

Making Use of Ocean Observing Systems: Applications to Marine Protected Areas and Water Quality

September 25 and 26, 2007

San Francisco, California

Workshop Report



Acknowledgements

The Coastal States Organization (CSO), through the guidance of Jena Carter and funding via a cooperative agreement with the National Oceanic and Atmospheric Administration (NOAA), provided the impetus and primary support for this workshop. Additional financial support was provided by the California Ocean Science Trust, Coastal Conservancy, CeNCOOS (Central and Northern California Ocean Observing System) and SCCOOS (Southern California Coastal Ocean Observing System).

CSO and the workshop sponsors would like to thank the workshop attendees for their time, ideas and thoughts, which furthered our understanding of managers' needs for improved ocean and coastal data and information.

CSO extends a special thank you to the members of the Steering Committee who developed the focus for the workshop, identified participants, reviewed numerous draft agendas and reports, and ensured that the workshop remained focused. The presenters—Paul Siri, Eric Terrill, Bill Sydeman, Heather Kerkering and Steve Weisberg—provided excellent background information on ocean observing that set the context for the working group discussions. The facilitation expertise of Debra Hernandez, Amber Mace, and Steve Weisberg kept the working group discussion on track. BCDC and the Coastal Commission graciously provided meeting space. The Sonoma County Water Agency provided much-appreciated sponsorship for the evening reception, including the full moon rising above the bay.

Heather Kerkering provided tireless and expert support for all aspects of the workshop—initiating and maintaining the workshop webpage, pulling together detailed information on the issues and on Monterey Bay, and coordinating the development of the GIS maps of California and Monterey Bay. Special thanks go to Dominic Gregario and Leo Anguiano of the State Water Quality Board and Sophie DeBeukelaer of the Monterey Bay National Marine Sanctuary for producing the elegant maps.

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Executive Summary

The Coastal States Organization (with funding provided by NOAA), California Coastal Conservancy, California's Ocean Science Trust, CeNCOOS and SCCOOS sponsored the workshop "Making Use of Ocean Observing: Water Quality and MPAs" on September 25 and 26, 2007, in San Francisco. The purpose of the workshop was to convene a group of managers and ocean observing experts to determine the requirements for a coastal ocean observing system that would benefit both water quality and marine protected area (MPA) managers in California. Workshop attendees participated in working groups focused on how ocean observing can address water quality issues and assist the monitoring of MPAs. The goal of the workshop was to develop a model for a high-level design of an observing system for water quality and MPA monitoring and to overlay those needs to develop a single system that could meet both needs. While Monterey Bay provided a geographic focus area for the discussions, the findings and recommendations are applicable coastwide.

Each group discussed how managers make decisions and the data they need to develop useful information products. Because the MPA monitoring program is in its early stages, further discussions between scientists and managers are required to understand the kinds of information needed by managers and how they will use that information. While the water quality group was able to better describe the needs and the requirements, more work is needed to refine the specific requirements that meet multiple management objectives. In short, the goal of designing a single system that would address these issues proved ambitious for a one-and-a-half-day workshop.

As such, the workshop's primary recommendation is to build on this effort quickly by retaining consulting services to work with the Regional Associations and the State to create a cohesive vision for ocean observing systems to meet managers' needs in California. This work should expand beyond the water quality and MPA topic areas to include other key areas such as harmful algal blooms, sediment transfer, ocean energy and maritime safety. The goal of the project should be to articulate a vision that meets managers' needs; is acceptable to and deemed feasible by the scientific and observation community; and is understandable by high-level decision makers. The complexities of integrating information for multiple user benefits underscore both the challenges and promise of ocean observing. In order to take full advantage of the potential of ocean observing, managers and scientists will need to establish well-defined objectives for designing information products.

The workshop produced additional recommendations to address the immediate need for accelerating access to ocean information for management of water quality and MPAs:

- Synthesize existing data sets so they can be compared, analyzed and made easily accessible to managers and others.
- Initiate a pilot project to demonstrate the utility of ocean observing to managers and non-scientists, and to provide an estimate of costs for a full-scale system.
- Market ocean observing by developing a clear statement of the benefits that is understandable to potential users, policy makers and the general public.
- Foster communication through innovative programs such as using Sea Grant fellowships and state fellowships to co-locate scientists and managers.

The workshop report includes specific recommendations for ocean observing systems that are intended for management of water quality and marine protected areas.

Workshop Findings and Recommendations

The Coastal States Organization (CSO), in partnership with the California Ocean Science Trust, Ocean Science Applications and the two IOOS Regional Associations serving California—Central and Northern California Ocean Observing System (CeNCOOS) and Southern California Coastal Ocean Observing System (SCCOOS)—and the California Coastal Conservancy hosted the workshop “Making Use of Ocean Observing: Water Quality and MPAs” on September 25 and 26, 2007, in San Francisco. The purpose of the workshop was to convene a small group of managers and ocean observing experts to determine the requirements for an ocean observing system that would meet the needs of water quality and marine protected area (MPA) managers.

Water quality and MPA monitoring are both issues of immediate interest to the State and for which ocean observing could make a difference. California recently adopted its first regional network of MPAs for implementation in the Central Coast and is setting up a monitoring program to assess changes and to evaluate program effectiveness. The increased occurrences of harmful algal blooms and the recent discovery of ocean hypoxia zones off the west coast have highlighted the need to better monitor coastal waters. Monterey Bay was selected as a case study to provide a place-based approach for the topics discussed and a basis from which to extrapolate recommendations appropriate for other areas in the State. The goal of the workshop was to develop a model for a high-level design of an observing system for water quality and MPA monitoring and to overlay those needs to develop a single system that could meet both needs.

Over 55 participants gathered for a day and a half in San Francisco. Breakout groups were divided by topic—water quality and MPA monitoring. Details on these discussions and the recommendations relevant to the topic areas are contained in the body of this report. The findings and recommendations here are overarching in nature and intended to facilitate moving forward and ensure that ocean observing in California is relevant and useful to State managers.

Background

Timely, sustained and integrated information on ocean resources is key to many of California’s coastal initiatives including the Governor’s Ocean Action Plan, Ocean Protection Council Strategic Plan, West Coast Governors’ Agreement on Ocean Health, Marine Life Protection Act (MLPA), Sediment Master Plan, and Marine

Life Management Act. California's investment in the Coastal Ocean Current Monitoring Program (COCMP) has strategically deployed high-frequency radar technology to provide statewide information on surface currents in real time. This technology has been used successfully in monitoring municipal discharges and in assisting with oil spills. Coastal ocean observing is not only about harnessing new state-of-the-art technology; it includes all observations such as traditional sampling by hand from shore and boats. More importantly, ocean observing is about integrating disparate data sources so people can access and combine the data they need, no matter what the source.

The Integrated Ocean Observing System (IOOS) is a multidisciplinary system designed to provide ocean and coastal data in formats, scales, and rates required by users. Currently, ocean and coastal data are collected by numerous federal, state, local and private entities. IOOS is gathering these disparate data sources into an integrated system, providing users access to data from all sources. In addition, IOOS is deploying new technology to fill in the gaps in measurements and to ensure that users have access to the best available information. IOOS is a continually evolving program that is designed to be flexible and respond to new technology and user needs. The national program consists of the contributions of federal agencies, coordinated through an interagency office (known as Ocean.US), and a network of regional programs designed to meet the diversity of users around the country, including the Great Lakes.

Coastal States Organization

The Coastal States Organization (CSO) is a non-profit organization in Washington, DC, that represents the interests of the Governors from the thirty-five coastal States, Commonwealths and Territories bordering the Atlantic and Pacific Oceans, the Gulf of Mexico and the Great Lakes on federal, legislative, administrative and policy issues relating to sound coastal, Great Lakes, and ocean management. CSO sponsored this and other similar workshops to build partnerships between coastal managers and the ocean observing community to ensure that coastal managers have access to the timely and accurate data they need to successfully manage resources.

Overall Finding

Ocean and coastal observations can directly serve the needs of ocean and coastal managers if those needs are clearly articulated to those developing and managing these systems. This workshop set the stage for identifying the management needs for two issues: water quality and monitoring marine protected areas (MPAs). However, these needs—and needs for other issues such as harmful algal blooms (HABs), sediment transport, placement of ocean energy facilities, and boating safety—must

be further understood, clearly articulated and incorporated into the design of the state's ocean and coastal observing systems.

This workshop successfully engaged a variety of users and scientists, further refined the needs for information products, and articulated the importance of a scaled approach to design. It was, however, unsuccessful in developing an integrated design that would address both water quality and MPA monitoring. A day-and-a-half workshop proved to be too short to complete this ambitious goal. Developing such a design requires a more-detailed evaluation to understand how managers use information—for what purposes, on what scales, in what format—and what technologies and data sets already exist that can provide this information. For the newly established MPA program, a continued dialog is needed between scientists and managers to further understand how the information will be used and to outline reasonable options for addressing those needs. This level of analysis and investigation is difficult to achieve in a large workshop setting, but this workshop established the groundwork necessary for moving forward.

Overall Recommendation

To build on the success of the workshop, the State of California will retain consulting services to create a cohesive vision for how the ocean observing system in California can meet the needs of managers. The work should expand beyond water quality and MPA monitoring to include other key issues such as harmful algal blooms, sediment management, ocean energy and maritime safety. The goal is to provide guidance for the federal, state and private investments while developing current awareness among management and industry regarding the value of the IOOS and the Regional Associations as centers of expertise delivering valuable products.

The primary role of the consultant(s) will be to facilitate the development of ideas through an iterative process with the State and the RAs. As a first step, the consultant will work with the RAs and others to synthesize the needs of managers for observing products. Based on an understanding of needs and the existing observing capabilities, the consultant will develop straw-man proposals to elicit reaction and input. The final report will articulate a vision that meets the needs of managers, is acceptable to and deemed feasible by the scientific and observation community, and is understandable by high-level decision makers.

The consultant(s) should work closely with the State (Ocean Science Applications, Ocean Science Trust, the State Coastal Conservancy's Ocean Protection Council, and others) and the two Regional Associations (SCCOOS and CeNCOOS). Both

RAs have completed user-needs evaluations that will provide a foundation for this work. In some areas, such as the monitoring of MPAs that represent a relatively new program, the observing community will need to develop and propose frameworks and approaches to monitoring. The initial proposal should include a concise statement of managers' needs; an outline of feasible options for meeting those needs; and a reasonable plan for the ocean observing network in the State to address these multiple needs.

The end product should include an executive summary aimed at informing high-level decision-makers about the utility and necessity of coastal observing to meet the four or five ocean and coastal management needs identified. The product should include a more-detailed document addressing the specific scientific and technical objectives and processes for moving forward.

In conducting this project, consideration should be given to establishing a small and agile advisory committee with observing scientists from the two RAs and State managers to

- identify the user groups to be consulted to help inform the process,
- provide guidance to the consultant(s) on existing information, and
- evaluate draft proposals, leading to the development of a final report.

Other Recommendations

The workshop generated other action items and recommendations that can be implemented along with the above initiative. Crosscutting recommendations are listed here. Specific recommendations on water quality and the monitoring of marine protected areas are contained in the main body of the report.

Design nested systems. For both water quality and MPA monitoring, observing systems must monitor the marine environment at multiple scales of time and space. Large-scale observations of the California Current and observation of regional upwelling events provide context for understanding changes or phenomena at the local scale. Local-scale observations allow comparisons of populations and ecosystems inside and outside MPAs. Nested observations provide information that managers and scientists need to understand environmental anomalies.

Integrate existing data. Various types of oceanographic data are being collected in California for use at the local, regional, state or national level. Much of this data is not easily accessible or available in forms that can be integrated with one another. The CeNCOOS data registry catalogs many of these assets. The SCCOOS clear-

inghouse for water quality data, which provides easy access for local managers to data from many sources, demonstrates the value of accessibility and interoperability of data. Data integration expands the types of data that managers can access and analyze, and it is a critical step in the development of decision-support tools (i.e., model simulations) of interest to managers.

Initiate a pilot project. The process can be initiated using a pilot project that will demonstrate the utility of ocean observing to managers and non-scientists, and provide a basis for estimating costs. The project should evaluate existing tools to determine their effectiveness in meeting user needs and their potential role in meeting statewide needs. Consideration should be given to the pilot projects initiated by the RAs that are working with managers and industry as data users.

Market the benefits of ocean observing. A clear statement of the benefits of ocean observing that is understandable to the Governor, legislators, Congress, private funders and the general public is needed. The messages should have two parts: one concise, compelling statement akin to an “elevator speech” and a more detailed description of the program, including a cost-benefit analysis suitable for financial managers. These messages are essential for building the partnerships between the Regional Associations and the management community.

Foster communication between managers and scientists. Ocean observing operates at the nexus between science and management. To foster better communication and understanding between these cultures, consideration should be given to collocating scientists and managers through programs such as Sea Grant fellowships, state fellowships and other mechanisms. RAs could place people at management agencies, and/or managers could do internships at RAs. These collaborations can foster the communication necessary to develop the custom information products that ocean observing is uniquely capable of providing.

Workshop Report

The Coastal States Organization (CSO), in partnership with the California Ocean Science Trust, Ocean Science Applications and the two IOOS Regional Associations serving California—Central and Northern California Ocean Observing System (CeNCOOS) and the Southern California Coastal Ocean Observing System (SCCOOS)—hosted the workshop “Making Use of Ocean Observing: Water Quality and MPAs” on September 25 and 26, 2007, in San Francisco. The purpose of the workshop was to convene a small group of managers and ocean observing experts to determine the requirements for an ocean observing system to meet the needs of water quality and marine protected area (MPA) managers.

After initial presentations on ocean observing in California and examples of how the information is being used to make a difference to managers, participants were divided into working groups focused on MPAs and water quality. Managers, scientists and observing experts were represented in each working group. The charge to the groups was to identify the needs of managers and to develop a concept plan for how an observing system could address those needs. These designs would be overlaid to identify the common elements of both and to illustrate how a single system can meet multiple needs. From this process, the working groups developed a set of recommendations.

IOOS in California: Making a Difference

Ocean observing is already making a difference to users in California, particularly in the areas of water quality, harmful algal blooms and emergency response. Success stories for MPA monitoring are fewer because the program is in its initial stages. To set the stage for discussion, examples of success stories were presented at the workshop. Eric Terrill of SCCOOS discussed how coastal observing provided critical information to environmental managers during the diversion of a municipal treatment discharge for maintenance of the ocean outfall pipe. As an example of how ocean observing can be applied to MPA monitoring, Bill Sydeman explained how physical oceanographic measurements combined with biological information are aiding studies of fish populations. David Caron and Burt Jones did not provide a formal presentation at the workshop, but they were asked to submit a short write-up for this report to describe how ocean observing has been used during the recent harmful algal bloom along the coast. The following are summaries of these examples.

Water Quality: The Hyperion Treatment Plant Diversion

Summary of presentation by Dr. Eric Terrill, Scripps Institution of Oceanography

In November 2006, the City of Los Angeles Environmental Monitoring Division inspected and repaired the 5-mile discharge pipe of the Hyperion Treatment Plant. To conduct the inspection, the City redirected over 800 million gallons of discharge over a three-day period to a shorter pipe that would discharge the effluent only one mile off the coast of Santa Monica Bay. Environmental groups, public health officials and the general public were concerned about the impact of this temporary diversion. The Southern California Coastal Ocean Observing System (SCCOOS) provided real-time data, satellite images and model results to help design a monitoring plan to comply with NPDES permits, to track effluent and to assess environmental impacts.

SCCOOS provided city officials with a variety of ocean information:

- Real-time surface current maps, derived from the State's HF radar network, to track the movement of the discharge plume.
- Wave-driven current maps within the surf zone.
- Boat sampling of the plume, including phytoplankton and nutrient sampling.
- Satellite images to track the spatial extent of the discharge's surface plume.
- Up-to-date wind and rain observations and forecasts.
- Forecasts based on trajectory models to predict the fate and transport of the plume.

A special website provided this up-to-date ocean information to coastal managers during the event (<http://sccoos.ucsd.edu/projects/hyperion/>). It was applauded for providing a public view of the ocean conditions during the event.

Models were critical to the planning and monitoring of the diversion. The near real-time trajectory modeling showed the most probable transport of the diverted effluent plume, indicating that the plume would not travel shoreward and impact the beaches. When high counts of bacteria near Ballona Creek occurred during the first day of the diversion, managers were able to prove that they were not from the diversion, but the recent rain event that caused storm-drain discharge.

The fate and transport model provided city officials with an assessment of where the effluent was moving. Actual data from drifters and boat samples (temperature, salinity, density and bacteria) corroborated the model results, providing a high degree of confidence in the understanding of the fate and potential impact of the effluent during the three-day diversion.

This multidisciplinary and multi-agency approach ensured that the best available information was used for the project. Stakeholders, environmental managers, environmental groups, public agencies, municipalities, and other parties interested in the decisions, outcome, and conclusions of the diversion event were confident in the information, which brought widespread support for the diversion project, including from environmental watch groups.

Water Quality: Harmful Algal Bloom Monitoring

This section was not presented at the workshop. It was submitted by two workshop participants, David Caron and Burt Jones, at the request of the Steering Committee to provide another example of ocean observing information addressing critical issues.

Recent summaries of available information have indicated that coastal ecosystems have witnessed a general increase in the occurrence and severity of harmful and toxic algal blooms. The coastline of California is no exception, with powerful neurotoxins such as saxitoxin and domoic acid now commonly observed throughout the state. Numerous factors have been implicated as possible contributors to these coastal algal blooms. Harmful blooms can result from natural, seasonal supply of nutrients to coastal waters during upwelling and from anthropogenic inputs of nutrients in river discharges and land runoff.

Unfortunately, quantifying the contribution of the many potential sources of nutri-

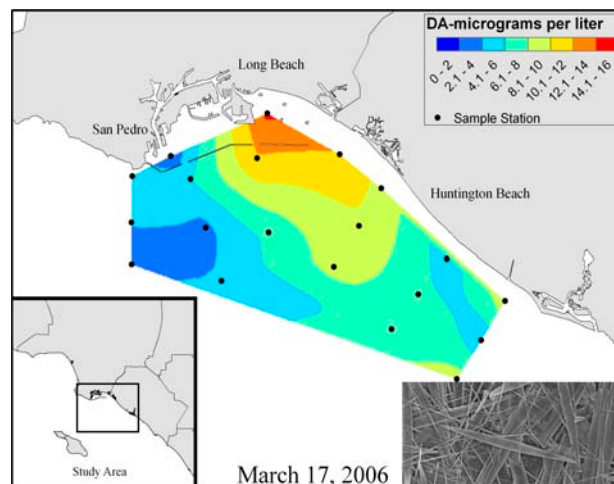


Figure 1 Contour plot showing the distribution of the neurotoxin domoic acid, produced by certain algae. High concentrations in the vicinity of the San Pedro-Long Beach harbor and Los Angeles River are shown by warm colors. Insets show the study area and an electron micrograph of the causative alga (*Pseudo-nitzschia australis*). This figure appeared in the *Los Angeles Times* in 2006 in a series entitled “Altered Oceans” by Kenneth Weiss, for which he received the Pulitzer Prize.

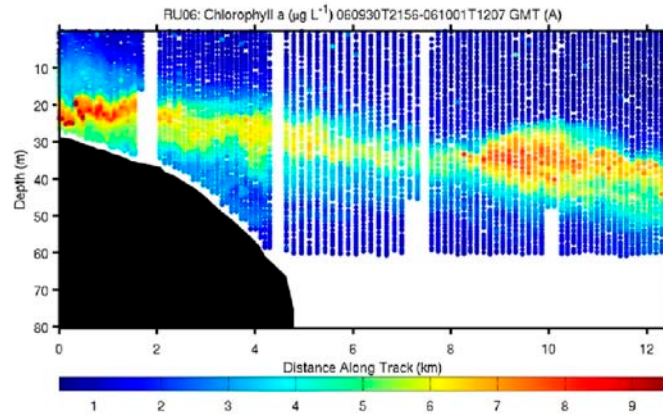


Figure 2 An example of sensing tools used to document algal biomass in a coastal ecosystem. Phytoplankton biomass in the water column (2006) along an onshore-to-offshore cross-section near Huntington Beach. Warm colors indicate high biomass forming a subsurface peak in the water column. An autonomous vehicle (operated by SCCOOS) was employed to obtain the information.

ents that can support algal blooms is a daunting task because of the difficulty of maintaining continuous observations in the ocean. Harmful algal blooms are ephemeral events that can develop quickly and dissipate before their causes can be adequately characterized. Efforts by municipalities, counties and the state to provide responsible environmental stewardship of coastal waters are often thwarted by the lack of sufficient observational capabilities to document water quality, let alone determine the cause(s) of adverse events such as harmful algal blooms. Partnerships are desperately needed between ocean observing programs, research/academic institutions, coastal managers and monitoring programs (including both government and nonprofit) to grapple with the increasing number of environmental influences on algal population growth and toxin production in coastal marine ecosystems.

Ocean observing systems provide a tool for monitoring, understanding and ultimately predicting harmful algal blooms. Sophisticated sensing instruments installed on piers, deployed from ocean buoys, or carried by mobile surface and underwater vehicles provide a ‘constant presence’ in the ocean that assists scientists to detect impending or emerging events, and guide their sampling effort. Aquatic sensors can provide information on salinity (which can identify sources of freshwater input to the coastal ocean), temperature (which yields information on the physical structure of the water column, a primary factor affecting algal growth in nature), chlorophyll fluorescence (which documents the biomass of algae in the water) and dissolved oxygen (which indicates biological activity and ecosystem health). A variety of ever-improving nutrient sensors can quantify specific substances that may stimulate algal growth (e.g., ammonium, nitrate, phosphate). In addition, new sensors that can detect specific microorganisms and/or toxins produced by these species are

under development and eventually will increase the capabilities of ocean observing systems. These observing systems fill a fundamental gap in our ability to document harmful or toxic events, and aid our attempts to attribute these events to specific environmental causes.

Application of Ocean Observing to MPA Monitoring

Summary of presentation by Dr. William J. Sydeman, Farallon Institute for Advanced Ecosystem Research

Ocean observing of basic and complex physical and biological parameters is a growing field in applied marine science. In time it is hoped that ocean observations will be seamlessly organized and communicated to marine resource managers and policy makers to be used in understanding patterns of change in fish and wildlife populations and for decision-making. There are many pressing management issues facing the marine environments of California, but one of the most important concerns evaluation of the State's new system of marine protected areas (MPAs). Under the Marine Life Protection Act (MLPA) of 1999, the State of California has designed and delineated a network of MPAs, and a monitoring plan has been developed to assess the efficacy of the MPAs. The MLPA calls for protection of fish populations of concern (e.g., rockfish of the genus *Sebastes*) as well as ecosystem processes and functions that support invertebrates and top predators (e.g., seabirds and marine mammals). The MLPA MPA monitoring plan states the need for integrating ocean observations into monitoring, but provides few details. Herein, we present some concepts that are applicable to using ocean observing in the context of MPA monitoring and evaluation.

Temporal and spatial scales of ocean observation are important considerations. Moreover, there are multiple scales of biological organization (individual, population, community and ecosystem) that need to be evaluated. Therefore, addressing and linking the scales of ocean observation with the appropriate scales of biological organization is a key element in application of ocean observing systems to interpreting biological change for decision-making. For California MPA monitoring, there are at least 4 spatial scales of ocean observing that should be considered: basin-wide (North Pacific Ocean), large marine ecosystem (California Current), regional/sub-ecosystem (e.g., the Southern California Bight), and local (inside and/or adjacent to the MPA of interest). Basin-scale observations include quasi-global phenomena that may affect local populations and communities. Examples of these large-scale effects include changes in the Pacific Decadal Oscillation (PDO) and the El Niño-Southern Oscillation cycle that have well-known influences on ecosystem productivity. On the large marine ecosystem scale, transport of nutrients and material (plankton) from the Gulf of Alaska into the California Current determines aspects

of ecosystem productivity. On the regional/sub-ecosystem scale, coastal geomorphology (headlands, etc.) influences upwelling of nutrients on the continental shelf, thereby promoting primary and secondary productivity. Upwelling, however, varies in relation to local wind patterns, with stronger upwelling generally found in more northerly latitudes. On the local scale, variation in temperature, salinity, and other factors may influence the productivity and dispersal characteristics of local populations through physiological or behavioral mechanisms.

Coupling of physical and biological measurements, at both large and small scales, and in consideration of the biological units of interest, is required for integrating ocean observing into MPA monitoring and evaluation. As an example, consider the typical population biology of rockfish (genus *Sebastes*). Population change in *Sebastes* and indeed many other long-lived vertebrates is dependent on the interplay of many demographic traits such as fecundity, survival of the adults, survival of the young, age at first breeding, recruitment probability, and immigration and emigration (dispersal). Each of these traits can be influenced by physical and/or biological changes in the environment, and they collectively alter population dynamics. Moreover, in long-lived species, the age and size structure of the population also determines demographic values. To simplify, population change can be viewed as the combined effects of birth and immigration minus death (from fishing or natural mortality) and emigration (BIDE). For MPA monitoring that focuses on the population level, ocean observing data can be used to assess the effects of changing oceanography on BIDE (and in more complex scenarios on age-specific rates of fecundity and survival, if such data were available). As an example, consider the effects of oceanographic variation on production (reproductive success) of shortbelly rockfish (*Sebastes jordanii*) (Figure 3). In this example, a conceptual model of physical and biological effects was considered, including the abundance of zooplankton prey. The model explained about 35% of the variation in fish production.

Successful application of ocean observing systems to MPA monitoring and evaluation is dependent on bio-physical coupling at multiple spatial and temporal scales. Oceanographic and ecosystem measurements at both the largest and smallest scales of observation will likely be important. It will be necessary to develop conceptual models of direct and indirect effects, which will lead to testable hypotheses on individual parameters. Biological variability of complex, age-structured vertebrate populations (fish, birds, mammals) is unlikely to be understood or predicted based solely on physical measurements because of complex, multivariate, and non-linear relationships. Therefore, an ocean observing system for management of living marine resources should include a suite of physical and biological measurements of important interactions (e.g., predator-prey relationships), which would facilitate understanding of changes observed in MPAs.

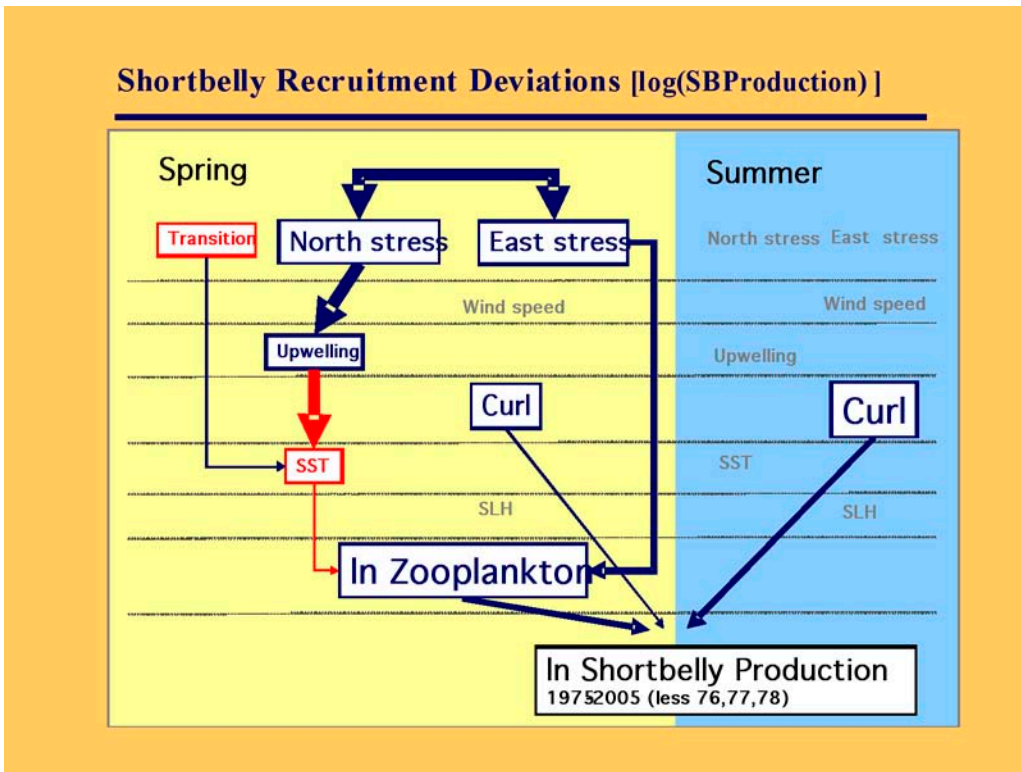


Figure 3 Effects of physical and biological variables on production of shortbelly rockfish (*Sebastes jordani*) in central-northern California (greater Gulf of the Farallones region). Blue arrows show positive correlations, and red arrows show negative associations. Thickness of the arrows is proportional to the strength of the correlation. Variables considered include date of the spring transition (when upwelling becomes positive), northern and eastern wind stress, Bakun's upwelling index, curl of the wind, sea surface temperature (SST, a core IOOS variable), and abundance of zooplankton prey. In spring, northern and eastern wind stress were positively related, and they positively and directly affected upwelling and zooplankton abundance. Date of the spring transition was weakly positively related to temperature (later springs were warmer), and SST weakly negatively affected zooplankton. Only zooplankton and curl of the wind (especially in summer) influenced fish production directly—zooplankton presumably through predator-prey relations, and curl through offshore transport of fish away from preferred habitats. Understanding multiple effects will improve the heuristic and long-term value of bio-physical models.

Figure reproduced with permission from: Brian Wells, John Field, Julie Thayer, Steven Bograd, William Sydeman, Franklin Schwing, Churchill Grimes, Roger Hewitt, and Kevin Hill. In press. Untangling ocean climate, prey, and top predators in an oceanic upwelling ecosystem. *Ecology*.

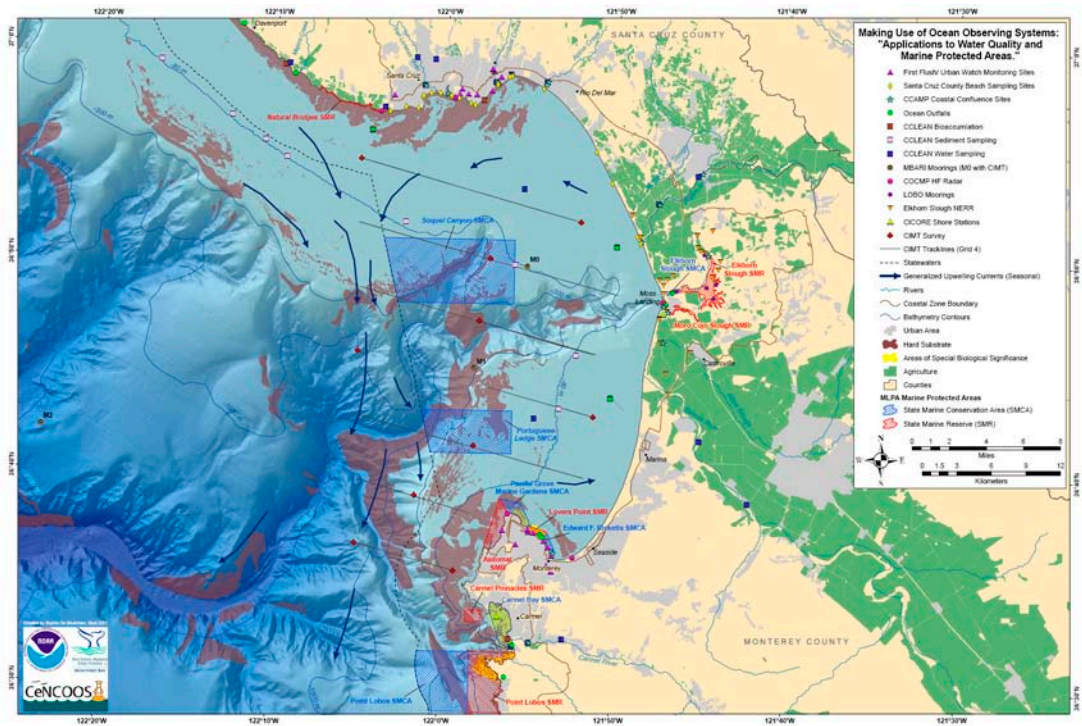


Figure 4 Map of Monterey Bay. Provided by Monterey Bay National Marine Sanctuary.

Monterey Bay: Providing a Geographic Reference

Monterey Bay served as a geographic focus area for workshop discussions. It provided real-world context for possible types of statewide monitoring. Monterey Bay was selected because the MLPA Initiative’s pilot project in that region led to the designation of the State’s first network of 29 MPAs. In addition, the area is bordered by urban, agricultural and rural lands, has rich biological diversity, hosts numerous recreational enthusiasts, and provides many commercially important species. It is a well-understood marine system because of research by institutions located along its coastline and elsewhere.

Like other regions along the coast, the natural variability in local and basin-wide states of the climate and ocean circulation drives the local ecosystem. The California Current, a broad, shallow southward-moving current transporting cool water with low salinity to the equator, is believed to be an important driver of food webs in the bay on an annual basis. Within the bay is a major upwelling zone caused by wind forcing warm surface waters offshore to be replaced by cold nutrient-rich waters.

Water Quality Issues and Recommendations

Background

Recent increases in harmful algal blooms (HABs) and anoxic zones have highlighted the need to better understand and manage the effects of excess nutrients in coastal waters. The Regional Water Quality Control Boards, EPA and local agencies all play a role in managing coastal nutrients. The California Department of Public Health is responsible for monitoring HAB events to protect public health. Shellfish harvesters, aquaculturists and the fishing industry are also interested in better information and are affected directly by water quality impairment and HABs. The general public and legislators monitor these issues and push for changes in public policy through rules, best management practices and laws. All of these users require more in-depth and sustained information to understand the impact of nutrients, provide predictive capacity, set standards and management practices and evaluate the effectiveness of management systems.

Water Boards/EPA: Managing Nutrients in Coastal Waters

Nutrient enrichment in coastal waters is a consequence of human activities. Coastal development, agriculture, municipal sewer discharges and atmospheric deposition increase the amount of nitrogen and phosphorus entering coastal waters. High levels of nutrients can cause water quality problems ranging from excessive algal blooms; depleted oxygen, causing hypoxia (low oxygen) or anoxic (no oxygen) events; and losses of submerged aquatic vegetation (SAVs). The recent increase of harmful algal blooms (HABs) along the California coast may be linked to increasing nutrients.

EPA and the Regional Water Boards regulate discharges into coastal waters through the issuance of permits. The Clean Water Act requires all discharges to receive a National Pollution Discharge Elimination System (NPDES) permit. In California, most NPDES permits are administered through the Regional Water Quality Control Boards. For nutrients, EPA requires states to prepare Total Maximum Daily Load (TMDL) programs for the management of nutrients to describe the nature and degree of impairment. These TMDL programs perform the following functions:

- Establish numeric water quality targets necessary to support beneficial uses.
- Evaluate nutrient inputs and sources.
- Determine nutrient-load reductions necessary to achieve numeric targets.
- Implement measures to control nutrient loads and limit the adverse effects of nutrients in the listed waterbodies.

Most of the Water Boards have developed TMDL programs for coastal rivers. Water Boards are now wrestling to assess the impact of nutrient inputs from different sources (rivers, agriculture, sewage plants, storm runoff) on the outbreak of algal blooms and to determine the fate of storm-water runoff in the bay (where does it go, how fast does it get there, and how long does it take to disperse) and its implications for Areas of Special Biological Significance (ASBS) and marine protected areas (MPAs). This information would be used for determining new water quality criteria, implementation of best management practices (e.g., work with resource conservation districts to agricultural runoff, work with local planners to reduce urban runoff), remediation work, and monitoring overall trends and effectiveness of management measures.

To address these issues, consideration needs to be given to the following questions:

- What are natural versus human-induced levels of nutrients?
- What is the acceptable level of nutrients?
- When should nutrients be controlled?
- What discharge concentration and volume are acceptable?
- How do water and river quality conditions vary over time?
- Where do the nutrients go in the ecosystem?
- How long does it take for a bloom to develop from an increase in nutrients?

Long-term, systematic data and studies are needed to determine trends, establish water quality criteria and indicators, and assess the effectiveness of management measures. Rivers and offshore areas are well monitored, but flow patterns are poorly known in the nearshore area, where it is difficult to deploy sensors. This is a problem because algal blooms often initiate near the mouths of rivers and near discharges.

California Department of Public Health: Shellfish Protection

Increases in nutrients can lead to outbreaks of harmful algal blooms that contaminate shellfish and other types of seafood (e.g., sardine, anchovy). The California Department of Public Health is responsible for protecting the public from exposure to toxins in shellfish through the Preharvest Shellfish Protection and Marine Biotxin Program. The Department routinely monitors commercial and recreational shellfish beds for the presence of domoic acid and saxitoxins, which cause amnesic shellfish poisoning and paralytic shellfish poisoning, respectively. Shellfish samples (e.g., mussels, clams) are carried to certified labs, where the tissue is tested for biotoxins. When toxins are detected at dangerous levels, the beds are closed until resampling indicates the threat has passed. Health advisories are issued through press releases

to alert the public when elevated toxin levels are detected.

The system is effective in protecting public health, but it is reactive and does not provide managers, harvesters, processors, or the general public with predictive capabilities of when or where outbreaks may occur. An early warning system that notified managers and harvesters of conditions favorable for a bloom would allow managers to conduct targeted sampling and harvesters to avoid harvesting contaminated shellfish. In 1992, responding to the first documented occurrence of domoic acid along the California coast, the California Department of Public Health initiated a volunteer phytoplankton monitoring program. This effort involves frequent sampling and field observations of coastal phytoplankton assemblages and provides early warning of the occurrence of known toxic species. As a result, the state's biotoxin monitoring program can increase shellfish sampling efforts in regions of concern.

Monitoring of changes in ocean water masses can detect signs that conditions are suitable for an algae bloom. Upwelling events that bring nutrients to the surface layer where light is available for photosynthesis are key to triggering possible blooms. Upwelling events can be detected by monitoring wind, sea surface temperature, the mixed layer water depth, sea surface currents, chlorophyll a, nutrients and phytoplankton species. Sophisticated offshore observing systems and nearshore volunteer phytoplankton monitoring programs provide complementary data that can potentially be used for the early detection and prediction of HABs.

Workshop Findings: Water Quality

An ocean observing system can monitor core variables that when analyzed alone or together can provide information to assist with both water quality concerns and shellfish sanitation. Key to understanding nutrient impacts is the transport of water masses and the development of nutrient mass balance models. Participants in the workshop identified the following variables to be monitored:

- Temperature at the surface and in the water column (warming and cooling trends)
- Salinity (influx of freshwater into system, also useful for monitoring movement of water masses)
- Currents (speed and direction of currents at the surface and throughout the water column, particularly for the surf zone and nearshore currents up to approximately 100 yards off the beach)
- Meteorological observations of wind and air temperature (surface layer mixing, storm events)
- Wave direction and period (mixing)
- Bathymetry (circulation patterns, substrate)

- Water column stratification (mixing layer)
- Chlorophyll a (availability of nutrients, biomass)
- Nutrients (phosphorus, nitrogen)
- Flow rates and concentrations (continuous measurements) at rivers and at the mouths of storm drains in key locations
- Phytoplankton species

The goal is to develop information products from these observations that are understandable, accessible, and useable by the target audience. The specific audience is important as the levels of expertise within a program can vary and the scale of information can vary depending on the mandate (i.e., is the mandate to monitor swimming beaches, storm drains, MPAs, or outfalls?). Product development is an iterative process that depends on close and frequent interactions with the user. Products identified at the workshop include:

- Time-series map of bloom events correlated with inputs
- Fish bed acre days of closures by year
- Series of indicators such as HAB acre days by year, loads by year
- Isotopic signatures
- Three-dimensional simulation models

The nearshore area was routinely cited as lacking adequate monitoring. It is a complex area, where shallow water and the high-energy environment make it difficult to sample. Instruments that provide synoptic coverage such as satellites and HF radar do not resolve the nearshore area well. However, the linkage between the surf zone and offshore areas is critical to understanding the fate and transport of nutrients.

Offshore areas were generally thought to be better monitored. The State's Coastal Ocean Currents Modeling Program (COCMP) has installed a network of HF radar technology that provides information about surface currents in real time.

Observations can be collected through a variety of platforms. Most observing systems integrate data from a variety of platforms such as the large regional-scale coverage available from satellites and the in-depth water column information provided by moorings or shipboard surveys. The following platforms were discussed:

- Satellites, which provide synoptic coverage of surface characteristics such as temperature, ocean color, and winds, but are affected by cloud cover.
- Land-based radar systems, which provide synoptic coverage of surface currents and are not affected by cloud cover, but may not provide near-shore measurements.
- Moorings and piers, which provide measurements under the water and detailed information at a given location.

- Autonomous underwater vehicles (AUVs), which provide three-dimensional continuous information.
- Shipboard sampling, which can capture information on the surface and in the water column at set stations or transects.
- Hand sampling, which can be done close to shore and in shellfish beds, and which allows rapid and adaptive monitoring.

Gliders offer an efficient way to monitor coastal currents and to develop a three-dimensional picture of the area, but this platform may not be economically viable (i.e., one year for one sampling line could cost \$100,000). Moorings provide in-depth data but need to be placed in areas that have high residence times. It was noted that the two existing Monterey Bay moorings (M1 and M0) are not well placed for understanding water quality issues in the bay. Widespread deployment of smaller temperature, salinity and current monitors can provide a picture of the nearshore area and the fate of storm water.

Models are powerful analytical tools for integrating data sets, understanding the complexity of coastal ecosystems and developing predictions such as the fate of nutrients. For nearshore waters, high-resolution (1 km) circulation models are needed, as are nearshore surf zone models. Nutrient mass balance models capture the external inputs into a system (runoff, river inputs, discharges and atmospheric deposition) with the internal system functions (upwelling and relaxation events, benthic resuspension, nutrient recycling) to describe the system and to determine threshold levels for nitrogen and phosphorus.

Workshop Recommendations: Water Quality

The recent increase in harmful algal blooms and their impact on water quality, marine ecosystems, and shellfish has highlighted the need to better understand and predict the impact of nutrients.

The working sessions on water quality developed the following recommendations:

- 1) Develop localized studies to determine optimal system design to meet the primary needs of the managers. These studies would identify target sampling sites, placement of sensors, and glider tracks.
- 2) Invest in the development of transport models, mass balance, and simulation models to provide managers with information on the threshold for nutrients, predictive ability for assessing the impact of permit decisions, and capacity for strategic sampling.

- 3) Continuously measure or model flow rates and concentrations at rivers and storm drains to enable predictions of storm loads to coastal waters.
- 4) Support research studies that link the surf zone with offshore currents.
- 5) Invest in biological and chemical sensors.
- 6) Increase nearshore measurements.

MPA Monitoring: Issues and Recommendations

Background

In 1999, California enacted the Marine Life Protection Act (MLPA), which requires the State to design and manage a network of marine protected areas (MPAs). The Act further requires adaptive management to ensure that the MPA system meets its goals, as stated in the Act. The Central Coastal MPA network was formally adopted in the spring of 2007 as the first regional system. The Master Plan for Marine Protected Areas (California Department of Fish and Game, 2007) calls for a program of adaptive management, monitoring and evaluation implemented on multiple spatial scales (individual MPA, regional MPA network, statewide system) to assess the effectiveness of the program and to adjust management actions if necessary. The Draft MPA Monitoring Plan for the Central Coast Study Region (December 2006) details the biophysical and socioeconomic objectives for the monitoring plan. The plan provides details on biological monitoring but provides only passing reference to the need to understand the oceanographic environment in which the MPAs are located. This workshop focused on describing the biological, chemical and physical oceanographic observations necessary to assist with this understanding.

The MPA Monitoring Plan states that biophysical monitoring is needed to evaluate whether the state's MPA network is meeting the following goals, specified in the MLPA:

- 1) Protect the natural diversity and abundance of marine life, and the structure, function, and integrity of marine ecosystems.
- 2) Help to sustain, conserve, and protect marine life populations, including those of economic value, and to rebuild those that are depleted.
- 3) Protect marine natural heritage, including representative and unique marine life habitats in Central California waters, for their intrinsic value.
- 4) Ensure that the Central Coast's MPAs are designated and managed, to the extent possible, as a component of a statewide network.

To assess performance against these goals, the plan calls for the monitoring of habitats; fish populations, including abundance and population structure of species of high ecological value or human-use value; composition and structure of a community of organisms; survival of young; ecosystem condition; type and level of fishing

effort; water quality; and areas whose habitat or wildlife populations are showing signs of recovery.

In addition to evaluating the performance of MPAs and supporting improved MPA effectiveness through adaptive management, monitoring inside and outside MPAs is needed to improve our understanding of marine ecosystems, their status, trends, and functioning, and the impacts of human activities on these systems. The MLPA states, for example, that “monitoring and evaluation shall be emphasized so that the interaction of different elements within marine systems may be better understood”.

This workshop identified oceanographic and environmental variables that should be monitored to provide local, regional, and statewide context for changes in these parameters. In discussing these issues, workshop participants addressed the following questions:

- 1) What oceanographic features impact the stated indicators of ecosystem structure (e.g., species abundance, species composition, species diversity, increased recruitment, amount and quality of benthic habitats)? What major oceanographic forcing factors should be monitored and over which spatial and temporal scales?
- 2) The monitoring plan will be examining local, regional and statewide phenomena. Are the key elements in place to provide these data on a statewide scale? On a regional scale? On a local scale? For example, if differences are detected inside MPAs compared to reference sites, what data are needed to explore the relative contributions of management (e.g., reduction of fishing) and possible oceanographic differences (e.g., differences in wave-swell regime) to the observed differences?
- 3) What oceanographic data are needed to evaluate the effectiveness of the network design? The MPA monitoring plan will seek to monitor the biological connectivity of the network components—movements of adults and larvae—among MPAs, for example by mark/recapture studies and acoustic tags. Larval sources, sinks and dispersal patterns are of interest both for evaluating connectivity among MPAs and for helping to understand and predict the role of MPAs in conserving and/or rebuilding populations of interest. Is there enough scientific understanding and technology to track larvae through an observing system? What would be required to do so?

- 4) What conceptual or quantitative models are needed to predict the impact of various forcing factors such as El Niño or changes in the California Coastal Current?
- 5) What models are needed for interpreting the observation data?

Workshop Discussion: Discerning the Effect of Environmental Conditions on MPAs

MLPA implementation is in its beginning stages, establishing a baseline from which the program will be evaluated over time. In the next 5, 10, or 15 years managers will be called upon to answer questions such as:

- Are the MPAs meeting the goals stated in the MLPA?
- Are there more fish inside the MPAs than outside? If so, why?
- Can the changes be attributed to the MPA process?
- How should management be adapted to enhance effectiveness? Should the boundaries of a MPA be changed? Should the management strategy be amended?

From the workshop discussion, it was clear that managers need information, not just the raw data. As the program matures, more detailed work will be needed to better understand the kinds of decisions that managers will be making and the kinds of information needed, in what format, and at what temporal and spatial scales. For example, it was noted that fishery managers are often interested in the extreme value, such as highest or lowest temperatures, as these can be limiting for a particular species. This is the type of detailed information about managers' needs that must be collected to ensure that the information products are useful to resource managers.

The intent and purpose of a given MPA must be considered in the monitoring process, as well as the objectives and goals of the regional MPA network and the statewide goals stipulated in the MLPA.

Scale is important. The MPA monitoring plan calls for assessing the effectiveness of individual MPAs, the regional network and the statewide system. Similarly, oceanographic conditions that influence the MPA range from basin-scale effects of the Pacific Ocean to offshore effects of the California Coastal Current to regional upwelling and relaxation effects to the small scale of the MPA itself. There was unanimous support for monitoring some critical parameters, such as temperature, within each MPA and in reference areas to discern small-scale variations in oceanographic conditions that may or may not affect conditions within the MPA. Research

in the Vandenberg marine reserve demonstrated the importance of monitoring both inside and outside of the protected areas. There was consensus among participants that a nested design (Figure 5) may provide the most useful and feasible approach. In a nested design, some measurements (e.g., important and comparatively inexpensive variables such as water temperature) are monitored at every MPA and reference area, while other variables are monitored at a few strategically selected locations.

Understanding the connectivity among and within MPAs is important to determining the overall effectiveness of a regional system. To complement monitoring of fish population dynamics, process studies are needed to understand how water properties influence nutrient availability, animal behavior, and recruitment and transport of phytoplankton and zooplankton. For example, strong wind events alter ocean stratification and can change the depth distribution of food, which can lead to changes in behavioral patterns of marine organisms. These relationships are important to understand in order to determine whether the success of a MPA is a result of changes in fishing pressure, environmental factors, or both.

Models can provide context for discrete observations, synthesize data, and describe the connectivity among MPAs. A variety of models exist for the Monterey Bay, including circulation models, flow models, and nutrient models. These models should be evaluated to determine their applicability and adequacy for meeting the adaptive management, monitoring, and evaluation goals of the MLPA, and thought should be given to the need for and feasibility of developing useful models throughout state waters.

In a general sense, the group thought that large-scale phenomena such as the California Coastal Current are being monitored sufficiently for the purposes of MPA monitoring. However, the nearshore environment is complex, it is comparatively under sampled, and it is critical to understand for management of important species and ecosystems.

The variables identified by the national IOOS program (see Appendix F) were determined to be a fairly comprehensive list with the exception of noise. There had been an acoustic monitor in Monterey Bay that listened for whales, but recently it was removed due to budget cuts. Certain key areas and features, such as upwelling in the northern bay and water exchange at the mouth of Elkhorn Slough were identified as areas where additional monitoring is needed. Monitoring the feeding behaviors and numbers of seabirds and marine mammals can complement physical observations, helping to identify forage areas and providing regional context for the MPAs.

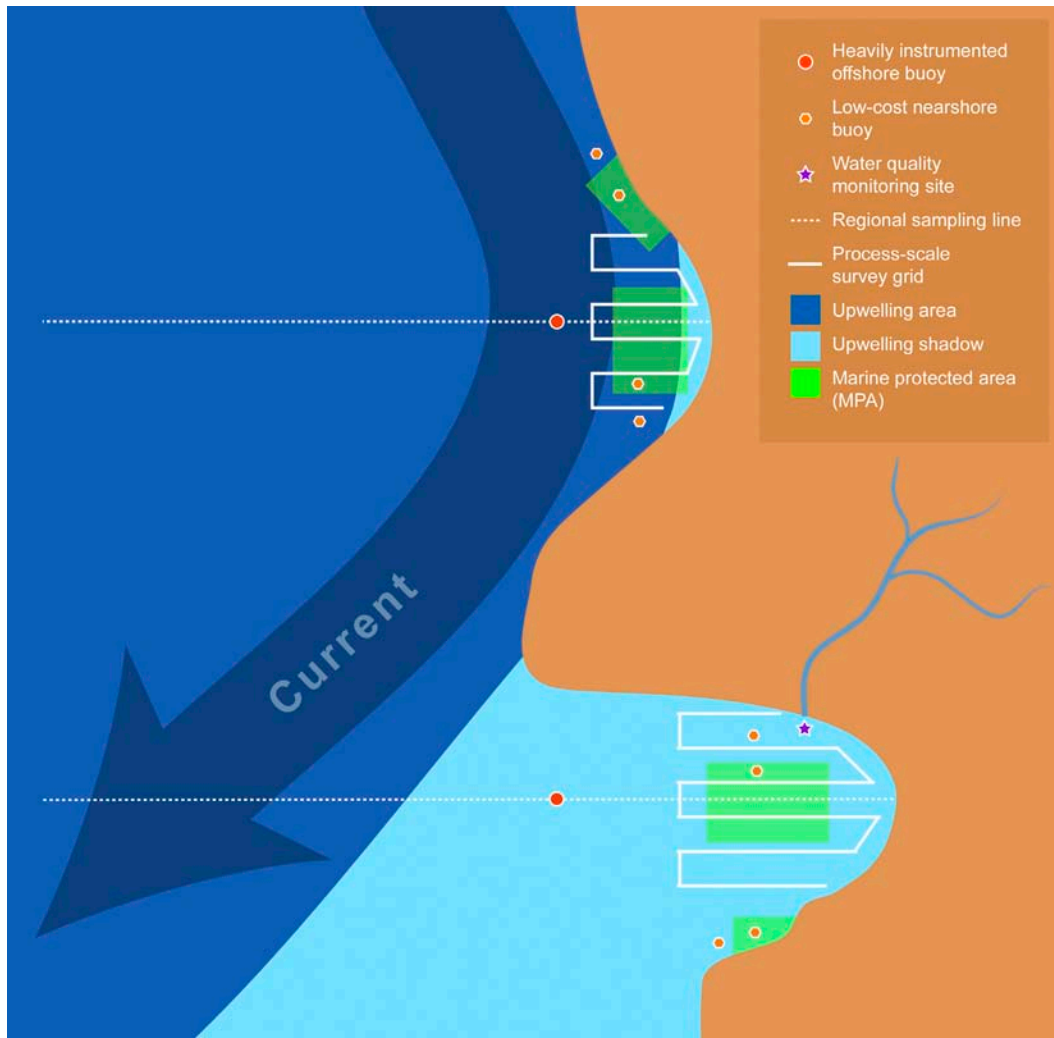


Figure 5 Conceptual design for a nested observing system. Graphic by Peter H. Taylor

Workshop Findings: MPA Monitoring

- 1) A nested design would integrate monitoring at various scales into a single observing system and would allow observations to be used in many ways. Figure 5 illustrates the nested design concept. For MPAs, the nested design would include well-instrumented offshore buoys to monitor the California Current and other large-scale phenomena; sampling lines and process-scale survey grids to monitor variations in regional phenomena; and low-cost monitoring stations located within and outside of MPAs to detect small-scale variations in environmental conditions. Existing monitoring systems for water quality, waves, and other variables would augment this information.

- 2) To determine the effectiveness of MPAs, basic measurements (e.g., temperature, salinity, and perhaps nutrients) need to be monitored at each site. More complex and therefore more expensive measurements are only required at a few sentinel sites to provide the regional context for the MPAs. Temperature, salinity, meteorological data, currents, nutrients and toxins should be monitored at these sites.
- 3) The need for real-time information was unclear. If managers need trend information and are not responding to emerging situations, real-time data may not be necessary.
- 4) Large-scale influences are generally understood. Influence of offshore biophysical factors on MPAs can be generally understood with existing observing capacity, such as MBARI buoys, CalCOFI and rockfish surveys, quarterly surveys, and satellites. Taken together, these provide a general overview of the movement of the California Current and how it may influence MPAs. The system could be expanded, particularly north of Point Reyes.
- 5) Models are needed to help understand connectivity among sites and the influences of physical forcing factors on biology. Models can help determine needs for strategic sampling.
- 6) Process studies are needed to better understand the influences of physical forcing factors on biology. Research projects could help to refine the design of the observing system to focus on sentinel sites. There is a need to distinguish between data for research projects and operational observations.

Workshop Recommendations: MPA Monitoring

- 1) Establish an ocean observing and MPA working group. A working group comprised of representatives from Ocean Science Applications, MPA Monitoring Enterprise, California Fish and Game, CeNCOOS, SCCOOS, and other interested parties (scientists, NGOs, managers) should ensure coordination and follow-through on the outcomes of this workshop.
- 2) Expand nested concept design. The working group should build upon the schematic of a nested design for the Central Coast region by using federal and state funding opportunities.

- 3) Through the ocean observing and MPA working group, continue to identify and understand managers' needs for biological, chemical and physical oceanographic data in the MLPA monitoring process.
- 4) Coordinate efforts, via the working group, to further understand the roles of Ocean Science Applications and the two Regional Associations in fulfilling management needs.
- 5) Develop a client-driven approach to guide the development of specific user products. The MLPA monitoring process is new, and the first network of MPAs was designated in 2006. As such, there is no track record of how managers make decisions to evaluate the MPAs or what the information needs are. Observing scientists must continue to work with managers to understand:
 - a) What decisions must be made with the monitoring information?
 - b) What information product(s) are needed to inform the decision process? What format should the data be in? On what time scale? What geographic scale?
 - c) What is the role of the various players? Do the Regional Associations provide raw data to the MPA Monitoring Enterprise and California Fish and Game, or do the Regional Associations provide synthesized data products?
- 6) Assess existing capacity for ocean observing in California and describe threats to that capacity in a manner understandable to lay audiences. Many references were made during the workshop that some of California's observing capacity may be withdrawn. While this is well known among observing scientists, it is unclear to the management community what resources are threatened and the implications for monitoring MPAs or water quality. As a first step, a non-biased entity should assess the ability of the existing assets to meet the needs for monitoring MPAs and water quality, and the implications of losing capacity.
- 7) Expand and further refine the following findings discussed in the workshop:
 - a) A nested design is necessary to capture the multiple scales that are needed from large basin-level scale to regional and local scale.
 - b) The effect of large-scale ocean phenomena such as the El Niño, La Niña and the California Current are thought to be fairly well monitored. North of Point Reyes was identified as an area that is poorly sampled.

- c) Increase monitoring in the nearshore area, which is poorly monitored and is critical to both water quality and MPAs.
- d) Deploy low-cost temperature, salinity and current sensors at many locations to provide better resolution.
- e) Deploy sentinel moorings to provide in-depth information on the water column.
- f) Supplement mooring data with seasonal transects either by ship or autonomous underwater vehicles to detect regional processes.
- g) Provide continuous flow measurements at the mouths of rivers, such as Elkhorn Slough.
- h) Ensure adequate monitoring in the upwelling zone.

Workshop Summary

Ocean and coastal observing systems can directly serve the needs of ocean and coastal managers, if the needs are clearly articulated to those developing and managing the systems. This workshop set the stage for identifying the management needs for two issues: water quality and monitoring marine protected areas. However, managers' needs related to these and other issues—such as sediment transport, placement of ocean energy facilities, and boating safety—must be understood better, articulated clearly and incorporated into the design of the state's ocean and coastal observing systems.

This workshop successfully engaged a variety of users and scientists, further refined the needs for information products, and articulated the importance of a scaled approach to design. It was, however, unsuccessful in developing an integrated design that would address both water quality and MPA monitoring. A day-and-a-half workshop proved to be too short to address this ambitious goal. Developing such a design requires a more detailed evaluation to understand how managers use information—for what purposes, on what scales, and in what format. For the newly established MPA program, a continued dialog is needed between scientists and managers to understand how the observing information will be used and to outline reasonable options for address those needs. This level of analysis and investigation is difficult to achieve in a large workshop setting, but this workshop established the groundwork necessary for moving forward.

Appendix A: Workshop Agenda

Tuesday, September 25, 2007

- 9:30 Registration
- 10:00 Welcome and purpose of the meeting
Brian Baird
- 10:20 Overview of ocean observing
Paul Siri
- 10:30 Examples of IOOS success
- 10:30 Water quality: Hyperion example
Eric Terrill
 - 11:00 Oceanography and California Current Ecosystem:
application to MPA monitoring
Bill Sydeman
- 11:30 Overview of Monterey Bay
Heather Kerkering
- 11:45 Candidate design for beach water quality application
Steve Weisberg
- 12:00 Charge to the Working Groups
Josie Quintrell
- 12:15 Lunch

1:00–4:00 Breakout session 1

Water Quality Theme

Facilitators: Steve Weisberg and Debra Hernandez

Recorders: Valerie Termini and Brad Hunt

Charge to the Water Quality Group: To develop a conceptual or schematic design for an observing system to address managers' needs for water quality information such as decision-support tools that allow Regional Water Quality Boards, local and state health agencies, animal rescue groups and others to

- assess the impact of nutrient inputs from different sources (rivers, agriculture, sewage plants, storm runoff) on the outbreak of algal blooms, and
- determine the fate of storm water runoff in the Bay (where does it go, how fast does it get there, how long does it take to disperse, impact on marine life) and its implications for Areas of Special Biological Significance (ASBS), MPAs and contact recreation.

The workshop will use Monterey Bay as a focus area but will draw out common procedures and issues for a template for how to consider such issues in other regions along the coast.

Outcome for session: A high-level schematic diagram of the elements of an observing system that would provide the foundation for addressing managers' needs. On the acetate map overlay, show the spatial location of such observations. Consideration should also be given to data rates, modeling and data integration, need for additional measurements.

1:00 Overview of working session

- Water quality issues in Monterey Bay (Dominic Gregorio)
- Review charge to the working group

1:30 Discussion

- What key parameters need to be monitored (review list of parameters)?
- How do these correspond to what already exists in the Monterey Bay (as a test case for other areas as well)?
- What can the existing observational network contribute?
- What kind of data integration and/or analysis is needed to make use of the existing information?
- What additional observations are needed (parameter, time scales, spatial coverage)? What are the most essential sites to be monitored (i.e., to establish a sense of priority)?
- What models or data analysis would be required?
- Is there a need for new technology to gather critical observations not currently obtainable?
- Provide a schematic diagram on the map to show the general location for key observations.

MPA Monitoring Theme

Facilitators: Amber Mace and Josie Quintrell

Recorders: Jena Carter and Amy Boone

Charge to the MPA Group: To develop a conceptual or schematic design for an observing system that would augment the State's MPA Monitoring Plan, which calls for monitoring oceanographic features at multiple scales to provide a context for the fish and biological monitoring. This group will identify the key parameters required to assist with monitoring, compare this with existing monitoring capacity and determine data integration and analysis needs. The group will also provide a sense of the priority for

implementing the additional capacity.

Outcome for session: A high-level schematic diagram of the elements (e.g., observations, data management, modeling/analysis and product delivery) of an observing system that would provide the foundation for addressing managers' needs. On the acetate map overlay, show the spatial location of such observations. Consideration should also be given to data rates, modeling and data integration, need for additional measurements.

1:00 Overview of working session

- The State's MPA DRAFT Monitoring Plan for the Central Coast and its reference to the need for monitoring oceanographic data.
- MPAs and observing assets in Monterey Bay; more-specific presentation of the issues in Monterey Bay.
- Review charge to the working group

1:30 Discussion (in smaller groups)

- What key parameters need to be monitored? (review list of parameters)
- How do these compare with what is currently being monitored in Monterey Bay (as a test case for other areas as well; note where there may be major differences)?
- What could existing data reveal about the bay? What is needed to access or integrate the data?
- What additional observations are needed (i.e., parameters and/or variables, time scales, spatial coverage)?
- What are the absolutely necessary observations or data integration that is required to develop a working understanding of the oceanographic environment (i.e., prioritize the various needs)?
- What models or data analysis would be required?
- What expertise is needed?
- Is there a need for new technology?

Provide a schematic diagram on the map on the general location of the observations.

4:00 Break: Session leaders convene to prepare for plenary

4:15 Plenary: Short recap of session discussions

Each breakout session presents overlay of schematic needs for additional observations.

What are the common needs? What are the differences? Can adjustments

be made to accommodate both interests? How can these examples be transferred to other parts of California? Can a methodology be developed from this exercise that could be used in other areas?

5:30 Adjourn for day

5:45 Reception

Wednesday, September 26, 2007

7:30 Breakfast

8:30 Plenary session

Recap of previous day's work

Charge for final breakout

8:45 Breakout session 2

Each group (Water Quality and MPA Monitoring) will recap previous day's discussion and identify the 3-7 top recommendations from each group. Recommendations can address: need for more information; identification of other groups to engage in the process; suggestions for the state's planning process for Prop 84 resources; Regional Associations' designs and planning; potential grant opportunities; and specific implementation activities

11:00 Plenary session

Presentations by Working Groups on top recommendations

Identify common recommendations

Next steps and action items

12:00 Adjourn

Appendix B: Workshop Attendees

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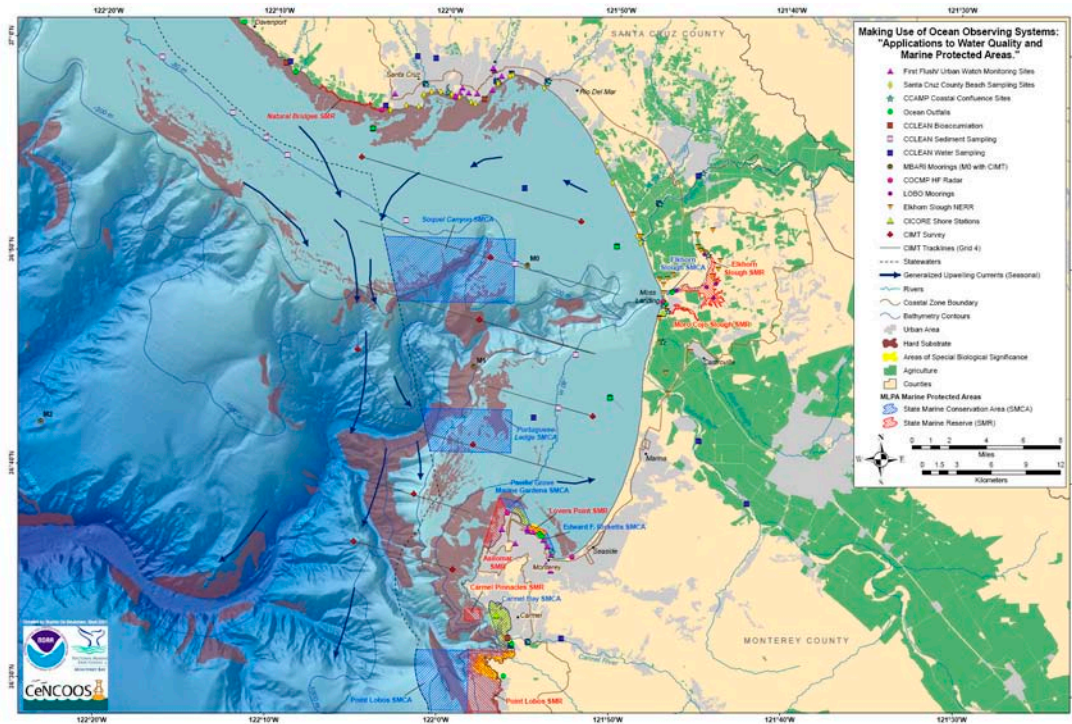
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Appendix D: Monterey Bay Map



Appendix E: Background Information

This list of information and links is not exhaustive but provides helpful background knowledge related to MPAs and water quality issues in California, specifically Monterey Bay.

National Integrated Ocean Observing Systems (IOOS)

Information on the national IOOS program and history can be found at the Ocean.US website: www.ocean.us

California Ocean Observing Initiatives

Central and Northern California Ocean Observing System: www.cencoos.org
Southern California Coastal Ocean Observing System: www.sccoos.org

Inventory of ocean observing activities and programs

<http://oceanobs.org>

California Ocean Protection Council and State Coastal Conservancy, Ocean Science Application program

This proposal is a great reference highlighting California-wide issues and the relationship between the state and the two Regional Associations, CeNCOOS and SCCOOS. http://resources.ca.gov/copc/6-8-06_meeting/0606 OPC_Book/0606COPC07_CA_Ocean_Observing_Program_MEMO.pdf

Marine Protected Areas

MLPA Initiative Central Coast Study Monitoring Plan DRAFT FINAL (Dec. 2006) available at: http://search.ca.gov/search?q=MLPA+Central+Coast+Study+Region+MPA+Monitoring+Plan&entqr=0&output=xml_no_dtd&sort=date%3AD%3AL%3Ad1&ud=1&client=ca_dfg&oe=UTF-8&ie=UTF-8&proxystylesheet=ca_dfg&site=ca_dfg

The California Department of Fish and Game website includes a wealth of information regarding the Marine Life Protection Act and the resulting Marine Protected Areas:

www.dfg.ca.gov/mlpa/masterplan2006.asp

State of California Marine Protected Areas Monitoring Enterprise:

www.calost.org/projects/monitoring_ent.asp

National Marine Protected Areas Center: <http://mpa.gov>

National MPA Center Science Institute in Santa Cruz, California:
http://mpa.gov/mpa_center/mpa_sci_institute.html

Water Quality

Monterey Bay National Marine Sanctuary
www.mbnms-simon.org/sections/waterQuality/overview.php?sec=wq

Harmful Algal Blooms Fact Sheet
www.cop.noaa.gov/stressors/extremeevents/hab/features/ca_pn_050807.html

Press releases on the recent HAB event in California:
<http://cimt.ucsc.edu/outreach.htm>

Examples of water quality programs in California

National Estuarine Research Reserve (San Francisco, Elkhorn Slough, Tijuana River):
www.nerrs.noaa.gov/Reserves.html

Sanctuary Citizen Watershed Monitoring Network, First Flush Event Monitoring:
www.mbnms-simon.org/sections/waterQuality/project_infophp?pid=100141&sec=wq

Santa Cruz Environmental Health Services: http://sccounty01.co.santa-cruz.ca.us/eh/environmental_water_quality/current_water_quality_data/index.htm

Monterey Environmental Health Services: www.co.monterey.ca.us/health/beaches

Southern California Water Quality Collection: www.sccoos.org/data/waterquality

State Water Resources Control Board: www.swrcb.ca.gov

Central Coast Ambient Monitoring Program (CCAMP): www.ccamp.org

Central Coast Long-term Environmental Assessment Network (CCLEAN):
www.cclean.org/index.html

Monterey Bay Aquarium Research Institute (MBARI): www.mbari.org

Land/Ocean Biogeochemical Observatory (LOBO): www.mbari.org/lobo

Center for Integrative Coastal Observations, Research and Education: www.cicore.org

Center for Integrated Marine Technologies: <http://cimt.ucsc.edu>

San Francisco Estuary Institute: www.sfei.org

USGS: <http://sfbay.wr.usgs.gov/access/wqdata/>

Appendix F: IOOS Core Variables

Physical Variables

- Salinity
- Temperature
- Bathymetry
- Sea level
- Surface waves
- Currents: surface
- Currents: vectors
- Heat flux
- Directional wave spectra

Chemical Variables

- Contaminants: water
- Contaminants: sediments
- Dissolved nutrients
- Dissolved oxygen
- Carbon: total organic suspended sediments
- pCO₂
- Total nitrogen

Biological Variables

- Optical properties
- Ocean color
- Bottom characteristics
- Pathogens
- Phytoplankton species
- Zooplankton species
- Chlorophyll-a

