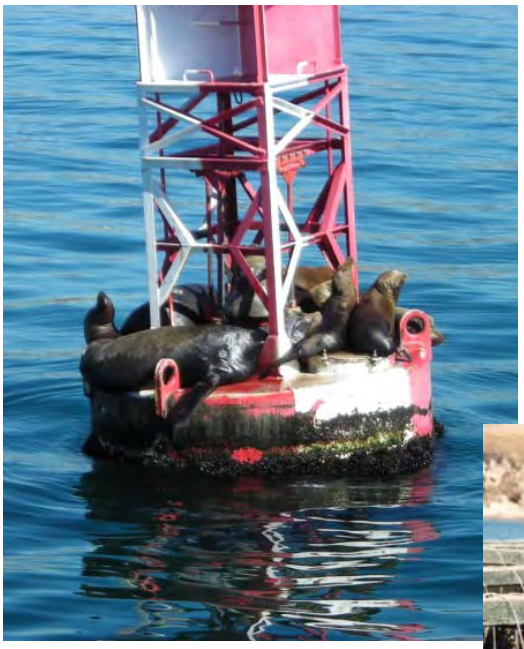
THE SECOND REGIONAL WORKSHOP FOR HARMFUL ALGAL BLOOMS (HABS) IN CALIFORNIA COASTAL WATERS

July 22, 2010 Workshop Proceedings



Center for Sponsored Coastal Ocean Research

California

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National Oceanic and Atmospheric Administration
California Ocean Science Trust
California Sea Grant
Southern California Coastal Water Research Project

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EXECUTIVE SUMMARY

Overview

An inaugural workshop in 2008 of leading HAB research groups, water quality managers, public health managers and animal rescue groups in California led to the formation of the California Harmful Algal Bloom Monitoring and Alert Program (California HABMAP). California HABMAP is an integrated statewide network which coordinates HAB researchers and HAB responders by facilitating information exchange. The ultimate vision for HABMAP is to create a regional prediction and forecasting system, which could be expanded into a U.S. west coast wide HAB regional forecasting system. The first step to implementing a coordinated statewide system was the development of an email listserve to rapidly transmit HAB and oceanographic data to HAB responders. The California HABMAP listserve has provided over 700 emails on current HAB conditions and animal strandings throughout the state of California since April 2008. To assess the value of the information provided through the listserve, outline improvements and impediments to the current information, and evaluate the need and desired output for a forecasting system, the National Oceanic and Atmospheric Administration's Center for Sponsored Coastal Ocean Research and the California Ocean Science Trust convened a workshop of 30 invited participants from various organizations including: water quality management, shellfish management and public health protections, animal rescue communities, and ocean observing networks.

The one-day workshop consisted of a general introduction to the California HABMAP program and two breakout sessions. The breakout sessions divided the participants into three groups of approximately 13 participants with similar foci. Group one consisted of the animal rescue and shellfish communities, group two comprised the water quality and public health communities, and group three contained state and federal agencies. After each breakout session, a summary of each group's findings was presented to the entire group.

The first breakout session was intended to provide feedback on the awareness and use of the information and data shared through the California HABMAP listserve and other California HAB related websites such as the California Department of Public Health (CDPH) plankton and shellfish monitoring program, the Central and Northern Coastal Ocean Observing (CeNCOOS), and the Southern California Ocean Observing System (SCCOOS). The general consensus among groups not directly involved with HAB monitoring was that they were unaware of the data and information provided through the California HABMAP listserve and the OOS websites. Most of the participants relied on the data provided through the CDPH phytoplankton and shellfish monitoring program, or through direct communication (phone and email) with specific groups collecting HAB or standing data in their region.

The second breakout session was focused on outlining improvements to the current information shared and evaluating the need and priorities for a HAB forecasting system. Two major improvements that resonated from all three groups was: 1) the need for interpreted analysis of the HAB data in order to understand the potential impact on human and ecosystem health, and 2) the need for timely data on both HABs and animal strandings in order to alert the community and respond to ongoing events. There was also a consensus among all groups that prediction and forecasting systems for HABs would be beneficial for responding to events as well as both short and long term planning and asset management.

Conclusion and Recommendations

The workshop participants agreed that the following steps should be implemented in the HABMAP Network:

- Development of a regional predictive system that can forecast potential HAB events was seen as critical for the future direction of HABMAP. This regional predictive system would help managers make crucial decisions on how to respond to HAB events and how to mitigate their impacts.

- Provide an interpretive synopsis when an event is occurring rather than providing quantitative data in order to facilitate assessment by non-expert users. HABMAP should develop common thresholds and formats for such alerts among data collectors. Automate alerts to be triggered only during events based on threshold levels of data (such as toxic species presence, toxin concentrations, contamination of shellfish, marine wildlife strandings). Alert based information should provide details on types of impact and actions needed to resolve issues.

- Provide real-time stranding information on all animals (birds, sea lions, dolphins, otters, etc.) to allow for more coordinated sampling efforts to assist with the assessment and evaluation of potential HAB impacts on resources and ecosystems. Develop and validate affordable toxin tests for species such as birds and sea otters and easy to use field tests to prescreen animals in the field. Follow-up with toxin analysis results and/or diagnosis on cause of stranding or death.

- Include freshwater toxin information (such as microcystins) to provide a more holistic picture since many of the marine mammal illnesses observed are not limited to toxins that originate in marine habitats. Coordinate and partner with a nascent freshwater HAB group the State Water Resources Control Board has started in order to provide more data on land-sea toxin exchange.

- Enable customization and visualization of HABMAP data particularly when an event begins in order to visualize spatial and historical context to determine intensity of the event. SCCOOS and CeNCOOS have agreed to work together to develop a single statewide display.

- Increase linkage to other data types that provide context such as nutrient loading information, marine mammal strandings, prey source information, oceanographic data, etc. Combine all relevant data into a common portal (website) with the capability to visualize multiple types of data on one graph.

INTRODUCTION

Algal blooms occur when environmental conditions promote the rapid growth of large numbers of single-celled algae. While blooms are often harmless or beneficial to the functioning of marine and freshwater ecosystems, there is increasing awareness that blooms can also be indicative of eutrophication, ecosystem disruption, or altered environmental states.

Some algal blooms can have negative impacts to the environment, human health and the economy (such as aquaculture, fisheries and tourism) and are thus termed "harmful algal blooms" (HABs). Several mechanisms that classify a particular organism as harmful are physical (gill irritation, viscosity and gelatinous barriers which lead to gill clogging and death), large blooms leading to anoxia, and/or production of phycotoxins or allelopathic deterrents to grazers.

Marine toxins can cause human illness and fatalities, marine mammal and bird mortalities and fish kills. Many of the negative impacts to humans and marine organisms are related to toxic shellfish ingestion. The number of HAB events are increasing worldwide, as is our recognition of marine toxins, and toxin producing algal species.

A workshop held in April, 2008 constituted the first tangible step towards a California statewide HAB monitoring and alert network. The workshop participants included the leading HAB researchers in California and a wide variety of interests, such as water quality management, shellfish management related to public health, animal rescue communities, universities, state and local agencies. These participants strongly agreed that there was a need for a coordinated HAB alert system and formed the California Harmful Algal Bloom Monitoring and Alert Program (California HABMAP). The goal of California HABMAP is to implement a proactive HAB alert network that will facilitate information exchange among HAB researchers, managers and the general public, and provide algal bloom forecasts. Crucial decisions on how to respond to HAB events, how to mitigate their impacts, how to predict them, and potentially how to prevent them require knowledge of their occurrence and impacts along our coast. Instituting a statewide alert network is a critical step in this direction, supporting a variety of policy decisions related to these events.

California HABMAP has begun the creation of an integrated, statewide, HAB monitoring and alert network by coordinating organizations and researchers currently collecting HAB data and creating a centralized portal for the dissemination of this information. The program will also perform studies to normalize the diverse methodologies employed to identify toxin and toxic algal species in coastal waters. HABMAP will also perform an economic analysis of resources along the California coast and the potential impact of HABs on these resources. HAB information will be made accessible in a form useful to water managers, human and animal health agencies and centers, and to the public.

The main goal of HABMAP is to ultimately implement a statewide HAB network and forecasting system for California, and potentially the U.S. West Coast. Specific HABMAP goals include the following:

- To design a HAB network that will meet the needs of, and be accessible to, all HAB stakeholders.
- To create a web portal within the California OOS' programs, and to act as a mechanism to bring these two programs together. The portal will be a centralized location where HAB data and predictive information can be used by many groups throughout the state.

- To conduct an economic analysis of the potential impacts of HABs along the California coast.
- To conduct a comparison of analytical methods for toxin analysis and harmful algae identification and enumeration, and review and disseminate the results through a workshop. The method comparison information will be critical to establish guidelines for comparing different data sets currently collected, and will help determine the finalized design for the California HABMAP network.
- To collaborate with the Water Quality Monitoring Council to ensure that HAB information and data is included in and accessible from water quality websites.

WORKSHOP GOALS

HAB researchers committed to California HABMAP have already begun taking low cost steps to create a network by establishing a HABs listserve that currently has over 100 subscribers from a variety of sectors such as federal agencies, ocean observing systems, commercial shellfish industries, public health, wildlife rescue, management and HAB research. Since April 2008, over 700 emails on HAB conditions and animal strandings have been shared through this network.

The goals for this workshop were to receive input from the HAB user community as to whether the current HABMAP program was providing useful information and tools on HABs, outline specific improvements and products for the user community, and identify the priorities for implementing these enhancements to the program. The primary goals of the workshop were to:

- Enhance the interaction between those that are focused on HAB research and monitoring (university and government researchers, government monitoring and regulatory agencies) and those groups that become involved when a HAB event occurs (wildlife researchers and rescue operations, shellfish aquaculture industry, other commercial fisheries, etc.).

- Determine which HABMAP efforts have been useful and which have not.

- Identify the information that is the most importance to each participant, as well as the timeline that makes this information usable to them.

- Identify what information each participant can share and in what time frame.

- Identify the best mechanism(s) for sharing information/data for each person.

- Create a list of primary contacts for use when an event may be developing (names and contact information for each organization; types of data collected by each group and where, etc.)

- Summarize the impact of HABs on groups represented in workshop: get actual numbers and current courses of response to HABs to help inform and provide context for breakout group discussions.

WORKSHOP STRUCTURE

The workshop was held at the Southern California Coastal Water Research Project (SCCWRP) offices in Costa Mesa, California on July 22, 2010. There were 30 invited participants representing various organizations including water quality management, shellfish management, public health, animal rescue and ocean observing networks.

The workshop consisted of an introduction to the California HABMAP program presented by one of the HABMAP Steering Committee members. This presentation explained what HABs are, what mechanisms make them harmful, the regulated and non-regulated HAB issues in California, detection of HABs, current monitoring programs in California and the establishment of the HABMAP program, and the vision and goals for the future of the program.

There were two breakout sessions that followed this presentation. The first breakout session was intended to provide feedback on the awareness and use of the information and data shared through the California HABMAP listserve and other California HAB related websites such as the California Department of Public Health (CDPH) plankton and shellfish monitoring program, the Central and Northern Coastal Ocean Observing, and the Southern California Ocean Observing System.

The second breakout session was focused on outlining improvements to the current information provided by the monitoring programs and evaluating the need and priorities for a HAB forecasting system.

The participants reconvened in a general assembly to determine which aspects of the current HABMAP program are useful and which are not, identify the elements that are needed to improve the program, establish timelines for the needed elements to be effective, identify impediments and to reach consensus on priorities for next steps for the program.

BREAKOUT SESSION SUMMARIES

Breakout Session Questions

1. We have been supplying a steady HABs data stream over the HABMAP listserve for a year:
    a. Have you been accessing that information?
    b. Have you been using that information to make decisions?

2. What specific HAB-related information would be more useful?

3. What specific HAB-related information/data can you share?

4. Would a short-term forecast (1-4 day) help you? What decisions or actions would this affect?

   Would a projection (seasonal or monthly) help you? What decisions or actions would this affect?

Awareness and Use of HAB Data and Information

The first break-out session was intended to determine if data and information provided over the California HABMAP listserve and various HAB websites such as the California Department of Public Health (CDPH) plankton and shellfish monitoring program, the Central and Northern Coastal Ocean Observing, and the Southern California Ocean Observing System, were being accessed and used for decision making or event response. A majority of the user community indicated they were unfamiliar with the California HABMAP listserve before being invited to this workshop (as part of the workshop planning, participants that were not already subscribed to the listserve were added to the subscription list a few weeks before the meeting). The user community also indicated they were unaware of the HAB data and information available on the ocean observing websites. The CDPH phytoplankton and shellfish monitoring programs were the most widely known by the user community since several of the participants contributed routine plankton, shellfish or other samples to this network. The rescue centers for marine mammals, birds, otters, and other marine taxa mostly relied on direct communication with CDPH or 'local' research groups collecting data within their region.

Information and data provided over the listserve and websites were also evaluated for their use in prospective or retrospective analysis, as well as their use in event based planning and management decisions. In general, the participants agreed that the listserve had the best potential for providing timely updates to respond to events. However, a major impediment to the current listserve was that only the data (plankton counts or toxin levels) were provided without an interpretation of these results leaving the user to evaluate the potential for adverse heath or ecosystem effects. The CDPH shellfish and plankton monitoring program was noted as a valuable resource for retrospective analysis mostly due to the time lag in obtaining the monthly and annual reports. These reports were also noted as providing more context with regard to impacts from toxin levels over a broad spatial range. Direct communication through phone and email contacts with the CDPH was also noted as a valuable tool for responding to HAB events though limited to a small number of participants. The participants agreed the ocean observing websites currently provide data without interpretation, and should move toward interpreted analyses to make the information more useful to managers, shellfish growers, and other agencies. The ocean observing networks serve as a valuable tool for retrospective analysis on HAB events and related ocean and environmental processes due to the diverse types and amounts of data available.

Participants also indicated that websites in general were less conducive to being used as an early warning system for HAB events since they require the user to actively seek out the most recent conditions. Automated email updates that include an interpreted synopsis of the data were concluded to be of greatest use to the user community.

Additional HAB-Related Information Needed

The first question of the second break-out session was focused on determining the data gaps and additional information needed by the user community respond to HAB events and make managerial decisions. As part of this session, participants outlined the types of data they collect and discussed the potential for adding these to the listserve.

Additional data that are already collected and could be provided through the listserve included the following: 1) all animal stranding data, 2) volunteer plankton monitoring efforts, 3) shellfish grower monitoring efforts, 4) POTW discharge impacts, and 5) nutrient and water quality data.

The user community pointed out the following major impediments to the current data and information shared currently through the California HABMAP listserve: 1) the HAB data provided needs to be interpreted to relay the potential risks to the public and ecosystem, 2) consistency is needed in the presentation and format of data and information shared among common data types, and 3) increased real-time reporting of animal strandings and HAB related data (plankton and toxins) is needed in order to aid in the event response and management of resources. The participants agreed that these impediments were relatively easy to change and could be resolved with the following steps:

- Revise the HABMAP listserve to provide consistent and timely interpretation of the HAB data for the user community.
- Arrange for the individual marine mammal stranding organizations and animal rescue groups to send out stranding information as it becomes available. Follow-up information can provide details on the cause of sickness or death and actions taken to respond to wildlife.

These modifications to the listserve will initiate the timely transfer of information rather than providing retrospective data that will improve coordinated response and planning within in the HAB community.

In addition, the following specific data requirements were outlined by the user community in order to assist with responding to HAB events:

- Near-real time notification on the location and status of all stranded animals.
- Follow-up information on stranded animals including toxin analysis (including non-NOAA species) and/or diagnosis on cause of stranding or death.
- Toxin analysis expanded to all plankton monitoring stations to better determine potential impact on resources.
- Expand the types of toxins analyzed when HAB species are above threshold levels (okadaic acid, yessotoxin, microcystins, etc.). Also expand toxin analysis to relevant vector organisms (fish, invertebrates, and plankton).

- Greater spatial coverage of phytoplankton and toxin data. Shoreline and pier sampling should be expanded to include offshore sampling, more northern stations, and sampling of areas with significant resources (MPA, ASBS, NMS, shellfish beds, fisheries).
- Include and expand freshwater HAB sampling locations (harbors, bays) and toxin analysis (microcystins).
- Notifications when HAB species abundance or toxin levels are above certain thresholds.
- Addition of links to websites or relevant programs (CDPH and OOS websites) where data will be incorporated.

The user community also identified and discussed areas where information was lacking on HABs that would provide a greater understanding of health risks, potential impacts, and enforcement of better management practices. These include:

- Economic analysis of the impacts of HABs on public and private resources.
- Thresholds of HAB cell abundance or toxin concentration that can impact public or ecosystem health.
- State requirements to improve and sustain water quality of beaches and coastal areas; better understanding of the impact of nutrient loading (from coastal runoff, stormwater drains and wastewater discharge) on the development and maintenance of HABs.
- Better understanding of each contributing agency, their mission and goals for HAB research and monitoring.

Forecasting and Prediction of HABs

A major focus of the second break-out session was to evaluate the need for HAB forecasting and predictions. Overall, there was consensus among the user community and researchers that both short-term and long-range forecasts are critical to improving event response, resource allocation, decision making, and improved management of public and private resources. Participants also strongly indicated that in order for the models to be a valuable asset they must be validated and provide reasonable predictions of future HAB conditions. In addition, modeling efforts based on a mechanistic understanding of HABs that are validated and improved upon will increase our understanding of the factors which influence the initiation and timing of HABs.

Participants also discussed the types of information that were required for models and forecasting to be useful. Short-term forecasts (0-4 days) should consist of both spatial and temporal information regarding HABs and potential impacts. These models should provide details and information on the current extent of the bloom, expected transport or fate of bloom, and evaluate resources potentially at risk. Long-term forecasts (seasonal to monthly) would be utilized more for long-term planning and management purposes. These predictions should provide insight into the potential for HABs, regions of impact, related risks and trends. Forecasts and model predictions should also be presented in a standard format that include interpreted results of future conditions and risks, context with regard to prior HAB events and/or years, and maps detailing potential areas impacted.

NEXT STEPS FOR IMPROVING CALIFORNIA HABMAP

The workshop participants outlined many improvements to the current HABMAP program and identified many benefits to a regional forecasting system.

First, the users need an interpretation of the data from the listserver, not just the actual data (such as cell counts, chlorophyll concentration, etc.). They also prefer to receive a consistently formatted interpretive synopsis when an event is occurring that is automatically generated based on threshold levels of data (such as toxic species presence, toxin concentrations, contamination of shellfish, marine wildlife strandings, etc.). HABMAP will need to develop common thresholds and format for such alerts among data collectors. Converting the HABMAP listserve to an alert based communication system is a high priority.

Second, the development of a regional predictive system that can forecast potential HAB events was seen as critical for the future direction of HABMAP. This regional predictive system would help managers make crucial decisions on how to respond to HAB events and how to mitigate their impacts. This action item will be directly addressed by the recent SeaGrant/OPC funding for HAB modeling (Project titled "Forecasts and Projetions of Environmental and Anthorpogenic Impacts on Harmful Algal Blooms in Coastal Ecosystems", Principal Investigator, Raphael Kudela, HABMAP Steering Committee Member).

Next the participants determined that additional data such as real-time stranding information on all wildlife animals would promote more coordinated sampling efforts and would determine the potential HAB impacts on resources and ecosystems. Additionally, the development and validation of affordable toxin test for species such as birds and sea otters as well as field tests that could prescreen animals in the field would be beneficial.

The participants also suggested including freshwater toxin information to provide a more holistic picture since many of the marine mammal illnesses have recently been linked to these toxins (particularly microcystins). HABMAP will need to coordinate and partner with the freshwater HAB working group that the State Water Resources Control Board has started to provide this information.

The participants also value a means for visualizing HAB data particularly to provide spatial and historical context to determine the intensity of the event. The SCCOOS web site provides some of the requested information and SCCOOS and CeNCOOS will be working together to link the web efforts into a statewide display. Participants also want to be able to access other data types to provide context for the events such as nutrient loading information, marine mammal strandings, prey source information, oceanographic data, etc. They would like to have all of this information combined into a common portal with the capacity to visualize multiple types of data on one display. This request is in line with the goals of SCCOOS and CeNCOOS therefore, the OOS representatives on the Steering Committee agreed that they would look into how to best accomplish this, particularly with their next proposal cycle in the fall.

The Steering Committee formed two subcommittees to determine how best to incorporate these improvements to the HABMAP program. The first committee will develop an action plan for revamping the listserver messaging. The second group will identify the marine mammal data to supply as part of HABMAP and to interact with that community to see how we can facilitate their participation.

CONCLUSIONS AND RECOMMENDATIONS

The workshop participants agreed that the following steps should be implemented in the HABMAP Network:

- Development of a regional predictive system that can forecast potential HAB events was seen as critical for the future direction of HABMAP. This regional predictive system would help managers make crucial decisions on how to respond to HAB events and how to mitigate their impacts.

- Provide an interpretive synopsis when an event is occurring rather than providing quantitative data in order to facilitate assessment by non-expert users. HABMAP should develop common thresholds and formats for such alerts among data collectors. Automate alerts to be triggered only during events based on threshold levels of data (such as toxic species presence, toxin concentrations, contamination of shellfish, marine wildlife strandings). Alert based information should provide details on types of impact and actions needed to resolve issues.

- Provide real-time stranding information on all animals (birds, sea lions, dolphins, otters, etc.) to allow for more coordinated sampling efforts to assist with the assessment and evaluation of potential HAB impacts on resources and ecosystems. Develop and validate affordable toxin tests for species such as birds and sea otters and easy to use field tests to prescreen animals in the field. Follow-up with toxin analysis results and/or diagnosis on cause of stranding or death.

- Include freshwater toxin information (such as microcystins) to provide a more holistic picture since many of the marine mammal illnesses observed are not limited to toxins that originate in marine habitats. Coordinate and partner with a nascent freshwater HAB group the State Water Resources Control Board has started in order to provide more data on land-sea toxin exchange.

- Enable customization and visualization of HABMAP data particularly when an event begins in order to visualize spatial and historical context to determine intensity of the event. SCCOOS and CeNCOOS have agreed to work together to develop a single statewide display.

- Increase linkage to other data types that provide context such as nutrient loading information, marine mammal strandings, prey source information, oceanographic data, etc. Combine all relevant data into a common portal (website) with the capability to visualize multiple types of data on one graph.

APPENDIX A. WORKSHOP AGENDA

8:00 – 8:15	Coffee
8:30 – 8:45	Welcome and Introductions (Steve Weisberg)
8:45 – 9:30	Introduction to HABMAP (David Caron)
9:30 – 9:50	Explanation of current workshop goals (Steve Weisberg)
9:50 – 10:00	Charge to breakout groups
10:00 – 10:15	**B*reak***
10:15 – 11:45	Breakout Sessions
11:45 – 1:00	***Lunch on site***
1:00 – 1:15	Reconvene entire workshop to address any questions if needed
1:15 – 2:30	Breakout Session (continued)
2:30 – 3:30	Breakout Session Wrap-up, reach agreement on next steps
3:30 – 3:45	***Break***
3:45 – 5:00	Reconvene General Assembly
	Moderator Summaries (10 minutes each)
	General Discussion: • Refine what works/doesn't work for the HABMAP observer groups; • Identify what is needed to engage larger HAB community. • Establish timelines for the needed information • Identify what can be done now, in 1 year, in 3 years • Identify impediments (specific, not “more funding”) • Agree on priorities for next steps
	Reach consensus on priorities for next steps
5:00	Adjourn

APPENDIX B. WORKSHOP PARICIPANT BIOPICS AND CONTACT INFORMATION

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Michelle Berman
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Michelle Berman is the Associate Curator of Vertebrate Zoology at the Santa Barbara Museum of Natural History and has been with the Museum since 2000. She received her BS from Colorado State University where she first gained marine mammal experience during an internship at Moss Landing Marine Laboratory. After completing her Masters studying lipid metabolism in fasting Steller sea lions at the University of Central Florida she returned to California. She participated with both the California and Florida Marine Mammal Stranding Networks previously and now is back with the CMMSN as the cetacean stranding coordinator for San Luis Obispo, Santa Barbara and Ventura Counties. Michelle's main research interests include bio-surveillance, life history and epidemiology of dead cetaceans through examination of specimens collected from beached whales, dolphins and porpoises. In addition, she curates regional mammals, marine mammals, and herps for the museum's research collection.

Dr. Earle Buckley
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Dr. Earle Buckley is President of Buckley Environmental, a professional services firm in Mt. Pleasant, SC, which partners with government, academic, and commercial clients for consulting services and technology solutions in coastal management and climate change. He is an oceanographer/microbiologist with expertise in technology adoption, diffusion, and integration; and 25+ years experience in coastal research, observations, and modeling; marine technology development and testing; and international technology transfer. His current work focuses on ocean observing, technology evaluation, and integration of ocean observing information into management decisions. Previously, at NC State University, he coordinated a regional coastal observing system. At the NOAA CSC in Charleston, SC, he established an IV&V program for ocean sensor technology, now ACT. He was on the team that contributed to WGIII of the IPCC that was awarded the 2007 Nobel Peace Prize, and was a co-author on Coastal Adaptation for the IPCC Report on Technology Transfer. His Ph.D. is in environmental science/engineering from UNC-Chapel Hill, and he has a B.S. in biology from Florida State University.

Dr. David A. Caron
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David A Caron is a Professor in the Marine Environmental Biology section of the Department of Biological Sciences at the University of Southern California. He has degrees in Microbiology (B.S.) and Oceanography (M.S.) from the University of Rhode Island, and in Biological Oceanography (Ph.D.) conferred jointly by Massachusetts Institute of Technology and Woods Hole Oceanographic Institution. His research interests broadly involve marine and freshwater microbial ecology. Ongoing research programs include studies of harmful blooming-forming species of microalgae, and investigations of the biodiversity and physiology of tropical, temperate and polar microbial communities. He has authored or co-authored approximately 170 scientific articles and book chapters. He is Fellow of the American Academy of Microbiology, and a member of several national societies.

Melissa Carter
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Melissa Carter is a Research Associate at the Scripps Institution of Oceanography. Over the last 11 years at SIO, she has worked on a wide variety of projects related to physical and biological interactions including anthropogenic and climate impacts on coastal areas. She currently leads the SIO pier based monitoring efforts for HABs with the assistance of Dr. John McGowan and Mary Hilbern. She contributes both pier and regional HAB data to HABMAP, the Southern California Coastal Ocean Observing Systems (SCCOOS), and the California Department of Public Health (CDPH). She received her degrees in Oceanography (B.S) at Humboldt State University and in Marine Science (M.S.) at the University of San Diego. She has also been formally trained and certified in the identification and enumeration of harmful algae through the International Oceanographic Commission of UNESCO which was funded through a NOAA/CSCOR award.

Elizabeth Copper
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I am a biologist with Avian Research Associates in Coronado, CA and have been working with nesting seabirds in California for more than 30 years. Our group has been involved with much of the monitoring of the listed California Least Tern and Western Snowy Plover in San Diego County and we have participated in multiple waterbird studies in Southern California. We have been gathering seabird and marine mammal mortality data at selected sites in San Diego since 1990 as well as in recent years participating in the plankton sampling done by the California Department of Public Health. I am particularly interested in potential effects of HABs on marine birds and effects on fisheries that might contribute to an apparent increase in unexplained mortality in the species we study.

Dr. Carolynn (Carrie) Culver
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Carolynn (Carrie) Culver is a Marine Advisor for the California Sea Grant Program, conducting applied research, education and extension programs on fisheries, mariculture and aquatic invasive species. Carrie received her Ph.D. from the University of California, Santa Barbara in Ecology, Evolution and Marine Biology. She was a lecturer and researcher at UCSB prior to working for Sea Grant. She also was a research biologist at private aquaculture companies, producing shellfish for consumption and production of marine natural products. Carrie is interested in the supply of safe and high quality seafood products (both cultured and wild-caught), including the impact of harmful algal blooms on these supplies and effective education of local communities about this issue. She has participated in the collection of shellfish samples for the state Marine Biotoxin Monitoring Program in California.

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Kerri's research focus is on the stranding patterns, life history, and health of marine mammals.

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Mas Dojiri has over 20 years of experience in environmental monitoring. Presently, he serves as the Division Manager of the Environmental Monitoring Division (EMD), where he manages and guides the division, which provides analytical services for various programs of the Bureau of Sanitation, City of Los Angeles. He served as the lead for the City of LA's Total Maximum Daily Load Program during its start-up period (2000-2002). He currently serves as the Chair of the Board of Commissioners for SCCWRP; chaired the Santa Monica Bay Bacterial Shoreline Monitoring Technical Steering Committee (TSC) and the Marina Del Rey Bacterial Monitoring TSC; represents the Bureau of Sanitation on the Santa Monica Bay Restoration Commission's Technical Advisory Committee; serves as a Senior Advisor for the Southern California Ocean Observing System; and is a member of the Scientific Advisory Committee for the Palos Verdes Peninsula Land Conservancy . Mas received his B.A. from UCSB, his M.A. from CSULB, his Ph.D. from the Boston University Marine Program at the Woods Hole Marine Biological Laboratory, and completed a Postdoctoral Fellowship at the National Museum of Natural History, Smithsonian Institution.

Wendy Enright
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Wendy Enright is a marine biologist with the City of San Diego's Ocean Monitoring Program whose research interests focus on molluscan community structure. She received her B.A. in Marine Biology from UC Santa Cruz in 1995, and her M.S. in Oceanography from UC San Diego (Scripps Institution of Oceanography) in 2000. Her thesis examined the effect of macro-nutrient deprivation on domoic acid production in *Pseudo-nitzschia multiseries* and *P. australis*. Wendy continued as a Staff Research Associate at SIO following graduation, working on various projects ranging from the physical dynamics of phytoplankton at small scales to the algorithms necessary to ground-truth satellite images. She joined the City of San Diego in 2001 where her primary duties currently include taxonomic identification of marine invertebrates, general water quality sampling, project management for moored observation system studies off Point Loma, and small database management and applications development as needed.

Dominic Gregorio
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Dominic Gregorio has been with the California State Water Resources Control Board since 2000, where he is a Senior Environmental Scientist managing the Board's Ocean Unit. The Ocean Unit is responsible for ocean and coastal water quality standards including the California Ocean Plan, Areas of Special Biological Significance, Sediment Quality Objectives, and Oncethrough Cooling at Coastal Power Plants. The Ocean Unit is also involved in addressing beach and shellfish contamination, harmful algal blooms, vessel discharges, ocean monitoring, and marine debris. Previously, Mr. Gregorio was a marine biology instructor at California State University, Dominguez Hills and at Cypress College, in Orange County, California. During that period he was also affiliated with the Southern California Marine Institute, where he was a principle investigator on projects including harmful algal blooms, marine pollution, and aquaculture. Prior to working in academia, Mr. Gregorio was an environmental coordinator for Texaco, USA, where he managed a number of marine biological surveys and pollution studies for offshore oil drilling projects, and was also responsible for oil spill contingency planning. Mr. Gregorio holds a M.S. in Environmental Biology, from California State University, Dominguez Hills.

Dr. Frances M. D. Gulland
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Frances Gulland is the Director of Veterinary Science at The Marine Mammal Center in Sausalito, California. She has been actively involved in the veterinary care and rehabilitation of stranded marine mammals and research into marine mammal diseases there since 1994. Her interests include determining the impacts of HABs on marine mammal health, and she has worked with colleagues to identify hippocampal atrophy, cardiac damage, abortion and behavioral changes in California sea lions exposed to domoic acid. She received a veterinary degree from the University of Cambridge, UK, in 1984, and a PhD in zoology in 1991.

Harriet Hill
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Harriet Hill has worked as an environmental consultant and biology teacher as well as spending a decade with EPA Region IX in the wetlands regulatory program. She currently is the Water Program Coordinator with Humboldt County Division of Environmental Health. Her duties include small water system inspections, beach sampling, shellfish collection, and recreational health education, including an annual blue green algae outreach campaign. She received an M.A. in zoology from U.C. Davis in 1980.

Bridget Hoover
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Bridget Hoover has worked for the Monterey Bay National Marine Sanctuary since January 1999. In March 2007 she was promoted to Director of the Water Quality Protection Program (WQPP). In this capacity she is responsible for implementation of the six WQPP Action Plans related to water quality monitoring, urban runoff, agriculture, beach closures, marinas, and wetlands through a collaborative approach with many partners. Prior to this position, Bridget was Coordinator of the Monterey Bay Sanctuary Citizen Watershed Monitoring Network where she provided water quality support to a wide range of school programs, watershed groups and government agencies. She has a Bachelor of Science degree in Earth Systems Science and Policy. Prior to her position with the Sanctuary, Bridget spent four years working for the Washington State Department of Ecology as an Environmental Planner/Spill Response and seven years in the United States Coast Guard as a Marine Science Technician.

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Chris is a veterinarian with a Ph.D. in Epidemiology. Her research focuses on the impact of ecosystem-level processes on wildlife population health, particularly with regard to applied investigations that can direct and inform policy needed to protect biodiversity and public health. Current activities seek to understand the ecology of infectious diseases emerging at the animal-human interface and develop surveillance strategies for emerging pandemic threats of wildlife origin. She also leads investigations for the California Department of Fish and Game (CDFG) on wildlife health issues impacting species at risk in California. She has implemented graduate level coursework to teach ecosystem health concepts and introduce emerging issues at the interface of human, animal and environmental health.

Dr. Burton Jones
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Burton Jones is a Biological Oceanographer in the Marine Biology and Biological Oceanography section of the Biology Department at the University of Southern California. His research interests include bio-optical oceanography, physical-biological interactions, coastal processes, and coastal ocean observing systems. He received his B.S. in biological engineering from Rose-Hulman Institute of Technology and his Ph.D. in biological oceanography from Duke University. After a postdoctoral fellowship at Bigelow Laboratory he joined the research faculty at University of Southern California. He has been involved in studying the dynamics of physical/bio-optical interactions in a variety of environments that include not only coastal California but a variety of open ocean and coastal environments throughout the world. Recently, as part of the Southern California Coastal Ocean Observing System (SCCOOS) and USC MERHAB research in harmful algal bloom monitoring, Dr. Jones has been involved in implementing a coastal observing system that includes both fixed sites and autonomous vehicles. This includes participation in the development of an intelligent network of fixed and mobile nodes capable of adaptive mapping and sampling strategies (USC CINAPS). He is co-chair of the SCCOOS Executive Steering Committee, and a member of the HABMAP steering committee.

Heather Kerkering
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Ms. Heather Kerkering is the Program Coordinator for the Central and Northern California Ocean Observing System (CeNCOOS), based at MBARI. She holds a Masters in Environmental Management from Duke University. In her five years with CeNCOOS, Ms. Kerkering has served on the National Federation of Regional Associations' Board and represented California to the greater IOOS community in numerous settings. With regards to HABs, Ms. Kerkering published an article with 8 others on the discovery of *Akashiwo sanguinea* as a culprit in a 2007 mass stranding event, led a CeNCOOS charge to participate in HABMAP, and is a member of the WCGA HAB Summit Team. In 2009, she worked with the MBARI EARTH program to connect teachers to HAB data and supervised an intern on creating HAB products for the classroom. She will provide education and outreach on a recently OPC/Sea Grant-approved HAB proposal, led by Dr. Kudela.

Dr. Raphael Kudela
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Raphael Kudela is a biological oceanographer who focuses on phytoplankton ecophysiology, particularly the interplay of light and nutrients. Recent HAB-related research includes development of monitoring programs in California (e.g. Cal-PreEMPT, CeNCOOS, and partnerships with California Water Boards and CDFG), optical and remote sensing methods for identifying true red tides as well as less visible HAB events, toxin production by various organisms, and more generally the ecophysiological conditions (from genomics to decadal timeseries analysis) leading to HAB events. Kudela serves on the US HAB National Committee, is the Chair of the GEOHAB program, and serves on the GEOHAB Core Research Program: HABs in Upwelling Systems committee.

Gregg Langlois
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Mr. Langlois is a Senior Environmental Scientist with the California Department of Public Health (CDPH). He has managed the state's marine biotoxin monitoring program since 1990 and has supervised the state's preharvest shellfish program since 1997. Biotoxin program responsibilities include: coordination of program participants responsible for the routine collection of shellfish samples; coordination of a volunteer network of phytoplankton samplers; liaison with the CDPH regulatory laboratories responsible for toxin analyses; declaration of commercial shellfish harvest closures and reopenings; drafting of quarantines and health advisories; collection of ancillary environmental data; routine reporting. He also supervises a small staff of four people who are responsible for classifying commercial shellfish growing areas statewide. This involves the conduct of sanitary surveys for pollution source identification; water quality data collection and analysis; development of management strategies for implementing harvest closures for public health protection; ensuring compliance with the National Shellfish Sanitation Program administered by the U.S. Food and Drug Administration. Recent focus has been on cost-effective approaches to improve early detection capabilities for harmful algal events. A joint project with UC Santa Cruz is currently evaluating the reliability and utility of field-based tools for identification of toxigenic phytoplankton species and toxin detection in shellfish.

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Kevin Lunny
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Kevin is a third generation family rancher/farmer who has lived on the Point Reyes Peninsula his entire 50 years. Love for the family farm is what originally prompted him to obtain a UC Davis degree in Animal Science, and, what 21 years later, inspired him to earn the first organic certification of beef cattle in Marin County. Kevin is passionate about producing food locally and organically, with minimum impacts to the environment, while supporting biodiversity and local food systems. One current project he is working on is the restoration and cultivation of two native shellfish species at the family oyster farm in Drakes Estero, Drakes Bay Oyster Farm. Although important to indigenous people, these native species have not been cultured by California shellfish farmers for many decades. Kevin is committed to ensuring that future generations of National Seashore family farmers/ranchers be encouraged, supported and valued in their role as food producers for our community. His 21 year-old daughter, Brigid, is a student of sustainable agriculture and hopes to carry the family farm into the fourth generation.

Kevin is one of the founders of the Point Reyes Seashore Ranchers Association, and remains active as a steering committee member. He is also a board member of Marin Organic and the Pacific Coast Shellfish Growers' Association, and serves as the board president of both the Marin Farmers Market Association and the Marin Agricultural Institute. In addition, he is a member of the Marin County Farm Bureau, the California Aquaculture Association, and the National Shellfisheries Association.

Skyli McAfee
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Skyli McAfee, Executive Director of the California Ocean Science Trust, has spent her career in marine science at laboratories throughout the country. Prior to leading the OST, Ms. McAfee was at the University of California, Davis, Bodega Marine Laboratory, where she served as Assistant Director. In that capacity, she facilitated program development and administration of a renowned research lab engaged in multidisciplinary marine and terrestrial research, encouraging productive collaborations with federal and state partners such as the National Oceanic and Atmospheric Administration, U.S. Geological Survey, and California Department of Fish and Game.

Ms. McAfee received her undergraduate degree from University of California, Santa Barbara in Aquatic Biology and a Master's degree from Moss Landing Marine Laboratories, where she studied the community ecology of reef fishes in the San Blas Archipelago, Panama.

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Coordinate annual mussel quarantine and marine biotoxin activities for County of Los Angeles, Department of Public Health.

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Martha Ramirez, R.E.H.S.
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Martha is a Registered Environmental Health Specialist (R.E.H.S.) for the Ventura County Environmental Health Division (EHD). In May of 2002, she graduated from California State University Northridge with a Bachelors of Science Degree in Environmental and Occupational Health. In July of 2003, she received my R.E.H.S. from the California Department of Public Health.

She began her career in Ventura County in March of 2003 performing regulatory inspections of retail food facilities, mobile food facilities, and recreational public swimming pools. She was also involved in the recruitment and outreach program in the division which allowed her to attend career and job outreach events, as well as provide public presentations to local high schools and colleges highlighting the career opportunities in the Environmental Health Field.

In July of 2007, she was promoted to an Environmental Health Specialist IV working as a Coordinator for the Temporary Food Facility Program. She reviews applications submitted for community events and conducts field inspections to ensure food vendors participating at community events, such as certified farmers' markets, swapmeets, and other festivals including our county fair, are in compliance with California Health & Safety Code. She also provides Food Handler Safety Training and Organizer Training associated with Community Events to the public. For the past 3 years, she has been a volunteer for the Mussel Sampling & Phytoplankton Collection Program which includes monitoring the levels of Domoic Acid and Paralytic Shellfish Poisoning for sports harvested mussels in our county.

John B. Richards, M.S.
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John Richards is a marine advisor emeritus with the California Sea Grant Extension Program and marine resources specialist with the Marine Science Institute (MSI) at the University of California, Santa Barbara. In 1976, he began development of a marine extension and applied research program for the south-central coast of California and served as Area Marine Advisor for the counties of San Luis Obispo, Santa Barbara, and Ventura until 1992. He managed an oyster and clam farm in Washington State in the early 1990's and became involved in the CDPH Marine Biotoxin Monitoring Program setting up a cooperative sampling program at UCSB upon returning to California in 1994. Richards is now a member of a team conducting research in marine fisheries and shellfish aquaculture at the Marine Science Institute. He continues to work on statewide projects with the Sea Grant Extension Program, including the HAB monitoring program at MSI-UCSB. He has a B.A. in zoology from the University of California, Santa Barbara, and an M.S. in fisheries biology from Oregon State University.

George Robertson
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Mr. Robertson received an M.S. in Environmental Studies from California State University, Fullerton in 1990 and a B.A. in Applied Ecology from the University of California, Irvine in 1983. He is a Senior Scientist with the Orange County Sanitation District's ocean monitoring and research program. In this capacity, Mr. Robertson assigns, oversees and coordinates the work of in-house scientists, technicians and interns, and several consulting firms. Additionally he is responsible for developing and maintaining relations with other government and university research and monitoring groups. He develops specifications for contracts for the ocean monitoring program and sets short- and long-term goals and objectives for the project. He produces reports and contributes to the publication of scientific papers in peer-reviewed journals. He has been with OCSD for over 21 years.

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Dr. G. Jason Smith
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G. Jason Smith, Ph.D. is a Research Faculty at the Moss Landing Marine Laboratories. Jason received his Ph.D. in Zoology from the University of Georgia in 1984 and his ongoing research program stems from his fascination with the molecular physiological ecology of marine algae. Specific research projects have ranged from nutrient regulation of coral-dinoflagellate symbioses, to investigation of the molecular regulation of nitrogen assimilation in marine phytoplankton, and biotechnology applications with diatoms and yeast. Current research seeks to identify molecular and biochemical markers associated with production of the neurotoxin domoic acid (DA) by diatoms in the genus *Pseudo-nitzschia*. His research group is developing molecular bioassays enabling identification of species actively metabolizing DA and well and genetic markers for robust enumeration of Pseudo-nitzschia population and community dynamics.

Jason currently serves as the Technical Coordinator / PI for the ACT-Pacific Coast Region, since the program's inception. In this position he has provided liaisons between resource managers, environmental scientists and the private sector, with the goal of fostering reliable and appropriate application of new technologies for monitoring water quality and ecosystem health in coastal waters. An important part of these regional efforts is coordinating the design and management of ACTs Technology Performance Verification trials which strive to provide credible and independent assessment of sensor technology performance both under controlled laboratory and in operational field deployment using ACT's nationally distributed test facilities.

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I'm an Environmental Scientist and registered Civil Engineer working in the Ocean Monitoring program of the Los Angeles County Sanitation Districts. I received a Masters in Oceanography from the University of Southern California and a BS in Geology/Geophysics from the University of Hawaii. I split my work at the Sanitation Districts between the physical oceanographic aspects of our coastal ocean monitoring program, special coastal ocean research projects of significance to our agency (e.g. climate change, nutrients, HABS), NPDES reporting and regulatory issues relating to our Joint Water Pollution Control Plant - which discharges a daily average of 280 MGD of treated effluent into the coastal ocean, and programming applications to manage and analyze our treatment plant and oceanographic data sets.

Dr. Richard P. Stumpf
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Dr. Stumpf has over twenty-five years experience in coastal oceanography, with particular interest in the detection and monitoring of algal blooms. His research includes developing methods to incorporate satellite data into solving such coastal problems as habitat and eutrophication assessment and algal bloom monitoring and forecasting, and has applied these methods over most of the US coast. He develops methods for developing operational forecasts of harmful algal blooms from research programs. In particular, Dr. Stumpf started NOAA's first operational monitoring program for harmful algae in 1988, which led to NOAA's CoastWatch program, and he led the effort to develop NOAA's operational Harmful Algal Bloom Forecast System for the Gulf of Mexico. Dr. Stumpf leads Remote Sensing activities in the Center for Coastal Monitoring and Assessment in NOAA's National Ocean Service. From 1989-1998, he headed remote sensing programs for the USGS Center for Center for Coastal & Watershed Studies in St Petersburg, Florida, and he developed assessment capabilities for the NOAA Satellite and Data from 1985-1989. He has authored or co-authored some 60 peer-reviewed publications. He received a B.A. degree in the Environmental Sciences from the University of Virginia, and M.S. and Ph.D. degrees in Marine Studies from the University of Delaware.

Marc Suddleson
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Position: Manager, Monitoring and Event Response for Harmful Algal Blooms (MERHAB) research program. Mr. Suddleson has worked at NOAA for 14 years. Since 2002, in his current position as program manager, he has promoted the development of new coastal monitoring and ocean observation technologies and has fostered sustainable monitoring, alert, and prediction systems for ocean phenomena, like harmful algal blooms. He has built strong state-wide and regional partnerships between NOAA laboratories, the academic community, and management agencies to provide strong science to support coastal resource use decision-makers. Mr. Suddleson has helped author national and regional strategic research guidance documents like *HARRNESS, Harmful Algal Research and Response: A National Environmental Science Strategy 2005–2015*. Mr. Suddleson also served on organizing and steering committees to implement the California Harmful Algal Bloom Monitoring and Alert Program (HABMAP). Mr. Suddleson received his Master in Marine Policy degree from the University of Delaware and his B.S. degree in Marine Science and Biology from the University of Miami.

Dale Sweetnam
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I administer the Marine Region field office in La Jolla at NOAA Fisheries' Southwest Fisheries Science Center. My major responsibilities include overseeing research on Coastal Pelagic Species (CPS, namely Pacific sardine, Pacific mackerel, and market squid), including implementation of the Market Squid Fisheries Management Plan. I am an appointed member of the Pacific Fisheries Management Council's Coastal Pelagic Species Management Team which is responsible for setting harvest guidelines for CPS fisheries in Oregon, Washington and California. I am the Department's contact person for market squid, coastal pelagic species and marine mammals.

The Marine Region is responsible for protecting and managing California's marine resources under the authority of laws and regulations created by the State Legislature, the Fish and Game Commission, and the Pacific Fishery Management Council. It is responsible for both policy and operational issues within the State's marine jurisdiction, which includes fisheries management and habitat restoration programs, environmental review, and water quality monitoring.

Julie Thomas
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For the past thirty-four years, Julie Thomas has been involved with the Coastal Data Information Program (CDIP), a real-time wave and shoreline change monitoring program. She has been the CDIP Program Manager for nine years, working to collect and disseminate high resolution wave data throughout the marine community. Since September 2008, Julie has also fulfilled the role of Executive Director for the Southern California Coastal Ocean Observing System (SCCOOS). She serves as a technical expert for the Ocean Observing Systems, at both regional and national levels, promoting interagency collaboration and formulating data management policies, priorities and resource requirements.

Shelly Tomlinson
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Shelly Tomlinson received her B.S. in Marine Science Biology from Southampton College of Long Island University, and a M.S. in Oceanography from Old Dominion University. Since 2002 she has been working as an oceanographer with the Center for Coastal Monitoring and Assessment, National Ocean Service, NOAA. Her current research focuses on the application of satellite derived ocean color sensors (SeaWiFS, MODIS, MERIS) to detect, monitor and forecast the occurrence of harmful algal blooms. This work has lead to the development of an operational forecast system for harmful Karenia brevis blooms in the Gulf of Mexico and a demonstration system in Lake Erie.

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Dr. Stephen Weisberg is Executive Director of the Southern California Coastal Water Research Project (SCCWRP), a research agency that serves as the interface between science and water quality management in California. Dr. Weisberg's research emphasis is in design of environmental monitoring programs and developing next generation assessment tools. He is Chair of the Southern California Bight Regional Monitoring Steering Committee and is on the Governing Boards of the California Ocean Science Trust and the Southern California Coastal Ocean Observing System. He serves on numerous advisory committees, including the State of California's Clean Beach Task Force, the California Ocean Protection Council Science Advisory Team, California's Water Quality Monitoring Council, the Alliance for Coastal Technologies Stakeholder Council, the NOAA Science Advisory Board Oceans and Health Committee, and the US EPA Board of Scientific Counselors. Dr. Weisberg received his undergraduate degree from the University of Michigan and his Ph.D. from the University of Delaware.

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