso et al., *Contrasting Futures for Ocean and Society from Different Anthropogenic CO_2 Emissions Scenarios*, 349 SCI. 1, 3 (2015), http://hal.upmc.fr/hal-01176217/document.

3. *Id.*

to an increase in public awareness and political attention.[4] The legal and policy responses to OA have only started to take shape in the past few years,[5] as the scope of the challenge has become clearer. Any approach to tackle OA must marry political opportunity to scientific insight.

OA is mainly a global CO_2-driven problem[6]—although local exacerbating factors can shift the policy calculus to favor local mitigating actions—which undermines any given jurisdiction's options and incentives for acting to mitigate its effects. Nevertheless, the State of Washington has made financial and political commitments that have already been a model for other jurisdictions wishing to combat OA.[7] Washington's experience suggests there are political and scientific opportunities in California, Oregon, and elsewhere, despite inevitable state-level differences in the political landscape.

Although Washington continues to lead other jurisdictions on OA policy, its actions remain focused on scientific research and monitoring, rather than on combating the causes or effects of OA.[8] Any jurisdiction wishing to actually mitigate OA will have to go further than Washington has gone to date, by curbing anthropogenic inputs to the ocean or buffering the social and ecological effects of an already-changed ocean. However, a critical question remains unanswered pending experimental

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4. Sarah R. Cooley et al., *Community-Level Actions that Can Address Ocean Acidification*, 2 FRONTIERS IN MARINE SCI. 1, 3 (2016) ("On the North American Pacific coast, California, Oregon, Washington, and British Columbia have agreed to share information and combat ocean acidification by urging the American and Canadian governments to further research, model, and monitor their shared waters for ocean acidification through the Pacific Coast Collaborative.").

5. *See, e.g.*, Ryan P. Kelly & Margaret R. Caldwell, *Ten Ways States Can Combat Ocean Acidification (and Why They Should)*, 37 HARV. ENVTL. L. REV. 57 (2013) [hereinafter *Ten Ways*]; Raphaël Billé et al., *Taking Action Against Ocean Acidification: A Review of Management and Policy Options*, 52 ENVTL. MGMT. 761 (2013); Aaron L. Strong et al., *Ocean Acidification 2.0: Managing our Changing Coastal Ocean Chemistry*, 64 BIOSCIENCE 581 (2014).

6. Gattuso et al., *supra* note 2, at 1.

7. For example, the California-led West Coast Ocean Acidification & Hypoxia Panel, discussed throughout this Article. "Inspired by the groundbreaking work of the Washington Blue Ribbon Panel on Ocean Acidification, the [California Ocean Protection Council] asked Ocean Science Trust to establish a scientific advisory panel on ocean acidification and hypoxia (OAH) in collaboration with Oregon, Washington, and British Columbia." *History*, THE WEST COAST OCEAN ACIDIFICATION & HYPOXIA SCI. PANEL, http://westcoastoah.org/history/ (last visited June 12, 2017).

8. Washington has a variety of CO_2-focused efforts aimed at curbing climate change, but I omit these here because they arose independently of the OA policies.

and modeling work: which state actions could have a measurable and meaningful impact on OA? Unless and until the scientific data are available to demonstrate the likely effect of such state action, it is unlikely that an agency will be willing to invest the time and political capital necessary to develop new rules. Even given a convincing demonstration of OA policy changes, effective social and economic adaptation to an inevitably changing ocean will require additional political leadership that has not yet arisen in Washington or elsewhere. Although basic science, modeling, and monitoring continue to be essential to address key unanswered questions in the OA policy landscape, it is clear that ocean chemistry will continue to change at an accelerating rate in the absence of governmental action to reduce inputs into the coastal ocean.[9]

In this short Article, I summarize the state of affairs—both politically and scientifically—in Washington and California regarding OA, the specific political motivations for action in Washington and California, and the lessons of the past several years that might benefit California and other jurisdictions. Then, I discuss a set of emerging issues at the science/policy boundary with respect to OA along the West Coast, via a list of key questions that interviewees raised, before concluding.

II. THE POLITICAL & SCIENTIFIC BACKDROP IN WASHINGTON AND CALIFORNIA

A. Recent Governmental Action

Washington and California have taken up OA policy as a result of different motivating factors, and these differences are informative for framing the next steps of OA policy in these states and elsewhere.

Washington's motivation for action on OA was a combination of a fortuitous political moment and an environmental problem that had started to harm the culturally important shellfish industry. The state's oyster industry used a single point of contact[10] to successfully advocate first for financial support from

9. *See generally, e.g.*, Gattuso et al., *supra* note 2. *See also* Scott C. Doney et al., *Ocean Acidification: The Other CO_2 Problem*, 1 ANN. REV. OF MARINE SCI. 169 (2009).

10. Bill Dewey, Director of Public Affairs for Taylor Shellfish. *See 2012 Panel Members and Meetings*, WASH. STATE DEP'T OF ECOLOGY, http://www.ecy.wa.gov/water/marine/oa/panel.html (last visited June 12, 2017)

the federal government[11] and then political support from the state government.[12] The then-governor was receptive to taking action on environmental issues in general, but likely especially so in 2012, which was her final year in office. By that time, data from NOAA's Pacific Marine Environmental Laboratory had become available and solidified the science of OA in the region.[13] In sum, industry drove action in Washington, and found willing partners in scientists and the state government.

In 2012, Washington created a Blue Ribbon Panel on Ocean Acidification, highlighting the shift in ocean chemistry as a political issue on the West Coast.[14] The Panel developed a set of political and scientific recommendations,[15] and the State successfully implemented a number of these recommendations in the succeeding years. Legislation in 2013 established the Marine Resources Advisory Council (MRAC) within the office of the Governor to coordinate work within the state and at the University of Washington on OA and to advise the Governor and state legislature on related matters.[16] The same year saw the legislature allocate funding to the Washington Ocean

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(highlighting Dewey's involvement on the Blue Ribbon Panel as the key shellfish industry representative).

11. In 2010, U.S. Senator Maria Cantwell's office helped provide financial support for real-time ocean-chemistry monitoring equipment that came to the industry's aid, particularly in Washington. *See Cantwell Introduces Bipartisan Bill to Establish National Ocean Acidification Monitoring Strategy*, MARIA CANTWELL U.S. SENATOR FOR WASH. (July 30, 2015), https://www.cantwell.senate.gov/news/press-releases/cantwell-introduces-bipartisan-bill-to-establish-national-ocean-acidification-monitoring-strategy.

12. In late 2011, then-Governor Gregoire initiated the Washington Blue Ribbon Panel on Ocean Acidification partly in response to industry entreaties. *See Washington Shellfish Initiative Ocean Acidification Blue Ribbon Panel Charter*, WASH. STATE DEP'T OF ECOLOGY (Feb. 21, 2012), http://www.ecy.wa.gov/water/marine/oa/charter.pdf.

13. *See, e.g.*, Richard A. Feely et al., *The Combined Effects of Ocean Acidification, Mixing, and Respiration on pH and Carbonate Saturation in an Urbanized Estuary*, 88 ESTUARINE, COASTAL & SHELF SCI. 442 (2010). *See also* Alan Barton et al., *The Pacific Oyster, Crassostrea Gigas, Shows Negative Correlation to Naturally Elevated Carbon Dioxide Levels: Implications for Near-Term Ocean Acidification Effects*, 57 LIMNOLOGY & OCEANOGRAPHY 698, 698 (2012).

14. *See* WASH. STATE BLUE RIBBON PANEL ON OCEAN ACIDIFICATION, OCEAN ACIDIFICATION: FROM KNOWLEDGE TO ACTION (2012), https://fortress.wa.gov/ecy/publications/documents/1201015.pdf [hereinafter KNOWLEDGE TO ACTION]. *See 2012 Blue Ribbon Panel on Ocean Acidification*, WASH. STATE DEP'T OF ECOLOGY, http://www.ecy.wa.gov/water/marine/oa/2012panel.html (last visited June 12, 2017).

15. KNOWLEDGE TO ACTION, *supra* note 14.

16. WASH. REV. CODE § 43.06.338 (2016).

Acidification Center at the University of Washington for research and monitoring purposes.[17]

A second element advancing the policy discussion in Washington was—and continues to be—lawsuits filed by the Center for Biological Diversity (CBD). These suits bear directly on the state's official reaction to its changing water chemistry. CBD filed the first OA-related lawsuit against the U.S. EPA in 2009, challenging that agency's approval of Washington's 2008 list of impaired waters (required under Section 303(d) of the Clean Water Act).[18] Although Washington was not the defendant in that suit or in subsequent ones, the CBD lawsuits put the state on notice that it was under national scrutiny for its handling of OA. The EPA eventually settled the suit, and, as a result of the settlement, the EPA requested data on OA and considered altering the national guideline for marine pH.[19] The EPA ultimately decided against the change, citing insufficient information to change the federal standard.[20] To date, no state has created a more stringent guideline.

In a more recent suit, CBD again lost on substantive grounds, largely as a result of a limited ability to tie global trends in OA to here-and-now violations of water quality criteria within state waters.[21] However, the group won an important procedural battle in the District Court for the Western District of Washington in 2015 by establishing causation and redressability in its suit over the EPA's 2012 approval of Washington's and Oregon's 2010 303(d) lists.[22] There, CBD successfully highlighted the possibility that state-level total

17. *Id.* § 79.105.150.

18. Meline MacCurdy, *EPA to Consider Ocean Acidification Under Section 303(d) of Clean Water Act*, MARTEN LAW (April 1, 2010), http://www.martenlaw.com/newsletter/20100401-cwa-ocean-acidification (citing Complaint at 2–3, Ctr. for Biological Diversity v. U.S. EPA, No. 2:09-cv-00670-JCC (W.D. Wash. filed May 14, 2009), 2009 WL 1390743).

19. Clean Water Act Section 303(d): Notice of Call for Public Comment on 303(d) Program and Ocean Acidification, 75 Fed. Reg. 13,537 (Mar. 22, 2010).

20. *See* Barton et al., *supra* note 13. *See also* EPA, MEMORANDUM ON INTEGRATED REPORTING AND LISTING DECISIONS RELATED TO OCEAN ACIDIFICATION (2010), https://www.epa.gov/sites/production/files/2016-01/documents/memo_integrated_reporting_and_listing_decisions_related_to_ocean_acidfication.pdf.

21. Ctr. for Biological Diversity v. U.S. EPA, 88 F. Supp. 3d 1231 (W.D. Wash. 2015).

22. Ctr. for Biological Diversity v. U.S. EPA, 90 F. Supp. 3d 1177, 1190 (W.D. Wash. 2015) (highlighting the possibility that state-level TMDLs could provide a remedy to coastal OA by reducing local inputs likely to exacerbate the global CO_2-driven trend).

maximum daily loads (TMDLs) could provide a remedy to coastal OA by reducing local inputs that are likely to exacerbate the global CO_2-driven trend.[23] More broadly, CBD's repeated lawsuits likely function as a constraint on the state's decision-making with respect to water quality criteria, insofar as they prevent the state from ignoring its changing ocean chemistry with impunity.

In contrast to Washington, California's initial motivation to tackle OA as a policy issue came from governmental (and politically connected non-governmental) scientists, who wanted to know if those same issues highlighted in Washington also mattered in California.[24] In particular, it was unclear whether OA in California was likely to be of a policy-relevant magnitude and whether OA threatened California's marine protected areas. The inquiry fell to the California Ocean Protection Council (OPC), a non-regulatory, cabinet-level body that coordinates administrative agencies and suggests legislative and policy actions on ocean issues in California.[25]

In 2013, the OPC asked the Ocean Science Trust (OST)—a non-profit entity created by state statute that works to integrate science and decision-making across state agencies—to commission a panel to study the effects of OA, as well as OA's linkages with hypoxia.[26] The OPC convened twenty leading experts in the field of OA from California, Oregon, Washington, and British Columbia, creating the West Coast Ocean Acidification & Hypoxia Science Panel (OA/H Panel).[27] At least four elements favored adding hypoxia to the mix of salient ocean

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23. *Id.* at 1195–96 (finding that CBD established causation and redressability, Judge Robart reasoned that "the relief CBD seeks—the listing of acidified-impaired waters—is the necessary forerunner to the establishment of TMDLs or other water quality improvement techniques, and, according to Congress, the appropriate means of achieving desired water quality.").

24. Although this assertion arose from interviews with OA/H Panel members, some additional support may be found in the fact that the California Panel's website lists the Washington Panel's report first among its linked "Key Documents." *See History,* THE WEST COAST OCEAN ACIDIFICATION AND HYPOXIA SCI. PANEL, http://westcoastoah.org/history/ (last visited June 13, 2017).

25. *See About the Council*, CAL. OCEAN PROT. COUNCIL, http://www.opc.ca.gov/about/ (last visited June 13, 2017). The OPC was created by the California Ocean Protection Act, Cal. Pub. Res. Code § 35500. *See infra* Part VI for a more detailed description of OPC and other key institutions in California and Washington that are relevant to OA.

26. F. CHAN ET. AL., THE WEST COAST OCEAN ACIDIFICATION AND HYPOXIA SCIENCE PANEL: MAJOR FINDINGS, RECOMMENDATIONS, AND ACTIONS 4 (2016).

27. *Id.* at 32.

focal points worthy of study: (1) Oregon's participation on the OA/H Panel—where commercial fisheries' losses due to hypoxia were a key concern; (2) public comment; (3) OPC and Ocean Science Trust's desire to evaluate OA in a multi-stressor context; and (4) then-OPC Executive Director Cat Kuhlman's significant background interest in water quality.[28]

One further enabling condition surrounding the OA/H Panel and California's involvement in OA as a policy issue was the existence of the California Current Acidification Network (C-CAN), a network for sharing OA information West Coast-wide.[29] The goal of C-CAN is to keep a wide variety of stakeholders informed, evenhandedly serving industry, academia, and relevant government scientists.[30] It may be that C-CAN facilitated a degree of consensus among a more diverse set of groups than was actually represented on the OA/H Panel, creating a background level political support for the panel and for policy action more generally.[31]

In 2016, the OA/H Panel finalized a set of recommendations,[32] similar to the recommendations made by Washington's Blue Ribbon Panel, creating a significant opportunity in California for political action on OA. Two new California state laws offer a partial response to the Panel's recommendations: AB 2139 (Williams, Ocean Acidification and Hypoxia Task Force)[33] and

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28. This list of rationales for including hypoxia comes from interviews with OA/H Panel participants and leadership.

29. CAL. CURRENT ACIDIFICATION NETWORK, VISION FOR DEVELOPMENT OF A WEST COAST NETWORK MONITORING MARINE ACIDIFICATION AND ITS LINKAGE TO BIOLOGICAL EFFECTS IN THE NEARSHORE ENVIRONMENT (2013), http://www.c-can.info/reference/C-CAN%20%20Vision%20Document%20Final.pdf.

30. *Id.* at 2.

31. For further discussion on this point *see* Sarah R. Cooley et al., *Getting Ocean Acidification on Decision Makers' To-Do Lists: Dissecting the Process Through Case Studies*, 28 OCEANOGRAPHY 198, 204 (2015).

32. CHAN ET AL., *supra* note 26. There is substantial overlap in the recommendations of the two panels, with the latter panel additionally highlighting (a) the desirability of understanding interactions among multiple stressors, and (b) the need for West Coast-wide collaboration on scientific and policy action. Jan Newton (a member of both Panels, and co-director of the Washington Ocean Acidification Center) generated a "crosswalk" between the recommendations of the Washington and California panels, presented to the Washington Marine Resources Advisory Council on April 25, 2016. *See* WASH. STATE DEP'T OF ECOLOGY, COALESCING SCIENCE FOR POLICY: PERSPECTIVES FROM THE WEST COAST OCEAN ACIDIFICATION AND HYPOXIA SCIENCE PANEL, http://www.ecy.wa.gov/water/marine/oa/20160425MRAChypoxiapanel.pdf (last visited June 13, 2017).

33. California Ocean Protection Act, CAL. PUB. RES. CODE § 35631 (West Supp. 2017).

SB 1363 (Monning, Ocean Acidification and Hypoxia Reduction Program).[34] These new laws are important mainly because they represent official recognition of OA as a challenge to coastal environmental quality, rather than for any new authority they provide. Nevertheless, the laws illustrate California's official recognition of OA and hypoxia-related issues, and of the state's emerging role in responding to these issues.

Washington's Blue Ribbon Panel and California's OA/H Panel illustrate the political momentum surrounding OA as an environmental issue and the growth of that momentum in recent years. The question is, what's next? How will Washington, California, or other states take action to mitigate and adapt to OA, and what are the politically feasible paths to these end goals?

B. Latitudinal Differences in Water Chemistry and Relevance for OA Politics

A key biophysical difference between California and Washington is relevant to the political and policy analysis that follows. On the whole, Washington's Puget Sound—where most of the state's human population is clustered[35] and the location of a significant portion of its aquaculture[36]—experiences OA to a somewhat greater degree than California or most other jurisdictions in the U.S. In part, this is because the calcium carbonate saturation state (Ω)[37]—a key factor for understanding

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(". . . the council may develop an ocean acidification and hypoxia science task force to ensure that decisionmaking is supported by the best available science.") The Act also includes mandatory language—subject to the availability of funding—for adaptive and potentially mitigative measures, including "ensure that criteria and standards for coastal water health to address ocean acidification and hypoxia are developed and informed by the best available science." *Id.*

34. California Ocean Protection Act, CAL. PUB. RES. CODE §§ 35630, 35632 (West Supp. 2017). ("[OPC] shall establish and administer the Ocean Acidification and Hypoxia Reduction Program," which includes demonstration projects of multiple stressors, inventories of candidate sites for mitigation, and other elements.).

35. *See generally* WASH. STATE OFFICE OF FIN. MGMT. FORECASTING & RESEARCH DIV., STATE OF WASHINGTON 2016 POPULATION TRENDS (2016), http://www.ofm.wa.gov/pop/april1/poptrends.pdf.

36. *See generally Overview Saving Puget Sound*, WASH. STATE DEP'T OF ECOLOGY, http://www.ecy.wa.gov/puget_sound/overview.html (last visited June 13, 2017).

37. This parameter reflects the chemical balance of compounds in seawater that affect species' ability to build shells and other hard parts. *See Ocean Acidification: Saturation State*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., https://sos.noaa.gov/Datasets/dataset.php?id=173 (last visited June 13, 2017). Higher

the impacts of changing pH on shell-forming marine life—is naturally lower at higher latitudes.[38] The building blocks of animals' shell material—calcite and aragonite—are less stable at lower Ω.[39] The deep, fjord-like shape of Puget Sound (setting up stratification and high-CO_2, low-Ω conditions at depth due to respiration), and a narrow continental shelf with significant upwelling (bringing low-Ω water to the surface) exacerbate the latitudinal effect.[40] By contrast, California's more open coastline is somewhat warmer (particularly in the Southern California Bight) and less stratified, and therefore tends to have overall higher ambient levels of Ω despite similar coastal upwelling in places.[41]

In practical terms, this means Washington's marine ecosystems are likely to be some years ahead of California in terms of exposure to OA. At present, we lack smoking-gun evidence of OA impacts in California of the kind that have led to political interest in Washington, where the well-organized shellfish industry quickly perceived that it was losing money as a result of OA and committed to raising and sustaining political attention to the issue.[42] In California, other aspects of changing ocean conditions—for example, increases in sea-surface temperature linked to outbreaks of harmful algal blooms (HABs),[43] as happened in 2015 and 2016—are indeed driving

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values of Ω mean that it is easier for marine species—such as oysters, mussels, corals, and many others—to build shells. *Id.* A value higher than 1 indicates an energetically favorable environment to build and maintain shell material, while a value less than 1 indicates an environment in which species have to expend energy maintaining shell material to prevent it from dissolving. *Id.* The negative effects of OA on shell-forming species has been one of the most visible impacts of OA to date, especially insofar as industries, including aquaculture (e.g., oysters) and tourism (e.g., coral reefs), face increasingly hostile ocean chemistry.

38. *See, e.g.*, Taro Takahashi et al., *Climatological Distributions of pH, pCO_2, Total CO_2, Alkalinity, and $CaCO_3$ Saturation in the Global Surface Ocean, and Temporal Changes at Selected Locations*, 164 MARINE CHEMISTRY 95 (2014).

39. Barton et al., *supra* note 13.

40. Debby Ianson et al., *Vulnerability of a Semienclosed Estuarine Sea to Ocean Acidification in Contrast with Hypoxia*, 43 GEOPHYSICAL RES. LETTERS 5793, 5793 (2016).

41. *See* Takahashi et al., *supra* note 38.

42. *See, e.g.*, *Gov. Inslee's Shellfish Initiative*, WASH. GOVERNOR JAY INSLEE, http://www.governor.wa.gov/issues/issues/energy-environment/shellfish (last visited June 13, 2017) (noting shellfish industry partnership with the state government, and noting OA as an issue area of concern).

43. A Harmful Algal Bloom is a phenomenon in which species of single-celled plant-like organisms ("algae" is the umbrella term for a large set of unrelated species that

economic losses (e.g., in the Dungeness crab fishery).[44] It may be that OA exacerbates these effects, but again, no smoking gun has yet surfaced.[45]

In light of these differences, existing political attention to the issue of OA in California appears to be largely a testament to the initiative of scientists, agency staff, and NGOs who have raised the issue and managed to develop and advance recommendations for new science and policy surrounding OA and hypoxia, some of which were recently incorporated into law.[46] However, it seems likely that sustained policy attention to these ocean issues will require a broader and deeper set of constituencies than has yet come to the table in California. Unless other and larger industries—such as tourism and commercial and recreational fishing—are engaged on the issue, it seems likely that the active constituency for action on OA will continue to be limited to a small coalition of actors with, in turn, limited political influence.

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meet this description; "alga" is the singular) grow rapidly and produce toxins that can harm humans and other animals. For NOAA's description of the issue and its effects, *see Harmful Algal Blooms*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., http://oceanservice.noaa.gov/hazards/hab/ (last visited May 9, 2017).

44. A compendium of regulations relevant to the 2016 Dungeness crab fishery closure is available online. *See Emergency Regulations to Keep Dungeness Crab Commercial Fishery Closed North of Point Reyes and Close Rock Crab Commercial Fishery North of Pigeon Point (Section 131, Title 14, CCR)*, CALIFORNIA DEP'T OF FISH & WILDLIFE, https://www.wildlife.ca.gov/Notices/Regulations/Emergency-Crab-Closure-2016 (last visited June 13, 2017). The archive of news bulletins from California Department of Fish and Wildlife regarding the 2015 and 2016 closures is available online as well. *See Invertebrates of Interest: Crabs*, CAL. DEP'T FISH & WILDLIFE, https://www.wildlife.ca.gov/conservation/marine/invertebrates/crabs (last visited June 13, 2017).

45. Put more bluntly: no one is yet losing money in California as a result of OA. As in Washington, California's most active industry on OA and related issues has been aquaculture. For example, Hog Island Oysters has been politically engaged on OA and has acquired two high-precision ocean chemistry sensors (Burkelators) to help adapt to changing ocean chemistry, demonstrating the degree to which the aquaculture industry is concerned with the issue. *See* Hog Island's description of its own work in the field, available at: *Ocean Acidification Research*, HOG ISLAND OYSTER CO., https://hogislandoysters.com/science-policy/ocean-acidification-research (last visited May 9, 2017). But by comparison, the role of Taylor Shellfish in Washington appears to have been much more substantial in terms of driving policy outcomes. For example, Bill Dewey, Director of Public Affairs for Taylor Shellfish, was a member of Washington's Blue Ribbon Panel, *see 2012 Panel Members and Meetings*, WASH. STATE DEP'T OF ECOLOGY, http://www.ecy.wa.gov/water/marine/oa/panel.html (last visited May 9, 2017), and was directly involved in Washington's political education surrounding OA as an environmental issue.

46. *See, e.g.*, CAL. PUB. RES. CODE §§ 35630–35632 (West Supp. 2017).

III. WASHINGTON AS A BLUEPRINT FOR CALIFORNIA

Below, I compare Washington and California along three axes—legal authority, the political framing of OA as an environmental issue and the relevant forums for developing OA policy—before analyzing the particular lessons of the Washington experience in terms of strategic mistakes to be avoided and missing constituencies. I then highlight important scientific unknowns, the use of Water Quality Criteria as a useful (but politically difficult) policy tool, and finally, the role communications and messaging plays for OA and related challenges.

A. Frameworks for Addressing OA in California and Washington

1. Authority

Legislative (or, by extension, agency) authority is not the factor that most immediately limits policy action on OA in either Washington or California. As in all states, these jurisdictions have broad authority to regulate water quality—including authority to do so more stringently than federal law demands[47]—and to fashion other remedies for environmental problems largely as they see fit.[48] In Washington, the only legislation explicitly providing authority for ocean acidification policy is that which created the Marine Resources Advisory Council (MRAC)—an advisory body with no permanent funding and few mandatory duties[49]—although the state's baseline authority to regulate water quality and air quality is sufficiently broad to encompass many of the proposed policy actions dealing with OA, hypoxia, and related chemical changes,[50] such as

47. *See, e.g.*, *Ten Ways*, *supra* note 5, for an extended discussion of this authority with respect to OA.

48. *See, e.g.*, WASH. REV. CODE §§ 90.48.260(a) (2016), (b); CAL. WATER CODE §§ 13001–13002 (West 2009).

49. WASH. REV. CODE § 43.06.338 (2016). *See infra* Part VI for additional information on MRAC.

50. Under the Washington State Water Pollution Control Act, WASH. REV. CODE § 90.48 (2016), the Department of Ecology has the authority to "prevent and control the pollution of the waters of the state." *Id.* § 90.48.030. Because "pollution" is broadly defined to include both point- and nonpoint-source pollution, *id.* § 90.48.020, Ecology has the authority to prevent and control nonpoint source pollution in the state. This authority extends to proactive actions to abate sources with "substantial potential" to

minimizing terrestrial nutrient inputs, stormwater, and greenhouse gases.[51] Despite broad authority to mitigate and abate nonpoint sources, Washington currently has no express provision for nonpoint source permitting.[52] California now has two laws expressly directing OPC to work on OA and related issues.[53] Moreover, California's Porter-Cologne Water Quality Control Act[54] expressly regulates point and nonpoint source pollution via waste discharge requirements, waivers of these requirements, and larger-scale basin plans (i.e. regional water quality control plan); these may include a variety of standards, regulations, and, if needed, prohibitions.[55]

Taken together, the existing set of legislative authorities mean that Washington and California, like many other jurisdictions, have ample authority to carry out point- and nonpoint-source water quality improvements to combat OA and hypoxia. California, however, unlike Washington, has a nonpoint source permitting program in place already,[56] which would be a valuable tool in any OA policy that aimed, for example, to reduce OA-exacerbating local-scale inputs into the coastal zone.

2. Viewing OA as a Political Issue

Jurisdictions must have political incentives for action on OA, or else they will not take such action. Consequently, the way in which OA is framed greatly affects how policy suggestions are

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pollute the state's waters. *Id.* A useful 2015 overview of the state's nonpoint source pollution plan (and related authorities) is available at http://www.ecy.wa.gov/programs/Wq/nonpoint/index.html.

51. *See Ten Ways*, *supra* note 5.

52. *See* WASH. STATE DEP'T OF ECOLOGY, PUBL'N NO. 15-10-015, WASHINGTON'S WATER QUALITY MANAGEMENT PLAN TO CONTROL NONPOINT SOURCES OF POLLUTION (2015), https://fortress.wa.gov/ecy/publications/documents/1510015.pdf (describing the state's efforts to control nonpoint source pollution, which notably do not include a permitting system).

53. *See supra* text accompanying notes 33–34.

54. CAL. STATE WATER RES. CONTROL BD., PORTER-COLOGNE WATER QUALITY CONTROL ACT WATER CODE DIVISION SEVEN AND RELATED SECTIONS (Apr. 2017).

55. CAL. STATE WATER RES. CONTROL BD., POLICY FOR THE IMPLEMENTATION AND ENFORCEMENT OF THE NONPOINT SOURCE POLLUTION CONTROL PROGRAM, RESOLUTION NO. 2004-0030 (2004). California's nonpoint source pollution plan, along with enforcement and implementation information, is available at http://www.waterboards.ca.gov/water_issues/programs/nps/plans_policies.shtml.

56. *Id.* at 4–5.

received and, in turn, whether they are implemented. In Washington and California—as elsewhere in the United States—state and local jurisdictions have some additional legal and policy options to mitigate OA.[57] However, it remains difficult to assess the benefits of these interventions relative to their costs, in part because there are few compelling demonstration projects underway.[58] Moreover, there has been little modeling or other research into the attribution of local versus global drivers of OA, or of the relative costs and benefits of different local source management measures and objectives, leading to an overall lack of specific information that would underpin regulatory or legislative action.[59] Some policy options, such as reducing nutrient inputs, may have benefits (and costs) in addition to their effects on OA.[60] If such follow-on benefits outweigh the costs at the appropriate spatial and jurisdictional scales, this kind of action might be a "no regret" solution—that is, one that the jurisdiction may find it reasonable to pursue even in the absence of OA. Finding actions with such co-benefits is a stated goal of SB 1363, newly enacted in California.[61]

Jurisdictions have no demonstrated ability to mitigate OA yet, and the incentives to undertake significant mitigation vary

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57. These include water-quality controls, land-use controls, nearshore remediation with eelgrass, direct CO_2 reduction, and a host of other options. For a full discussion of these in a legal context, *see, e.g.*, *Ten Ways*, *supra* note 5; R.P. KELLY & M. CALDWELL, CTR. FOR OCEAN SOLUTIONS, WHY OCEAN ACIDIFICATION MATTERS TO CALIFORNIA, AND WHAT CALIFORNIA CAN DO ABOUT IT 38 (2012) [hereinafter WHY OCEAN ACIDIFICATION MATTERS]; *and* R.P. KELLY & J. GROTE STOUTENBURG, CTR. FOR OCEAN SOLUTIONS, WASHINGTON STATE'S LEGAL AND POLICY OPTIONS FOR COMBATING OCEAN ACIDIFICATION IN STATE WATERS 51 (2012). *See also* CAL. PUB. RES. CODE §§ 35630, 35631, 35632 (West Supp. 2017).

58. CAL. PUB. RES. CODE §§ 35630, 35632(a)(1) (West Supp. 2017) requires such demonstration projects, but even if these were started immediately, their results would not be available for some years.

59. A notable and recent exception is R.A. Feely et al., *Chemical and Biological Impacts of Ocean Acidification Along the West Coast of North America*, 183 ESTUARINE, COASTAL & SHELF SCI. 260 (2016) (apportioning the responsibility for regional chemical changes between anthropogenic carbon inputs and respiration by organisms living in the water).

60. *See* WHY OCEAN ACIDIFICATION MATTERS, *supra* note 57 (discussing options and co-benefits).

61. CAL. PUB. RES. CODE § 35632(b) (West Supp. 2017) ("In advancing approaches in the program to remove carbon dioxide from seawater, the council shall consider approaches that provide multiple cobenefits, including, but not limited to, providing essential fish and bird habitat, improving water quality, and mitigating the impacts of sea level rise.").

by geography, driver, and the financial and political costs and benefits of any proposed action. Both as a strategic and as a practical matter, then, a reasonable next step for OA policy would be to (1) conceive of OA as part of a larger basket of water-quality issues that jurisdictions can (and may want to) address, together with hypoxia, nutrient pollution, warming, and perhaps sea-level rise, and (2) simultaneously work toward adoption and implementation of adaptation strategies to reduce social/economic impacts of OA and related ocean change. California has taken a significant step towards the first of these points by linking hypoxia and OA through the OA/H Panel. But West Coast-wide policy might benefit from seeing OA as a leading indicator of a changing ocean, broadening the tent under which diverse constituencies can fit. Put differently, OA might be useful to spur action on the suite of other ocean changes (warming, deoxygenation, stratification, etc.) that are interacting with OA in ways that we do not yet understand.[62] Because each of these changes or issues may have its own constituency—stemming from the costs of each to different industries, for example—explicitly linking these related changes is a way to frame regional/global ocean change as relevant to state and local policy.[63]

Nevertheless, it is important to be able to single out the particular effects of OA—as distinct from other aspects of ocean change—for making the case for specific policy and regulatory changes, budget appropriations, outreach, and other purposes. One needs to point to a specific phenomenon of concern, rather than simply "ocean change." It therefore makes sense to develop a decision-making model in which several key elements of ocean change—again, each perhaps having its own political constituency—are modules that fit together into a larger whole.

3. Forum

Washington's MRAC has reportedly been successful as a low-

62. For examples and discussion of multistressor impacts to particular organisms, *see generally* Nina Bednaršek et al., *Pteropods on the Edge: Cumulative Effects of Ocean Acidification, Warming, and Deoxygenation*, 145 PROGRESS IN OCEANOGRAPHY 1 (2016); Maria Byrne & Rachel Przeslawski, *Multistressor Impacts of Warming and Acidification of the Ocean on Marine Invertebrates' Life Histories*, 53.4 INTEGRATIVE AND COMPARATIVE BIOLOGY 582 (2013).

63. Perhaps this framing would be a reasonable topic for future communications and political science research.

pressure environment in which a set of interested parties with quite different interests can share views and data.[64] Members include state elected officials; tribal representatives; shellfish, recreational, and commercial fishing industries; other business interests, NGOs, government agencies (including state departments of Agriculture, Public Lands, Fish & Wildlife, Ecology, and others, as well as the U.S. EPA); and others.[65] The strengths of this body are its multidisciplinary expertise, its non-regulatory (and hence, low-stakes) nature, and its official status in the Governor's office, suggesting its importance as an advisory body.[66] Its weaknesses are a lack of dedicated funding and staff, and its non-regulatory role. Essentially, it has neither carrot nor stick with which to spur specific on-the-ground action, but instead generates value by developing a set of shared views across diverse sets of interests.

By contrast, California's OPC and State Water Resources Control Board (SWRCB)—a state agency with authority over both water quality and water quantity[67]—have greater legislative authority and far more permanence than the MRAC. Both are state agencies with specific mandates, permanent staffs, in-house expertise—and, in the case of SWRCB, regulatory authority.[68] With respect to the OPC, the non-regulatory nature of the agency can be helpful because it creates a non-threatening forum for hashing out differences among stakeholders (similar to the MRAC in Washington).[69] This function of the OPC will not change under the agency's new legal mandates regarding OA and hypoxia, although the explicit mandates the new legislation provides—the Task Force and the

64. Interview with Jan Newton, Co-Director, Wash. Ocean Acidification Ctr., in Seattle, Wash. (Sept. 21, 2016); Interview with Lisa Graumlich, Dean, College of the Environment, Univ. of Wash., in Seattle, Wash. (Sept. 19, 2016).

65. Information about the Council is available at http://www.ecy.wa.gov/water/marine/oceanacidification.html (last visited June 13, 2017); meeting documents and products are also available at the same site. *See also* WASH. REV. CODE § 43.06.338 (2016) (listing membership of the Council).

66. *See* WASH. REV. CODE § 43.06.338(1) (2016).

67. *See generally* CAL. STATE WATER RES. CONTROL BD., http://www.swrcb.ca.gov/about_us/ (last visited June 13, 2017).

68. *Compare* CAL. OCEAN PROT. COUNCIL, http://www.opc.ca.gov/about/ (last visited May 10, 2017), *with* CAL. STATE WATER RES. CONTROL BD., http://www.swrcb.ca.gov/about_us/ (last visited May 6, 2017).

69. Interview with Cat Kuhlman, former Exec. Dir., Cal. Ocean Prot. Council (Oct. 5, 2016).

Reduction Program[70]—seem likely to spur the agency to support new data-collection and recommendations that could point towards greater scrutiny of coastal contributors to OA.

It may be that a feedback loop between information supply and demand will develop among California's state agencies, such that OPC-supported science might suggest answers to key questions relevant for coastal mitigation strategies (e.g., eelgrass CO_2 sequestration, coastal nutrient mitigation), with SWRCB then demanding more specific information before developing regulations in response to OPC's findings. This interaction—which I emphasize is speculative, at this point—would not only create an iterative working relationship between those agencies, but would also significantly depend upon the existence of funding for carrying out the necessary science. If OPC's new legislative mandates come with the expectation of further and more permanent funding, it seems likely that California's focus on OA and hypoxia might benefit related scientific work on coastal ecosystems and ecosystem services in the coastal zone more generally.

B. Lessons for California and Other Jurisdictions

1. Strategic Mistakes in Washington that California Could Avoid

In moving forward on OA, California and other jurisdictions have the opportunity to use Washington as an example of how to create successful and actionable OA policies. Washington made few obvious mistakes during its 2012 Blue Ribbon Panel process and in the policy process that followed.[71] Apart from missing key constituencies—which I treat directly below in a separate subsection—the only repeatedly perceived mistakes were (1) the failure of the Washington process to tie OA to larger trends in a changing ocean, such as HABs, warming and the

70. See *supra* text accompanying notes 33–34.

71. Here I report a synthesis of perceived mistakes reported by my interviewees, listed above in note 1.

warm blob,[72] and the Pacific Decadal Oscillation[73] and El Niño[74]; and (2) the failure to tie OA to human communities and concerns surrounding social/ecological resilience.

In part, the first of these perceived mistakes is only a mistake in hindsight: the warm blob did not make its first appearance until late 2013, after the bulk of the Washington process had concluded.[75] The relevant data linking OA to HABs were lacking—and to some extent, remain thin[76]—and it is still not obvious how cyclical phenomena such as the Pacific Decadal Oscillation[77] relate to directional phenomena such as OA. California's process leveraged more recent data and insight when it linked OA with hypoxia;[78] the result of this more holistic framing of OA-plus-hypoxia was a political and scientific success, insofar as the outcome included two pieces of legislation and increased scientific attention. It seems that agencies,

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72. The "warm blob" was a large body of anomalously warm water in the Pacific Ocean near the West Coast of North America beginning in 2013. *The Blob: Warm Water off the Coast of the PNW and What it May Mean for Our Summer Weather—A Message From the State Climatologist*, MAY EVENT SUMMARY (Office of the Wash. State Climatologist), June 3, 2014, at 2–4. For a more technical discussion, *see* Nicholas A. Bond, *Causes and Impacts of the 2014 Warm Anomaly in the NE Pacific*, 42 GEOPHYSICAL RESEARCH LETTERS 3414 (2015).

73. The PDO is a phenomenon by which parts of the Pacific Ocean experience warmer or colder phases over periods of decades. *See* Nathan J. Mantua & Steven R. Hare, *The Pacific Decadal Oscillation*, 58 J. OCEANOGRAPHY 35, 37 (2002).

74. El Niño is the warm phase of the El Niño-Southern Oscillation (ENSO), a large-scale weather pattern that affects sea-surface temperatures, winds, and coastal upwelling patterns—and hence primary productivity—worldwide. For an explanation of the phenomenon, *see generally El Niño & La Niña*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., https://www.climate.gov/enso (last visited June 13, 2017).

75. *The Demise of the Warm Blob,* EARTH OBSERVATORY (Feb. 16, 2016), http://earthobservatory.nasa.gov/IOTD/view.php?id=87513.

76. Research on several species indicates that CO_2 can play a role in promoting toxicity in HABs. *See, e.g.*, J. Sun et al., *Effects of Changing pCO_2 and Phosphate Availability on Domoic Acid Production and Physiology of the Marine Harmful Bloom Diatom* Pseudo-Nitzschia multiseries, 56 LIMNOLOGY & OCEANOGRAPHY 829, 830 (2011); Fei-Xue Fu et al., *CO_2 and Phosphate Availability Control the Toxicity of the Harmful Bloom Dinoflagellate* Karlodinium veneficum, 59 AQUATIC MICROBIAL ECOLOGY 55, 55–56 (2010); Avery O. Tatters et al., *High CO_2 Promotes the Production of Paralytic Shellfish Poisoning Toxins by* Alexandrium catenella *from Southern California Waters*, 30 HARMFUL ALGAE 37, 41 (2013). However, this effect does not occur in all species or subspecific strains. *See* Theresa Hattenrath-Lehmann, et al., *The Effects of Elevated CO_2 on the Growth and Toxicity of Field Populations and Cultures of the Saxitoxin-Producing Dinoflagellate,* Alexandrium fundyense, 60 LIMNOLOGY & OCEANOGRAPHY 198, 208 (2015).

77. *See supra* note 73.

78. *See* Chan et al., *supra* note 26 (citing literature from 2012 and later).

industry, and others could make a stronger political case for action on OA if they discussed OA as part of a broader set of changing ocean conditions, to the extent this is feasible from a management and scientific perspective.

As to the second perceived mistake, even now (as of early 2017), only limited data linking OA effects to resilience and well-being in human communities are available.[79] The Washington process operated at the leading edge of scientific information available at the time—and indeed, developed new data on the fly in some instances—in an iterative, months-long interaction between scientific and policy voices.[80] To the extent that California and other jurisdictions seek to create effective institutions and policy aims, better developing the science to understand linkages between OA/hypoxia/ocean change and human well-being seems a necessary step. As yet, there is little information to act on. But in learning from the Washington process, California and other jurisdictions need not simply wait for such data to become available; instead, the OA policy process can drive the creation of the necessary information through such mechanisms as the OPC's new Task Force and Reduction Program.

2. Missing Constituencies

A common thread between Washington's experience with OA policy and California's emerging engagement on the issue is the narrow set of constituencies that have so far been involved. In both states, it has largely been academic and government scientists, together with aquaculture and to some extent conservation organizations, that have been responsible for raising the public profile of OA.[81] The only for-profit-sector actors pushing for policy changes have been from the

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79. *See, e.g.*, J.A. Ekstrom et al., *Vulnerability and Adaptation of US Shellfisheries to Ocean Acidification*, 5 NATURE CLIMATE CHANGE 207, 207 (2015); Sarah R. Cooley et al., *Nutrition and Income from Molluscs Today Imply Vulnerability to Ocean Acidification Tomorrow*, 13 FISH & FISHERIES 182, 185–86 (2012).

80. *2012 Panel Members and Meetings*, WASH. STATE DEP'T OF ECOLOGY http://www.ecy.wa.gov/water/marine/oa/panel.html (last visited June 13, 2017) (listing links to panel documents from 2012 meetings). One can track the progress of the Panel's analysis over the summer of 2012 through these documents.

81. *See supra* note 64 and text accompanying notes 73–74. Both Panels' websites list the members' affiliations; this is a good indication of the set of constituencies involved to date.

commercial aquaculture industry, which has so far played a larger role in Washington than in California. It will be necessary to engage a much broader and more diverse set of constituencies to build and support a durable set of policy efforts surrounding the changing coastal ocean. What follows is a selection of potential constituencies that respondents named as being missing from (or under-represented in) the state-level OA conversations so far.

- *Commercial and recreational fishing industries*. Having lost money and jobs in 2015–16 as a result of the warm blob and the attendant HABs[82]—more symptoms of a changing ocean—these industries now have an appreciation for the scale of the problems they are facing, and may be receptive to advocating for policy changes to mitigate or adapt to these challenges. To the extent that future science ties OA more directly to developmental or demographic failures in commercially valuable species, one might expect these industries to be increasingly interested in the issue.

- *Native American tribes*. Tribes in Washington have already been engaged on the issue, from the Blue Ribbon Panel to the MRAC and elsewhere.[83] This engagement will likely increase after the tribes' victory in the Culvert Case.[84] In California, engaging the tribes in a meaningful way has been particularly important with respect to marine protected areas,[85]

82. For a roundup of economic effects of these phenomena, *see West Coast Harmful Algal Bloom*, NAT'L OCEAN SERV., http://oceanservice.noaa.gov/news/sep15/westcoast-habs.html (last visited June 13, 2017).

83. KNOWLEDGE TO ACTION *supra* note 14 (listing membership); *Ocean Acidification and Washington State*, WASH. STATE DEP'T OF ECOLOGY, http://www.ecy.wa.gov/water/marine/oceanacidification.html (last visited May 6, 2017) (listing membership).

84. United States v. Washington, 827 F.3d 836 (9th Cir. 2016) (reaffirming the role of the treaty tribes in a suite of environmental policy decisions in Washington, most directly to do with culverts blocking salmon habitat). The Culvert Case has implications that go well beyond culverts and salmon; the logic underpinning the decision is that upstream state-level decisions that can lead to a decline in salmon runs—and therefore, a wide variety of land-use decisions well inland from the ocean—may violate tribes' treaty rights to salmon. *Id.* at 853.

85. *See, e.g.*, Dan Bacher, *The Tension Between the Yurok Tribe and the State of*

but in California (and elsewhere), tribes remain important potential voices on OA and ocean change more generally.

- *Commercial agriculture and related industries*. Agriculture is a huge and indispensable industry, and attempting to mitigate nonpoint source pollution stemming from agricultural activities has been a decades-long, conflict-laden effort with no clear endpoint in sight.[86] The industry is not likely to be receptive to further efforts to minimize runoff and nutrient pollution. However, several respondents in this project saw OA as a relatively new lens through which to talk about the effects of nutrient pollution, and perhaps a means of "chipping away at the vitriol" between environmental groups and agriculture. Agriculture has an economic incentive not to over-use fertilizer, the runoff of which is a potential contributor to OA.[87] Fertilizer costs money, and so there is a possibility of a solution benefitting all parties, but the economic risk of under-fertilizing fields—and hence losing potential crop yields—is often greater. OA as an additional potential effect of agricultural runoff does not alter this balance of incentives, which has remained in place for decades. Nevertheless, simply ignoring the agriculture industry is not an option for the future of OA policy, particularly to the extent that nutrient reductions are shown to be an effective tool for mitigating coastal OA and hypoxia. In sum, some OA constituents see

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California in Setting up the North Coast Marine Protected Areas, DAILYKOS (June 9, 2012), http://www.dailykos.com/story/2012/6/9/1098820/-Yurok-Tribe-challenges-MLPA-Initiative-s-terminally-flawed-science.

86. *See, e.g.*, Concerned Area Residents for Env't v. Southview Farm, 34 F.3d 114, 120 (2d Cir. 1994) (finding that manure from a confined animal feeding operation is a point source discharge for purposes of the Clean Water Act, and thus not subject to the Act's agricultural exemption, under which agricultural stormwater is a nonpoint source and therefore exempt from permitting requirements); League of Wilderness Defs. Blue Mountains Biodiversity Project v. Forsgren, 309 F.3d 1181, 1189 (9th Cir. 2002) (discussing the difference between a statutory Clean Water Act exemption for agricultural nonpoint source discharges and silvicultural pest control); Waterkeeper All., Inc. v. EPA, 399 F.3d 486, 490 (2d Cir. 2005) (reviewing "various challenges to [an EPA regulation] under the Clean Water Act in order to abate and control the emission of water pollutants from concentrated animal feeding operations.").

87. *See, e.g.*, KNOWLEDGE TO ACTION, *supra* note 14.

OA as a new lens through which to view the politics of agricultural runoff mitigation, but given the economic incentives at play, no clear framing or policy option currently exists for doing so.

- *Cities*. In the view of at least one high-level respondent, reducing nutrient loads from stormwater is an easier target than nutrient loads from agriculture, despite the high cost of the infrastructure required for this kind of city-scale mitigation. Existing federal programs under the Clean Water Act, and other major infrastructure financing, are likely to be useful in reducing runoff from urban areas (e.g., via combined sewer overflows), another no-regrets solution. A similar logic applies to publicly-owned treatment works (POTWs), which are point sources under the Clean Water Act.[88]

- *Larger environmental NGO communities*. Engagement from these groups to help develop specific, actionable policy on OA—and for broader policy response to a changing ocean—is important and likely achievable by linking issue areas and broadening the base of groups interested in ocean change. Joining such groups in a longer-term coalition would also be useful for improving the outreach and communications capacity of the OA constituency.

- *Federal agencies*. Although NOAA is involved in OA science (and to some extent, policy) via its OA program,[89] other federal agencies such as the Army Corps and the EPA have been less engaged. Reaching out to these agencies by speaking to their existing nondiscretionary duties may create greater cooperation and leverage existing resources. Moreover, the EPA is responsible for implementing

88. 40 C.F.R. § 122.2 (2016).

89. NOAA OCEAN ACIDIFICATION PROGRAM, http://oceanacidification.noaa.gov/ (last visited June 13, 2017).

the Clean Water Act[90], and may play a potentially important role in developing water-quality science, criteria, and standards. With the change of presidential administrations beginning in January 2017, it seems less likely that federal agencies will be willing to undertake discretionary duties toward these same ends.

- *Foundations*. One high-level respondent suggested that private foundations should be more involved with developing options to mitigate and adapt to coastal ocean change. The political and financial capital these groups bring could help build a more sustainable political coalition and policy infrastructure, particularly given the uncertainty of federal money in a new administration.

3. Important Scientific Unknowns

In California, as in Washington, state agencies are cautiously awaiting more concrete information about a few critical unknowns surrounding OA and related policy.[91] Of primary importance is the effect of local contributions to OA in coastal water bodies. Although a few scientific papers have addressed this topic preliminarily,[92] ongoing modeling efforts in California will help reduce the uncertainty about how much difference local contributions make to the overall OA picture. Similarly, demonstration projects and other emerging science will help specify how effective seagrass restoration/expansion and other

90. 33 U.S.C. §§ 1251–1387 (2012).

91. OPC staff participated in a recent forum at Stanford University focused on water quality criteria. CAL. OCEAN PROT. COUNCIL, MEETING SUMMARY, OCEAN ACIDIFICATION: SETTING WATER QUALITY GOALS 2016, http://www.opc.ca.gov/webmaster/_media_library/2017/01/OA_Uncommon_Dialogue.pdf. Also, OPC is funding six demonstration projects to fill these scientific gaps. *Ocean Protection Council Meeting of October 17, 2016—Item 4: Consideration of Authorization to Disburse Proposition 84 Funds*, CAL. OCEAN PROT. COUNCIL (Oct. 17, 2016), http://www.opc.ca.gov/item-4-consideration-of-authorization-to-disburse-proposition-84-funds/ [hereinafter *OPC Meeting Notes*].

92. *See* Richard A. Feely et al., *The Combined Effects of Ocean Acidification, Mixing, and Respiration on pH and Carbonate Saturation in an Urbanized Estuary*, 88 ESTUARINE, COASTAL & SHELF SCI. 442, 443 (2010); Richard A. Feely et al., *Chemical and Biological Impacts of Ocean Acidification Along the West Coast of North America*, 183 ESTUARINE, COASTAL & SHELF SCI. 260 (2016).

mitigating techniques might be.[93] As soon as these scientific data are available, discussions around mitigation and adaptation can become more specific and targeted. In particular, the SWRCB will very likely wait until hard data are available before considering revising pH or nutrient Water Quality Criteria, although OPC's Task Force and Reduction Plan may be able to drive the development of these kinds of data more quickly than would have otherwise happened.

4. Water Quality Criteria

Adopting new or revised Water Quality Criteria under the Clean Water Act is perhaps the most concrete way in which states could move to quickly mitigate the effects of OA, hypoxia, and related issues. However, water quality has been a policy battleground for decades, and OA is not likely to be the issue that tips the scales in favor of more comprehensively regulating water pollution from either point or nonpoint sources.[94] A key strategy question is whether there is sufficient political appetite in California (or elsewhere) to take on a revision of Water Quality Criteria, which Washington has so far declined to do. Some evidence points to the existence of such an appetite in California: its mention in the new OA legislation, discussion at high levels (OPC, SWRCB, SCCWRP), and conversation at the recent Stanford-sponsored Uncommon Dialogue, which focused on the water quality question.[95] Nevertheless, nonpoint source pollution is a political third rail in California and any other state in which agriculture (with which nonpoint source pollution is associated) is a major industry.[96] This seems unlikely to change, although as noted above in the discussion of missing constituencies, OA does provide a new lens through which to

93. For example, consider the six projects funded by OPC that are ongoing. *See OPC Meeting Notes*, *supra* note 91.

94. Several years ago, one source expressed this sentiment to me as (to paraphrase): "[K]ids are dying of selenium poisoning in their drinking water in the Salinas Valley, and you want to change Water Quality Criteria because oysters are somewhat unhappy in current ocean conditions?" This is an excellent moral, practical, and political question to keep in mind in any conversation surrounding water quality.

95. *See* discussion of this meeting, *supra* note 91.

96. For one of many discussions of the challenges of nonpoint-source pollution regulation in agricultural areas, *see* Mark Lubell, *Policy Perspective: Is Non-Point Source Pollution a Myth?*, CTR. FOR ENVTL. POL'Y & BEHAVIOR (Dec. 1, 2010), http://environmentalpolicy.ucdavis.edu/node/158.

understand the impacts of nutrient pollution on the coastal ocean and the human communities that depend upon it.

5. Communications and Messaging

A minority of Americans has even heard of OA,[97] let alone engaged on the issue. Consequently, a central challenge in building a political constituency for OA is adequately communicating the challenge to new and more diverse groups who are likely to have concrete interests in OA and in the ways it might be addressed. I suggest that "water pollution" is likely to be a successful framing for OA as an issue. "Air pollution" (as a frame) engenders far more policy support for greenhouse gas reductions than does "climate change" or related frames,[98] perhaps in part because of co-benefits of air-pollution reduction such as declines in asthma.[99] By analogy, "water pollution" may be an effective and accurate way of linking OA to larger water-quality issues, entraining a more varied suite of constituents, and building popular support for mitigation and adaptation. Such a framing perhaps rightly situates OA as an issue squarely within the purview of OPC, the Water Boards, and other agencies concerned with surface water quality in California, and can provide important links to co-benefits of OA reduction, such as mitigating eutrophication, hypoxia, and HABs. A concern with framing OA squarely as a water pollution issue is that doing so may make it more difficult to build support among those who are passionate about climate change (and therefore, perhaps OA) but have been less engaged on water-quality issues. Alternatively, "water quality" may be a useful frame for developing actionable policy elements that overlap with existing water-quality constituencies, while a broader "global change" frame is useful for connecting with climate-change and allied

97. *Summer 2012 Special Report: Public Awareness of Ocean Acidification*, THE OCEAN PROJECT, http://theoceanproject.org/wp-content/uploads/2012/09/Special_Report_Summer_2012_Public_Awareness_of_Ocean_Acidification.pdf. *But see* L.C. Frisch et al., *Gauging Perceptions of Ocean Acidification in Alaska*, 53 MARINE POL'Y 101, 105 (2015) (suggesting a majority of Alaskans had heard of OA).

98. M. Mossler et al., *How Does Framing Affect Policy Support for Emissions Mitigation? Testing the Effect of Ocean Acidification and Other Carbon Emissions Frames*, 45 GLOB. ENVTL. CHANGE 63, 63 (2017).

99. EPA, THE BENEFITS AND COSTS OF THE CLEAN AIR ACT, 1970 TO 1990 ES-4 (1997), https://www.epa.gov/sites/production/files/2015-06/documents/contsetc.pdf.

constituencies.[100]

HABs, too, are a crucial link to human well-being and to the fishing community specifically.[101] Talking about OA as a phenomenon of global ocean change related to HABs may bring agencies, industry, and others into the OA conversation to a greater degree. However, stronger science describing the interactions between OA and HABs is needed to effectively facilitate these communications.

IV. EMERGING ISSUES

Many open questions persist at the boundary of emerging OA science and policy. What follows is a summary of questions and ideas that respondents[102] suggested, which I include here to illustrate the frontiers along which policy actors are thinking.

1. In what ways can OA policy better link to existing agency mandates and programs leverages government investment in science and infrastructure, and therefore build a broader OA constituency? These mandates and programs include marine protected areas, National Estuarine Research Reserves, artificial reefs, oyster reefs (particularly with reference to flood control), aquaculture health and safety, and others.
2. What does social adaptation to OA look like? Can we define what it means to be prepared for change we can't prevent?
3. How can OA policy actions best dovetail with existing social priorities—for example by helping vulnerable human communities—to create no-regrets social/ecological policies?
4. What are the costs and benefits of legislative versus administrative action on OA, and how should we start thinking about information needs and constituency development for each? This seems an especially relevant question in the context of

100. An important note here: "climate change" (as a frame) can alienate constituencies. Alaska declined to participate in the West Coast OA/H Panel because of its explicit link to anthropogenic climate change.

101. As illustrated by the economic and social effects of the emergency crab fishery closure in 2016, *supra* note 40.

102. Respondents were the interviewees listed in *supra* note 1.

California's recent state legislation on OA, and the political changes at the federal level that will continue to emerge with the change of presidential administration in 2017, such that the choice of legislative versus administrative forum might differ depending on the jurisdiction in question.

5. With respect to administrative action and to water quality criteria in particular, what is the return-on-investment (in terms of OA harm reduction) we might expect, given the timelines, capital cost, and political cost of action?
6. What is the overall vision guiding the set of coastal environmental policies at issue here? What are the relevant targets at which OA/hypoxia actions should ultimately aim? We live in a changing world, and the management question is not how to maintain status quo, but instead, what we want our world to look like and how to get there.
7. What is the minimum set of information California needs to arrive at a decision on each of its likely OA policy decision points, and how can California realistically secure funding to develop the needed information?
8. Given the recent OPC-funded efforts in biogeochemical modeling to inform California policy questions,[103] developing social-science modeling or experimentation to integrate with those data would help determine least-cost ways of meeting ocean chemistry goals. For example, voluntary and incentive-based programs might achieve greater gains at a lower cost than regulatory approaches to OA, but finding out would require dedicated research on the matter.
9. How dependent are California and its science community on federal support—either political or financial—in moving OA science forward? Given the change of presidential administration in early 2017, are adjustments necessary? If so, what are likely sources of support for the necessary science?
10. How would California likely respond to a lawsuit from conservation organizations, similar to

103. *E.g.*, the six projects funded by OPC in October 2016, *supra* note 93.

previous suits against Washington State?

11. With respect to regional and international coordination, what effect will the Pacific Coast Collaborative have in the U.S. and Canada, and elsewhere? One attractive element of a larger, region-wide collaborative policy effort is the option of developing regional pollutant limits, as states in the Northeast have done with mercury emissions and other air pollutants.[104] Could this be a model for concerted West Coast CO_2 action? What will come of the International Alliance to Combat Ocean Acidification?
12. Relevant to the discussion surrounding networked resources and interactions among jurisdictions, it is worth noting that regional monitoring and science—standing alone—does not mitigate anything.
13. The costs of routine ocean chemistry monitoring continue to be high, and only specialized and reasonably well-funded entities such as wastewater dischargers or aquaculture firms (e.g., Taylor Shellfish and Hog Island Oyster Company) are likely to acquire high-precision monitoring tools.[105] Will the costs of routine monitoring drop with the development of tools such as the SeaFET and SAMI sensors, enabling citizen-science groups and other non-specialist users?
14. Relatedly, if the costs of monitoring come down and reliability increases, what ways might state water quality regulators start building monitoring

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104. *See* NESCAUM: NORTHEAST STATES FOR COORDINATED AIR USE MANAGEMENT, http://www.nescaum.org/ (last visited June 13, 2017). Interestingly, airborne pollutants such as mercury—and CO_2—can be eligible for Clean Water Act funding under § 319 because they become nonpoint source water pollutants. For example, the state of Michigan has a statewide Total Maximum Daily Load (TMDL) for nonpoint-source mercury, most of which comes from atmospheric deposition. MICH. DEP'T OF ENVTL. QUALITY, STATEWIDE MICHIGAN MERCURY TMDL PUBLIC REVIEW DRAFT ES-2 (2013), https://www.michigan.gov/documents/deq/wrd-swas-hgtmdl-draft_415360_7.pdf ("In Michigan, the majority of mercury pollution is a result of atmospheric deposition.").

105. For example, Sunburst Sensors LLC won an international competition—the $2 million Wendy Schmidt Ocean Health X-Prize—in 2015 for creating high-precision pH sensors that were also affordable. These units remain in prototype, but the company anticipates them being available commercially in 2017. When available, they will cost thousands of dollars. Telephone Interview with James Beck, Co-Owner, Sunburst Sensors LLC (May 10, 2017).

requirements into new NPDES permits/waste discharge requirements? Would these data be useful for biogeochemical monitoring of the kind envisioned for OA, hypoxia, and related issues?

15. A longer-term question is whether, and how, OA efforts might link to California's cap-and-trade greenhouse gas system for reducing CO_2. For example, it might be reasonable to create carbon credits for storage through eelgrass/seagrass restoration if the science were there to support it and the policy tools were in place to properly account for the additionality (or lack thereof) associated with such restoration efforts. Another high-level respondent referred to this linkage as a "secret hope," as it would legitimize OA mitigation while creating incentives (i.e., value) for action. Note that this policy path would bridge social adaptation and mitigation, while providing the co-benefits associated with seagrasses and wetlands.

V. CONCLUSION

Over the past decade, two identifiable waves of OA work have focused on (1) the existence of OA as a phenomenon,[106] and (2) drivers and consequences of that phenomenon.[107] The third wave of work—what to do about it—has built more slowly, but has a clear trajectory, with NOAA showing early interest, and then Washington, Oregon, California, Maine, Massachusetts, Maryland, and New York taking some amount of state-level action on OA in the past three years.[108] California, in particular, has both the scientific and the policy infrastructure in place to develop a sustained program on OA and related issues. Maintaining this focus will require new science to answer the key policy question quite reasonably posed by California

106. *E.g.*, Joan A. Kleypas et al., *Geochemical Consequences of Increased Atmospheric Carbon Dioxide on Coral Reefs*, 284 SCI. 118 (1999); THE ROYAL SOC'Y, OCEAN ACIDIFICATION DUE TO INCREASING ATMOSPHERIC CARBON DIOXIDE (2005), www.royalsociety.org/uploadedFiles/Royal_Society_Content/policy/publications/2005/9634.pdf.

107. *E.g.*, Scott C. Doney et al., *Ocean Acidification: The Other CO_2 Problem*, 1 ANN. REV. OF MARINE SCI. 169 (2009); Wei-Jun Cai et al., *Acidification of Subsurface Coastal Waters Enhanced by Eutrophication*, 4 NATURE GEOSCIENCE 766, 766 (2011).

108. Sarah R. Cooley, et al., *Community-Level Actions that Can Address Ocean Acidification*, 2 FRONTIERS MARINE SCI. 1, 7 (2016); Assemb. B. 10264, 2016 Leg. Sess. (N.Y. 2016) (enacted) (establishing the New York State ocean acidification task force).

agencies: can we really make a difference, and if so, how much? Long-term success will require a broader and more diverse political constituency than OA currently enjoys. Developing this constituency requires directly linking OA to human well-being, and in turn, conceiving of OA in the broader context of a changing ocean in which warming, hypoxia, HABs, and other related challenges simultaneously shift ecosystems and the services from which societies benefit.

VI. APPENDIX: KEY INSTITUTIONS

Among the institutions likely to be centers of gravity for future OA and related policy work along the West Coast are Washington's Marine Resources Advisory Council and Departments of Ecology and Natural Resources, and California's Ocean Protection Council and State Water Resources Control Board. These institutions are state governmental bodies with significant connections to academia, industry, NGOs, and federal agencies. As such, they may be able to overcome the chicken-or-egg problems that underlie many of the potential OA policy actions by setting up clear science-policy questions, generating relevant data, and then acting on those data in relatively short order.

A. Washington

The *Marine Resources Advisory Council* (MRAC)[109] is a non-regulatory (i.e., advisory) panel in the Washington Governor's office, created by statute[110] as a result of the Blue Ribbon Panel's recommendations. The purpose of the Council is to function as a forum for the exchange of views and information, without the immediate possibility of regulation.[111] Its role is to coordinate among stakeholders, advise the Governor and scientists at the University of Washington, seek funding to advance its own recommendations, and do public outreach and education.[112]

The *Washington OA Center* is a research entity at the University of Washington, created by statute following the Blue

109. WASH. REV. CODE § 43.06.338 (2016).

110. *Id.*

111. *Id.*

112. *Id.*

Ribbon Panel's recommendations to serve the state.[113] It coordinates research among University and allied scientists (e.g., NOAA, Department of Ecology) on OA and provides scientific input to the Marine Resources Advisory Council and the Governor's office.[114]

The *Washington State Department of Ecology* is the main state regulatory agency for environmental affairs.[115] The Department of Ecology facilitates work on OA in Washington through collaborations with NOAA, UW, and others.[116] The Department of Ecology also has regulatory authority over water and air quality in the State, and as such it combines functions that some other States have separated into different administrative agencies (e.g., California has separate air- and water-quality control agencies).[117] The Department of Ecology is therefore both a producer of OA information and a target audience for that same information.

The *Washington State Department of Natural Resources* (DNR) is the state agency that manages state trust lands to generate revenue and to preserve public natural resources including forests, water, and aquatic lands.[118] DNR's current strategic plan calls for developing OA mitigation and adaptation strategies, and its role as steward of aquatic lands could put the agency in an important position for testing—and developing incentives for—policy actions in nearshore habitat.[119]

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113. WASH. REV. CODE § 79.105.150 (2016) (establishing funding for the OA Center); *see also* Amanda Carr, *We Can Lead: Washington State's Efforts to Address Ocean Acidification*, 3 WASH. J. ENVTL. L. & POL'Y 188 (2013) (describing Washington's experience with OA policy); Amanda Carr, *Continuing to Lead: Washington State's Efforts to Address Ocean Acidification*, 6 WASH. J. ENVTL. L. & POL'Y 543 (2016) (describing Washington's progress in addressing OA and its influence on other States).

114. WASH. REV. CODE § 79.105.150 (2016).

115. *Id.* § 43.21A.020 (2016).

116. WASH. ADMIN. CODE § 173-98-010 (2013); *Water Quality Program*, WASH. STATE DEP'T OF ECOLOGY (2016), http://www.ecy.wa.gov/programs/wq/wqhome.html. For an example of such collaboration and facilitation, see the Department of Ecology's hosting of the Marine Resources Advisory Council's website and meetings, which feature content from NOAA, University of Washington, and many others. *Ocean Acidification and Washington State,* WASH. STATE DEP'T OF ECOLOGY, http://www.ecy.wa.gov/water/marine/oceanacidification.html (last visited June 13, 2017).

117. *See* CAL. AIR RES. BD., https://www.arb.ca.gov/homepage.htm (last visited June 13, 2017); CAL. STATE WATER RES. CONTROL BD., http://www.waterboards.ca.gov (last visited June 13, 2017).

118. WASH. REV. CODE § 43.30 (2016).

119. WASH. STATE DEP'T OF NAT. RES., 2014–2017 STRATEGIC PLAN 11, 35 (June 2014),

The *NOAA Pacific Marine Environmental Laboratory* is a federal laboratory, located in Seattle and focused on atmospheric and oceanographic research.[120] The lab has close ties to the University of Washington, the Department of Ecology, and related researchers, and its work has underpinned much of the scientific consensus surrounding OA in Washington.[121]

B. California

The *California Ocean Protection Council* (OPC) is a non-regulatory, cabinet-level body that coordinates administrative agencies and suggests legislative and policy actions on ocean issues in California. OPC is the entity through which the state's new OA legislation—AB 2139 (Williams, Ocean Acidification and Hypoxia Task Force) and SB 1363 (Monning, Ocean Acidification and Hypoxia Reduction Program)[122]—will work. Given the express role of the OPC in California's environmental apparatus, and especially given OPC's role in helping to convene the OA/H panel and as the locus of new statutory cover for OA work, it seems likely that OPC will be a center of gravity for OA-related work in California for the foreseeable future. In particular, OPC has recently funded six projects to follow up on the Panel's recommendations,[123] and will be using the new legislation to guide the implementation of the state's OA program over the coming years. Historically, OPC has had significant bond funding to invest in strategic research, on-the-ground restoration and environmental protection projects, and policy development (for example, Proposition 84[124] provided funding, supporting the first round of work under the new legislation). Future legislation will need to fund research and other OA-related activities if those activities—and OPC's role in

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http://file.dnr.wa.gov/publications/em_strategic_plan_2014_2017.pdf.

120. *About PMEL*, NOAA PACIFIC MARITIME ENVIRONMENTAL LABORATORY, https://pmel.noaa.gov/about-pmel (last visited June 13, 2017).

121. *E.g.*, Richard A. Feely et al., *Evidence for Upwelling of Corrosive "Acidified" Water onto the Continental Shelf,* 320 SCI. 1490, 1490 (2008).

122. CAL. PUB. RES. CODE §§ 35630–35632 (West Supp. 2017).

123. *OPC Meeting Notes*, *supra* note 91.

124. The Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act of 2006 (Proposition 84) passed in 2006, authorizing $5.388 billion. *Proposition 84 Overview*, CAL. NAT. RES. AGENCY, http://bondaccountability.resources.ca.gov/p84.aspx (last visited June 13, 2017).

the field—are to remain stable in the long run. OPC's partners include scientists in the field, the NOAA OA program, and the Pacific Coast Collaborative partners in other jurisdictions.

California Ocean Science Trust (OST) is a non-profit entity created by state statute, and guided by a Board of Trustees appointed by the Secretary for Natural Resources.[125] OST works to integrate science and decision-making across state agencies, and convenes the OPC's Science Advisory Team.[126] OST plans to continue working with the OPC and its Science Advisory Team to address some of the critical science needs raised by the OA/H Panel's recommendations. In light of its mission and past activities, OST could also potentially take on roles supporting the science task force required by the Williams bill.[127]

The *State Water Resources Control Board* (SWRCB) is a state agency—under the larger umbrella of the California Environmental Protection Agency (CalEPA)—with authority over both water quality and water quantity (allocation),[128] the former of which is particularly relevant for OA policy in California. Although authority for developing most terrestrial water quality objectives and plans falls to nine Regional Water Quality Control Boards, the state-level Board remains the primary responsible agency for the California Ocean Plan and the Enclosed Bays & Estuaries Plan, the two sets of standards, criteria, and implementation measures that are most relevant for OA, hypoxia, and related issues.[129] Consequently, to the extent there is a political appetite to develop or revise relevant Water Quality Criteria—and to the extent that compelling data exist on which to base such criteria—the SWRCB would lead that effort. Presumably, the SWRCB and the OPC would work together should new Criteria become necessary, although there is not currently a dedicated mechanism for such cooperation.

The *California Air Resources Board* (CARB) is a State

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125. *About Us*, CAL. OCEAN SCI. TR. http://www.oceansciencetrust.org/about-us/ (last visited June 13, 2017).

126. *Id.*

127. CAL. PUB. RES. CODE § 35631 (West Supp. 2017).

128. CAL. WATER CODE § 174(b) (West Supp. 2017).

129. In addition to the Plans stated, several amendments to other Plans were recently adopted or are under development. *See Ocean Standards*, CAL. STATE WATER RES. CONTROL BD., http://www.waterboards.ca.gov/water_issues/programs/ocean/index.shtml (last visited June 13, 2017).

agency—also under the umbrella of CalEPA—with authority to regulate greenhouse gases and other air pollutants.[130] It remains unclear how to link policy mechanisms for mitigating OA with California's larger efforts to reduce greenhouse gas emissions such as the current CO_2 cap and trade system.[131] To date, CARB has not been a major contributor to the OA/H policy process in California, but it remains conceptually important as a possible link to the state's mechanism for reducing the ultimate causes of OA.[132]

The *Pacific Coast Collaborative* is an association among California, Oregon, Washington, and British Columbia (with Alaska observing) formed in 2008[133] to better coordinate actions to address climate change and related effects, of which OA is one. This body is important for regional-scale coordination and for outreach to the wider international community.[134]

130. CAL. HEALTH & SAFETY CODE § 39003 (West 2009).

131. *Cap-and-Trade Program*, CAL. AIR RES. BD., https://www.arb.ca.gov/cc/capandtrade/capandtrade.htm (last visited May 7, 2017).

132. The current discussion draft of the 2030 cap & trade scoping plan highlights some potential work on eelgrass with respect to OA. CAL. AIR RES. BD., 2030 TARGET SCOPING PLAN UPDATE, DISCUSSION DRAFT 64, 67 (2016), https://www.arb.ca.gov/cc/scopingplan/2030target_sp_dd120216.pdf.

133. MEMORANDUM TO ESTABLISH THE PACIFIC COAST COLLABORATIVE (June 30, 2008), http://pacificcoastcollaborative.org/agreements/.

134. This outreach may take place through the recently announced International Alliance on OA. *See* INT'L ALL. TO COMBAT OCEAN ACIDIFICATION, http://oaalliance.org (last visited May 7, 2017).