

Recommendations for co-located monitoring of marine harmful algal blooms, ocean acidification, and hypoxia

September 14-15, 2023
Workshop Proceedings



*Karen McLaughlin
Jayme Smith
Martha Sutula*

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Karen McLaughlin, Jayme Smith, and Martha Sutula
Southern California Coastal Water Research Project, Costa Mesa, CA

January 2026

Technical Report 1462

ACKNOWLEDGEMENTS

This document was produced with funding from the Ocean Protection Council Grant #C0831023. The authors thank the workshop participants for their engagement and sound recommendations, communicated through this workshop summary.

CITATION

This report should be cited as: McLaughlin K., J. Smith, and M. Sutula. 2026. Recommendations for co-located monitoring of marine harmful algal blooms, ocean acidification and hypoxia, September 14-15, 2023, workshop proceedings. Technical Report 1462. Southern California Coastal Water Research Project. Costa Mesa, CA.

TABLE OF CONTENTS

Acknowledgements.....	i
Citation	i
Table of Contents.....	ii
Table of Figures	iii
Table of Tables	iii
Executive Summary.....	iv
Introduction	1
Workshop Goals	2
Workshop Structure and Session Summaries	2
Session 1. What are pathways by which OAH and HABs interact?	2
Session 2. Summarize existing monitoring and recommend core indicators	6
Session 3. Prioritizing Investments: What Are the Low Hanging Fruit versus Long -Term Investments?	12
Appendix A. Workshop Agenda.....	14
Appendix B. Workshop Participants	16

TABLE OF FIGURES

Figure 1. Overview of factors linking OAH and HABs.....	4
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TABLE OF TABLES

Table 1. Examples of existing OAH chemistry and algal biomass monitoring in existing regional programs.....	8
Table 2. Examples of existing HAB monitoring across different programs.	9
Table 3. Summarized list of workshop priorities, ranging from near-term (low hanging fruit), to long term investments.....	12

EXECUTIVE SUMMARY

California's coastal ecosystems are facing intensifying pressures from global change phenomena. Marine harmful algal blooms (HABs), species that proliferate to high densities (causing nuisance conditions) or produce toxins, are intensifying and have emerged as critical threat to ecosystem health, with frequent and widespread impacts to wildlife and humans through direct toxicity, economic loss to fisheries and aquaculture, and interruptions to tribal cultural practices, artisanal harvesting, and recreation. Global climate change is causing increasing ocean acidification and hypoxia (OAH) and rising sea temperatures. Understanding the commonalities in environmental factors influence these stressors, how they interact, and how marine species and ecosystems respond is essential for effective, adaptive management. While both HABs and OAH have received significant management attention in California, monitoring of these two issues have been largely siloed.

The California Ocean Protection Council (OPC) expressed interest in identifying optimal strategies and early priorities to break down the siloes between OAH and HABs monitoring. In response, this workshop brought together scientists, resource managers, and monitoring program leads in a 2-day workshop in at the Southern California Coastal Water Research Project (SCCWRP) in Costa Mesa, California to explore the connections between HABs and OAH, and to assess how California's existing monitoring frameworks might be adapted or enhanced to address these emerging challenges. Towards this end, the goals of the workshop were to:

- (1) Summarize the status of our understanding on how OAH and HABs can interact.
- (2) Summarize existing OAH and HAB monitoring and recommend key indicators to incorporate into existing monitoring efforts.
- (3) Recommend strategies to optimize or leverage effort for existing monitoring frameworks to enhance collocated monitoring of HABs and OAH.

Significant Workshop Findings and Recommendations

The workshop resulted in two major findings. First, there was consensus among workshop participants that while there is evidence that coastal eutrophication may be influencing both OAH and HABs via enhanced anthropogenic nutrient loads, more research is needed to understand where this may be occurring along the coastline. Many other factors that shape HAB community dynamics, including the role of gradients in OA vis-a-vis other environmental drivers, are poorly understood. A comprehensive understanding of these linkages can be achieved through strategic investments in monitoring, experimental studies, and numerical modeling.

Second, a diverse and regionally distributed network of OAH and HAB monitoring programs collectively span the California's coastal waters from north to south, but the programs are topically siloed. Fundamental temporal and spatial gaps exist that, if filled, would strengthen this network to make it more integrative and effective to support adaptive management. OAH monitoring is generally "climate"-oriented, involving ship-based sampling conducted quarterly to annually across large spatial scales to capture long-term trends. In contrast, HAB monitoring resembles "weather"-type monitoring, with daily to weekly sampling focused at specific coastal or pier-based locations to track more localized and short-term events. Moorings provide another layer of data, offering high-frequency (hourly to daily) observations similar to weather monitoring, though they are limited to a few locations. However, current shore-focused HAB monitoring misses the occurrence of offshore phenomena. Ship-based monitoring of OAH conducted during only summertime or less frequency misses the high frequency variability at weekly seasonal and interannual timescales inherent in OAH regimes inshore.

The workgroup highlighted three near-term priority investments

- (1) Prioritize longevity and consistency across all fixed shore and ship-based stations (including both HABMAP and marine Regional Monitoring Program ship-based transects for a core set of parameters: CTDs (temp, salinity and O₂), bottle chemistry (pH, TA, and a consistent set of macro and micronutrient).
- (2) Integrate total and particulate toxins via LCMS at fixed inshore and ship-based stations.
- (3) Widen the practice of taking eDNA archival samples that can be processed when resources are available or when an event occurs that requires reconstruction.

Long-term investments include:

- (1) Add strategic, fixed offshore HAB stations to strategically pair with coastal stations.
- (2) Addition of pCO₂/DIC sensors to fixed HAB stations (at surface and at depth), focusing on depth resolved information.
- (3) Investments in community led observing, particularly focused on recreational fisheries at risk for both HABs and OAH (e.g., Dungeness crab, shellfish, aquaculture)

INTRODUCTION

California's coastal ecosystems are facing intensifying pressures from global change phenomena. Marine harmful algal blooms (HABs), species that proliferate to high densities (causing nuisance conditions) or produce toxins, are intensifying and have emerged as critical threat to ecosystem health, with frequent and widespread impacts to wildlife and humans through direct toxicity, economic loss to fisheries and aquaculture, and interruptions to tribal cultural practices, artisanal harvesting, and recreation. Global climate change is causing increasing ocean acidification and hypoxia (OAH) and rising sea temperatures. Understanding environmental factors that influence these stressors, how they interact, and how marine species and ecosystems respond is essential for effective, adaptive management. While both HABs and OAH have received significant management attention in California, these efforts have been largely siloed. However, increasing evidence suggested that HABs and OA are intrinsically linked both in drivers, interactions, and their biological effects.

To date, research has provided insights into many of the factors that control HAB dynamics and only a few of those studies have included OA. Similarly, research on OA has examined ocean biogeochemistry and its impacts on marine resources and over the past 10 years has expanded into multi-stressor research to include hypoxia and warming alongside OA. A nuanced understanding of how HABs and OA interact to affect coastal resources (e.g., aquaculture, wild fisheries, and tourism) is needed to develop research products and management plans that protect reliant industries and human communities. HABs and OA are symptoms of complex environmental management issues with drivers at multiple spatial and temporal scales. Collaboration and coordinated efforts among scientists, managers, and stakeholders will be required to disentangle these complexities. With sufficient understanding, forecasts, vulnerability assessments, and other products can be produced to communicate impacts and risks and to develop holistic solutions. Growing our understanding of the linkages between HABs and OA requires strategic investments in observations, experimental studies, and numerical modeling.

The OPC expressed interest in identifying optimal strategies and early priorities to break down the siloes between OAH and HABs monitoring. In response, this workshop brought together scientists, resource managers, and monitoring program leads to explore the connections between HABs and OAH, and to assess how California's existing monitoring frameworks might be adapted or enhanced to address these emerging challenges.

WORKSHOP GOALS

The Southern California Coastal Water Research Project Authority (SCCWRP) convened a 2-day workshop of fifteen leading researchers, including leading experts in HAB ecology, eDNA approaches for HAB monitoring, HAB physiology and interactions with OA and, California monitoring programs. Participants identified the biological and environmental indicators that could be integrated into current OAH or HAB monitoring efforts to better detect and understand these interactions. The workshop also focused on developing actionable recommendations for incorporating these indicators into ongoing monitoring programs, with an emphasis on practical implementation. Towards this end, the specific goals of the workshop were to:

- (1) Summarize the status of our understanding of how OAH and HABs can interact.
- (2) Summarize existing OAH and HAB regional monitoring and identify what key indicators could be incorporated into existing OAH or HABs monitoring efforts.
- (3) Prioritize recommendations for potential strategic investments and ways to optimize or leverage effort of existing monitoring to enhance collocated monitoring of HABs and OAH.

WORKSHOP STRUCTURE AND SESSION SUMMARIES

The first workshop session focused on identifying and summarizing the pathways by which OAH and HABs interact. The second session focused on summarizing existing monitoring and recommending core indicators. The third session focused on identifying investments that could be considered “low-hanging fruit” versus long-term substantial investments.

Session 1. What are pathways by which OAH and HABs interact?

Session 1 began with a discussion of the complex and potentially synergistic interactions between HABs and ocean acidification and hypoxia (OAH). The linkage between OAH and HABs takes two forms: 1) **environmental factors** that result in the increase of HABs and OAHs, via pathways of anthropogenic nutrient loading and increased primary production as well as changes that enhance primary production (increased temperature, irradiance, etc.) and 2) **mechanisms by which OAH may be enhancing HABs**.

There was consensus among workshop participants that while there is evidence that coastal eutrophication may be influencing both OAH and HABs via enhanced anthropogenic nutrient loads, more research is needed to understand where this may be occurring along the coastline. Many other factors that shape HAB community dynamics, including the role of gradients in OA vis-a-vis other environmental drivers, are poorly understood. A comprehensive understanding

of these linkages can be achieved through strategic investments in monitoring, experimental studies, and numerical modeling.

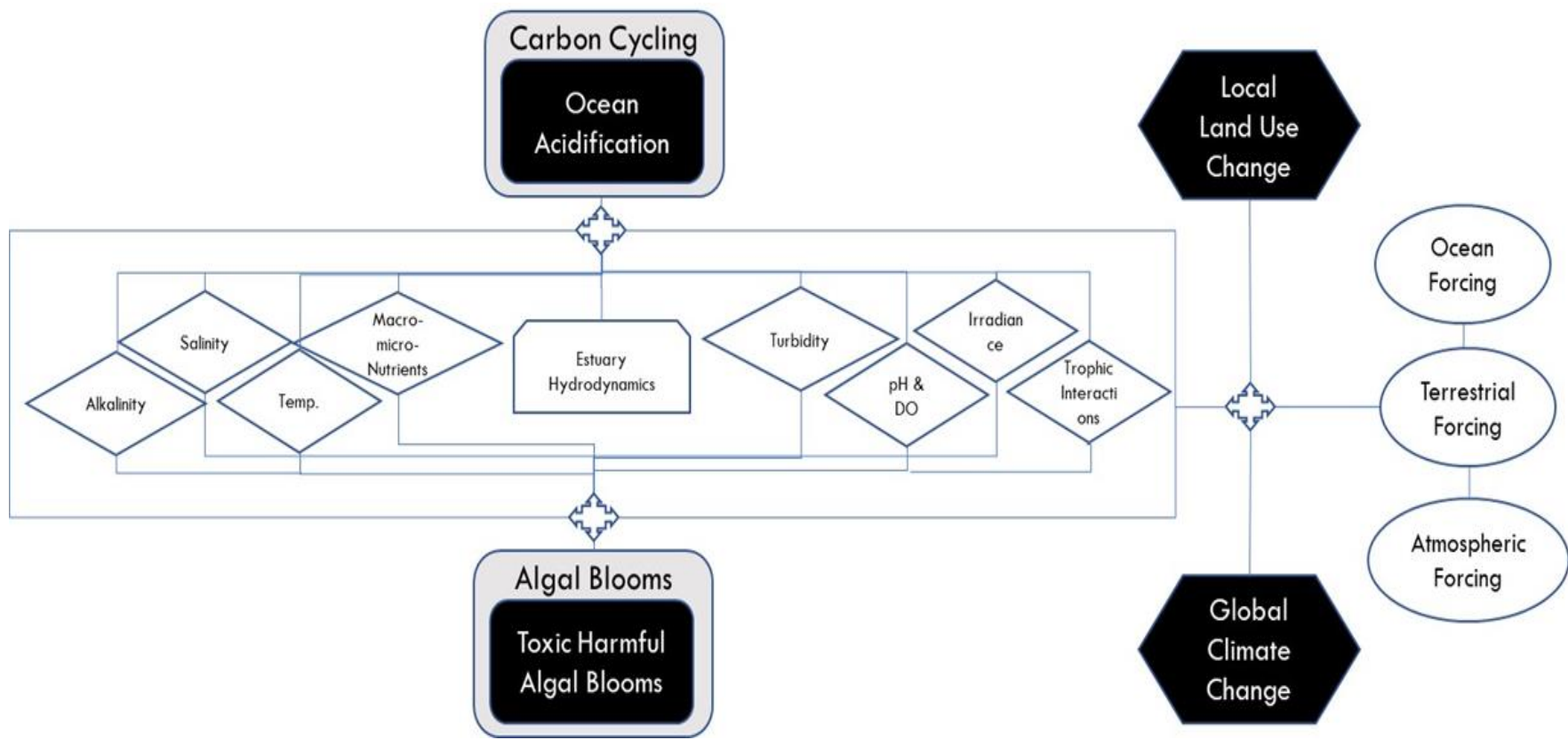


Figure 1. Overview of factors linking OAH and HABs.

Environmental Factors Increasing OAH and HABs. Human activities are altering the environment in ways that promote both HABs and OAH, increasing their magnitude, frequency, and extent (Figure 1). The degree to which this is occurring in California coastal waters is dependent on sites-specific factors, and the science to document where this is occurring is still evolving.

The window of opportunity for toxic HABs are increased by favorable salinity, temperature, and alkalinity; ample supply of nutrients; calm water and stratified conditions; and plenty of irradiance. Thus, increased anthropogenic nutrient loading, rising temperatures, and hydromodification can all favor the increased frequency and severity of coastal HABs. Eutrophication that promotes both OAH and HABs are frequently linked with excessive anthropogenic N loading, although co-limitation occurs with other macro- and micronutrients. Triggers of toxin production are less well-understood and can vary greatly by species and environment.

Ocean carbonate and oxygen chemistry are controlled by an equilibrium between respiration and photosynthesis. The rates at which CO₂ and O₂ are added and removed from the system through air-sea exchange (aeration and degassing) and hydrodynamic processes that control the source and mass flux of DIC O₂ (i.e., oceanic deep water source concentrations and advection, and coastal circulation). O₂ solubility is modulated by temperature and salinity, while the resultant pH changes for a given CO₂ flux is also dependent on alkalinity which is altered by processes such as the mixing of fresh and salt water in coastal zones.

Factors that increase the magnitude and extent of HABs are also inextricably linked to the carbon cycle and controls on OAH particularly in cases of coastal eutrophication-driven acidification. Global change is resulting in an increased frequency, extent, and magnitude of both HABs and OA in many regions because it enhances the specific environmental drivers that promote eutrophication (e.g., increased temperature, atmospheric CO₂, irradiance, or hydromodification).

Impacts of OAH on HABs. Multiple pathways exist by which OAH could impact toxic HABs, but how these pathways impact the growth and toxin production of the various HAB species present in California waters is poorly understood.

Ocean acidification *may enhance HAB toxicity*, either by increasing toxin production or by affecting the accumulation of toxins in environments where algal cells experience stress (e.g., nutrient limitation or slower growth). Most available evidence from California pertains to domoic acid (DA) from *Pseudo-nitzschia* (albeit for a limited number of *Pseudo-nitzschia* species), with limited understanding of other HAB taxa.

OAH may also influence the *community composition* of phytoplankton, potentially selecting for HAB species. For example, dinoflagellates may gain a competitive advantage in acidified

conditions due to differences in carbon uptake strategies. These mechanisms are still under investigation, and model-based hypothesis testing may help guide future lab experiments.

Nutrient dynamics further complicate the picture. Laboratory results on how nutrients and OAH interact to affect toxin production are mixed and highly variable by species and strain. Nutrient depletion (e.g., phosphorus, silicate and/or micronutrients) often coincides with increased DA accumulation, although it's unclear whether this reflects increased toxin synthesis or slower cell division. Regional differences in nutrient availability, anthropogenic nutrient loading, OAH dynamics, and species-specific responses add another layer of complexity.

Food web impacts are a critical but understudied area. OAH may affect the physiology and vulnerability of organisms that serve as vectors for toxins, altering trophic transfer, and potentially exacerbating ecosystem impacts. For instance, hypoxic events may concentrate toxins in benthic sediments, where they could be stored or reintroduced into the food web. Models may help trace these dynamics and evaluate whether observed impacts stem from highly toxic blooms or a confluence of vulnerable species and food web pathways.

Spatial and temporal dynamics are another critical component, especially regarding the connectivity between offshore and nearshore communities. Upwelling delivers both nutrients that fuel blooms and low-oxygen waters that contribute to hypoxia. However, the cross-shore gradients in physical oceanography and their influence on bloom development and transport are not well characterized, particularly in suboxic offshore zones where monitoring is sparse.

Session 2. Summarize existing monitoring and recommend core indicators

Federal and state partnerships have maintained a diverse and regionally distributed network of OAH and HAB monitoring programs that collectively span California's coastal waters.

OAH Monitoring. For OAH monitoring, these efforts include NOAA's West Coast Ocean Acidification (WCOA) cruises, which conduct offshore transects every 2 to 5 years along the entire U.S. West Coast. The cruises gather a broad suite of chemical (e.g., DIC, pH, alkalinity, nutrients, oxygen) as well as other data that represent the lower trophic ecosystem and OA specific biological indicators (e.g., plankton abundance and taxonomy, crab and shell dissolution data).

In Southern California, CALCOFI (California Cooperative Oceanic Fisheries Investigations) contributes long-term data through quarterly cruises across Southern and Central California, incorporating extensive chemistry and biological sampling, including ichthyoplankton taxonomy and eDNA.

Inshore of CalCOFI, the Southern California Bight Regional Monitoring Program, conducted by wastewater treatment agencies to support compliance with their National Pollutant Discharge

Elimination System (NPDES) permits, conducts quarterly sampling focused on CTD casts of pH, O₂, salinity, temperature, and chlorophyll fluorescence.

Table 1. Examples of existing OAH chemistry and algal biomass monitoring in existing regional programs

PROGRAM	GEOGRAPHY	FREQUENCY	BOTTLE DATA	CTD DATA	CARBONATE CHEMISTRY CALCULATION
WCOA	CA Coast	One time cruise of onshore-offshore transects, summertime, every 2 to 5 years	Approximately every 10 m DIC, TA, Silicate, PO4, NO3, NO2, NH4	T, S, O ₂ , chl-a	Bottle
ACCESS	Northern and Central California	Three times a year, every year, during the summer	Surface and depth (~200 m) pH, TA, Silicate, PO4, NO3, NO2, NH4	T, S, O ₂ , chl-a	Linear model using O ₂ , T, S fit with bottle data
SCB Regional Monitoring Program	Southern California	Quarterly, every year, with participation in Bight Regional Monitoring Program every 5 years	Surface and depth (~100 m) only during Bight surveys. pH, TA, ammonium	T, S, O ₂ , pH (potentiometric), chl-a	Linear model using O ₂ , T, S fit with bottle data
CalCOFI	CA Coast	Quarterly, every year	Vertical resolution TBD pH, TA, Silicate, PO4, NO3, NO2, NH4	T, S, O ₂ , chl-a	TBD, archived
Trinidad Head Line	Northern California	Monthly to Quarterly	Vertical resolution TBD Chl-a, Silicate, PO4, NO3, NO2, NH4	T, S, O ₂ , pH, chl-a	

In Central California, the Applied California Current Ecosystem Studies (ACCESS) program samples three times per year, emphasizing shell condition monitoring, CHL fluorescence, and CTD casts. Farther north, the Trinidad Headline sampling program conducts seasonal cruises with similar parameters. Together, these complementary efforts provide a statewide observational foundation that supports understanding of OAH chemistry—positioning California as a leader in coordinated coastal monitoring.

Marine HAB Monitoring. California’s harmful algal bloom (HAB) monitoring network is made up of several coordinated programs that provide coast-wide coverage and varying levels of biological and environmental detail (Table 2).

Table 2. Examples of existing HAB monitoring across different programs.

Program	Frequency	HAB Indicators	Other Indicators
CDPH Shellfish Biotxin Monitoring Program	Weekly - biweekly	Tissue toxin concentrations	None
CDPH Phytoplankton Monitoring Program	Weekly - biweekly	Qualitative cell abundances	None
Cal-HABMAP Pier Monitoring	Weekly	Cell abundances, particulate DA	Temperature, Dissolved micronutrients, chlorophyll-a
Pier based Automated shore stations	Continuous	None	CTD with chlorophyll, oxygen and pH at select stations
California IFCB Network	Continuous	Cell abundances	None
C-HARM	Continuous	Probabilities of DA and cells	None

The California Department of Public Health (CDPH) conducts two foundational programs: the Shellfish Biotxin Monitoring Program, which collects samples twice monthly at most locations to test for algal toxins in shellfish, and the Phytoplankton Monitoring Program, which tracks the relative abundance of key HAB taxa at similar frequencies, leveraging a community science approach.

The California Harmful Algal Bloom Monitoring and Alert Program (Cal-HABMAP), a longstanding collaborative program funded by the California Ocean Observing Systems (CeNCOOS and SCCOOS), conducts weekly sampling at sentinel sites statewide, analyzing algal community composition, chlorophyll, domoic acid, and nutrients. High-frequency data is

supported by automated shore stations at most of the pier locations, which provide chlorophyll-a concentrations as well as basic water quality parameters via CTD. Additionally, the recently implemented Imaging FlowCytobot (IFCB) network, provides hourly to daily observations of phytoplankton community composition at select sites. These sites primarily capture nearshore HAB dynamics, often missing the initiation of blooms that form offshore.

Additionally, the California-Harmful Algal bloom Risk Mapping (C-HARM) project delivers daily model outputs forecasting 3-day risk of domoic acid presence and *Pseudo-nitzschia* cell concentrations for Central and Southern California. Together, these programs form a complementary and increasingly integrated network that supports early detection, risk forecasting, and management response to HABs along the California coast.

OAH and HAB monitoring programs differ significantly in their temporal and spatial approaches. OAH monitoring is generally “climate”-oriented, involving ship-based sampling conducted quarterly to annually across large spatial scales to capture long-term trends. In contrast, HAB monitoring resembles “weather”-type monitoring, with daily to weekly sampling focused at specific coastal or pier-based locations to track more localized and short-term events. Moorings provide another layer of data, offering high-frequency (hourly to daily) observations similar to weather monitoring, though they are limited to a few locations. These distinctions reflect the different scientific and management needs associated with monitoring OAH versus HAB phenomena. However, current shore-focused HAB monitoring misses the occurrence of offshore phenomena that are predicted but not observed by C-HARM. Ship-based monitoring of OAH conducted during only summertime or less frequency misses the high frequency variability at tidal, weekly seasonal and interannual timescales inherent in OAH regimes inshore.

Co-locating monitoring of HABs and OAH offers valuable opportunities to identify potential correlations between environmental stressors and bloom dynamics across time and space. By integrating data on water chemistry, biological communities, and toxin presence, co-monitoring can help reveal whether OAH conditions are associated with increased HAB frequency, intensity, toxin production, or changes in species composition. It can also illuminate how spatial patterns—such as upwelling zones or cross-shore gradients—might link OAH variability with bloom development and ecological impacts. These insights are essential for improving early warning systems, informing risk assessments, and guiding adaptive management strategies. Opportunities exist to improve this co-location within both marine monitoring communities, specifically:

For HABMAP stations, improved water chemistry might involve pH and O₂ sensors and discrete bottle samples analyzed for total alkalinity and pH, in addition to a basic suite of nutrients (nitrate+nitrite, ammonium, phosphorus, and silicate) that are already being monitored. Targeted investments to locate moored real time sensors like Imaging FlowCytobot (IFCB)

offshore, O₂, salinity, temperature and a basic suite of nutrients would enhance understanding of the origin and evolution of HABs.

For regional marine monitoring programs that routinely monitor OAH, a number of parameters can be considered. First of all, most of these programs are already measuring bottle chemistry for pH and TA and have CTD data that characterize important temperature, oxygen, and salinity conditions. Standardizing the suite of nutrients in bottle samples could also help to characterize conditions pre-, during and post-bloom event.

Some programs are already measuring algal biomass indicators, including chlorophyll-a, particulate CHN, and/or algal biovolume, and can be expanded to include characterization of the phytoplankton community including HAB taxa. Incorporation of the assessment of the phytoplankton community would provide better context to understand HAB dynamics. In particular, eDNA estimates of phytoplankton community relative abundance, with qPCR methods to estimate quantitative abundance of priority HAB species, would enhance understanding of baseline conditions. These eDNA and other 'omics methods are becoming increasingly accessible but require more investment to standardize if used within these programs.

Toxin monitoring can begin with single target methods like ELISA, progressing toward long-term implementation of LC-MS to detect a full suite of toxins including domoic acid (DA), diarrhetic shellfish toxins (DST), and saxitoxins (PSTs). SPATT samplers may also be integrated. Finally, toxin monitoring is expensive, so we encourage the analysis of archived toxin filters based on the abundance of HAB species in the community data. In addition, archived eDNA and other 'omics methods can support retrospective analyses and emerging research needs.

Community science programs are another venue by which co-located observations could be enhanced. Of the programs assessed, only the Shellfish Biotoxin Monitoring Program and Phytoplankton Monitoring Program provide opportunities for community engagement via the submission of samples to the CDPH. As co-monitoring enhancements are explored, opportunities for community led observations should also be considered.

However, while co-monitoring can detect patterns and associations, it cannot by itself determine the underlying biological or chemical mechanisms driving these relationships. Experimental research and numerical modeling are needed to test hypotheses and uncover causality behind observed patterns. Specific examples were discussed and included:

- Multi-stressor experimental research is needed on how OA affects nutrient uptake across different species and nutrient forms (e.g., NO_x, NH₄, urea), as the kinetics of these processes remain largely unknown.

- Strategic investments in monitoring and experimental studies should target refinements in OAH and HAB model development, validation, and hypothesis testing. Advances have been made for *Pseudo-nitzschia* modeling, but more work is needed to refine this modeling approach and expand to other marine HAB species.
- Organismal responses to combined HAB and OAH stressors, such as variation in toxin uptake, retention, depuration, and overall physiological impacts, need to be explored, especially in terms of acute versus chronic exposures and species-specific susceptibility.
- Other critical research areas include shifts in vector species distributions due to changes in physiologically viable habitat under OAH conditions, and the accumulation, persistence, and trophic transfer of toxins like domoic acid in benthic sediments—areas where kinetic data are also lacking. These knowledge gaps highlight the importance of special studies to inform monitoring, modeling, and management efforts.

Session 3. Prioritizing potential investments: what are the low hanging fruit versus long -term investments?

Workshop participants then prioritized potential monitoring investments based on several key criteria to guide decision-making, summarized in Table 3.

- Value of the observations to resource managers
- The degree to which observations are linked to OAH or HABs stressors
- Scientific feasibility of the measurements
- Time required to detect an OAH signal
- Overall cost-effectiveness

Table 3. Summarized list of workshop priorities, ranging from near-term (low hanging fruit), to long term investments.

<p>Near-term Priorities</p> <ul style="list-style-type: none"> • Prioritize longevity and consistency across all fixed shore and ship-based stations (including both HABMAP and marine Regional Monitoring Program ship-based transects for a core set of parameters: CTDs (temp, salinity and O2), bottle chemistry (pH, TA, and a consistent set of macro and micronutrient). • Invest in total and particulate toxins via LCMS at fixed inshore and ship-based stations • Widen the practice of taking eDNA archival samples that can be processed when resources are available or when an event occurs that requires reconstruction.

Long-term Investments

- Add strategic, fixed offshore HAB stations to strategically pair with coastal stations.
- Addition of pCO₂/DIC sensors to fixed HAB stations (at surface and at depth), focusing on depth resolved information.
- Investments in community led observing, particularly focused on recreational fisheries at risk for both HABs and OA (e.g., Dungeness crab, shellfish, aquaculture).

APPENDIX A. WORKSHOP AGENDA

Day 1

8:30 Breakfast

9:00 Welcome and introductions, workshop goals, review of agenda (Jayme Smith)

9:30 Session 1: Status of our understanding of OA-HABs interactions

- **Key monitoring and research questions related to HABs and OAH** (Karen McLaughlin/Megan Williams)
- **NOAA's National HABs and OA research and monitoring priorities** (Maggie Broadwater, Erica Ombres)
- **Discussion:** Synthesis of knowledge of interactions

12:00 Lunch

10:30 Session 2 How should we monitor for OA/HABs and how does this align with an inventory of current effort?

To supplement monitoring, what additional studies are needed to understand HAB-OA interactions?

4:30 Summary and adjourn

5:30 Group Dinner

Day 2

8:30 Breakfast

9:00 Recap (Jayme Smith)

9:15 Session 3: Filling in the Gaps and Prioritizing

What can we add to existing OA monitoring programs with little additional cost/effort? (high impact/low effort)

What can we add to existing HABs monitoring programs with little additional cost/effort? (high impact/low effort)

Prioritizing:

- What could/should be added to monitoring programs now?
- What should be added in the future?

12:00 Lunch

1:00 Recap findings, and identify next steps

2:00 Adjourn

APPENDIX B. WORKSHOP PARTICIPANTS

Clarissa Anderson (SCCOOS)

Holly Bowers (SJSU)

Maggie Broadwater (NOAA HABs Program)

David Caron (USC)

Bill Cochlan (SFSU)

Alex Harper (CenCOOS)

Justine Kimball (OPC)

Raphe Kudela (UCSC)

Karen McLaughlin, SCCWRP

Stephanie Moore (NOAA Northwest Fisheries Science Center)

Erica Ombres (NOAA Ocean Acidification Program)

Misty Peacock (Northwest Indian College, Washington)

Jayme Smith (SCCWRP)

Martha Sutula (SCCWRP)

Steve Weisberg (SCCWRP)