

# SCCOOS

SOUTHERN CALIFORNIA COASTAL OCEAN OBSERVING SYSTEM

## Strategic Operational Plan 2016-2021



**IOOS**  
Integrated Ocean  
Observing System



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# MISSION

*The mission of the Southern California Coastal Ocean Observing System (SCCOOS) is to produce, integrate and communicate high quality information that helps ensure safety, economic and environmental resilience, and sustainable use of the coastal ocean.*

# EXECUTIVE SUMMARY

Julie Thomas is the Executive Director of SCCOOS. She has promoted agency collaboration at local, state, federal and international levels. Julie is an advocate for high quality data standards and interoperability as manifested through participation on several national Ocean Observing efforts.

Note from the Director:

*December 1, 2015*

*Dear Friends,*

*The year 2015 is such an exciting time on the U.S. West Coast. We have higher sea surface temperatures than we recorded in our 100 year sampling, we have the strongest El Nino on record, and a four year drought that is plaguing the State of California. Many questions about this winter are unanswered. Will we have flooding from a series of storms bringing above normal precipitation? Will we have larger, more energetic waves that will cause coastal erosion and shoreline damage? Long term, sustained observations and user friendly products are more critical than ever. Advocating for the Ocean Observing Systems makes sense. Thanks to all the scientists and community participants who are committed to Ocean Observing, promoting the understanding and preservation of our ocean resources.*

*Sincerely,*

*Julie Thomas*



# U.S. INTERGRATED OCEAN OBSERVING SYSTEM (IOOS) & THE REGIONAL ASSOCIATIONS

**U.S. IOOS** has a mandate to “lead the integration of ocean, coastal, and Great Lake observing capabilities, in collaboration with Federal partners, to maximize access to data and generation of information products, inform decision making, and promote economic, environmental, and social benefits to our nation and the world”.



*U.S. IOOS regions.*

**SCCOOS** was formed in 2003 under the nationwide U.S. IOOS directive to form 11 Regional Associations to generate and deliver data for improved decision making to agencies and stakeholders at both local and national levels. SCCOOS works within IOOS to coordinate and expand an integrated coastal observing system in the Southern California Bight, supporting national and regional priorities (sccoos.org). Spanning from Point Conception to the Mexican border, the major currents of this region contribute to its biodiversity including the poleward flowing Southern California Counter Current, the equatorward flowing California Current and the poleward flowing, subsurface current.



*SCCOOS Region.*

# SOUTHERN CALIFORNIA COASTAL OCEAN OBSERVING SYSTEM (SCCOOS)

The principal goal of SCCOOS is to provide observations and products to a diverse stakeholder community of managers and planners, operational decision makers, scientists, and the general public. As the regional observing system for Southern California, SCCOOS has developed the capabilities to support short-term decision-making and long-term assessment by implementing and leveraging biological, chemical, and physical observations and models, many of which are available in near real-time. Many of the projects outlined in the 2016 and 2011 Build-Out Plan's demonstrate that SCCOOS advocates for sustained and enhanced observations while supporting product development. SCCOOS priorities and objectives are aligned with the seven societal goals as outlined in the U.S. IOOS Summit Report<sup>1</sup>. The focus themes, as designated by IOOS, highlight these priorities and are designed to improve safety, enhance the economy and protect our environment.

- **Marine Operations:** Enhance products for safe and efficient marine commerce and transportation, search and rescue, homeland security and events such as oil spill response.
- **Coastal Hazards:** Improve coastal resiliency through accurate, geo-specific and validated flooding models and critical shoreline information with the long-term goal of improving coastal safety, reducing natural hazards and environmental change impacts and protecting coastal economics.
- **Climate Variability and Change:** Improve the understanding and track secular ocean change including sea level rise, ocean temperatures, and other climate trends in the Southern California Bight.
- **Ecosystems, Fisheries and Water Quality:** Provide physical, geochemical and biological monitoring, including harmful algal blooms (HABs) forecasts, fisheries management, and water quality pathogen and ocean acidification tracking to promote and sustain living marine resources.

SCCOOS works interactively with local, state, and federal agencies, resource managers, industry, policy makers, educators, scientists, non-governmental organizations and the public. As a result, a framework has been developed which provides for the complete life-cycle of the data. The information is readily available in a variety of formats to ensure that products are useful and easy to access while preserving the necessary detail to support the scientific and educational communities. SCCOOS continues to explore new visualizations and technologies to make the information more comprehensible.

## U.S. IOOS

### SEVEN SOCIETAL GOALS

1. Improve predictions of climate change and weather and their effects on coastal communities and the nation
2. Improve the safety and efficiency of maritime operations
3. More effectively mitigate the effects of the natural hazards
4. Improve national and homeland security
5. Reduce public health risks
6. More effectively protect and restore healthy coastal ecosystems
7. Enable the sustained use of ocean and coastal resources

### PRIMARY PARTNERS

California Polytechnic State University, San Luis Obispo (CalPoly)  
California State, University, Los Angeles  
Center for Scientific Research and Higher Learning (CICESE)  
City of Los Angeles  
Farallon Institute  
Marine Exchange of Southern California  
NASA Jet Propulsion Laboratory  
NOAA Southwest Fisheries Science Center  
Southern California Coastal Water Research Project  
The Maritime Alliance  
U.S. Army Corps of Engineers  
Universidad de Baja California  
University of California, Irvine (UCI)  
University of California, Los Angeles (UCLA)  
University of California, San Diego (UCSD)  
University of California, Santa Barbara (UCSB)  
University of Southern California (USC)

# MANAGEMENT STRUCTURE

SCCOOS is a collaborative observing system with a broad base of stakeholders and partners, and demonstrated ability to thrive with a diverse set of interests and users. The governance structure was based on a Memorandum of Understanding (MOU) that identifies a consortium of institutions and organizations to fulfill SCCOOS objectives. Representatives from the consortium form the Board of Governors (BOG). In addition, the BOG has expanded to include representatives of federal and public agencies, industry, academia and international partners in Mexico. BOG members are responsible for the corporate decisions concerning management and operations with commitment to the SCCOOS mission and program longevity. The Executive Steering Committee (ESC) advises the BOG on technical matters, funding distribution and strategic planning. In order to connect with various stakeholders throughout the State of California, SCCOOS and the Central and Northern California Ocean Observing System (CeNCOOS) share a Joint Strategic Advisory Committee (JSAC).



*SCCOOS management structure and personnel.*

**PROGRAM OPERATIONS AND STAFF:** SCCOOS operates as a system of partnerships and contractual agreements facilitated by technical and programmatic staff at the University of California, San Diego. The Chairs of the BOG and ESC work closely with the program staff, including structured weekly calls to ensure a flow of communication

The SCCOOS Program Office will function as the official representative of SCCOOS and have cognizance over the components of the ocean observation and information system. The SCCOOS Program Office will:

- Develop and maintain a Strategic Operational Plan, which defines long term objectives and goals as well as an Operational Plan which defines the tasks to obtain short term objectives and goals.
- Serve as the Southern California regional node to coordinate SCCOOS activities with IOOS and other federal and non-federal partners.
- Support the work of the BOG, ESC, and JSAC.
- Recommend enhancements to the existing system, including new research and development projects. Identify system components appropriate for transition from research to operations.
- Provide publicly available data at no cost in a timely manner.

# CALIFORNIA INITIATIVES

The State of California committed to ocean observing with the 2005 investment of \$21 million for the Coastal Ocean Currents Monitoring Program that established a network of high frequency (HF) radar systems, glider survey capabilities, and modeling infrastructure. SCCOOS will continue to align program activities with the priorities of state-sponsored initiatives, such as Marine Protected Area monitoring.

In addition, SCCOOS continues to align with broader regional initiatives including the West Coast Governor's Alliance (WCGA) 2008 Ocean Health Action Plan. In 2012, the three West Coast Ocean Observing Systems and the WCGA signed a MOU to collaborate and advance the effective management of coastal and ocean resources. Intra- and inter-regional efforts across the west coast have continued, most recently demonstrated by the WCGA Ocean Data Portal sponsoring of a Sea Grant Fellow to support West Coast Ocean Observing Systems and WCGA collaboration to develop and disseminate derived data products to inform regional policy.

Since 2009, the JSAC has been facilitating the identification and prioritization of ocean observing requirements across the state. The JSAC includes representatives from city, state, and federal agencies, industry, non-governmental organizations and educational partners. The JSAC is intended to provide a means for stakeholders to participate in strategic planning efforts, identify the data and information products that are necessary, and provide feedback and guidance for the observing system. In addition to the JSAC, SCCOOS continues to connect with a broad range of coastal and global observing systems and users through extensive outreach.





## FOCUS AREA: MARINE OPERATIONS

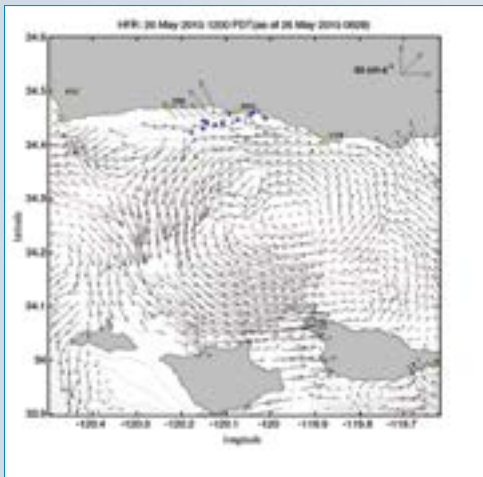
Maritime transportation plays a major role both in Southern California’s economy and national security. Los Angeles and Long Beach combined comprise the largest port in the U.S. and the eighth largest port in the world. With 140 shipping lanes connecting Long Beach to 217 seaports, the Port handles \$180 billion in cargo, supporting hundreds of thousands of jobs. The Port of San Diego includes the largest naval fleet in the world, and Port Hueneme is the only deep water port in the 400 nm between Los Angeles and San Francisco, and the only U.S. Navy (Navy) controlled port between San Diego and the Puget Sound. Additionally, the Southern California Bight is also home to two of the Navy’s major training and test ranges.

There are three unique challenges for marine operations (1) to assure that the vast amount of maritime traffic is provided with the highest quality ocean observations and models to assure safe and efficient transit, (2) to enable effective event responses as needed and (3) to assure accurate historical data are present to allow for risk assessments and plan

for new facilities. SCCOOS has addressed these challenges by partnering with institutions and agencies to provide data access and visualization of critical oceanographic parameters necessary for safe and efficient maritime operations.

## OIL SPILL RESPONSE, REFUGIO BEACH

An operational example of HF radar derived surface currents usage occurred on May 19, 2015, in response to a ruptured oil pipeline just north of Refugio State Beach in Santa Barbara County. Approximately 21,000 gallons of crude oil flowed into the ocean triggering action from participants on the U.S. Coast Guard (USCG) led oil spill response Area Committee. Ocean surface current data were used to assist in analyzing and tracking the oil spill as it entered the region of coverage approximately 1 km offshore. HF radar operators also established an additional mobile site at Gaviota filling in coverage north of the spill further refining the potential path of the slick. Programmers integrated the new site into the near real-time visualization and distribution to operational organizations and the public responding to the spill.



(Left) HF radar ocean surface current display during the time of the spill. (Right) Oil spill clean-up response at Refugio State Beach, CA.



## KEY PARTNERS AND LEVERAGED PROGRAMS

**Goal and Objectives:** The Marine Operations focus area will maintain and advance efforts that are critical for safe and efficient navigation, search and rescue, oil spill response and renewable energy projects. Specific objectives that develop products for a wide, diverse user base include (1) maintain and develop customized products: multi-layer views of observations, nowcast and forecast models including waves, currents, winds, sea surface temperature, bathymetry and navigation charts, (2) deliver these products to aid oil spill and search and rescue real-time recovery and post-analysis trajectories, and (3) distribute these data for assimilation into operational ocean models that subscribe to the Global Telecommunication Service (GTS), including the SCCOOS and CeNCOOS Regional Ocean Model System (ROMS) and Navy models.

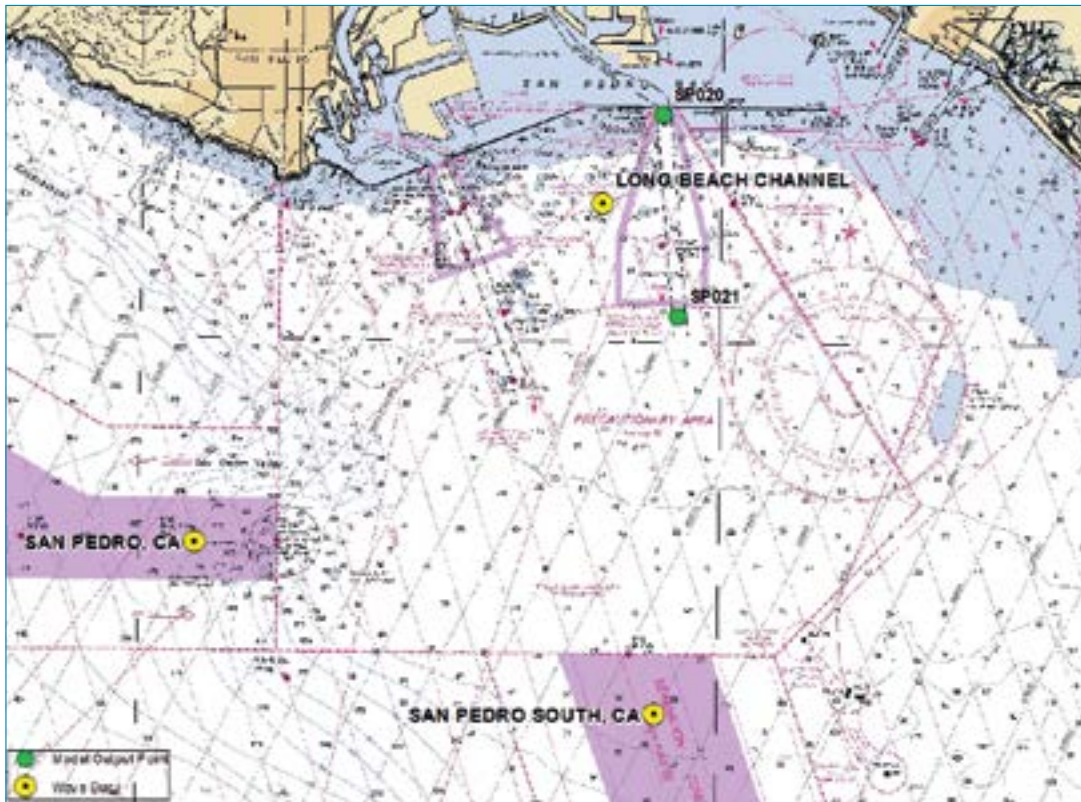
**Audience and Benefits:** At the national level, on July 31, 2013 SCCOOS testified before the United States House Committee on Transportation and Infrastructure Subcommittee on Coast Guard and Maritime Transportation on, “How to improve the efficiency, safety, and security of maritime transportation: better use and integration of maritime domain awareness data”. Stakeholders are interested in both real-time and forecast customized data that complement their decision-support tools. Representative regional users include: California Office of Oil Spill Prevention Response (OSPR), National Weather Service (NWS), National Oceanic and Atmospheric Administration (NOAA) Hazardous Materials Division, Navy, U.S. Army Corps of Engineers (USACE) dredgers, Catalina Express Ferry, Marine Exchange, commercial bulk and tanker cargo vessels, cruise ships, commercial fishermen, harbor pilots and recreational boaters.

Real-time surface current measurements are integrated into the General NOAA Operational Modeling Environment (GNOME) for trajectory analysis. HF radar data are also communicated to U.S. Coast Guard Environmental Data Server for search and rescue, the Environmental Protection Agency for their marine debris tracking application, and used in multiple problem-driven applications such as the NOAA Environmental Response Management Application.

1. **HIGH FREQUENCY RADAR NETWORK (HFRNet)**, funded by IOOS and maintained by Scripps, aggregates and distributes HF radar derived surface current maps for all regional as well as global partners. SCCOOS leverages HFRNet for total vector calculations, online visualization, data access via web services, and radial and total vector archiving.
2. **COASTAL DATA INFORMATION PROGRAM (CDIP)**, funded by the California Department of Parks and Recreation, Division of Boating and Waterways (CDBW), and the USACE, provides near real-time wave measurements, nowcast and forecast wave models and surface temperature. The USACE considers CDIP as one component of their contribution to IOOS.
3. **CLIMATE OBSERVATIONS DIVISION** – funded by NOAA, provides for the development of operational climate observing systems. While principally a global based system, the program supports the surveillance of ocean conditions across the California Current Ecosystem to provide long term time records of ocean climate for development of indices, tracking El Niño and climate variability, and testing ocean forecast models.
4. **COUPLED OCEAN/ATMOSPHERE MESOSCALE PREDICTION SYSTEM (COAMPS)**, produced by the Naval Research Laboratory, Monterey provides high resolution modeled atmospheric fields (wind, rain).
5. **MODERATE RESOLUTION IMAGING SPECTRORADIOMETER (MODIS)**, funded by NASA and NOAA, provides atmospheric, oceanic and land parameters including sea surface temperature chlorophyll and radiance water vapor.

## UNDER KEEL CLEARANCE PROJECT- PORT OF LONG BEACH

With the deepening of the Panama Canal, bigger, deeper draft vessels are requesting entry to California ports. Out of the 4,422 vessels that entered the ports of Los Angeles/Long Beach in 2014, 606 were oil tankers. The issue is how can the port entry be maximized to accommodate these larger vessels while reducing the risk of a vessel running aground? Oceanographic parameters are critical in assuring the safety and operations of vessel traffic. For the past ten years, SCCOOS has provided automated messaging to Long Beach Jacobsen Pilots and port marine operators when large swell has exceeded their operational limits. Installed in 2015 with additional National Ocean Service/IOOS and industry funding, were two new wave buoys. The data from these buoys are ingested by the Oxnard NWS and the National Centers for Environmental Prediction for model validation and for local real-time display. Additional integration and continuation of threshold notifications increases efficiency and safety due to reduced risk.



*Three wave buoys and two wave model points (SP020 & SP021) in the San Pedro Bight are providing real-time observations and model nowcasts for mariners transiting the area. These products are used for both operations and model validation.*

# FOCUS AREA: COASTAL HAZARDS

Coastal resiliency preparation is critical on the West Coast where inundation is often caused by the co-occurrence of high tides, energetic ocean waves and beach erosion. High waves raise the mean water level above the tide level (e.g. wave setup), and create large wave run-up in addition to setup. Erosion of the beach further increases the shoreward penetration of large waves.

The 2008 California Coastal Sediment Management Workgroup's, California Beach Restoration Survey indicates that many beaches and structures in the Southern California Bight are vulnerable to coincident high surf and tides. Synergies have developed between the U.S. Geological Survey (USGS) Coastal Storm Modeling Project, USACE, CDBW and the Coastal Sediment Management Workgroup.

During storms, wave uprushes can reach more than 3 m above tide level, and beach face erosion can exceed 2 m vertical. Simple inundation models (where the uprush limit depends only on the tide level, wave height and wave period) yield qualitative, general information. Localized warnings for highway closures and/or structure sand-bagging require site specific wave, beach slope and berm elevations for model calibration.



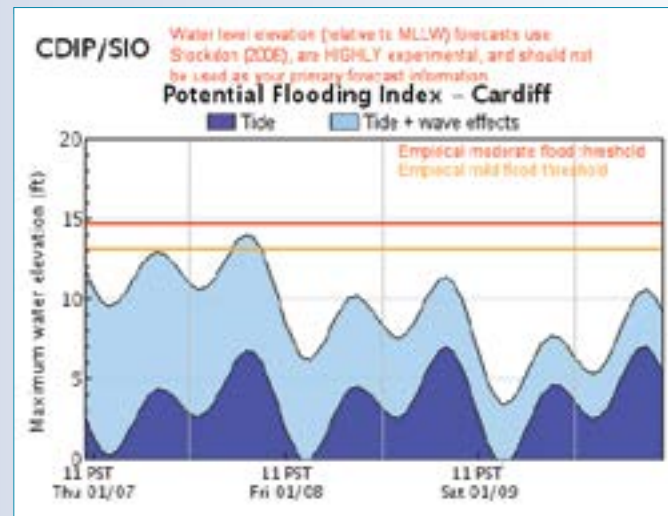
*Certain index sites contain three day forecast flooding information.*

*Partnerships have been established with local municipalities to assist with equipment permissions and observational validation of inundation notifications. Inundation warnings are disseminated to the Naval Air Warfare Center Division at Point Mugu for an area that overtops during high tides and energetic waves.*



## POTENTIAL FLOOD INDEX, CARDIFF STATE BEACH

A field monitoring site established at Cardiff State Beach includes monthly sand surveys, in-situ water level and inundation measurements to examine the role of waves, tides and nourishments on ocean front flooding. Results include online real-time and three day inundation forecasts (sccoos.org/data/flooding-storm-surge-models/). The proposed work will build upon the prototype Cardiff project at four new sites. Specific objectives are to (1) develop site-specific models for tide and wave-driven inundation for Cardiff, Newport, Seal, and Imperial Beaches (only Cardiff has an on-going field monitoring program), (2) assemble databases of historical observations and bathymetry data for model development, calibration and verification and (3) develop and expand integrated, online products that will provide warnings of wave and tide-induced coastal inundation.



Through leveraged funding, SCCOOS operates a real-time three day flood index. The flood index is sent to the NWS and city planners enabling science to aid in regional management decisions.

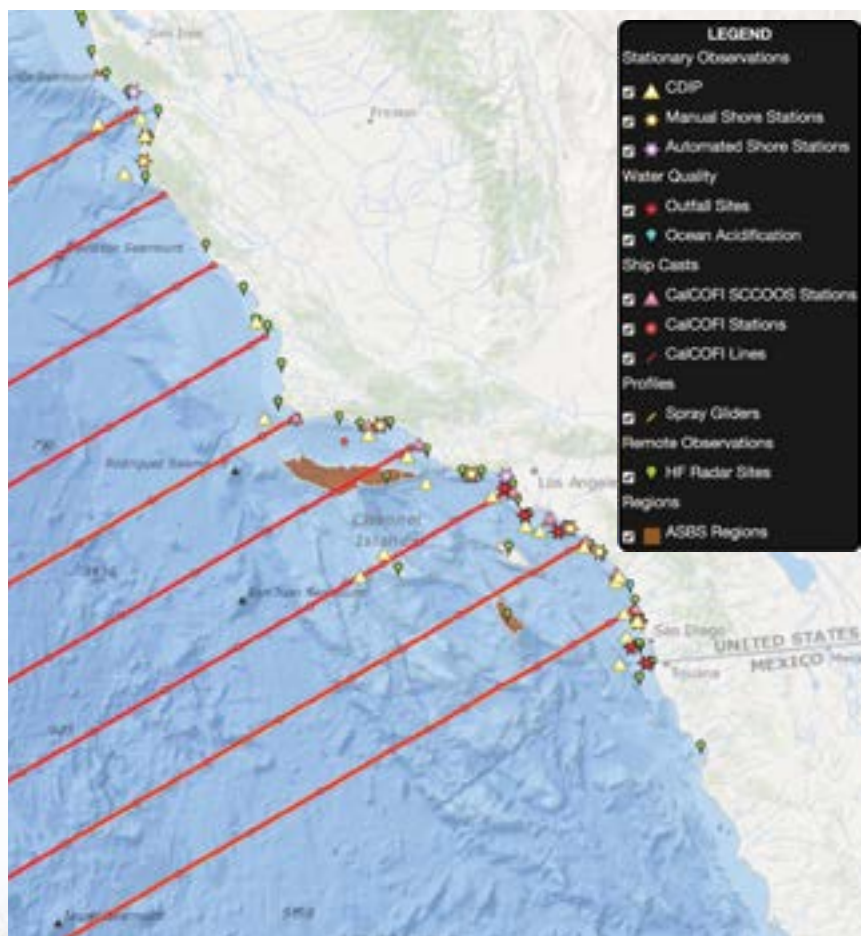
**Goals and Objectives:** The long term goal of the Coastal Hazards focus area is to develop and distribute validated, customized warnings of wave and tide-induced coastal inundation, erosion and nearshore transport. This work will promote safe recreational use of beaches and help cities meet emerging challenges to coastal infrastructure resiliency and reduce loss of life and property associated with nearshore waves and wave-driven currents in the populous coastal communities of the Southern California Bight.

**Audience and Benefits:** The audience for real-time and forecast inundation warnings includes the U.S. Navy, NWS, Emergency Alert Network, USACE, California Department of Transportation, California Coastal Commission, regional city and county governments, coastal businesses and recreational beachgoers. Based upon threshold exceedance, model-based inundation nowcasts, forecasts, and special warnings are now being disseminated directly to the NWS and coastal users via email.



# FOCUS AREA: CLIMATE VARIABILITY & CHANGE

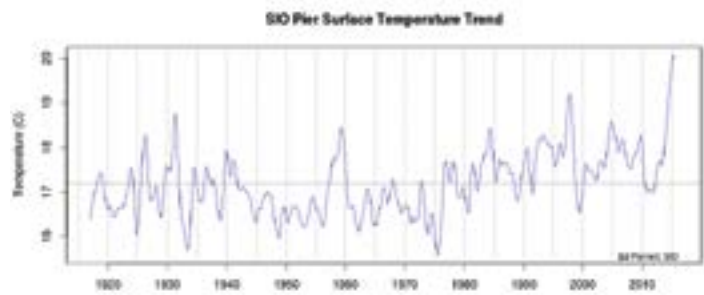
Within the SCCOOS region, major currents contribute to its unique variability and nutrient rich waters. These major currents consist of the poleward flowing Southern California Counter Current, the equatorward flowing California Current and the poleward flowing, subsurface current. Atmospheric and oceanographic coupling also drive physical conditions through climatic patterns known as El Niño, associated with warm ocean temperature anomalies, and La Niña, associated with cold ocean water anomalies at the equatorial Pacific. For example, the Southern California Bight is profoundly influenced by El Niños with southern influences arriving by advection, coastally trapped waves and atmospheric teleconnection. However, ocean temperatures were historically warmer in 2014-2015, in ways different from previous El Niños with warming extending as far north as the Gulf of Alaska. SCCOOS continues to utilize their observational assets such as autonomous ocean profiling gliders, to monitor and track these unique and variable conditions.



*The SCCOOS network contains many long-term ocean observations.*

## PACIFIC ANOMALIES TWO-PART WORKSHOP 2015-2016

The unique climate signal in 2014-2015 had a large effect on the ecosystem. Sponsored by our Federal partners, including U.S. IOOS, the first workshop focused on “what” is driving these anomalies, and the second workshop will focus on “why” these anomalies occurred. In collaboration with the West Coast Ocean Observing Systems, the workshops demonstrated the need to span coastal and global research and operational communities across diverse disciplines to improve our overall ability to integrate oceanographic information.



Manual Shore Station, Scripps Pier has been collecting ocean temperature data since 1916.

**Goals and Objectives:** An important SCCOOS goal is maintaining and interpreting data from long-term observations. Quality time series data are vital to establish baselines in key environmental parameters for detecting long-term climate changes. Emerging concerns, such as ocean acidification, introduce new priorities to add measurements of the ocean carbonate system for constraining coastal carbon budgets and characterizing natural variability and ocean change. Even though SCCOOS directly funds only a small portion of the data collection for understanding the climate variability, synergistic projects are leveraged.

**Audience and Users:** Managers responsible for long-range planning and members of the general public concerned about the ecosystem and the long term effect of climate change including ocean acidification are potential users of the data and indices. The 2014-2015 anomalous North Central and Eastern Pacific conditions have captured the attention of the public and the concern of resource managers, fisherman, and other ocean-related agencies. SCCOOS will continue to provide information to these stakeholders, who include marine scientists, coastal and marine resource managers and decision-makers working in marine health and climate-related fields, economic sectors affected by ocean climate (including aquaculture, mariculture, recreation and tourism), educators and the public. For instance, SCCOOS observations will be critical for observing climate-scale natural variability of coastal salinity for analyzing potential impact of brine discharges from planned desalination plants. It is expected that maintenance of these long-term time series will aid development of future climate change indices for agencies such as the Southern California operational desalinization plant and the Marine Protected Areas which now cover approximately 2,351 square miles of ocean, estuaries and reefs.

The NWS and coastal managers interested in coastal resiliency, with the anticipated larger more frequent storms and sea level rise, will be informed through the wave observation and models, including the flooding index product. In support of coastal resiliency, the long-term observation of waves, beach sand levels, alongshore currents and inundation are critical for building a historical database for coastal managers. As climate trends and changes become increasingly evident, the value of these databases will grow.

### Time Series of Ocean Observations

Dataset	Year of Initial Data	Measurements
Automated Shore Stations	2000	Temperature, Salinity, Chl A, Pressure
Burkolator	2014	Alkalinity, CO2 Water, Dissolved Inorganic Carbon, Aragonite Saturation, Salinity, Water Temperature
California Cooperative Oceanic Fisheries Investigations (CalCOFI)	1946	Ichthyoplankton Samples, Zooplankton Biomass, Seabird Surveys, Temperature, Salinity, Dissolved Oxygen, Nutrients, Chl A
California HF Radar	2005	Ocean Surface Currents (radial velocities)
Wave Buoys (CDIP)	1978	Wave Height, Period, Direction, Sea Surface Temperature
Nearshore & Topographic Data (CDIP)	2001	Transects Measuring Beach Elevation, LiDAR Elevation Data
Gliders	2007	Temperature, Salinity, Dissolved Oxygen, Fluorescence, Velocity, Acoustic Backscatter, Pressure
HABs	2005	Chlorophyll, Nutrients, Salinity, Weekly HABs Species Cell Count
Manual Shore Stations (CDBW)	1916	Temperature, Salinity
Survey Sampling Publicly Owned Treatment Works (POTWs)	2006	Temperature, Salinity, Dissolved Oxygen, Fluorescence



# FOCUS AREA: ECOSYSTEMS, FISHERIES, & WATER QUALITY

The Southern California Bight hosts diverse ecosystems such as extensive kelp forests, intertidal habitats and sandy beaches along with large populations of seabirds, marine mammals, fish and plankton. A broad range of physical transport processes supply nutrients to surface waters of the Southern California Bight that drive primary production productivity and support higher trophic levels. These include meso- and sub-mesoscale fronts and eddies, internal tides, coastally trapped waves, intermittent wind-driven upwelling and seasonal river inflows. The large human population, vast development of coastal areas, and broad range of human uses for the waters of the Southern California Bight present challenges for its ecosystems and biodiversity.

Rainfall during winter storms produces extensive plumes of urban runoff that contain pollutants along with pathogenic bacteria and viruses, often resulting in closure of public beaches. A challenge to maintaining water quality, essential for the large population and economy in the Southern California Bight, is the daily discharge of treated sewage into the ocean along with additional inputs from river systems carrying urban and agricultural runoff. The Los Angeles Hyperion alone, serving a population of 4 million, discharges 340 million gallons of treated wastewater per day into the ocean. In addition, untreated sewage also crosses the shoreline border from Mexico.

Two related issues that have come to the forefront over the last few years are the decreases of seawater pH (increased ocean acidification) and dissolved oxygen (increased hypoxia). Ocean acidification and hypoxia can have significant impacts on marine species. For example, calcifying organisms may decline as ocean acidification increases since they rely on calcium carbonate to build and maintain their shells and skeletons. Increased hypoxia has been found in Southern California Bight waters while regional changes in ocean acidification are currently being investigated.

**Goal and Objectives:** The overarching goal is to support management efforts through the monitoring of physical, chemical, and biological variables relevant to the ecosystems, while prioritizing those projects in line with NOAA's ecological forecasting roadmap. Specific goals are to (1) sustain observations of currents, temperature, salinity, phytoplankton and zooplankton throughout the Southern California Bight by glider, HF radar, Shore Stations and enhancement of nearshore CalCOFI ship surveys including monitoring sea bird, mammal and krill distribution, (2) sustain HABS monitoring of the episodic occurrence of blooms of toxic algal species in the California Current Ecosystem, develop enhanced products and efficiently deliver information to HAB stakeholders, (3) sustain the development of products to observe and forecast the dispersion of outfall and storm water plumes, in particular the levels of pathogens and (4) work with SCCOOS scientists and users to develop and refine regional ocean indices such as abundance species relevant to coastal habitats, estuarine ecosystem and fisheries.

## CALIFORNIA CURRENT ACIDIFICATION NETWORK (C-CAN)

The C-CAN is a collaboration of scientists, interdisciplinary scientists, resource managers, industry and others from local, state, federal, and tribal levels dedicated to advancing the understanding of ocean acidification and its effects on biological resources on the West Coast. Quantifying the many processes affecting water quality is critical for assessing threats posed for the Southern California Bight ecosystems. The West Coast Ocean Observing networks participate in C-CAN on many levels.

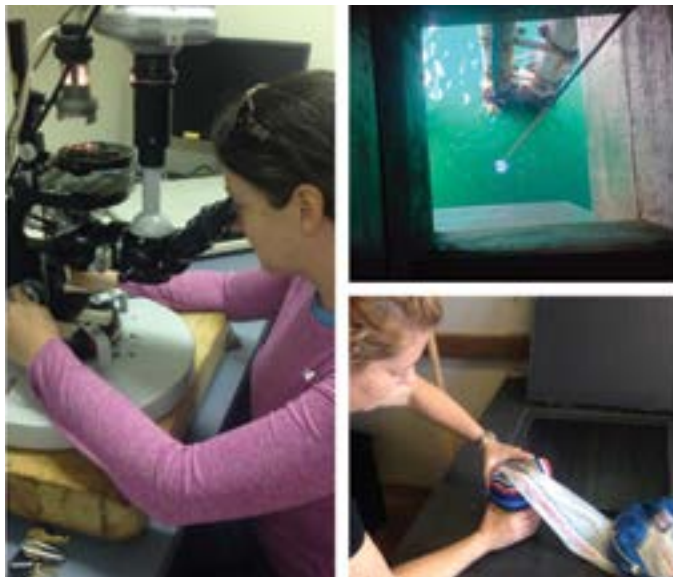




**Audience and Benefits:** Through collaborations with researchers, public health officials, water quality agencies and state regulators, SCCOOS has developed useful products for a broad range of users. Managers responsible for long-range planning and members of the general public concerned about the ecosystem are identified users of the data and indices. These include the National Marine Fisheries Service, Southwest Fisheries Science Center, Channel Islands National Marine Sanctuary, Tijuana River National Estuarine Reserve, Environmental Protection Agency, USGS, Bureau of Ocean Energy Management, California Department of Fish and Wildlife, Multi-Agency Rocky Intertidal Network, non-profit organizations, marine mammal stranding networks, marine managers attempting to minimize whale strikes by ships, commercial fishermen and aquafarms.

SCCOOS provides many agencies with useful products addressing water management and policy of the coastal ocean, including the Publicly Owned Treatment Works (POTW) to improve regional monitoring by mapping POTW plumes from ocean outfalls. The outfall water component provides trajectory data products for estimating the transport of surface discharges from POTWs and river runoff, and uses subsurface observations and high resolution modeling to describe sub-surface movement of outfall plumes<sup>vii</sup>. SCCOOS has recently developed trajectory maps for the California State Water Resources Control Board to track coastal non-point discharges to Areas of Special Biological Significance (ASBS) in our region. In the latest study, Bight 13, SCCOOS is working with Southern California Coastal Water Research Project (SCCWRP) and regional water quality agencies to understand the relative importance of natural versus anthropogenic sources of nutrient fluxes into the Southern California Bight. Another objective is to understand the carbonate system in nearshore waters, particularly coastal and estuarine ocean acidification and hypoxia. Extensive observations are being conducted by POTWs in pursuit of these objectives.

SCCOOS together with CeNCOOS provide statewide weekly HAB and phycotoxin monitoring at several locations. These observations and forecasts are used as a successful early warning system by public health agencies as a service to the citizens of the state. The HAB's website provides real-time notifications to the California Department of Public Health, marine mammal and bird rescue centers, and regional agencies of detection of potentially toxic HAB species and their toxins. In collaboration with CeNCOOS, SCCOOS provides forecast models that predict the formation and evolution of blooms. HAB climatology will continue to develop statistical forecasts of toxic events.



HABs can threaten human health. Weekly water samples are taken at select pier stations.

## CARLSBAD AQUAFARM

In support of the West Coast Shellfish industry, the Ocean Observing Systems have added ocean acidification and hypoxia monitoring to their ongoing observations, developing an integrated website with the goal of displaying a comprehensive picture of Eastern Pacific ocean acidification efforts ([ipacoa.org](http://ipacoa.org)). As part of this project, SCCOOS maintains a CO<sub>2</sub> analyzer “burkolator” located at Carlsbad Aquafarm, reporting alkalinity, CO<sub>2</sub>, TCO<sub>2</sub>, omega aragonite saturation, salinity and water temperature. Additional funding was awarded through a West Coast Ocean Observing System’s joint proposal which will continue the operation of the instrument by SCCOOS subject matter experts.

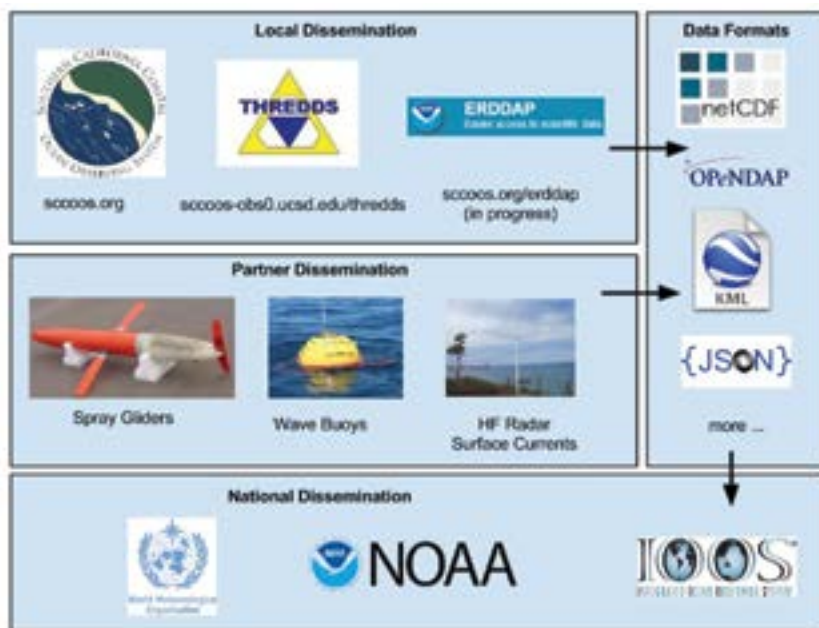


*Thomas Grimm, CEO and President of the Carlsbad Aquafarm.*

# DATA MANAGEMENT AND COMMUNICATIONS (DMAC)

As an operational Data Assembly Center (DAC), SCCOOS aggregates, curates and manages the integration and distribution of ocean data. Serving as a federal repository for various stakeholders, the DAC provides data assembly, quality control and discovery/access services. The DMAC effort provides scientists, decision makers and the public access to products and data services that will facilitate a scientific basis for research and management of ocean observations and models. Observational information is made available in a variety of formats to ensure that products are useful and easy to access, while preserving the necessary detail to support the scientific and educational communities. SCCOOS continues to foster advances in new visualizations and technologies, making their products more comprehensible and ensuring timely and sustained dissemination. SCCOOS DMAC participates in and contributes to international programs such as OceanSITES and the Joint Commission of Oceans and Meteorology wave evaluation testing.

**Goals and Objectives:** The SCCOOS Regional DMAC Implementation Plan describes in detail the infrastructure and data lifecycle for each data stream ([sccoos.org/about/dmac/](http://sccoos.org/about/dmac/)). SCCOOS will continue to provide access to high-quality integrated data and support regional user needs while complying with the national standards and protocols for sharing and archiving data following the “Guidance for Implementation of the IOOS DMAC Subsystem”. SCCOOS will also continue to integrate a broad suite of observations in the form of raw data and products. Collaboration with other Regional Associations to advance stakeholders access to cross-regional data services as defined by commonalities in specified user requirements is on-going through IOOS DMAC including workshops. SCCOOS DMAC is well poised to improve ingestion with a level of quality control based on Quality Assurance of Real Time Ocean Data (QARTOD) parameters, standardize the web services for all the parameters, submit to National Centers for Environmental Information for archive and enhance data visualization. Supplementing a detailed Data Management Plan are numerous Sensor Plans per SCCOOS data stream describing in detail ingestion, quality assurance, quality control, dissemination, distribution, and archiving.



Data management flow diagram.

# MODELING & ANALYSIS

SCCOOS relies upon models to synthesize data in ways consistent with known physical and biogeochemical processes in support of the focus areas of operation. Regional scale forecasts of the ocean are provided by partnerships with the University of California, Los Angeles in support of the two models operated by SCCOOS (1) 3 km ROMS, spanning coastal waters of California, and (2) the coupled ROMS/biogeochemical model which aids evaluation of the effects of nutrient inputs from outfall plumes, river plumes, and upwelling processes on bloom formation and nutrient cycles<sup>viii</sup>. The 3 km ROMS nowcast and three day forecast model includes the tidal forcing prescribed at the open boundaries and has a data assimilation capability using a multi-scale Data Assimilation System (3DVAR) method.

SCCOOS participates in several nationwide efforts concurrently being advanced including the:

- West Coast Coastal Ocean Model Testbed
- West Coast Ocean Forecast System
- Nearshore Wave Prediction System

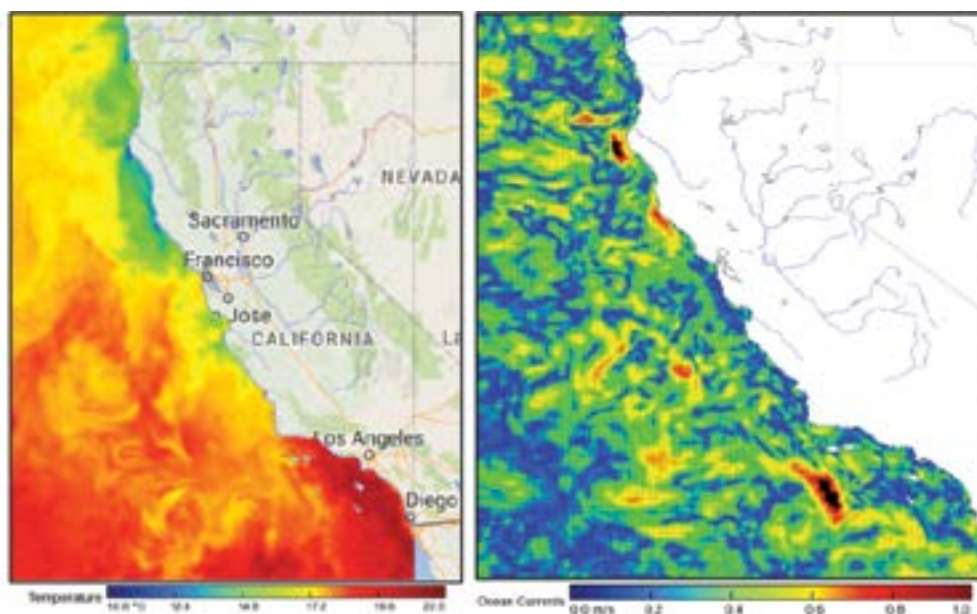
## Goals and Objectives:

SCCOOS will continue to serve a coordinating role for the model efforts occurring at the regional level. Increasing spatial resolutions of our nowcast and forecast models will be necessary to meet users'

needs. This implementation will either consist of an increase (e.g., tripling) of the model resolution over the entire state domain or within a subdomain (e.g., Santa Monica or San Diego Bight). The increase of our model resolution will be coordinated with the West Coast Ocean Forecast System and the West Coast Coastal Ocean Model Testbed.

Biogeochemical modeling will be used to differentiate anthropogenic from natural components of the nitrogen cycle. For example, a principal focus of the ongoing Bight '13 program is to differentiate nitrogen inputs in the Southern California Bight due to coastal upwelling versus those due to human activities such as wastewater discharge. Biogeochemical modeling, combined with field observations, is essential, and critical for also understanding future trajectories of hypoxia, ocean acidification and other climate change effects on the Southern California Bight ecosystems.

Re-analyses of the atmosphere provides a basis for understanding past climate variability. The re-analyses of the coastal ocean is expected to complement a similar record of the ocean climate, allowing retrospective studies relevant to the ecosystem and fisheries, a first step to developing indices and forecasts. For example, SCCOOS will use the re-analysis to identify if recurrent patterns of circulation favor certain species, by comparison with egg, larvae, and catch data, important factors for the Marine Protected Areas.



(Left) California 3 km ROMS: Temperature and (Right) deep water circulation.

Validation of models supported by SCCOOS is critical for establishing predictive skill for support of operations such as spill response and plume dispersion. It is also critical for effective use of model outputs in re-analysis studies aimed at understanding climate change effects on Southern California Bight ecosystems. Validation of modeled fields of surface and sub-surface water properties and currents will be carried out using data from glider transects, HF radar, satellite remote sensing and other data sources such as the Plumes and Blooms program, CalCOFI and moorings such as operated by SCCOOS, Monterey Bay Aquarium Research Institute and water quality agencies. Since the output from the 3 km ROMS model can be accessed from the SCCOOS website, it is expected the model performance skill will be evaluated and assessed as a collaborative effort involving both modelers and data providers.

To fill the gap between the existing Southern California Bight-wide SCCOOS models, and the inner-shelf to surfzone, the goal is to develop wave-driven site-specific models for shelf-surfzone interaction at particular sites (e.g., Imperial Beach) that have significant pollution and water quality impacts. Nearshore currents, driven by wave breaking, transport sediment, biota and toxic substances alongshore. In a few hours, waterborne materials can advect long distances with weak dilution. Modeling offers the prospect of predicting these occurrences in support of management response.

**Audience and Users:** The biogeochemical models will provide decision-support tools for the complex nutrient ecosystems. All three of the models support water quality management by providing ROMS real-time for current prediction, water properties and trajectories. The POTW partners who discharge into the SCB have identified these models of plume location as important data products. In addition the International Boundary Water Commission, CA State Parks and non-governmental organizations such as Coastkeeper, Heal the Bay and WiLDCOAST will benefit. Ocean surface current circulation tracking during critical events (e.g. Refugio Oil Spill) will utilize the ROMS 3 km model, HF radar trajectory models, in addition to the site-specific models. Both the USCG and NOAA Office of Response and Restoration have access to the 3 km ROMS nowcast/forecast as they become available in real-time to support their decision making processes during search and rescue and oil spill response operations.



# OUTREACH, STAKEHOLDER ENGAGEMENT & EDUCATION

SCCOOS has partnered with local science education centers, universities and state/federal agencies with the goal of encouraging educators and general public to learn, educate and promote scientific research through the use of high quality data and products.

**Audience and Users:** SCCOOS increased their outreach by installing touchscreen displays of real-time products at education centers at the Birch Aquarium, Ocean Institute, the Marine Exchange of Southern California, National Marine Sanctuary Kiosk and the California Surf Museum. In August 2014, CeNCOOS and SCCOOS jointly held a statewide Marine Symposium highlighting “Ocean Observing along California’s Central Coast in a Changing Climate” where 75 participants spanning industry and science applauded the State of California and federal Representatives for their long-term support of IOOS. The following summary table highlights additional outreach and education efforts.



July 2014, Marine Symposium highlighted Federal and State collaboration. Pictured (top) are Leslie Rosenfeld, previous CeNCOOS Director, Representative Louis Capps, Julie Thomas, SCCOOS Executive Director, (bottom) Representative Sam Farr and Deputy Secretary for Ocean Policy in California, Cat Kuhlman.



Displays of real-time products at education centers such as the Birch Aquarium (430,000 visitors/ 40,000 school groups annually), Ocean Institute (115,000 K-12 students and participation by 6000 teachers), the Marine Exchange of Southern California (750 tours annually) a Marine Sanctuary Kiosk in Ventura and the California Surf Museum (21,000 annually).



## Outreach Partners and Collaborative Activities

	Curricula	Custom Displays	Tours	Panel Participation	Presentations	Workshops & Seminars	Conferences & Summits	Booths	Webinars	Meetings	Publications
<b>LOCAL - SOUTHERN CALIFORNIA BIGHT</b>											
Area Planning Committees - San Diego and Long Beach	•		•	•	•	•				•	
Aquariums (Birch, Cabrillo, Long Beach)	•	•	•					•		•	
Carlsbad Aquafarm		•	•		•					•	
Catalina Sea Ranch		•	•		•					•	•
City Governments (Encinitas, San Diego)				•	•	•				•	•
Education Centers (Ocean Inst., California Surf Museum)	•	•	•		•	•		•		•	
Harbor Safety Committees (San Diego, Los Angeles, and Long Beach)				•	•	•	•			•	•
Jacobsen's Pilot Services- Long Beach		•	•	•	•	•				•	•
LTERs (Santa Barbara, California Current)											
Marine Exchange of Southern of Southern California		•	•		•	•				•	•
San Diego Coastkeeper					•	•	•			•	•
San Diego Foundation				•	•	•	•			•	•
San Diego MPA Collaborative					•	•	•		•	•	•
Sanitation Districts (San Diego, Orange County, and Los Angeles)											
Scripps Institution of Oceanography				•	•	•	•	•	•	•	•
SCUBA Diving Clubs/Businesses, Marinas, and Yacht Clubs			•		•	•	•	•		•	•
Sea Grant (California and USC)					•	•	•			•	•
Southern California Coastal Water Research Project				•	•	•	•		•	•	•
The Maritime Alliance			•	•	•	•	•	•	•	•	•
Tijuana River National Estuarine Research Reserve					•	•	•			•	•
<b>STATEWIDE AND WEST COAST</b>											
CalCOFI/PISCO										•	•
California Coastal Commission			•	•	•	•	•		•	•	•
California Dept. of Public Health				•	•		•			•	•
California HABmap		•			•					•	•
California Ocean Protection Council/Ocean Science Trust			•		•	•	•		•	•	•
Coastal Estuarine Research Federation					•	•	•	•	•	•	•
Dept. of Fish and Wildlife			•	•	•	•	•			•	•
Farallon Institute										•	•
Oil Spill Prevention and Response			•	•	•	•	•		•	•	•
State Water Resource Control Boards				•	•	•	•	•	•	•	•
The Marine Mammal Center	•	•	•	•	•	•	•			•	•
West Coast Governors Alliance on Ocean Health				•	•	•	•		•		•
<b>NATIONAL</b>											
BOEM			•		•	•	•			•	•
Council of America Masters Mariners										•	•
Marine Technology Society MTS/IEEE			•	•	•	•	•			•	•
NASA Jet Propulsion Laboratory										•	•
Naval Research Laboratory										•	•
NOAA NOS (CO-OPS, OAP, OCM, OCS)			•		•		•			•	•
NOAA Earth System Research Laboratory Global Systems Division							•			•	•
NOAA Fisheries					•		•			•	•
NOAA National Marine Sanctuaries					•		•		•	•	•
NOAA NWS			•	•	•		•		•	•	•
NOAA Office of Response and Restoration			•		•		•			•	•
NOAA Regional Collaboration - Western Region			•	•	•	•	•			•	•
Military (USCG, Navy, Marines)			•	•	•		•			•	•
U.S. Army Corps of Engineers			•	•		•	•			•	•
U.S. EPA			•		•					•	•
U.S. Geological Survey					•					•	•
U.S. Senate and House Representatives			•	•	•					•	•
<b>INTERNATIONAL</b>											
Border Environment Educational Project - Mexico		•			•	•				•	•
Centers for Scientific Research and Higher Learning - Mexico					•	•	•			•	•
University Autonoma de Baja California					•	•	•			•	•
U.S. International Boundary and Water Commission					•	•	•			•	•
Wild Coast					•	•	•			•	•

# CONCLUSION

SCCOOS maintains unique, long-term observations in the Southern California Bight in order to distribute ocean information of public interest. SCCOOS fulfills the U.S. IOOS priorities by: (1) identifying trends in the climate environment, and supporting the ecosystem, fisheries and water quality management, (2) informing operational users for marine and national safety, and (3) supporting coastal resiliency by delivering coastal hazard information to coastal managers. SCCOOS has the data framework to provide these critical observations and products for effective life-cycle management of ocean resources critical to the environment in the Southern California Bight. SCCOOS has the infrastructure, flexibility, and stakeholder participation necessary to address emerging coastal management issues including desalination and ocean energy. SCCOOS is committed to contributing to larger ocean observing collaborations at the regional, national, and international levels with other Regional Associations, state and federal agencies, users, and partnerships, furthering our role as stewards of ocean resources.



# REFERENCES

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