CREATING AN INTEGRATED OCEAN MONITORING SYSTEM; CALIFORNIA'S RECENT INITIATIVES TO PROVIDE BETTER SCIENCE FOR RESOURCE MANAGEMENT

Sheila Semans, State Coastal Conservancy/Ocean Protection Council
Paul Siri, Ocean Science Applications, State Coastal Conservancy

The oceans are critically important to California society. They are the underpinning of weather systems and modifiers of climate; they are highways for marine commerce and a buffer for national security; they are a major reservoir of natural resources; haven for recreation; virtual schoolrooms for educators; and natural laboratories for science. Pacific Northwest coastal ecosystems drive salmon across large marine ecosystems (LMEs) inextricably coupling oceans and watersheds. Additionally, LMEs are being evaluated for previously undervalued provisional services, such as precipitation and ocean energy. Unfortunately, the growing number of people living near the coast is placing conflicting demands on coastal ecosystems. Our understanding of coastal waters has not kept pace with the economic needs associated with the ecosystem services provided by marine systems. Despite the growing threats to our oceans, there is no integrated monitoring network in place to assess their status, track changes over time, or determine the success of our management efforts.

In addition to monitoring and assessment, decision makers increasingly require predictive tools to manage risk and optimize outcomes in resource management especially with increasing uncertainty associated with climate change.

Now more than ever, society needs reliable information to make wise decisions that will provide maximum societal benefit while ensuring a sustained production of ecosystem goods and services. In the past several years, California has adopted progressive policies and embarked on ambitious initiatives to address ocean management concerns. In 2004 the California Ocean Protection Act became law establishing the Ocean Protection Council (OPC), a cabinet-level council to assist the Governor and the State in managing its marine resources. Two immediate priorities for the OPC included implementation of the Coastal Ocean Currents Monitoring Program and the California Seafloor Mapping Program. Both of these programs are being implemented with a goal to bring together the state's exceptional oceanographic expertise with its resource managers to provide high quality information on ocean health. A robust and integrated system for observing the coastal ocean is vital to the sustained recovery of our marine ecosystems. Continuous collection of basic ocean physical, biological and chemical data provides information critical to managing our marine ecosystems increasing the capability to mitigate threats to their health and sustainability. Beyond basic data collection, information is frequently required to understand specific events- both natural and anthropogenic- operating on different time and space scales.

The Coastal Ocean Currents Monitoring Program (COCMP) focuses primarily on mapping surface currents with High Frequency Radar (HF Radar), widely regarded as the most economical technology available to assess- in close to real time- physical and biological change in the coastal ocean. Over the past 3 years, an array of long range and standard range radar has been deployed along California's coastline. However, in order to better understand the movement of water throughout the water column, other COCMP elements include propeller and buoyancy driven autonomous platforms; integration of data from moorings maintained by local agencies; surf zone current measurements and modeling; a Regional Ocean Modeling System with data assimilation for now casting and forecasting of the physical properties of the ocean; and acquisition, storage, and distribution of remote sensing data products including ocean color and sea surface temperature. Together, COCMP data and modeling provide value-added products assisting a number of the state's management needs from marine protected area monitoring and ocean energy development to increased marine operations safety and oil spill response. California's $21 million investment in COCMP represents the largest commitment to coastal surface current mapping in the world, and COCMP is helping define national priorities for surface current mapping.

In addition, the OPC has recently embarked on an ambitious program to obtain another data set critical to guide multiple ocean management decisions. The California Seafloor Mapping Program (CSMP) has been designed to create a comprehensive coastal/marine geologic and habitat base map series for all state waters (mean high water out to 3 nautical miles) in support of the Marine Life Protection Act (MLPA) Initiative. Multibeam sonar operated from vessels of various sizes will be used to efficiently collect data from the 3nm state waters limit into approximately 10 to 6 m of water, or as shallow as safe navigation will allow.

A highly collaborative program, the CSMP currently involves the United States Geological Survey (USGS), the Seafloor Mapping Lab (SML) at California State University (CSU) Monterey Bay, 4 programs within the National Oceanic and Atmospheric Agency (NOAA) (the Office of Coast Survey, the National Marine Sanctuary Program, the National Marine Fisheries Service, and the Coastal Services Center), Moss Landing Marine Labs, the California Geological Survey, and the California Department of Fish and Game.

Approximately 33% of the California coast has been mapped with enough detail to support the MLPA process and other resource management needs critical to the state. The CSMP aims to complete the remaining 67%. To that end, the OPC has authorized nearly $12 million, and appropriate another $7.5m in 2009 should the funds become available. Creating seafloor maps for all CA waters was identified as an early goal of the OPC and was written into its 5-Year Strategic Plan as a high priority (see consistency section below). Furthermore, seafloor mapping has been identified as a priority in the OPC 5-year Strategic Plan, in the West Coast Governor's Agreement on Ocean Health, and was specifically identified for funding in the recently approved proposition 84.

The challenge ahead is to integrate these data and address management priorities: understanding sediment transport and sand delivery, ensuring shipping safety, describing tsunami potential, improving wastewater management, and fish recovery programs. This paper will provide recent examples as to how these data are being used to inform management decisions, how models are being created to improve our ability to predict ocean response to natural and human-induced change, and how resource managers and scientist are working together to assess potential applications.

Three case studies are briefly described below.

Erosion at San Francisco's Ocean Beach

San Francisco has battled severe erosion at the south end of Ocean Beach for years. One of San Francisco's largest combined sewer and stormwater outfall discharges in this area, and rocks placed over the plant's ocean outfall pipe are now partially exposed at times when the beach is most eroded. Past efforts to address this problem have been unsuccessful.

In the past few years, the city, the USGS, the Army Corps of Engineers, and the SML at CSU at Monterey Bay have teamed up to solve this problem.

Sand transport model requires a) the amount, speed, and direction of water moving thorough the area, and b) the depth and topography of the bottom, which provides the size and shape of the space the water is moving through. Five recently installed Acoustic Doppler Current Profiler buoys have given USGS precise current direction and speed information at different depths for the study area, and SML has created a detailed map of the seafloor from the mouth of the Golden Gate south along Ocean Beach using multibeam and sidescan sonar.

The mapping revealed that significant changes had occurred in the last 50 years and that the bottom topography is more complex than anyone had known. The tidal migration of massive dune fields at the bay mouth was observed and quantified for the first time. It was previously thought that sand would migrate to the beaches and sand bars south of the Golden Gate. However, the new mapping revealed that this sand source was not feeding the beach and might instead be moving offshore and out of the system. As a result, the Army Corps moved the deposit site of dredged sand from channel maintenance to a location a few hundred yards west of the Ocean Beach erosion site. The Mapping Lab is monitoring selected areas routinely to evaluate where the sand is moving. The monitoring results will allow USGS and the Army Corps to refine future placement of dredge spoils and hopefully successfully deliver much needed sand to Ocean Beach and export these management tools to other locations.

Hyperion Outfall Diversion

Since 1960, the City of Los Angeles (LA), as well as many neighboring cities, has discharged treated sewage from an outfall 5 miles out to sea. Until last fall, the 50 year old Hyperion outfall had never been internally inspected. To address this overdue deferred maintenance the City of LA Environmental Monitoring Division decided it was time to send divers down into the pipe to check its structural integrity. This would require the City to divert it sewage to a backup outfall that discharged only 1 mile out to sea and in 60 feet of water for three days. As a precaution, the LA County Department of Public Health officials closed miles of beaches north and south of the outfall.

To help asses the impacts of this diversion, the City of LA contacted the Southern California Coastal Ocean Observing System (SCCOOS) to provide ocean data support. Fortunately, as part of COCMP, SCCOOS was conducting a full scale nearshore assessment at Huntington Beach and were able to apply these efforts to the diversion. Surface current maps, derived from an array of HF radars, were used to assist in tracking the discharge plume offshore of the beaches. Wave-driven currents within the surf zone were forecasted to provide estimates of how far down-coast the sewage moved once it reached shore. And research vessels conducted boat-based tracking of the discharge plume, in addition to phytoplankton and nutrient sampling. Remote sensing data from satellites were also used to optically track the spatial extent of the discharge's surface plume. Up-to-date wind and rain observations and forecasts also are being conducted.

Near real-time data was able to show that an offshore wind helped keep the plume away from the popular shoreline of south Santa Monica Bay. And scientists were able to demonstrate the potential utility of a fully robust and integrated ocean observing system.

The Cosco Busan Oil Spill

In the early morning hours last November, on its way out to sea, the Cosco Busan hit the Bay Bridge and discharged 58,000 gallons of bunker fuel into the Bay within 10 seconds. The standard operation procedure of the United States Coast Guard (USCG) in response to such an event is to follow the ship to port, and in doing so, assess the extent spill. However, San Francisco Bay is heavily influenced by strong tides, and by the time the USCG reached the scene, most of the spilled fuel had been pushed further into the Bay, covered by heavy fog. Aerial and ship surveillance remains a key response technology, with limited effectiveness in fog. As a result, the USCG initially underestimated the extent of the spill, and response times were delayed.

However, although still not formally incorporated into state or federal spill response protocols, new ocean monitoring technology has been proven effective in enhancing oil spill response efforts. Regardless of fog or rain, COCMP is able to provide spill trajectories in a hindcast or forecast mode. The Coastal Data Information Program (CDIP) provides real-time and archived information on wind and waves. And the Physical Oceanographic Real-Time System (PORTS) provides navigation products aimed at promoting safe and efficient navigation within U.S. waters. All these data are now being incorporated into an ocean circulation model for California that will further refine predictions.

Proven reliable, these data sources need to be formally incorporated into our oil spill response models. Data will have to be provided in one location for easy retrieval by response agencies and the responsible parties, and data products will need to be provided in useful and accessible formats for a variety of end users (e.g. responders to public).

Additional OPC projects are being assessed for their potential contribution to oil spill response and SF Bay resource management. For example, in 2007 the OPC funded the development of a three-dimensional hydrodynamic circulation model for SF Bay. This model will have the capability to provide important information for assessing change resulting from large scale ecosystem restoration programs such as the South Bay Salt Ponds, understanding the impacts of the 77 derelict WWII ships deteriorating in Suisun Bay, and helping develop new navigational products for safer maritime operations. For each of the three case studies above, the Suisun Fleet impacts and the South Bay Salt Ponds are examples of seemingly diverse projects are served by the application of real time observations integrated with bathymetry products that can result in higher resolution modeling and predictive capability.

Sheila Semans
State Coastal Conservancy/Ocean Protection Council
Ocean Program
17351 Franklin Road
Fort Bragg, CA 95437
707-964-0176
ssemans@scc.ca.gov