Item 4b

CALIFORNIA OCEAN PROTECTION COUNCIL

Staff Recommendation
October 17, 2016

Potential seagrass buffering of Humboldt Bay to ocean acidification and implication for aquaculture industry and hatchery and eelgrass managers

Jenn Phillips, Program Manager

RECOMMENDED ACTION: Authorization to disburse up to $650,000 to Humboldt State University to understand and quantify seagrass buffering of estuarine acidification compared to the open ocean and explore the implication for oyster aquaculture development and operation and eelgrass management in Humboldt Bay

LOCATION: Humboldt Bay and Trinidad, CA

STRATEGIC PLAN OBJECTIVE(S): Climate Change and science-based decision making

---

EXHIBITS

Exhibit A: Support Letters

Exhibit B: Site Images and Map (with NOAA Sea Level Rise Viewer)

FINDINGS AND RESOLUTION:

Staff recommends that the Ocean Protection Council (OPC) adopt the following findings:
"Based on the accompanying staff report and attached exhibit(s), the Ocean Protection Council hereby finds that:

1) The proposed projects are consistent with the purposes of Division 26.5 of the Public Resources Code, the Ocean Protection Act.
2) The proposed projects are consistent with the Ocean Protection Council's grant program funding guidelines (Interim Standards and Protocols, August 2013).
3) The proposed project is not a 'legal project' that triggers the California Environmental Quality Act (CEQA) pursuant to Public Resources Code section 21068 and Title 14 of the California Code of Regulations, section 15378. If it were determined to be a 'legal project' under CEQA, the proposed project is categorically exempt from review under CEQA pursuant to 14 Cal. Code of Regulations Section 15306 because the project involves information collection, consisting of data collection, research, and resource

evaluation activities that will not result in a serious or major disturbance to an environmental resource."

Staff further recommends that the OPC adopt the following resolution pursuant to Sections 35500 *et seq.* of the Public Resources Code:

"The California Ocean Protection Council hereby approves the disbursement of up to $650,000 to Humboldt State University to understand and quantify seagrass buffering of estuarine acidification compared to the open ocean and explore the implication for oyster aquaculture development and operation and eelgrass management in Humboldt Bay.

This authorization is subject to the condition that prior to disbursement of funds, Humboldt State University shall submit for the review and approval of the Executive Director of the OPC detailed work plans, schedules, staff requirements, budgets, and the names of any contractors intended to be used to complete the projects, as well as discrete deliverables that can be produced in intervals to ensure the projects are on target for successful completion. All projects will be developed under a shared understanding of process, management and delivery."

PROJECT SUMMARY:

The overarching goals of this project are to advance understanding of the dynamics of ocean acidification along the open coast of the California Current System and within Humboldt Bay; to establish a bay-wide eelgrass monitoring program within Humboldt Bay to ensure that significant changes in its distribution or abundance are detected; and to contribute insight valuable to the operation and development of aquaculture and the management of eelgrass in Humboldt Bay.

Background & Justification

Ocean acidification (OA) is a change in the chemistry of seawater that is a direct result of excess atmospheric carbon dioxide from human activities dissolving into the world's oceans and increasing their acidity. Though the ongoing change in this fundamental property of seawater and its impacts on organisms and ecosystems has been the subject of a great deal of recent study, our understanding is far from complete. One of the most direct and well-understood effects of this increasing acidity is that it reduces the availability of carbonate that is needed by shell-producing organisms including bivalves to form and maintain their shells. Bivalve larvae are especially vulnerable to OA because of their limited energy reserves and the fact that aragonite, the form of calcium carbonate from which larvae build shells, is less resistant to dissolution. Because the availability of bivalve larvae for cultivation is a key limitation for bivalve aquaculture, the impact of OA on larvae makes it a significant and growing threat to this

sustainable and expanding industry that already produces over $220 million in farm gate[1] value annually and directly supports over 3,800 jobs on the U.S. West Coast. OA has already had substantial impacts on bivalve hatcheries in Oregon and Washington, affecting the availability of larvae for the whole West Coast. To adapt, many hatcheries have begun to monitor the carbonate chemistry of incoming seawater and when carbonate saturation is too low, buffering the water or shutting off intakes and temporarily running the hatchery on tanks of water pumped previously.

Because deep ocean circulation transports seawater to the surface that last came into contact with the atmosphere 30-50 years ago, OA will continue to intensify for at least that long. Upwelling circulation transports this deep, carbon-laden, nutrient-rich water toward the coast where it fuels the productivity of the California Current System, but also results in highly acidic water along the West Coast. Humboldt Bay appears to naturally buffer seawater to some extent. Data from sensors of the Central and Northern California Ocean Observing System (CeNCOOS) shows that while the pH of open coastal waters frequently drops below 7.75 during upwelling events in the spring and summer, the pH within Humboldt Bay remains 0.2-0.4 units higher than these open coastal source waters. Further, the buffering effect within Humboldt Bay is 0.2-0.3 pH units greater during low tide than high tide suggesting that this buffering may occur fairly rapidly. Eelgrass may play an important role in this buffering given that it is carbon-limited and grows rapidly in response to increased dissolved inorganic carbon (DIC), the extensive beds within Humboldt Bay, and recent work indicating that buffering by eelgrass may be significant in shallow bays like Humboldt. However, there are other potential drivers of the natural buffering in Humboldt Bay besides CO_2 uptake by eelgrass including: temperature changes that alter the carbonate equilibrium, CO_2 uptake by phytoplankton, and changes in alkalinity due to re-suspension of calcite in sediments by tidal currents. Measurements of additional carbonate chemistry parameters beyond pH will allow quantification of the buffering contributed by these potential mechanisms.

In addition to its natural buffering and conditions generally favorable for bivalve cultivation, Humboldt Bay is a good location for hatcheries because of its High Health Plan. This monitoring program ensures that bivalves grown there are free of damaging parasites and diseases, and has made Humboldt Bay one of the few places that can export seed oysters and clams anywhere on the West Coast. Producing larvae locally will reduce or eliminate the need to import them from other locations, further protecting its pathogen-free status. The Hog Island Oyster Company is currently building a hatchery on Humboldt Bay to produce oyster larvae and other major producers are considering renting space for hatcheries within an aquaculture

[1] The farm gate value is in principal the price received by farmers for their product at the location of farm. Thus the costs of transporting from the farm gate to the nearest market or first point of sale and market charges (if any) for selling the product are, by definition, not included in the farm gate prices.

industry and research park that the Humboldt Bay Harbor District is developing on the site of a former pulp mill. Though Humboldt Bay apparently provides some degree of natural buffering, the limitations of existing data (pH only, not carbonate saturation state), the sensitivity of bivalve larvae to OA, and the fact that OA will intensify for 30-50 years, create substantial uncertainty about the rapidity and severity of its impacts. Real-time carbonate chemistry data for Humboldt Bay and adjacent open coast will greatly reduce this uncertainty, and along with interpretation and collaboration with local scientists, will allow hatchery managers to more effectively anticipate, strategize, and adjust their operations to mitigate OA impacts.

This project will establish real-time monitoring of key carbonate chemistry parameters in Humboldt Bay and the open coast of northern California by installing high-resolution sensors, known as 'Burkolators' at the Hog Island Oyster Company's new hatchery facility in Humboldt Bay and at the open coast CeNCOOS station on Trinidad pier. Unlike existing OA-monitoring instruments in the region that measure only pH, the Burkolator quantifies dissolved inorganic carbon (DIC) and partial pressure of carbon dioxide (pCO_2) which are necessary to accurately determine the carbonate saturation state (Ω) of seawater – the value most directly related to the growth and development of bivalves since it indicates whether water is conducive to the deposition of new shell or corrosive. The Burkolator was essential in firmly establishing OA as a major cause of larval mortality in bivalve hatcheries, and now provides data that are actively used by managers of industrial and research hatcheries up and down the West Coast including Dabob Bay and Willapa Bay in Washington, Netarts Bay and Yaquina Bay in Oregon, and Tomales Bay and Carlsbad, California, and is also being incorporated into Ocean Observing Systems including CeNCOOS and PaCOOS (Pacific Coast Ocean Observing System).

This project will also establish Humboldt Bay's first bay-wide monitoring program for eelgrass – a clear scientific need given that this bay has the most extensive eelgrass in California, the ecological importance of eelgrass, its function as an indicator of water quality and bay health, as well as the multiple foreseeable impacts it faces including climate change, sea level rise, and aquaculture expansion. Specifically, a baseline survey of eelgrass in Humboldt Bay will be conducted that will facilitate ongoing monitoring with little or no additional external funding.

Project Objectives

Through the establishment of real-time carbonate chemistry monitoring of Humboldt Bay and the open coast of northern California, along with associated research, the objectives of this project focus on three key questions:

1) To what extent do physical and biological factors in Humboldt Bay alter carbonate parameters relative to open coastal waters and what impact do these alterations have on the variability in Humboldt Bay? This will help translate the long-term prognosis for OA in open coastal waters to conditions within Humboldt Bay.

2) To what extent do eelgrass beds alter DIC concentrations in Humboldt Bay? What impact does this alteration have on the magnitude and variability of pH in Humboldt Bay and how does this impact vary with eelgrass density and aquaculture development? This will help inform eelgrass management and aquaculture development.
3) How does saturation state (Ω) vary in the vicinity of new and potential bivalve hatchery facilities? Are there predictable spatial and temporal patterns of DIC or alkalinity that can be exploited by the aquaculture industry to minimize OA impacts? This will help guide aquaculture operations and facilities development to make use of natural buffering to improve growing conditions.
4) What are the abundance, distribution, and condition of eelgrass beds in Humboldt Bay? Are changes in eelgrass occurrence associated with changes in climate (air/water temperature, fog/cloud cover, sea level), sediment accretion/scour, pathogens, and/or long-line aquaculture? Establishing a baseline monitoring program for eelgrass will ensure that shifts or declines do not go unnoticed, will provide data essential for assessing drivers behind any changes, and will be valuable for ground truthing remote sensing surveys.

Data Sharing Plan

Environmental data generated by this project will be publicly available in real-time through the web portal of the Central and Northern California Ocean Observing System (CeNCOOS, www.cencoos.org) and the IOOS (Integrated Ocean Observing System) Pacific Region Ocean Acidification data portal (IPACOA; http://www.ipacoa.org).

Benefits

This project will quantify the extent to which OA is mitigated by physical and biological processes in Humboldt Bay, and will provide valuable insight into the long-term prognosis for aquaculture in the Bay as well as the progression of OA in the California Current System. With the nearest Burkolators 500 km north in Netarts, OR and 400 km south in Tomales Bay (and the nearest open coast sensor 1,100 km south in Carlsbad, CA), high-precision and real-time instruments at Trinidad and in Humboldt Bay will greatly enhance geographic coverage of monitoring of these key OA parameters by CeNCOOS and PaCOOS. In addition to maintaining the instrument and making data publicly available through the data portals of CeNCOOS and IPACOA (IOOS [Integrated Ocean Observing System] Pacific Region Ocean Acidification; see Data Sharing Plan), the project PIs will analyze and interpret data, and work with aquaculture managers to help them derive the greatest possible benefit. Because larvae are the bivalve life stage most sensitive to OA, hatcheries will benefit soonest and most directly from this project. The high value of shellfish hatchery product (larvae) and the skilled, living-wage jobs they support will be especially beneficial to the economically disadvantaged communities in this region. Improved understanding of spatial and temporal patterns of DIC and alkalinity, and the role of eelgrass DIC uptake will also help the aquaculture industry develop strategies for daily

operations that mitigate OA impacts by maximizing delivery of naturally buffered water to cultivated shellfish (and minimizing their exposure when seawater is most corrosive). At a regional scale, this project will support the production of pathogen-free larvae in Humboldt Bay, increasing the availability of larvae for West Coast bivalve culture. The data produced should also prove valuable in informing the decision of other bivalve producers considering the development of hatchery facilities in Humboldt Bay.

The natural buffering in Humboldt Bay may significantly mitigate the impacts of OA on hatcheries. To the extent that eelgrass contributes to this buffering, this would constitute yet another important ecosystem service provided by eelgrass – and one that directly benefits the aquaculture industry. Quantification of DIC uptake by eelgrass with and without aquaculture may also provide a valuable, integrated measure of the physiological status of eelgrass. By clarifying role of eelgrass in natural buffering in the Bay and facilitating the quantification of DIC uptake as a possible integrated metric of eelgrass condition, this project will contribute valuable information that can help inform management decisions about eelgrass and potential impacts on it from long-line cultivation of oysters.

Data generated by this project will be utilized by a range of stakeholders, and the availability of these instruments will lay the foundation for further OA research with long-term, far-reaching impacts. Especially in conjunction with the HSU Marine Lab's new OA facilities, the Burkolator will facilitate further research on OA and its ecological impacts on the West Coast, including interactions between eelgrass and bivalve aquaculture.

This project will also generate rigorous measurements of eelgrass abundance and distribution throughout Humboldt Bay and its critical slough habitats. The results of the survey will serve as a foundation for ongoing monitoring that can be maintained without further external funding. This ongoing monitoring will provide vastly improved insight into the causes of any changes in eelgrass abundance and distribution and will allow better-informed management decisions.

Further, AB 2139 (Williams) references the West Coast Ocean Acidification and Hypoxia Science Panel report action items, and asks OPC to work on these action items as well as to report back to the Council annually on what has been done to address ocean acidification. The proposed work will directly address AB 2139, specifically to – in coordination with relevant federal, state, and academic entities – identify gaps between the monitoring of ocean acidification and hypoxia and management needs, and the actions necessary to address these gaps. In addition, SB 1363 (Monning) highlights actions that can be taken at local and regional scales through eelgrass restoration, protection, and associated monitoring to implement strategies and consider carbon dioxide removal and hypoxia reduction in future habitat planning.

Project Timeline: 2 years

PROJECT FINANCING:

Staff recommends that the Ocean Protection Council (OPC) authorize encumbrance of up to $650,000 to Humboldt State University to understand and quantify seagrass buffering of estuarine acidification compared to the open ocean and explore the implication for oyster aquaculture development and operation and eelgrass management in Humboldt Bay.

Ocean Protection Council	$650,000
Humboldt State University	$48,000
University of California, Davis	$13,000
TOTAL	**$711,000**

The anticipated source of funds will be from the Ocean Protection Council's appropriation of the Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act of 2006 (Proposition 84). Proposition 84 authorizes the use of funds for purposes consistent with Section 35650 of the Public Resources Code, establishing the California Ocean Protection Trust Fund (Pub. Res. Code § 75060(g)). Under Section 35650(b), Ocean Protection Trust Fund monies may be expended for projects authorized by the OPC that are identified as appropriate Trust Fund purposes, as specified. The project is consistent with the Trust Fund purposes as discussed in the following section.

Leverage of OPC funds

Humboldt State University and University of California, Davis are providing match funds for this project.

CONSISTENCY WITH CALIFORNIA OCEAN PROTECTION ACT:

The proposed project is consistent with the Ocean Protection Act, Division 26.5 of the Public Resources Code, because it is consistent with trust-fund allowable projects, defined in Public Resources Code Section 35650(b) as projects which:

- Provide monitoring and scientific data to improve state efforts to protect and conserve ocean resources
- Provide funding for adaptive management, planning, coordination, monitoring, research, and other necessary activities to minimize the adverse impacts of climate change on California's ocean ecosystem, including, but not limited to, the effects of sea level rise, changes in ocean productivity, and ocean acidification on coastal and ocean habitat, wildlife, fisheries, chemistry, and other key attributes of ocean ecosystems and

> to increase the state's understanding of the ocean's role in carbon sequestration. Adaptive management strategies, planning, research, monitoring, or other activities shall be designed to improve the management of coastal and ocean resources or aid the state to adapt to climate change impacts.

This proposed project has the potential to improve the management and promote active conservation and restoration of California's seagrass habitat based on the additional service this habitat provides in storing carbon and locally ameliorating ocean acidification. This information and project will promote coordination between the State Coastal Conservancy and the OPC who are both interested in these questions and local ocean acidification strategies, and it will also promote coordination and knowledge sharing with the federal government, academia, industry, tribes, and the NGO community. This data will be shared publicly and widely to promote such discussion, coordination, and advancement of this mitigation strategy.

CONSISTENCY WITH THE OPC'S STRATEGIC PLAN:
This project implement Focal A: Science-based decision-making and Focal Area B: Climate change. The dominant cause of ocean acidification is atmospheric carbon dioxide emissions; therefore, this is an issue that is global in nature and will require global solutions. At the same time, the pace and magnitude of OA on the West Coast requires that we explore and employ regional and local strategies and actions as we continue to reduce CO_2 emissions. These strategies must acted upon quickly and be informed by the best available science to offer the possibility of forestalling at least some of negative consequences of OA on ecosystems and communities.

CONSISTENCY WITH PROPOSITION 84 (The Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act of 2006; Public Resources Code §75060(g)
This project is consistent with the purposes outlined in Proposition 84, specifically it includes the development of scientific data needed to adaptively manage the state's marine resources and reserves. OA data of high precision, quality, and frequency that is collected inside and outside of seagrass habitat across the state will allow managers to understand the extent to which seagrass removes CO_2 from seawater so we can understand where restoration and conservation of such habitat will successfully and meaningfully mitigate OA.

CONSISTENCY WITH THE OPC'S GRANT PROGRAM FUNDING GUIDELINES:
The proposed project is consistent with the OPC's Grant Program Funding Guidelines for Proposition 84 funds, in the following respects:

Required Criteria

1. Directly relate to the ocean, coast, associated estuaries, or coastal-draining watersheds: *This project will be carried out in Humboldt Bay and off the coast of Trinidad, CA.*
2. Support of the public: *See Exhibit A*
3. Greater-than-local interest: *Given that this project is addressing a global challenge like ocean acidification and will help local communities and industry adapt to and plan for these ocean changes, it will garner attention across the state and findings will be shared broadly with seagrass researchers, industry, and managers working on ocean acidification, sustainable fisheries, and aquaculture.*

Additional Criteria

4. Improvements to management approaches or techniques: *This project would help managers discern and consider the extent to which seagrass habitat should be conserved and/or restored for OA mitigation in addition to the many other services this habitat provides. This project will also allow hatchery managers to more effectively anticipate, strategize, and adjust their operations to mitigate OA impacts.*
5. Resolution of more than one issue: *By monitoring and studying seagrass habitat for OA benefits, we will better equipped and informed to smartly manage such habitat which will have benefits for fisheries and aquaculture.*
6. Leverage: *See 'Project Financing' section above.*
7. Timeliness or Urgency: *This project should be funded now given the urgency of identifying local solutions to ocean acidification, the Panel's recommendations which must be addressed expediently, and given that the instrumentation can be outfitted at Hog Island Oyster Company's new hatchery facility which is currently being built.*
8. Coordination: *This project involves a local tribe and two academic institutions.*

COMPLIANCE WITH CEQA:

The proposed project is not a 'legal project' that triggers the California Environmental Quality Act (CEQA) pursuant to Public Resources Code section 21068 and Title 14 of the California Code of Regulations, section 15378. If it were determined to be a 'legal project' under CEQA, the proposed project is categorically exempt from review under CEQA pursuant to 14 Cal. Code of Regulations Section 15306 because the project involves information collection, consisting of data collection, research, and resource evaluation activities that will not result in a serious or major disturbance to an environmental resource. Staff will file a Notice of Exemption upon approval by the OPC.