Sustaining and Expanding the Southern California Coastal Ocean Observing System (SCCOOS)

In response to Federal Funding Opportunity: NOAA-NOS-IOOS-2021-2006475
Topic Area 1: Implementation and Development of Regional Coastal Ocean Observing Systems

Proposal Duration: June 1, 2021 - May 31, 2026
Funding Request: $30,000,000
Funds transferred to NOAA Partners: $1,011,000

This project complies with the IOOS Programmatic Environmental Assessment (3.1.7 page 14-15, 3.2.7 page 43-45, & 3.3.7 page 66)

Dr. Eric Terrill, Principal Investigator
SCCOOS Technical Director
Scripps Institution of Oceanography
University of California, San Diego
9500 Gilman Drive, Mail Code 0214
La Jolla, CA 92093-0214
(858) 822-3101
eterrill@ucsd.edu

Dr. Clarissa Anderson, Co-Investigator
SCCOOS Executive Director
Scripps Institution of Oceanography
University of California, San Diego
9500 Gilman Drive, Mail Code 0214
La Jolla, CA 92093-0214
(858) 246-2226
clrander@ucsd.edu

William Park III, Contract & Grant Officer
SIO Contract & Grant Office
Scripps Institution of Oceanography
University of California, San Diego
9500 Gilman Drive, Mail Code 0210
San Diego, CA 92093-0219
(858 534-1802
wparkiii@ucsd.edu

Anne Footer, Financial Representative
Marine Physical Laboratory (MPL)
Scripps Institution of Oceanography
University of California, San Diego
291 Rosecrans, Building 4
San Diego, CA 92016
(858) 822-1350
afooter@ucsd.edu

TABLE OF CONTENTS

2. PROJECT SUMMARY

Project Title: Sustaining and Expanding the Southern California Coastal Ocean Observing System (SCCOOS)

Primary Contact: Dr. Clarissa Anderson, SCCOOS Executive Director
University of California, San Diego
Scripps Institution of Oceanography
9500 Gilman Drive, Mail Code 0206
La Jolla, CA 92093 – 0206
Phone: (858) 246-2226
Email: clrander@ucsd.edu

Recipient Institution: The Regents of the University of California, San Diego Scripps Institution of Oceanography (SIO)

Other Investigators: Dr. Eric Terrill, Principal Investigator, SCCOOS Technical Director

Partners:
UCSD Birch Aquarium
California Polytechnic State University San Luis Obispo (Cal Poly SLO)
California State University Long Beach (CSULB)
California State University Northridge (CSUN)
Farallon Institute
Monterey Bay Aquarium Research Institute (MBARI)
NOAA, National Marine Fisheries Service (NMFS)
NOAA, Office of National Marine Sanctuaries (ONMS)
NOAA, Southwest Fisheries Science Center (SWFSC)
Ocean Data Network, LLC
Pacific Marine Mammal Center (PMMC)
Reef Check Foundation
Southern California Coastal Water Research Project (SCCWRP)
University of California Irvine (UCI)
University of California Los Angeles (UCLA)
University of California Santa Barbara (UCSB)
University of Southern California (USC)
Woods Hole Oceanographic Institution (WHOI)

Other Partners: A full list of SCCOOS partners and stakeholders is listed in Table 7 (Board of Governors), Table 8 (Executive Steering Committee), Table 5 (Joint Strategic Advisory Committee list), and Appendix F. Letters of Support.

Project Summary:
The Southern California Coastal Ocean Observing System (SCCOOS) is a science-based decision-support system for the coastal ocean with a focus on the production, quality control, and delivery of data, along with the creation of value-added products for end-users across all sectors. As the IOOS Regional Association for Southern California, SCCOOS has spent the last decade building infrastructure for ocean observing that

establishes robust platforms for geophysical parameters in the areas of surface current measurements, continuous observation of the ocean's interior with autonomous underwater vehicles, nearshore real-time measurements, and operational hydrodynamic forecasts. SCCOOS priorities were identified early on to align with the seven societal goals as outlined in the U.S. Integrated Ocean Observing System Summit Report. The ensuing flagship capabilities were thus developed to support short-term decision-making (operational users) and long-term assessment (management community) by implementing and leveraging regional capacity in ocean observing and state-of-the-art model development. In addition to national directives, both SCCOOS and our partner to the north, Central and Northern California Ocean Observing System (CeNCOOS), are guided by the California Ocean Protection Council Strategic Plan to advance state priorities in ocean observing. While both systems support critical marine operations and ecosystem studies in coastal California, there remain growth opportunities to meet the needs of a new Blue Economy bolstered by California's living marine resources. SCCOOS endeavors to expand the development of a regionally relevant system -- in close collaboration with CeNCOOS -- that monitors ecosystem dynamics, from physics to biogeochemistry to biology, and simultaneously serves the need of existing and future stakeholders, from governmental agencies and the private sector, to leading national researchers. We propose to maintain and grow these four thematic focus areas codified in our Strategic Plan (and prior funding cycles), as they define our core capabilities: 1) Marine Operations, 2) Coastal Hazards, 3) Ecosystems, Fisheries, and Water Quality, and 4) Climate Variability and Change. Over the next five years, we anticipate growth in the program office to adequately adapt to program expansion, particularly if Congressional "Fill the Gaps" funds continue and "Tier 2" projects are funded.

<u>Significant observing system developments in this proposal include:</u>

- Upgrading and replacing equipment in the 31+ sites of the HF Radar Network
- Upgrading the operational California Glider Network with next-generation gliders and BioEco sensors
- Expanding the California Coastal Ocean Flood Network
- Installing Self-Calibrating SeapHOx at automated shore stations for pH and DO for OAH
- Expanding the Harmful Algal Bloom (HAB) Monitoring and Alert Program and the California HAB Bulletin
- Supporting a California-wide network of pier and mooring-based Imaging Flow Cytobots for HABs
- Developing a cohesive Essential Ocean Variable monitoring network, buttressed by citizen science support
- Supporting biogeochemical model development and stakeholder visualization/access
- Biodiversity Monitoring: Animal Telemetry of great white sharks, Ocean Sound Observing Network, and eDNA method advancement for fisheries and ecosystem services
- Expanding SCCOOS data management and infrastructure to meet growing capacity

While SCCOOS is at the forefront of implementing ocean technology, observing, and interpreting data, an underpinning of the organization are stakeholder requirements that inform data and product delivery in an iterative process. In essence, products, tools, customized dashboards, and applications are optimized for the users using the expertise of SCCOOS to apply the latest science and technology. In the coming years, additional resources will be directed towards an outreach and education plan to further exploit IOOS data resources to respond to end users as well as enhance the STEM pipeline in underserved and underrepresented communities. In summary, SCCOOS project goals and objectives are all driven by a collaborative, stakeholder-driven process of developing observing capacity for the benefit of society.

3. PROJECT DESCRIPTION AND NARRATIVE

A. BACKGROUND

SCCOOS Vision and Mission - *Who We Are*

The mission of the Southern California Coastal Ocean Observing System (SCCOOS) is to produce, integrate, and communicate high-quality, science-based information to promote coastal ocean safety, resilience, and sustainability for all members of society. SCCOOS is a collaborative network of experts and research teams at universities, private organizations, and federal laboratories that work together to collect, generate, and aggregate coastal ocean data and forecasts to provide a single online access point for distribution and value-added products. SCCOOS goals and objectives are adapted from the 2018-2022 IOOS Strategic Plan[1] and therefore align closely with IOOS goals, objectives, and priorities. SCCOOS priorities were identified early on to align with the seven societal goals as outlined in the U.S. Integrated Ocean Observing System (IOOS) Summit Report.[2] SCCOOS leadership has emphasized the intersection of the 2018-2022 IOOS strategic priorities with legacy IOOS focus areas to establish a formal mechanism for enacting our vision and mission (Table 1) and provide continuity to our existing broad stakeholder base. We **propose to maintain and grow these four thematic focus areas** codified in our Strategic Plan (and prior funding cycles), as they define our core capabilities: **1)** Marine Operations, **2)** Coastal Hazards, **3)** Ecosystems, Fisheries, and Water Quality, and **4)** Climate Variability and Change. While the impacts of climate change cut across the first three thematic areas in profound ways, SCCOOS has prioritized its treatment as a unique focus area in keeping with legacy and in order to emphasize the societal gravitas associated with sustaining climate-quality datasets of broad intrinsic value.[3]

SCCOOS Region - *Where We Are*

SCCOOS encompasses the region from Morro Bay, California (overlapping slightly with the CeNCOOS domain) to Ensenada, Baja California (Mexico),[4] and includes the Southern California Bight (SCB; Figs. 1 & 2). The SCCOOS region is located in the southern portion of the California Current Ecosystem (CCE), a biologically productive eastern boundary upwelling system that is increasingly impacted by changes in climate, ocean acidification, deoxygenation, marine heatwaves, harmful algal blooms, and the input of anthropogenic nutrients from a coastal population of 20 million people.[5-13] Southern California is home to one of the world's largest seaports, the contiguous Ports of Los Angeles and Long Beach, which collectively regulate the entry of trans--Pacific trade to the U.S.A. to the tune of over $170 billion annually, supporting more than 575,000 Southern California jobs and importing over 30% of U.S. goods.[14] The Port of San Diego had an overall economic impact of $9.4 billion in 2017, a 22% increase since 2013.[15] Southern California is not only a highly populated and economically dynamic region, but it is experiencing rapid environmental change that affects the way people establish and pursue their livelihoods in the coastal zone, where 75% of the state's population lives. This has led to social inequities related to environmental justice because negative impacts are disproportionately felt by vulnerable communities.[16] Food insecurity is an associated growing global challenge that will, in part, be met by aquaculture in the coming decades given that, since 2016, aquaculture has been the main source of fish available for human consumption and is expected to increase 32% by 2030.[17] The SCB is home to the only federally permitted offshore aquaculture site, and a recent State of California recommendation will result in an Aquaculture Action Plan to create a comprehensive framework for marine macroalgae, shellfish, and finfish, with "focused support for a sustainable Blue Economy."[18] Coastal resilience and a growing Blue Economy will also depend on global sea level rise, which is driving a trend towards increasing coastal flooding during storms in response to total water inundation and often deadly coastal erosion,[19] with greater attention by the U.S. military and Ports to harden against these coastal threats in our region. Coastal pollution at the border with Mexico is further driving state, national, and international policy on regulating and monitoring water quality. For all these societal issues, whether in support of living marine resources, coastal resilience, or homeland security, the timely provision of ocean data and prediction

is essential for mitigating hazards, securing coastal and international boundaries, and ensuring a vibrant economy sustained by life in the sea.

SCCOOS History and Synergy - *How We Work*

Serving as the U.S. IOOS Regional Association (RA) for Southern California, SCCOOS was formed in 2004 as a consortium of scientists who recognized the fundamental need to provide granular, oceanographic observations and model products to a diverse regional stakeholder community in Southern California, including managers and planners, operational decision makers, scientists, and the general public. A pivotal moment was the California Coastal Conservancy investment of $21M USD into the Coastal Ocean Currents Monitoring Program (COCMP), which established a network of high frequency radar (HFR) systems, glider survey capabilities, and modeling infrastructure. The HFR network in California remains one of the world's largest continuous networks mapping coastal ocean surface currents, placing SCCOOS and our partner to the north, the Central and Northern California Ocean Observing System (CeNCOOS), at the forefront of HFR technology demonstration in the nation.[20-21] This early state investment fostered a unique relationship between the two IOOS RAs in California, united to accomplish statewide priorities through leveraging state and federal resources. Both SCCOOS and CeNCOOS have spent the last decade building robust infrastructure for ocean observing that establishes platforms for biophysical parameters in the areas of surface current measurements, continuous subsurface observing with autonomous underwater vehicles, nearshore real-time measurements, and operational hydrodynamic forecasts. It cannot be overstated that these flagship capabilities were developed by implementing and *highly leveraging* regional capacity in marine science, ocean observing, and prediction. While the California ocean observing systems have successfully evolved to support critical marine operations and ecosystem monitoring, there is ample motivation to expand to meet the needs of a growing Blue Economy bolstered by California's living marine resources.[22] Here, SCCOOS proposes to expand the development of a regionally relevant system -- in close collaboration with our partner CeNCOOS -- that monitors IOOS Core Variables and ecosystem dynamics, from physics to biogeochemistry to biology (Fig. 2, Table 2), while serving the needs of existing and future stakeholders from governmental agencies and the private sector, to leading national researchers (Fig. 3, Table 3). By engaging industry to fill critical observing gaps, SCCOOS is establishing a forward-thinking network for the next decade and beyond that benefits California, the nation, and the global ocean observing community.[23]

SCCOOS on the U.S. West Coast - *How We Partner*

In addition to national directives, it is noteworthy that both SCCOOS and CeNCOOS are guided by the California Ocean Protection Council (OPC) Strategic Plan[24] that defines state priorities to "safeguard coastal and marine ecosystems and communities in the face of climate change," "advance equity across ocean and coastal policies and action," "enhance coastal and marine biodiversity," and "support ocean health through a sustainable Blue Economy." The West Coast IOOS RAs, which include SCCOOS, CeNCOOS, and the Northwest Association of Networked Ocean Observing Systems (NANOOS), share the responsibility of providing high-quality data and information to stakeholders within the California Current Large Marine Ecosystem (CC-LME).[25] As such, we have a history of partnering on pan-regional ocean observing and product development in support of regional priorities articulated years ago by the West Coast Governors Alliance on Ocean Health[26] and more recently, by the Pacific Coast Collaborative (PCC), and the Regional Ocean Partnership - West Coast Ocean Alliance (WCOA). At the global level, the West Coast RAs have collectively contributed to major initiatives, such as the Global Ocean Observing System (GOOS), Global Ocean Acidification-Observing Network (GOA-ON), OceanObs'19, and the UN Decade of the Oceans.[27] The goals and objectives described below all directly link back to these initiatives and to a collaborative, stakeholder-driven process of developing observing capacity for the benefit of society (Fig. 3, Table 3).

B. GOALS AND OBJECTIVES

A full list of Goals, Objectives, Tasks, Tiers, Investigators, and Project Periods is provided in Table 4.

SCCOOS goals, and objectives to achieve those goals, are modeled after the IOOS Strategic Plan's Goals and Objectives and retain the general IOOS ordering in order to emphasize the central role of observations. **Goal 1** describes how ocean observations are procured, delivered, and sustained to serve societal needs; it encompasses the vast and challenging effort prioritized by the SCCOOS ocean observing team, often in direct partnership with CeNCOOS and/or NANOOS, to fill critical observing gaps and satisfy statewide and regional priorities, while also supporting national and international initiatives. **Goal 2** describes the Data Management and Cyberinfrastructure (DMAC) backbone of SCCOOS and initiatives to improve data- and model- serving capacity. **Goal 3** describes the model predictions supported by SCCOOS. **Goal 4** outlines the downstream products and services developed with partners and stakeholders represented across many sectors: public health, fisheries science, regional water quality control boards, ocean dischargers that include Publicly Owned Treatment Works (POTWs), marine safety officers, local U.S. Navy and Coast Guard personnel, the commercial shipping industry, and many others represented by 76 letters of support (Appendix F). **Goal 5** pertains to SCCOOS governance, strategic stakeholder engagement, and proposed efforts to extend the reach of SCCOOS to age groups and communities that would otherwise not have the opportunity to benefit from these public services.

C. CONNECTION TO USERS/STAKEHOLDERS AND BENEFITS (Obj. 5.2 - 5.3)

**The large network of specific SCCOOS stakeholders is illustrated in Figure 4 and demonstrated through 76 Letters of Support from our closest partners in Appendix F; Engagement details are in Appendix D.*

While SCCOOS is at the forefront of implementing ocean technology, observing, and interpreting data, an underpinning of the organization is to meet stakeholder requirements. End-users may not shape the theoretical limits of technology and services, but their requirements inform the data and product-delivery process in an iterative manner, such that the best of science-based observing is fashioned into *useful* and *used* aggregate data products, tools, customized dashboards, and applications[28] (Fig. 3). For instance, the California Harmful Algal Bloom (HAB) Bulletin[29] is, in part, built from data contributions by stakeholder partners and vetted by a stakeholder-based steering committee each month before being distributed to the public. SCCOOS staff attend routine meetings, such as NOAA West Watch Webinars, Channel Islands National Marine Sanctuary board meetings, Harbor Safety Meetings, Southern California Bight Regional Monitoring Program Meetings, California Office of Spill Prevention and Response (OSPR) Area Committee Planning Meetings, Marine Protected Area (MPA) Collaboratives, and OPC Public Fora to continually foster relationships and gauge user needs. A critical part of relationship-building is our annual Congressional outreach campaign, for which extensive materials are developed and tailored for California Senators and House of Representative Districts in the SCCOOS region (Fig. 5). In-person meetings with staffers from every coastal district, both in Washington D.C. on an annual basis and at their home district offices throughout the year, ensure clear communication of IOOS and SCCOOS/CeNCOOS priorities. When possible, experiential field trips are hosted for Representatives to engage with stakeholders and practitioners (Image 1). The huge success of this effort is reflected in the FY18-20 "Fill the Gaps" funding increases to IOOS for gliders, HFR, and "Streamlining observations for stakeholders."

SCCOOS-CeNCOOS-NANOOS have held joint stakeholder workshops in support of 1) U.S. West Coast Biological Observations (Nov 2018), and 2) the IOOS Coastal Ocean Modeling Testbed (COMT, Sep 2019) to assess the needs of West Coast partners relative to emerging issues, biological data, and physical and ecological forecasts. A detailed list of user requirements was compiled for regional-to-national capacity building.[30] SCCOOS and CeNCOOS partner formally to engage all State-level partners as one California observing system; our Joint Strategic Advisory Committee (JSAC; Table 5) is composed of agency, non-

profit, and industry leadership and is charged with meeting annually to provide feedback on extant and emerging products. The OPC, non-profit Ocean Science Trust, California Sea Grant (CASG), and USC Sea Grant are all critical partners for approaching state observing needs, often developed with SCCOOS/CeNCOOS input via working groups on observing and modeling gaps (note: SCCOOS Co-I Anderson is an elected member of the OPC Science Advisory Team). A statewide showcase[31] in Nov 2019 included the JSAC, California Congressional representatives, policy makers, The Maritime Alliance, and OPC staff (Image 2). System requirements were compiled from a series of breakout sessions at these workshops, and this format will serve as the blueprint for proposed, more targeted, stakeholder workshops in the next cycle.

D. WORK PLAN

**Detailed Statements of Work for each project described in the Work Plan are available upon request*

The five-year plan fundamentally advances the SCCOOS central mission to provide timely, scientific data, predictions, and information to address critical and emerging coastal issues in Southern California. The Work Plan is structured to map the Goals, Objectives, and Tasks from Table 4 onto the "Subsystems" required for a Regional Coastal Ocean Observing System (RCOOS) in the IOOS funding opportunity (Governance/Management, Observing, DMAC, Modeling/Analysis, Engagement). SCCOOS Program Office Goals 2 and 5 are spread across the *Governance/Management, DMAC, and Engagement Subsystems*. For the *Observing Subsystem,* Goal 1 objectives are ordered in terms of their alignment with the four SCCOOS Focus Areas: 1) Marine Operations, 2) Coastal Hazards, 3) Ecosystems, Fisheries, and Water Quality, and 4) Climate Variability/Change (Table 1). Goal 3 is described in the *Modeling and Analysis Subsystem,* which complements, and is even supported by, the *Observing Subsystem*. Product development (Goal 4) is necessarily peppered throughout several Subsystems. Note that Tier 1 and 2 projects are prioritized in Table 6. Taken together, the two tiers in each Subsystem significantly advance the ability for SCCOOS to strategically contribute to the priorities articulated in the implementation plan of the UN Decade of the Oceans,[32] the UN Sustainable Development Goals (e.g., SDG 14 - Life Below Water),[33] and the OceanObs'19[34] decadal directive to sustain physical, biogeochemical (BGC), and biological observations that maximize societal benefit (Figs. 1 & 2, Tables 2 & 3).

I. GOVERNANCE AND MANAGEMENT SUBSYSTEM (Obj. 5.1, Task 1-2)

Background - SCCOOS organization (Fig. 6) is represented by 1) a lean program office with internal data management based at Scripps Institution of Oceanography (SIO), and by 2) a regional consortium of institutions with 11 founding members[35] and five signatories of memoranda of understanding (MOU).[36][37][38][39] These MOUs are continually increasing in number as new partnerships are formalized. SCCOOS follows a set of by-laws voted in by the SCCOOS Board of Governors (BOG) (Table 7), a group whose charge is to advise SCCOOS vision and direction. The Executive Steering Committee (ESC; Table 8) prioritizes recommendations, reviews Expressions of Interest (EOIs), meets to formulate scopes of work documented in the Work Plan, and advises the BOG on technical manners and strategic planning. The SCCOOS Executive Director works with the BOG, ESC, and Technical Director to enact the Operational Work Plan[40] and Strategic Plan,[41] expand the program through extramural projects, build capacity via international-to-regional working groups (including IOOS Association governance), and interact with partner organizations via frequent travel and conference calls. *For the first time, SCCOOS and CeNCOOS have joined their EOI processes to better coordinate statewide priorities and cost-share a significant number of overlapping projects in our respective programs.* **Project Objectives** - Task 1. We will sustain the SCCOOS Program Office in support of SCCOOS and IOOS core capabilities, provide uninterrupted product and data delivery via our newly designed website and DMAC system, provide frequent community communications via our listserv and social media platforms, participate in all IOOS Association activities to improve IOOS RA

coordination and national messaging, and conduct meaningful stakeholder outreach, engagement, and relationship-building to ensure we are meeting the needs of our regional and state-level constituents (Table 9). Task 2. Over the next five years, we anticipate growth in the program office to adequately adapt to program expansion, particularly if "Fill the Gaps" funds continue and projects listed as Tier 2 come to fruition (Table 4 & 6). SCCOOS anticipates co-hiring research assistants with close partners, CASG (based at SIO) and UCSD Birch Aquarium, an arrangement already underway as part of a state-funded MPA Monitoring grant to SCCOOS and CeNCOOS. New personnel will specialize in ocean data science, stakeholder engagement, and outreach/education specifically directed at identifying SCCOOS opportunities to enhance the STEM pipeline in underserved and underrepresented communities. **Relevant Users and Deliverables** - The primary metric for ensuring we meet milestones and deliver data, products, and services is sustaining the program office and successful engagement activities, such as JSAC workshops, communications with partners, and regional-to-national activities (e.g., routine stakeholder meetings, SIO webinar series, IOOS-sponsored workshops). Tier 2 funding allows us to significantly expand our reach through targeted workshops and curated content, e.g., user tutorials and education materials, all of which is described further in the detailed Outreach & Engagement Plan (*subsection iv* and Appendix D).

II. OBSERVING SUBSYSTEM

Focus Area 1. *Marine Operations*

SCCOOS is committed to providing data and enhancing products for safe and efficient marine commerce, transportation, search and rescue, and improved homeland security. SCCOOS has been well-positioned over the years to support marine operations given the regional reliance on large ports for commerce and our close working relationships with the national wave buoy Coastal Data Information Program (CDIP) and the HFR legacy system. CDIP is funded primarily by the US Army Corps of Engineers, State of California, and IOOS. Communication with regional stakeholders in the early days of SCCOOS, partners like the U.S. Navy and The Marine Exchange of Southern California, resulted in detailed, customized data views and forecasts to better enable operations. End-user requirements and the systems SCCOOS has or will develop to enhance marine operations in support of a Blue Economy[42] are described below.

a. California's Surface Current Mapping Network (Obj. 1.1, Task 1-2)

Societal Issue - Several societal challenges related to the coastal ocean can be met, at least in part, by surface current measurements from HFR. These include improved search and rescue operations; better targeting of clean-up and containment efforts during oil and other pollutant spills; and improved hazard assessment by the recreational/commercial ocean users, such as boaters and ocean swimmers (Fig. 7). **Project Objectives** - SCCOOS will continue to provide continuous, accurate measurements of surface currents in the SCCOOS region, collaborate closely with CeNCOOS regional HFR PIs via weekly calls, and update the network via recapitalizing aging HFR equipment and hardening HFR sites. Task 1. **Operational objectives** are: 1) Operate and maintain the California HFR network to sustain regional measurements of surface currents. Currently, SCCOOS operates 31 sites, but efforts are underway to add new sites; 2) Ensure high-quality data are delivered in near real-time to the national HFR Network Data Assembly Center (DAC) (HFRNet, supported through a non-SCCOOS award to UCSD); 3) Provide access to a growing data record, currently 15-years long, with increasing value for examining the oceanic response to climate variability in the state of California and more broadly in the CC-LME; 4) Provide data to operational users for assimilative models and product development; 5) Work with all IOOS HFR groups to implement newly developed, near real-time quality assurance/quality control (QA/QC) procedures throughout the IOOS HFR network; 6) Develop new validation, data processing, and QA/QC strategies for improving accuracy of surface currents from HFR; 7) Engage with operational and scientific communities on data access and assimilation. Task 2. **Recapitalization objectives** are: 1) Replace aging HFR equipment and infrastructure (e.g., antennae, electronics chassis, and networking equipment); 2) Improve network resilience to changing climatic factors,

such as increasing wildfires and coastal inundation by HFR-site hardening. **Relevant Users and Deliverables** - HFR data support the National Surface Current Mapping Plan[43] and are used in multiple prediction-driven applications, such as the NOAA Environmental Response Management Application (ERMA), National Weather Service (NWS) Advanced Weather Interactive Processing System (AWIPS) II, and USCG Search and Rescue Optimal Planning System (SAROPS). The CA oil spill community relies on NOAA's Office of Response and Restoration (OR&R) for oil spill trajectories during spill training and response activities. OR&R acquires the near real-time surface current vectors as a reference and validation to the General NOAA Operational Modeling Environment (GNOME). These applications and requests continue to increase as the public, managers, and scientists use ocean observations to further our stewardship of ocean resources. Regional Ocean Modeling System (ROMS) applications, such as the West Coast Ocean Forecast System (WCOFS) and the 3 km California ROMS, assimilate HFR surface-current data, greatly improving model skill.[44] An ongoing effort to assimilate radial currents into these models will further improve skill and enhance coverage of assimilation data.

b. Stakeholder Products for Marine Operations (Obj. 4.1, Task 1-2)

Relevant Products - Task 1. SCCOOS developed and maintains the Ports and Harbors webpage in support of mariners, boaters and harbor officials at El Segundo/Chevron, Los Angeles/Long Beach (LALB), San Diego, and San Francisco Harbors, and mirrors the CDIP Marine Exchange of Southern California page for the Ports of LALB (POLA/LB).[45] The Under-Keel Clearance Project[46] -- a long-standing public-private partnership between CDIP, the Marine Exchange, ProTide, and SCCOOS -- improves local swell models at the POLA/LB harbor entrance, where three buoys (with one buoy supported by IOOS via SCCOOS) are critical to delivering customized information to ship captains and harbor pilots. Maximum operational vessel draft has increased by four feet, thereby decreasing the number of vessels lightering - less fuel consumption, quicker loading/offloading (more revenue) - and improving working conditions. Another CDIP/SCCOOS partner critical to this effort is the NOAA Office of Coast Survey for provision of accurate seafloor bathymetry maps in and around ports. For partners in the U.S. Naval Air Station - Naval Air Systems Command (NAVAIR) at Pt. Mugu Sea Range, the NAVAIR page[47] on the SCCOOS website is another collaboration with CDIP and HFRNet; NAVAIR depends on wave buoy data and surface currents from HFR for its weapons-testing exercises. For the Automatic Identification System (AIS) data view, SCCOOS "iframes" the large marine vessel AIS and tracks official marine traffic.[48] Task 2. While SCCOOS has long been at the forefront of curating data views for users before such aggregations were commonplace, the products listed in Task 1 now require new architectures. SCCOOS is actively collaborating with NAVAIR to redesign a portal for visualizing real-time meteorological, CDIP, and HFR data. SCCOOS will focus on standardizing and serving all SCCOOS data via the NOAA Environmental Research Division Data Access Program (ERDDAP) for flexible re-use and front end display. As HFR recapitalization occurs and new sites are acquired, coverage will increase along the coastline, thereby enhancing value for stakeholders (Navy, USCG, ports managers) and models they use, such as GNOME, WCOFS, and other assimilative ROMS applications.

Focus Area 2. *Coastal Hazards*

A number of existing projects comprise the SCCOOS response to stakeholder needs to improve coastal resiliency through accurate, geo-specific, and validated flooding models and critical coastal information with the long-term goal of improving coastal safety, mitigating the impacts of natural hazards and sea level rise, and enhancing coastal economies. A persistent observing partnership is the close coordination and collaboration between SCCOOS and CDIP to provide timely forecasts of coastal flooding in an effort now stewarded by the Center for Climate Change Impacts and Adaptation (CCCIA) at SIO.

a. California Coastal Flood Network (Obj. 3.1, Task 1)

Societal Issue - Improving Total Water Level (TWL) predictions for the broad range of shorelines that typify the California coast is a primary concern for coastal resiliency. The aim is to improve wave runup estimates,

which are the largest source of error in TWL predictions, and to establish TWL thresholds for wave overtopping and flooding. **Project Objectives** - We will: 1) Combine runup, tides, and sea level anomalies to predict TWL for high priority sites across the SCCOOS region using a nonhydrostatic wave model to establish runup parameterizations and to specify uncertainties associated with available boundary conditions (e.g., offshore wave forcing, beach topography); 2) Make Lidar observations of runup and beach morphology to validate and calibrate model results; 3) Compare runup estimates to reported flood events, which will be used to establish TWL flood thresholds. Our goal is to collect sufficient wave and beach information to add one new validated site in Southern California each year. **Relevant Users and Deliverables** - TWL 6-day forecasts and hindcasts (2000-present) will be available on the SCCOOS website (Fig. 5). The forecasts will include TWL uncertainties and probabilistic estimates of near-term flood events.[49] Users include the U.S. Army Corps of Engineers, NWS, California State Parks, city and county managers, lifeguards, coastal property owners, coastal engineers, and beach users. These observations and products will support TWL efforts at the national level (e.g., the Coastal Inundation Dashboard)[50] as well as support the NOAA Integrated Ocean and Coastal Mapping[51] plan and international Seabed 2030 Project[52] by providing nearshore bathymetry data as part of the TWL prediction system. SCCOOS and CCCIA recently collaborated with the City of Santa Cruz (northern California) on an NSF Civic Challenge Grant to transfer TWL prediction methods to that region and will coordinate with CeNCOOS on future funding opportunities.

b. Stakeholder Products for Coastal Hazards (Obj. 4.1, Task 1-2)

Relevant Products - Task 1. In addition to hosting HFRNet products and services mentioned above, SCCOOS co-creates the Flooding and Storm Surge webpage[53] in support of the Coastal Flood Network. Along with a landing page with descriptions of observations and methodology, automated and curated data views with flood forecasts and CDIP wave conditions are provided for most Southern California beaches, with specific thresholds noted for Imperial Beach and Cardiff Beach. Additional data about wave conditions may become available from ongoing efforts to use the IOOS HFR network for wave measurements.[54] The Storm Photos page[55] collates *citizen scientist* photos to document flooding events from Imperial Beach (San Diego County) to Point Conception and is now buttressed by the CDIP Coastal Flooding Reporting Tool.[56] Task 2. SCCOOS will improve existing flooding and inundation pages, in collaboration with CCCIA and CDIP, incorporating complementary geospatial products, such as the NASA Earth Observatory Sentinel (e.g., Sentinel-6 Michael Freilich) and Shuttle Radar Topography Mission (SRTM) data, to allow better regional assessment of essential ecosystem services and coastal resilience.[57]

Focus Area 3. *Ecosystems, Fisheries, and Water Quality*

The following section addresses a burgeoning component of the SCCOOS observing system -- a strategic build out of Focus Area 3 in support of protecting human and ecosystem health, monitoring how changes in physics and BGC affect life in the sea, and facilitating ecological forecasts (Fig. 2). Projects are proposed based on their alignment with global initiatives, such as the OceanObs'19 Conference Living Action Plan[58] decadal recommendations for Ecosystem Health and Biodiversity, Integration of Biological Observations, and a Global HAB Observing System.[59-62] The highest-level goal is to strategically implement GOOS Essential Ocean Variable (EOV) and GEO BON Essential Biodiversity Variable (EBV) monitoring (Table 2) and paired measurements in accordance with GOOS BioEco Panel guidelines[63-65] to prepare for implementing actions for the UN Ocean Decade. At the national level, proposed projects are responsive to IOOS priorities articulated by the U.S. Marine Biodiversity Observation Network[66] (MBON), Animal Telemetry Network (ATN), and Marine Mammal Health Monitoring and Analysis (M.A.P.) platform. At the regional level, SCCOOS is motivated by (1) recent recommendations from the West Coast Biological Observations Coordination Network[67] to better monitor living marine resources, (2) the California Current Ocean Acidification Network (C-CAN), CA Ocean Acidification Action Plan,[68] and the CA Ocean Science Trust (OST) report to fill critical gaps in ocean acidification and hypoxia (OAH) observing and prediction,[69] (3) the recent Executive Order

from Governor Newsom to establish a California Biodiversity Collaborative, and (4) a close partnership with the Southern California Coastal Water Research Project (SCCWRP), the Santa Barbara Coastal- and California Current Ecosystem- Long Term Ecological Research (SBC-LTER, CCE-LTER) projects, and the Southern California Bight MBON (SCB-MBON). With the SCB-MBON, SCCOOS is co-leading an NSF-funded Coastlines and People (CoPe) Research Coordination Network to develop regionally focused networks of sensors and data sources necessary to take the pulse of coastal ecosystems, spanning their structure, function, and services provided to people. The following projects advance all these initiatives and link them to the global-to-local nesting that has come to characterize the U.S. IOOS Enterprise.

a. California's Surface Current Mapping Network (Obj. 1.1, Task 1-2)

*HFR *System overarching objectives already described in detail in Focus Area 1.*

Relevant Users and Products - The HFR network is increasingly being used to understand regional and local circulation patterns in oceanographic studies for water quality, trajectory patterns of HABs and other phytoplankton blooms, larval connectivity and settlement, and MPA design and assessment.[70-73] Water quality is an important concern locally with the cross-border San Diego South Bay-Tijuana region home to state parks, an MPA, a federally sponsored National Estuarine Research Reserve (TRNERR), Navy bases, the Port of San Diego, recreational beaches, and border communities that are impacted by infrastructure failure in Tijuana that drains wastewater into the Tijuana River (TR) Estuary and coastal zone. In 2002, SCCOOS partnered with the City of Imperial Beach and the County of San Diego Department of Environmental Health to establish the first bi-national ocean observing system focused on using HFR to describe physics driving coastal water quality. SCCOOS maintains an operational TR Plume Tracker[74] for the public to visualize the trajectory of potential plume waters. Local governments and the TR-NERR use the plume tracker to determine time-varying spatial patterns of pollution, and SCCOOS is engaged with scientists in State proposals to improve surfzone pollution prediction (Fig. 5). Future efforts include better engagement with state and federal agencies to incorporate HFR data into design and assessment of MPAs (e.g., CDFW network design; baseline assessment; federal marine sanctuaries) and water quality management.

b. California Underwater Glider Network (CUGN) (Obj. 1.2, Task 1-4)

Societal Issue - The overarching goal of this project is to sustain baseline observations of ecosystem variability in coastal California for improved understanding of low-frequency climate variability and our ability to predict ecosystem change. CUGN is a network of underwater gliders supported by both NOAA Global Ocean Monitoring and Observation (GOMO) and IOOS and is a model for sustained glider observations on the national and international scene. Collection of such data is an essential first step towards ocean weather prediction, e.g., corrosive upwelling and hypoxia events, marine heatwaves, and HABs. The CCE is a hotspot for OAH, but the spatiotemporal structure of corrosive waters is poorly understood, thus requiring integration of emerging BGC sensing technologies. A major limitation faced by fisheries managers, in particular, is lack of timely data on the prey-scape of commercial fishes for decision-making. Acoustic measurement of zooplankton allows the collection of high temporal and spatial resolution data, but is limited to snapshots from vessels, making the CUGN uniquely qualified to fill this data gap. **Project Objectives** - Task 1. Continue operation of the CUGN. The CUGN uses Spray underwater gliders for making repeated dives from the surface to 500 m and back, repeating the cycle every three hours, and travelling 3 km in the horizontal during that time. The Southern California portion of the CUGN includes three sustained glider lines on the California Cooperative Oceanic Fisheries Investigations (CalCOFI) geometry: line 80 off Point Conception, line 90 off Dana Point, and alongshore at station 60 connecting lines 80 and 90 (Fig. 1). GOMO supports line 90, while SCCOOS supports line 80 and the alongshore line introduced with 2018 Fill the Gaps funding. The glider missions typically last about 100 days, and cover over 2000 km, thus providing 4-6 sections on lines extending 300-500 km offshore. A reasonable metric of performance is the number of operational glider-days/day, with the goal of having continuous coverage on each line (Fig. 8). Measured variables include pressure, temperature, salinity, velocity, chlorophyll fluorescence (Chl), acoustic backscatter, and dissolved

oxygen (DO), providing bulk EOVs of physics, phytoplankton, and zooplankton, while DO measurements are relevant to periodic hypoxia in the CCE and are a step towards the monitoring of ocean acidification. Task 2. Recapitalize the glider fleet. This is a major issue on the SCCOOS horizon, and towards this end, the Spray team is currently developing a second-generation underwater glider through a NOPP grant from NSF. This Spray 2 glider is scaled up to carry nearly twice the battery power of the current Spray, allowing longer duration missions and/or a larger sensor payload. Spray 2 is being expressly designed to support the BGC Argo sensor suite, so that gliders can contribute to BGC observation. Task 3. Integrate BGC EOVs (pH and nitrate sensors) onto Spray 2 gliders to be operated in the CUGN along line 80 as they become available. Collaboration with CeNCOOS will outfit CUGN gliders that operate in the Central and Northern California region. Task 4. Develop a zooplankton abundance product. Over 15 years of high spatial and temporal resolution acoustic data from Acoustic Doppler Current Profilers (ADCPs) are available from the CUGN and can be used to discern information on how both environmental drivers influence zooplankton communities and abundance. Indices of zooplankton abundance will be developed by combining ADCP data, CalCOFI net data, and CalCOFI acoustic data processed for krill. The model to relate these data products will allow the calculation of a zooplankton abundance product that can be produced in a timely fashion and on a fine horizontal and vertical scale. **Relevant Users and Deliverables** - Task 1. CUGN supports U.S. Glider activities and best practices.[75] Data are made available as CF-compliant NetCDF files on the National Glider DAC, sent directly to NAVO and forwarded to the WMO GTS, and made available on SIO and SCCOOS servers for academic modeling groups (Fig. 8). With these sources of data, all the major groups modeling the CCE use data from CUGN: NAVO, NOAA, SIO, UCSD, UCLA, and OSU. A key stakeholder is NOAA Southwest Fisheries Science Center (SWFSC), which uses CUGN data for the California Current Integrated Ecosystem Assessments (CCIEA). Orange County Sanitation District (OCSD) uses CUGN data in annual reports of ocean conditions and is working with SCCOOS to develop a custom product based on automatically updated CUGN climatologies. Task 3 and 4 observations are in direct alignment with State monitoring priorities to fill OAH observing gaps offshore and for constraining state estimates to improve forecasts and ecosystem-level assessment. Zooplankton data are the primary source of data in ecosystem considerations for fisheries management; thus, a CUGN zooplankton indicator will be used by CCIEA.

c. HAB Monitoring and Implementation of an Early Warning System for CA (Obj. 1.3, Task 1-5)

Societal Issue - In addition to OAH processes, the CCE also experiences frequent HABs, characterized by phytoplankton species capable of releasing toxins during periods of rapid growth or causing economic and environmental damage. The genera *Pseudo-nitzschia* (produces domoic acid -DA) and *Alexandrium* (produces saxitoxin) raise the most concern in California. DA poisoning can cause memory loss, brain damage and fatalities; saxitoxin poisoning can lead to numbness, respiratory failure and fatalities. Algal biotoxins from HABs biomagnify and concentrate in marine mammals; signs of DA exposure are commonly recognized in stranded marine mammals and are reported as early indicators of HABs in the monthly California HAB Bulletin produced by SCCOOS. Prior to the establishment of the California Harmful Algal Bloom Monitoring and Alert Program (HABMAP),[76] the many research programs in California were not well-coordinated with the ocean observing community or end-users. HABMAP addresses this challenge by providing consistent and coordinated monitoring of HABs and relevant environmental drivers across the entire State (SCCOOS + CeNCOOS). This information provides real-time warning for managers, information on the prevalence of HABs, and high-quality time series used to better understand and predict HABs in a changing ocean. The CA OPC Strategic Plan explicitly prioritizes working with SCCOOS and CeNCOOS to facilitate HAB monitoring,[77] and predicting the spatial variability of HABs is emerging as a top priority for State action.[78] California OPC recently funded a three-year SCCOOS-led project with 10 partner institutions across academia, industry, and state government to purchase, install, and operate (FY20 only) a network of 10 Imaging Flow Cytobots (IFCBs) to be deployed at HABMAP piers and on offshore moorings in the SCCOOS & CeNCOOS regions (Fig. 9). The automated, real-time classification of phytoplankton taxa will revolutionize

the early HAB warning system for California and is serving as a prototype for the nation via the fledgling National HAB Observing Network (NHABON)[79] and a new SCCOOS-led NOAA Prevention, Control, and Mitigation of HABs (PCMHAB)[80] project to develop a national HAB DAC. Methods codified by the IFCB Network will also advance the NOAA Artificial Intelligence Strategy[81] and the Ecological Forecasting Roadmap[82] by improving prediction of HABs (one NASA and two ECOHAB projects led or co-led by SCCOOS Co-I Anderson). The presence of specific microbes can further indicate enhanced risk of a water-borne pathogens and/or HABs, thus molecular-level, genetic insights achieve a degree of taxonomic resolution that complements existing microscopy and IFCB observations. Methodological advances make it possible to link these data to specific ecosystem processes and health risks, further advancing the objectives of the NOAA 'Omics Strategy.[83] **Project Objectives** - Task 1. 1) Maintain continuity and quality of weekly observations of core HAB parameters at five existing SCCOOS pier sites (Fig. 1): Relative Abundance Index of eight HAB taxa via net tow, quantitative cell counts of HAB taxa, macronutrient and domoic acid measurements; 2) Maintain Solid Phase Adsorption Toxin Tracking (SPATT) for a suite of dissolved toxins from three demonstration sites begun in FY19 with IOOS Fill the Gaps "Streamlining Observations to Stakeholders" funding. Task 2. 1) Expand SPATT to the remaining two sites (Santa Monica Pier and Cal Poly Pier) and aid in weekly sample collection for microbial community monitoring. Task 3. Fully support annual IFCB operations and maintenance at three SCCOOS Automated Shore Stations (SASS) and Del Mar mooring in support of HABON. Task 4. Develop microbial community structure and abundance data products to assess the risk of biologically mediated events in the coastal ocean. Twice-weekly sampling for DNA and flow cytometry will be sustained at Scripps and weekly at the Cal Poly Pier (HABMAP personnel at other stations will be trained to collect samples) to develop basic and advanced products based on flow cytometry and DNA sequence data. Task 5. Measure DA levels in urine and feces of all stranded pinnipeds, dolphins and whales. Samples will represent animals from San Diego, Orange, Los Angeles, San Luis Obispo, Monterey, Santa Cruz, San Mateo, Marin, Sonoma and Mendocino counties. This will contribute objectively measured, high quality, near real-time, biological data that will enhance existing observations of HABs with biological metrics of ocean health, advancing the NOAA Health M.A.P. mission. **Relevant Users and Deliverables** - California HABMAP data are routinely used in conjunction with the operational CoastWatch product, California Harmful Algae Risk Mapping (C-HARM) System.[84] The data are served on SCCOOS and CeNCOOS websites, are used for the Pacific Northwest HAB Bulletin maintained by NANOOS, and are reported in NMFS CCIEAs. Observations and C-HARM predictions (from MODISA+VIIRS and models) are used to generate the monthly CA HAB Bulletin (Fig. 10). HABMAP data will continue to be disseminated to researchers, managers, and the public via a listserv and SCCOOS-run database on ERDDAP as Darwin-Core compliant csv files and eventually via the HAB DAC. Co-I Anderson is a member of the NASA Phytoplankton, Aerosols, Clouds, and Ecosystems (PACE) Early Adopter team to transition C-HARM from VIIRS to PACE, and this elevates the visibility of the CA HAB Bulletin. The IFCB Network will create automated alerts of HAB initiation and feed into the bulletin summaries along with marine mammal DA data and microbial community surveys. End-users for HABMAP data and products include aquaria, the California Department of Public Health (CDPH), California Department of Fish and Wildlife (CDFW), NOAA's Marine Mammal Stranding Network, The Marine Mammal Center (TMMC) of Sausalito, Channel Islands Marine Wildlife Institute, Pacific Marine Mammal Center (PMMC), Marine Mammal Care Center of Los Angeles, Marine Animal Rescue, California Wildlife Center, SeaWorld, POTWs, Office of Environmental Health Hazard Assessment, OCSD, City of LA Hyperion Treatment Plant, Carlsbad and Santa Barbara Desalination Plants, Catalina Sea Ranch (Pacific Mariculture), and Carlsbad Aquafarm (CAF).

d. Essential Ocean Variable (EOV) Monitoring - Automated Shore Stations (Obj. 1.4, Task 1-3)

Societal Issue - The near-shore environment is highly dynamic and thus requires continuous sensor-based observations to capture event-scale phenomena and pair them with biological measurements such as those from HABMAP. A wide range of anthropogenic and natural processes can impair water quality in coastal

waters and thus limit human uses, including recreation, desalination operations, sewage disposal, coastal fisheries, and aquaculture. Long-term observations allow managers to assess the effects of anthropogenic processes and climate cycles as well as improve ocean models with nearshore boundary conditions. The SASS Program is an integrated network providing critical long-term measurements in support of ocean health and coastal-ocean water quality in real-time for use by coastal managers, agencies, researchers, and the general public; it is also envisioned as a testbed to allow rapid testing/evaluation of new ocean-observing technologies. For example, OAH is of strong agency interest in the Southern California Bight as exemplified by the SCCWRP Bight '18 Regional Monitoring Program, with which SCCOOS actively partners. Through a joint IOOS Ocean Technology Transition (OTT) project with NANOOS and CeNCOOS, SCCOOS has been supporting OAH EOV monitoring at Carlsbad Aquafarm (Agua Hedionda Lagoon, San Diego County) to support shellfish growing operations; now co-supported by NOAA OAP and IOOS, instrumentation has shifted from the Burkeolator (full suite of carbonate system parameters) to a SeapHoX developed at SIO (real-time pH and DO).[85] While some SASS stations are already collecting pH and DO measurements, a high priority goal is to expand pH and DO observations at all stations for better coverage. Partnering with CeNCOOS to develop a statewide shore station network and data products is important for ensuring a *weather-ready nation.*[86] **Project Objectives** - Task 1. Continue long term, high-frequency, and high-quality observations of the SASS network at the four SCCOOS automated shore stations (Figs. 1 & 2), with observations from Santa Barbara to San Diego. EOVs currently collected include temperature, salinity, pressure, and Chl. Data from these sensors are QC'd, displayed in real time, and made available online for public use. The Santa Monica Pier station was recently re-commissioned with funds from the City of Los Angeles and The Santa Monica (SM) Bay Foundation; this proposal reinstates SM Pier long-term support. Task 2. 1) Incorporate new sensors into the SASS network, e.g., nitrate and colored dissolved organic matter (CDOM) along with passive collectors for measuring trace seawater constituents. The suite of parameters envisioned will enhance monitoring of HABs, eutrophication, and transport of discharge effluent to the nearshore. 2) Develop new data products to visualize climatologies and outline extreme levels of each parameter. 3) Collect calibration samples at all sites to evaluate data quality and consistency. Task 3. Self-calibrating SeapHOx (SCS) sensor packages will be constructed and then operated at three SCCOOS SASS stations for pH/DO tandem measurements; this is an emerging technology capable of *in situ* validation and calibration of pH data by injecting a standard pH buffer into the flow cell during deployment. SCS will be deployed long-term to further assess their performance, as well as establish data management and analysis protocols for real-time, calibrated pH sensor data from shore stations. **Relevant Users and Deliverables** - The most important deliverable is real-time water quality and high-quality, traceable pH/DO data (Internet of Things). SASS provides critical data within the nearshore region to investigate linkages between nutrient discharge from POTWs (e.g., OCSD) and blooms, and to assess timing, extent, and duration of OAH events. Fisheries managers, state regulators, and modelers all benefit from reliable water quality and OAH observations to characterize nearshore variability.

e. EOV Monitoring - Bight-wide Physical and BGC Data Collection (Obj. 1.4, Task 4-9)

Societal Issue - Coastal regions are where ocean model and forecast accuracy matter most to maritime stakeholders and industries, yet they are severely undersampled. Programs like SASS have helped fill very nearshore data gaps, but dynamics on the shelf are still neglected. In Southern California, little is known about the temporal and spatial scales of events that bring deep, cold, low-oxygen, nutrient-rich, and low-pH "corrosive" waters into the nearshore areas even though they are the main driver of blooms and pH/DO variability in the near-shore environment, and the impacts are profound: HABs, mortality of benthic species, fisheries decline, aquaculture threats, and water quality erosion. *The following Tasks 4-9 involve targeted data collection that fills critical observing gaps,* e.g., cost-effectively collecting oceanographic data in collaboration with fishers operating in these data-scarce regions, or by incorporating continuously measured multidisciplinary reference sites at representative locations. **Project Objectives** - Task 4. The

multidisciplinary Del Mar (DM) mooring sits 5 km from shore in 100 m water depth off the coast of San Diego and has a 14-year record to date. The DM site is proposed as a SCCOOS "node" and in a future national ecosystem mooring network, delivering continuous long-term reference and event-detection data to maximize utility to stakeholders (Fig. 11). The objective is to: 1) Sustain operation of the DM mooring; 2) Maintain a multi-disciplinary set of EOV sensors delivering real-time data throughout the water column (including an IFCB from Obj 1.3, and ocean sound sensors); and 3) Provision the mooring as a test, development, and demonstration site for new sensors and methods in support of OTT. Task 5. Sustained autonomous observations will be conducted offshore of San Diego for studying, detecting, and ultimately forecasting triggers leading to bloom and OAH events. This will rely on SUNA nitrate profiling measurements using a WireWalker, together with nitrate and BGC measurements on the DM and other moorings (Fig. 11). The high-frequency measurements of nitrate will compare natural variability with that from sources of anthropogenically influenced nutrients, such as from POTWs. Task 6. A network of low-cost real-time mini-moorings will be ramped up that observe temperature, salinity, pH, and DO in nearshore regions off Southern California, highlighting variability and events of OAH parameters close to shore (Fig. 11). Task 7. Monthly small-boat surveys will be conducted between the shoreline and 40m depth to characterize the cross-shore variability of physical and BGC parameters. Additional along-shore transects will be conducted during the upwelling season to support critical gaps in monitoring and modeling efforts (Fig. 2). Task 8. To monitor shoaling wave impact on DO, 48 temperature sensors with annual increments of 15 temp and 15 DO sensors will be placed on rocky reefs (a) by recreational divers as a citizen science project and (b) in cooperation with Reef Check operations (Fig. 2). Task 9. California Fishing Vessels of Opportunity Partnership (CFVOP)- temperature and velocity profiles will be collected in near real-time from sensors on fishing gear and vessels (by ship-mounted ADCPs), respectively. In this pilot project the frameworks and data pathways will be laid to evaluate future scaling up of operational networks of fishing vessels and is an essential first step towards integrating fisheries ocean observations into existing ocean observation networks in a cohesive manner (Fig. 12). **Relevant Users and Deliverables** - Potential users for all tasks include fisheries managers, aquafarm operators, POTWs, NOAA OA Program, California OPC, and researchers/modelers who seek to understand the processes driving both HABs and OAH, per California OST recommendations.[87] Task 4. DM mooring is also co-located with an inshore CalCOFI station where water sampling is part of SCCOOS and supports an IFCB. Thus, the mooring adds a time dimension to an ongoing quarterly SCCOOS observing effort. Delivery of real-time data streams from the DM mooring to SCCOOS, plus delayed mode data once per year, will enable gradual QC and delivery of data from all sensors going back to 2006. SCCOOS and NOAA will make these data widely available via ERDDAP and GTS. Task 5. Specific WireWalker deliverables are: 1) measurements of nitrate on isopycnal surfaces; 2) assessments of biological response to nitrate fluctuations (Chl and backscatter, IFCB data); 3) visualizations of on-isopycnal water properties across the shelf; and 4) retrospective understanding of natural vs. anthropogenic drivers of bloom/HAB initiation critical for water quality managers that will be incorporated into the CA HAB Bulletin summaries. Task 6. Mini-mooring data will be available in real-time, are suitable for ingestion into numerical simulations of the ocean, and along with the DM Mooring, fulfill a well-articulated mission in the National Ecosystem Mooring Plan[88]. Task 7. SCCOOS will host monthly graphical visualizations and data from the cross-shore boat surveys and a growing framework of OAH statistics addressing the magnitude, duration, and habitats affected. Task 8. Temperature sensors deployed on rocky reefs must be recovered annually to retrieve data, and products will include maps of variability and individual time series at 1-s resolution, which will be of use to benthic fisheries managers, fishermen, recreational divers, and suitable for data assimilation. Task 9. CFVOP data will be made accessible in near real-time via ERDDAP, Copernicus Marine, and submitted to WMO via GTS, EMODnet Physics portal, and SCCOOS & CeNCOOS portals and eventually merge with a complementary NANOOS-proposed project with the same team. An important deliverable will be an evaluation of using these combined industry and

oceanographic data streams to provide a proprietary precision-fishing product, exemplifying the utility of public-private partnership.

f. EOV Monitoring - Kelp Forests in MPAs (Obj. 1.4, Task 10-11)

Societal Issue – MPAs play a critical role in establishing science-based management of key ecosystems, with shallow rocky reefs and kelp forests targeted for protection in the Marine Life Protection Act (MLPA) and prioritized in the California MPA Monitoring Action Plan and by US MBON. In some regions of California, the loss of kelp forests has been rapid and extensive. Existing large scale, long-term kelp forest monitoring programs provide critical observations of biodiversity in these ecologically, economically, and culturally significant ecosystems. Sustained environmental data for stressors such as OAH, however, are usually not collected alongside long-term ecological monitoring efforts, making it difficult to disentangle the impacts of protection vs. natural variability. **Project Objectives** – Task 10. Ecological surveys will be annually conducted at sites currently being surveyed in association with ongoing monitoring studies of the California MPA network in Southern California, prioritizing those sites with the longest monitoring time-series, including sites distributed inside and outside of MPAs (Fig. 2). Task 11. With CeNCOOS, we will maintain a citizen-science based OAH sensor network that started in 2017, spanning six kelp forest MPA sites from northern to Southern California. These sites measure pH, DO, temperature, and salinity; pH sensors are calibrated by Reef Check citizen scientists and do not rely on collecting discrete samples. In addition to these six OAH sites, continuous temperature data have been collected at an additional 70 sites since 2017 (Fig. 2). **Relevant Users and Deliverables** - Data obtained from this observational network help interpret the impacts of MPAs and validate and improve high-resolution models to assess and predict vulnerabilities from OAH. Key users are those who manage California MPAs: CDFW, California State Parks, NOAA National Marine Sanctuaries (NMS) and NMFS, among other agencies. Federally, these data inform condition reports and stock assessments for NMS and NMFS and have been used by global biodiversity databases to support development of EBVs.

g. EOV Monitoring - Seabirds and Marine Mammals (Obj. 1.4, Task 12)

Societal Issue - A flagship biological observing program at SCCOOS is marine bird observations for the Southern California Bight. Societal applications of seabird distribution and abundance data include marine spatial planning, endangered species management, and assessments of anthropogenic forcing of the marine ecosystem (e.g., ocean energy development, wind and wave farms). The proposed continued observations and novel integration of these data correspond with national and State of California goals to "understand, share, and conserve,"[89] "monitor, protect, and measure core biotic variables,"[90] and "safeguard biodiversity and develop a Blue Economy."[91] **Project Objectives** - Task 12. The project will augment a 34-year time series of seasonal seabird observations (1987–present), with an additional five years of data (2021–2026). To conduct these observations, an experienced seabird and mammal observer collects data using standard techniques aboard two CalCOFI/CCE-LTER shipboard surveys (~45 d/y) and a portion of the NMFS Rockfish Recruitment and Ecosystem Analysis surveys (~25 d/y) each year. Data is converted into a standardized database structure, summarized in individual cruise reports, paired with simultaneously collected underway hydrographic and fish data, and made public by December 30 each year. **Relevant Users and Deliverables** - Stakeholders, collaborators, and researchers who regularly access these data include California Energy Commission and HT Harvey & Associates (minimizing potential impacts on seabirds by wind energy developments), NMFS (CCE-IEA), BOEM/USGS (minimizing impacts on seabirds by the oil and gas industry), and USFWS (assessing population status of endangered species).

h. Incorporate Innovative Technologies in Support of Emerging National Priorities and a Sustained Blue Economy (Obj. 1.5, Task 1-3)

Societal Issue - SCCOOS, CeNCOOS, and NANOOS are proposing several collaborative and/or synergistic projects that advance national priorities for assessing ecosystem viability: ATN, ocean sound,[92] and 'omics.'[93] Regional marine animal tracking networks have formed *de novo* around the country among researchers using acoustic telemetry to tag and track a wide range of economic and ecologically important marine species. The

formation of these networks has enabled independent researchers to expand their ability to track target species across much larger stretches of coastline, leveraging collective data sharing, and enabling networks the ability to share data with the public. Due to efforts by researchers on the West Coast within different telemetry networks to tag and track Great White Sharks (*Carcharodon carcharias*), we know that numbers are rising. Sightings along the California coastline have raised public safety concerns, and there is growing evidence that climate change may be increasing northerly movements of white sharks into northern California and Oregon. Information on the behavior/movement, composition, and sound of marine animals is essential for tracking range shifts and protecting biodiversity, and with increasing human use, threats like ocean noise also affect wildlife and human livelihoods. **Project Objectives** - Task 1. There is an obvious need to merge West Coast-wide ocean observing systems with marine animal telemetry networks, creating a more comprehensive data serving platform; this project will expand acoustic nearshore receiver arrays and data services in Southern California to track white sharks and improve real-time delivery of sightings to lifeguards as part of the West Coast ATN effort. Task 2. The Ocean Sound Observation Network (OSON) capitalizes on existing partnerships, infrastructure, and expertise to consistently produce robust, standardized sound metrics that are valuable as ecosystem health indicators for NMS condition reporting and management planning. The goal is to sustain a critical network of passive sound listening stations (with **federal partners at ONMS and NMFS** and SIO) along the West Coast in partnership with CeNCOOS and NANOOS (three mooring sites in the SCCOOS region) to monitor the underwater soundscape, understand its composition and measure the variability of sound levels at various frequencies and on different time scales. Task 3. A fisheries-led team will monitor biodiversity by sustaining a data collection program for prokaryotic and eukaryotic metabarcoding (eDNA). The metabarcoding-based biodiversity sampling program will focus on the pelagic water column across the continental shelf in the Bight, sampled monthly by the NASA/NOAA Plumes and Blooms time series program and the quarterly CalCOFI sampling (emphasis on SCCOOS-CalCOFI stations). Environmental DNA sampling will be done in partnership with our **federal partners at NOAA NMFS SWFSC**, CalCOFI, CCE-LTER, SBC-LTER, SCB-MBON, and Channel Islands National Park, each of which also sample fish communities with non-genetic methods. We will thus compare metabarcoding results with visually identified abundances of adult and larval fishes. **Relevant Users and Deliverables** - Task 1. Fifteen additional real-time acoustic receiver buoys for white shark detection will be deployed along Southern California beaches to augment an established array of 80 receiver data loggers and four buoys. Lifeguards will receive real-time SMS/email alerts when tagged white sharks are detected by a buoy receiver, enhancing public beach safety management. White shark acoustic receiver detection and associated environmental data from datalogging receivers and real-time buoys will be collected and stored in the CSULB Shark Lab microservice-based, hybrid cloud data management system (SharkBytes II) and then pushed to SCCOOS via ERDDAP protocols for further processing and web-visualization for public access. Shark detection and corresponding environmental data visualization tools will be developed working with ATN and ESRI. Task 2. Southern California passive acoustic data (GOOS-recommended EOV) will be managed by the SIO/SCCOOS teams and will be accessible directly after mooring recovery. Post-processing codes and automated routines to make all regional data interoperable have already been developed and tested within the SanctSound project and are being shared in the Marine Bioacoustics Research Collective Github repository and will be further supported by a Passive Acoustic Monitoring Access Network (IOOS Topic Area #2 Proposal). OSON will help close the acoustic environment knowledge gap by sustaining strategic, long-term sampling and producing standardized time-series of ocean sound metrics for federal and state agencies, such as NMS, the U.S. Navy, and NOAA, in support of US MBON goals. Task 3. Metabarcoding markers will be used to sequence plankton and fish assemblages for biodiversity assessments (archived at NCBI). The effort to metabarcode fishes will be facilitated by a newly-created fish library that includes reference sequences for nearly all fishes in the CCE[94], mirrors CeNCOOS eDNA efforts, and significantly advances NOAA 'Omics strategies.

i. **Stakeholder Products for Ecosystems, Fisheries, and Water Quality (Obj. 4.1, Task 1-2)**

Relevant Products - Marine managers need data that are accessible in an easily navigable and interpretable format that meets the needs of users with a wide variety of technical abilities. Task 1. SCCOOS developed and hosts a number of products that aggregate and package ecological datasets for end-users. a) SCCOOS co-creates/produces the monthly CA HAB Bulletin. b) The TR Plume Tracker is hosted by SCCOOS with real-time delivery to the public (Fig. 5). c) UCSD Environmental Health and Services Department partnered with SCCOOS to develop aggregated/layered visualizations to aid in water quality monitoring of the La Jolla Area of Special Biological Significance (ASBS) directly impacted by UCSD discharge. Task 2. The ensuing curated data view was designed before user-friendly GIS products were readily available, and while SCCOOS still hosts the page, we are working closely with Water Quality partners to re-envision the interactive workspace via RStudio Shiny Apps and new data products (e.g., our NASA Jet Propulsion Laboratory partner has agreed to provide Synthetic Aperture Radar (SAR) imagery of coastal plumes).

j. Pan-regional Products and Tools that Span Varying Scales of the California Current Ecosystem (Obj. 4.2, Task 1-4)

Societal Issue - Through informative and user-friendly infographics, and compelling narratives, we will distill complex relationships, trends, and indicators into an interactive digital format and build on pan-regional expertise. This will generate renewed interest by stakeholders and higher engagement with ocean observation products. CalCOFI's State of The California Current Report provides a comprehensive overview of the CC-LME on an annual basis but requires marine managers to wait for and digest this report each year. Dynamic, web-based data products for end-users enable discovery of CalCOFI, IOOS, and NMFS data through the development of an interactive portal that pulls from available data streams and indicators. For instance, the Farallon Institute developed and continually updates a Multivariate Ocean-Climate Indicator (MOCI), which tracks the main mode of variability in coastal conditions across three distinctive regions of California's coast and has relevance to the marine ecosystem, from primary producers to top predators, akin to El Niño Southern Oscillation (ENSO) indices. **Project Objectives** - Task 1. The legacy SCCOOS investment in nearshore CalCOFI stations (now routine) will be redirected to 1) Greatly increase the integration of CalCOFI data into accessible/searchable databases; 2) Build and "webinize" data products that deliver critical status and trends via a novel platform that complements and interacts with the U.S. MBON data portal,[95] and 3) Build adaptable workflows that serve the needs of ocean observation programs (with in-kind support from CeNCOOS). Task 2. The Farallon Institute will continue updating MOCI quarterly in collaboration with CeNCOOS and share it through the SCCOOS/CeNCOOS data portals and Task 1-synthesis products to facilitate its use and visibility by a greater number and diversity of stakeholders. Task 3. A 36+ year dataset of kelp canopy area and biomass dynamics spanning the entire coast of California, including the Channel Islands, has been developed -- using the Landsat satellite sensors -- for giant kelp and bull kelp at a 30-meter spatial resolution from 1984 to present. Quarterly updates will be served on ERDDAP, displayed on SCCOOS and CeNCOOS public portals, and ingested into automated condition reporting for NMS, CC-LME, etc. Task 4. Pan-regional products - 1) With CeNCOOS, NANOOS, and the Alaska Ocean Observing System (AOOS), we will develop a new, user-friendly data portal, the "Oyster Dashboard," as a Tier 1 project, which will be customizable by RA and site, incorporating data, model output, or content tailored to each aquaculture group/shellfish growing site up and down the coast. This builds off a previous proposal with CeNCOOS and has interest from the Canadian CIOOS-Pacific as well. 2) NANOOS is spearheading an OAH/Ocean Warming Pilot indicator in collaboration with SCCWRP, CeNCOOS, and SCCOOS that will be sustained via the three RAs and the WCOA West Coast Ocean Data Portal (WCODP). 3) SCCOOS and CeNCOOS are currently collaborating via an OPC and CASG-funded MPA Monitoring project to co-create spatially explicit, interactive curated data and model views for state managers via harmonization with a state DataOne portal and use of R Studio Shiny App technology; a prototype application developed by SCCOOS/CASG collocates spatially explicit, operational ecological forecasts (C-HARM, EcoCast, and

Dynamic Seascapes).[96] Task 1-3 products will be merged with this effort. **Relevant Users and Deliverables** - Task 1. CalCOFI will deliver synthesized data products developed through direct consultation with key stakeholders within the NMS, IOOS, CalCOFI/LTER, and MBON networks (Fig. 3), that allow evaluation of multiple stressors on ecosystems. Task 2. A quarterly update of MOCI will be delivered to SCCOOS/CeNCOOS for ingestion into synthesis products; it has received attention from academics, agency biologists (CDFW, USFWS), fisheries and resource managers (NMFS/PFMC, OCSD), and policy makers (e.g., OST/CA OPC), as evidenced by its use in more than 30 publications. Task 3. The kelp remote sensing imagery is used by academic researchers and coastal managers; a continuous, quarterly updated dataset will be delivered to state and federal agencies (CDFW, NMS). Task 4. Collaborative Shiny Apps, Jupyter Workspace/Dashboards, and Report Cards will be delivered for pan-regional partnerships and leveraged to meet the needs of shared stakeholders in aquaculture, fisheries management, and coastal energy and resilience.

Focus Area 4. *Climate Variability and Change*

a. California Underwater Glider Network (CUGN) (Obj. 1.2, Task 1-3)

*CUGN/BioEco *objectives and tasks already described above in Focus Area 3*

Societal Issue - The CCE is strongly affected by climate variability generated at the equator, e.g., ENSO events. ENSO is felt across the Pacific Basin, and especially in the CCE through changes in temperature, salinity, and currents. More recently, the Pacific Warm Anomaly (PWA) persisted in the SCB for many years[97-99] and may still be present with a lower anomaly as evidenced by CUGN data (Fig. 13; SCCOOS and NANOOS each hosted IOOS-OAR funded Pacific Anomalies Workshops in 2015 and 2016).[100-101] The last several years have also witnessed an as-yet unexplained salinity anomaly in the Southern California Bight, in conjunction with the marine heatwave, that would have gone mostly unobserved without CUGN profiles (Fig. 13). Changes in the ecosystem brought on by these events are so profound that nearly all users of ocean resources notice and want information about the magnitude and extent of the effects. The CUGN therefore serves society's need for sustained observations of the CCE to address climate variability and assess environmental drivers that influence long-term change in the physics up to zooplankton communities and abundance. Continual subsurface surveys are essential for capturing physical/BGC and Essential Climate Variable (ECV) variability and calculating basin-scale heat budgets that inform ecosystem predictability.[102] Given that the physical and BGC properties of the CCE are changing, and potentially in a secular manner tied to global increases in greenhouse gas emissions,[103] integration of BioEco sensors on Spray gliders will be an essential mode of monitoring long-term ecosystem trends and impacts. **Relevant Users and Deliverables** - Task 1-3. A climatology is created of each CUGN line, consisting of the measured variables mapped onto a regular grid as a function of time, distance on the line, and depth.[104] Quality-controlled, delayed mode data and the climatologies are available on the SCCOOS & CUGN websites along with calculation of the SoCal Temperature Index, a measure of climate variability in the SCB, an indicator of basin-scale coupling or decoupling with variability at the Equator (Fig. 13). The SoCal temperature index is used for CCIEA and other reporting; data synthesis and aggregation efforts proposed in Obj 4.2 will aggregate CUGN climatologies, indices, and indicators to improve stakeholder reporting and linkages to higher trophic level trends, movement, and population impacts. Additionally, future IOOS-OAR initiatives are expected that harness the shared capacity in each line office for understanding and predicting climate impacts on the ocean.

b. EOV Monitoring - Moorings and Nearshore Surveys (Obj. 1.4, Task 4, 6, 7, 9)

**Objectives and tasks already detailed above in Focus Area 3 and described here for Focus Area 4.*

Relevant Users and Deliverables - For all tasks listed here (DM Mooring, min-mooring network, OAH small-boat surveys, CFVOP) and many others not listed, long-term provision of EOVs and ECVs establish environmental baselines and allow studies of the ecosystem and its change over time, such that local and state decision makers who require both real-time and long-term sustained data and information can respond

to short-term events (such as HABs) or long-term mitigation of ecosystem change (driven by OAH, warming, etc.). Coastal and shelf profile and time-series measurements have a range of climate related applications, e.g., validation and parameterization of physical and BGC models to understand longer term trends (and make climate projections) for coastal ocean heat content and resulting decreases in ocean carbon uptake. Citizen-science data have additional interdisciplinary benefits for both fisheries science and for the economic and ecological sustainability of fisheries since sensors deployed on fishing gear are co-located with hydrography and catch data, thereby enabling mechanistic understanding of relationships between physical ocean conditions and species distribution as a changing climate disrupts historic correlations.[105-106] A mechanistic understanding of physical-ecological effects will enable better planning and mitigation strategies in the face of these climate changes.[107]

c. **Stakeholder Products for Climate Variability and Change (Obj. 4.1, Task 1-2)**

Relevant Products - In 2019-2020, SCCOOS Co-I Anderson was an invited participant to The Pew Charitable Trusts Lenfest Ocean Program: 1) "Ideas Lab" to evaluate observing and modeling benefits for understanding shifting marine species distributions, and 2) the Marine Biodiversity Dialogues Working Group. These efforts have generated recommendations for how ocean observing systems can help visualize climate change and human impacts on biodiversity and species range shifts. These concepts will form the basis for novel product development. SCCOOS already supports data visualization of CUGN via the Spray team and will serve all long-term data products from Obj. 1.4 to the public in aggregated/curated data views, such as the pan-regional portals, dashboards, and infographics previously described that will include other relevant climate indices, such as MOCI, ENSO, PDO, and the North Pacific Gyre Oscillation (NPGO).[108] Collectively, these indices and indicators will be showcased in regional and pan-regional analyses of climate impacts that establish a central role for ocean observing in climate monitoring.

III. DATA MANAGEMENT AND CYBERINFRASTRUCTURE (DMAC) SUBSYSTEM

**Objectives 2.1-2.4 are described in more detail in the DMAC Plan in Appendix C; the eight IOOS Core DMAC Capabilities are referenced in 5. Data Sharing/Management Plan.*

SCCOOS leverages both on-site and cloud computer cyberinfrastructure (CI) and works closely with the IOOS Program Office DMAC to align our systems with national priorities. As a certified NOAA IOOS Regional Information Coordination Entity (RICE), SCCOOS has a mandate to collect, organize, and provide access to regional oceanographic and biological data using community-developed standards (Fig. 14). In order to maximize sharing of data, SCCOOS adheres to FAIR principles and endeavors to make its datasets (F)indable, (A)ccessible, (I)nteroperable and (R)eusable through extensive leveraging of metadata, use of standard protocols and tools to provide access and participation in larger national and international data catalogs and repositories, including NCEI, NDBC, IPACOA, GBIF, and OBIS (Fig. 15). SCCOOS endeavors to make these data easily understood, electronically accessible, and well-organized to allow policy makers, researchers, managers, and the general public to make informed decisions. Our publicly facing website is designed for multiple points of entry for a given user to maximize data discoverability and align observing categories with established GOOS EOVs. SCCOOS' flexible, scalable CI facilitates continual growth, improvement of services offered, and integration of emerging technologies related to cloud computing, artificial intelligence, and distributed computing platforms. The project will leverage this CI to aggregate, manage, and share data from data providers with minimum time delay and at no additional cost, adding value to products and services. This system meets the core data requirements as defined in IOOS Data Standards and Requirements, as well as the RICE Certification Requirements Guidance (described more fully in Appendix C). Details of the data SCCOOS will make available from both its funded projects and local, state, federal and NGO sources, which includes EOVs, EBVs, and ECVs, as well as information on time from data acquisition to its availability from SCCOOS, can be found in *5. Data Sharing Plan*. An important development is the planned merger of SCCOOS- and CeNCOOS-attributed assets into an independent statewide portal

supported by Axiom Data Science (CeNCOOS DMAC lead) that will allow the two systems to better leverage mutual CI capacity, streamline production of pan-regional products, and provide improved support for inter-regional stakeholders in need of a unified California data portal for efficient decision-making.

IV. MODELING AND ANALYSIS SUBSYSTEM (Obj. 3.1-3.2)

Our modeling and analysis subsystem complements the observing system, is responsive to stakeholder requirements, advances coastal ocean modeling and ecological forecasting,[109-110] and remains nimble relative to national initiatives that might position SCCOOS to leverage cloud computing resources[111] or machine-learning methods[112] to improve ecological forecasts.

a. Sustain Research and Community Models (Obj. 3.1, Task 1-4)

Societal Issue - The region close to the coast is where human uses and risks are greatest and where biological activity and BGC cycling are especially strong. Thus, a realistic simulation capability for ecosystem/BGC properties that includes important atmospheric, oceanic, and land-margin influences on the shelf and into the surf zone, will provide a powerful means of environmental assessment and planning. Numerical BGC models coupled to physics have become essential tools for assessing the impact of complex environmental drivers, providing a new array of information to a variety of stakeholders. Dissemination of model solutions to the broader community allows multiple lines of scientific investigation and management applications. **Project Objectives** - Task 1. Continue operation and development of models for predicting TWL and pollutant transport. The California Coastal Ocean Flood Network is described in *Focus Area #2 Coastal Hazards* and is a component of the physical prediction supported by SCCOOS. Previously, SCCOOS TWL prediction efforts were paired with a small investment in nearshore wave model development for better resolving waves and tracking pollution; SCCOOS continues to host a webpage for the on-going North American Development Bank "Border 2020" project for evaluating cross-border wastewater spills.[113] Task 2. Continue real-time operation of the California state-wide 3-km ROMS using 3DVAR (3-dimensional variational) routines to assimilate observational data and enable 72-hour forecasting, in partnership with CeNCOOS.[114] As a reliable, real-time 2-km 4DVAR WCOFS becomes available as a NOAA operational product, the 3-km ROMS product will be phased out. Task 3. We will create and validate new ROMS capabilities that improve realism, comprehensiveness of represented processes, and spatial resolution compared to present community standards, for the shelf and nearshore regions along the California coast in order to guide societal management of ecosystems, water quality, and risks to ports (Fig. 16). Task 4. We will develop, validate, and interpret the BGC component of the ROMS- Biogeochemical Elemental Cycling (BEC) model for the SCCOOS domain (Task 2), improving the realism of the simulations, and supporting translation of scientific findings to stakeholders. Proposed developments include improvement in the representation of functional plankton diversity, HABs, micronutrient and detritus dynamics, water column-sediment coupling, local terrestrial and atmospheric inputs, and biological interpretations (Fig. 16). Task 5. We will publicly share ROMS-BEC model output, hosted on the SCCOOS ERDDAP server, in two ways: Develop: (1) a retrieval platform to allow users to download NetCDF files, (2) an online visualization tool, served through the SCCOOS website, to permit the users to view all available model data in various formats (Fig. 16). **Relevant Users and Deliverables** - Task 1. Daily flood/inundation forecasts and the TR Plume Tracker were already described. Task 2. The California ROMS real-time forecast is available for use by the USCG SAROPS and NOAA OR&R GNOME to enable users to access ocean currents to respond to oil spills; the 3-km ROMS configuration is also the operational circulation model used for C-HARM predictions of neurotoxic domoic acid evens in California. Task 3. Embedding the fine-scale ROMS simulation within operational assimilation and forecast models on larger scales is of great value for local stakeholders, e.g., ecosystems, fisheries, water quality, consequences of climate variability, coastal hazards (e.g., rip currents), and marine operations (e.g., dredging). Tasks 4 and 5. Model simulations generated by these tasks will serve scientists engaged in observational and monitoring efforts, coastal managers in partnership with SCCWRP,

non-profit environmental organizations, and local residents. End-users are: 1) scientists needing access to interactive data queries (e.g., ROMS-BEC is the core of an ECOHAB project with Co-I Anderson), 2) marine resource and WQ managers, which include: 1) CA OPC, CDFW, State and Regional Water Board staff, 3) POTWs, 4) non-profits (e.g., Coastkeeper, Heal the Bay, the Bay Foundation, Resource Legacy Foundation). Data/products include: 1) raw model output downloaded via interactive data query, 2) visualizations routinely available as NetCDF files through the SCCOOS portal, and 3) data visualizations customized for WQ, fisheries and marine resource managers that can be used on routine GIS applications and incorporated into pan-regional products.

b. Serve as a Modeling Testbed Environment in Support of R2O Transitions (Obj. 3.2, Task 1-2)
Societal Issue - SCCOOS-CeNCOOS-NANOOS collectively support a diversity of community models that serve real-time and hindcast objectives, thus enabling modeling testbeds for vetting alternate model configurations/types, assessing observational impacts, or supporting transition to operations, such as for WCOFS, which is expected to be operational at NOAA, as of Feb 2021, and will ultimately replace many of the real-time circulation products supported by RAs, e.g., 3-km California ROMS. All three West Coast RA directors serve on the WCOFS Oversight Committee and are working to integrate WCOFS into a regional modeling strategy that satisfies the needs of regional stakeholders of robust ecological forecasts but also aligns with national priorities for a Unified Modeling Framework (UMF);[115] SCCOOS Co-I Anderson serves on the UMF Marine Modeling Working Group. **Project Objectives** - Task 1. We will enable evaluation of the transition to WCOFS by comparing it with California ROMS and providing feedback to the NOAA WCOFS Oversight Committee and operators at NOAA Coast Survey Development Lab. A complement to this task is performing model validations; a number of observational variables will be displayed side-by-side to facilitate model evaluation in real-time by users. Value-added products will be derived in order to meet the needs for various user groups, including management decision makers. Task 2. We will continue to evaluate stakeholder requirements for circulation and ecosystem models, in support of COMT and ecological forecasts. In addition to co-leading the current WCOFS COMT project and associated stakeholder engagement/Transition Plan development for a real-time WCOFS, SCCOOS participates in quarterly reviews of the ROMS-BEC model configuration at SCCWRP and is a member of the Technical Advisory Group that interfaces with dischargers to ensure that ROMS-BEC is meeting industry requirements for regulatory oversight. **Relevant Users and Deliverables -** Once WCOFS meets operational acceptance criteria, 3-km California ROMS will be retired and output will be archived by OpenDAP servers as part of SCCOOS/CeNCOOS DMAC teams, facilitating historic comparisons with WCOFS. As part of an on-going WCOFS COMT project, user requirements are being compiled through stakeholder workshops[116] and will inform NOAA procedures (e.g., UMF), future outreach related to community modeling, West Coast model/data reanalyses, and the regional ecological forecasting portfolio.[117]

IV. ENGAGEMENT SUBSYSTEM (Obj. 5.2-5.4)
**Objectives 5.2-5.4 are fully detailed in the Engagement, Outreach, and Communication Plan in Appendix D.*
SCCOOS supports diversity, equity, and inclusion initiatives (DEI), both within its research programs and in its engagement activities within our network, the community we serve, and the public. SCCOOS will invest in an IOOS Association specialist to increase DEI across the IOOS RA Network. We propose to advance the SCCOOS mission and engage with the public, stakeholders, and academic pipeline by collaborating with the SIO Director's Office, AltaSea, UCSD Birch Aquarium, The Ocean Discovery Institute, Heal the Bay, Scientific Research and Education Network (SciRENs) San Diego, and UCSD CREATE. Over the next five years, SCCOOS will: (1) institute a set of formal mechanisms for routinely acquiring stakeholder feedback via Google Analytics (already in use), targeted user surveys, and digital media campaigns, (2) codify an annual schedule of workshop-based communications with targeted stakeholder groups to strategically initiate new products and leverage partner resources, (3) bring together our wide stakeholder and researcher network

with K12 students and educators, especially engaging communities underrepresented in STEM and higher education, (4) leverage existing infrastructure and cement collaborations with academic programs and centers of informal education to create Next Generation Science Standards (NGSS)-aligned curricula and educational programs focused on career pathways related to ocean observing, (5) integrate undergraduate and graduate students in our programmatic research and engage them in professional development opportunities and (6) build a strong evaluation and assessment plan for these outreach activities and programs. A compiled list of education and outreach (E&O) efforts from 2018, 2019 and 2020 is provided in Table 10, and our engagement plan in Appendix D illustrates methods for strengthening relationships with all stakeholder partners listed in the Work Plan.

E. MILESTONE SCHEDULE

**SCCOOS PO and DMAC Subsystem Milestone Schedules are detailed in Table 9; all proposed deliverables for the Observing and Modeling/Analysis Subsystems are detailed in Table 11.*

Governance/Management, E&O, and DMAC milestones involve year-round activities with some variation (Table 10). Tier 2 Program Office activities pertain to expanding DMAC capacity and expanding our E&O plan. The majority of the proposed Tier 1 and Tier 2 tasks for the Observing Subsystem and Modeling/Analysis Subsystem deliver data or intermediate products for all five years of the project, while staggered start dates occur for only a few tasks, such as real-time ROMS (Yr1-3), which transitions to the NOAA WCOFS model product, and outreach plan assessments (Yr1, Yr2, Yr4). Additional variation is introduced in terms of instrument acquisition/recapitalization, scheduled annually for priority sites or platforms for HFR, CUGN, and SASS, or as needed. Data delivery frequency varies from every six minutes to daily for continuous measurements and real-time models (HFR, TR Plume Tracker, CUGN, Coastal Ocean Flood Network, mooring network, 3-km real-time ROMS, SASS, and IFCBs), weekly to monthly for HABMAP data, monthly for the CA HAB Bulletin and marine mammal toxin levels, to quarterly for many of the data collection programs that depend upon ship-based surveys or field-intensive sampling programs (Table 11). Consistent and reliable access to data/products is a top priority for the SCCOOS team.

F. PROJECT BUDGET:

Table 12. **SCCOOS FY21-26 Summary Budget**

	Year 1	Year 2	Year 3	Year 4	Year 5	Total Project
A. Personnel	$886,718	$890,301	$889,958	$884,616	$885,379	**$4,436,972**
B. Benefits	$399,480	$420,525	$435,975	$451,604	$457,015	**$2,164,599**
C. Travel	$97,281	$84,456	$98,666	$98,779	$104,752	**$483,934**
D. Equipment	$613,195	$566,872	$566,599	$581,324	$587,721	**$2,915,711**
E. Supplies	$168,068	$146,288	$144,423	$142,991	$138,233	**$740,003**
H. Other	$408,467	$439,446	$435,319	$440,965	$434,885	**$2,159,082**
UC Campuses	$886,101	$887,688	$888,253	$845,206	$844,258	**$4,351,506**
Subawards	$1,345,320	$1,402,154	$1,382,704	$1,379,367	$1,378,584	**$6,888,129**
I. Total Direct Costs	**$4,804,630**	**$4,837,730**	**$4,841,897**	**$4,824,852**	**$4,830,827**	**$24,139,936**
J. Indirect Costs	$939,570	$948,470	$963,203	$973,148	$975,173	**$4,799,564**
Subawards IDC	$46,800	$1,800	$900	$0	$0	**$49,500**
K. Total	**$5,791,000**	**$5,788,000**	**$5,806,000**	**$5,798,000**	**$5,806,000**	**$28,989,000**
NOAA Partners	**$209,000**	**$212,000**	**$194,000**	**$202,200**	**$194,000**	**$1,011,000**

4. APPENDICES

A. LIST OF ABBREVIATIONS

3DVAR	Three-Dimensional Variational
4DVAR	Four-Dimensional Variational
ACDD	Attribute Convention for Data Discovery
ADCP	Acoustic Doppler Current Profiler
AIS	Automatic Identification System
ASBS	Area of Special Biological Significance
ATN	Animal Telemetry Network
AOOS	Alaska Ocean Observing System
AWIPS	Advanced Weather Interactive Processing System
BEC	Biogeochemical Elemental Cycling
BGC	Biogeochemical
BioEco	Biology and Ecosystems Panel (GOOS)
BOG	Board of Governors
BOEM	Bureau of Ocean Energy Management
BOON	Boundary Ocean Observing Network
CAF	Carlsbad Aquafarm
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CASG	California Sea Grant
CWC	California Wildlife Center
C-CAN	California Current Ocean Acidification Network
CCE	California Current Ecosystem
CC-IEA	California Current Integrated Ecosystem Assessment
CC-LME	California Current Large Marine Ecosystem
CDFW	California Department of Fish and Wildlife
CDIP	Coastal Data Information Program
CDPH	California Department of Public Health
CDOM	Colored Dissolved Organic Matter
CeNCOOS	Central and Northern California Ocean Observing System
CF	Climate and Forecast Metadata Conventions
CFVOP	California Fishing Vessels of Opportunity Partnership
C-HARM	California Harmful Algae Risk Mapping system
CIMWI	Channel Islands Marine Wildlife Institute
CIOOS	Canadian Integrated Ocean Observing System
COCMP	Coastal Ocean Currents Monitoring Program
COMT	Coastal Ocean Modeling Testbed
CoPe	Coastlines and People (NSF) Program
CSR	Catalina Sea Ranch
CUGN	California Underwater Glider Network

CIMWI	Channel Islands Marine Wildlife Institute
DAC	Data Assembly Center
D-C	Darwin Core Standards
DMAC	Data Management and Cyberinfrastructure
DO	Dissolved Oxygen
E&O	Education and Outreach
EBV	Essential Biodiversity Variable
ECV	Essential Climate Variable
eDNA	Environmental DNA
EDS	Environmental Data System
ENSO	El Niño Southern Oscillation
EOI	Expressions of Interest
EOV	Essential Ocean Variable
ERDDAP	Environmental Research Division's Data Access Program
ERMA	Environmental Response Management Application
ESC	Executive Steering Committee
ESRI	Environmental Systems Research Institute
FAIR	Findable, Accessible, Interoperable, and Reusable
FTP	File Transfer Protocol
FOO	Framework for Ocean Observing (GOOS)
GBIF	Global Biodiversity Information Facility
GEO BON	The Group on Earth Observations Biodiversity Observation Network
GIS	Geographic Information System
GNOME	General NOAA Operational Modeling Environment
GOA-ON	Global Ocean Acidification-Observing Network
GOODS	GNOME Online Oceanographic Data Server
GOOS	Global Ocean Observing System
GTS	Global Telecommunication System (WMO)
HAB	Harmful Algal Bloom
HABMAP	California Harmful Algal Bloom Monitoring and Alert Program
HABDAC	Harmful Algal Bloom Data Assembly Center
HFR	High Frequency Radar
IFCB	Imaging Flow Cytobot
IOOS®	U.S. Integrated Ocean Observing System
IoC	Infrastructure as Code
IoT	Internet of Things
IPACOA	IOOS Partners Across Coasts Ocean Acidification Data Portal
JSAC	Joint Strategic Advisory Committee
LTER	Long Term Ecological Research
MAR	Marine Animal Rescue
M.A.P.	Marine Mammal Health Monitoring and Analysis Platform

MBON	U.S. Marine Biodiversity Observation Network
MLPA	Marine Life Protection Act
MMCC-LA	Marine Mammal Care Center of Los Angeles
MOCI	Multivariate Ocean-Climate Indicator
MODIS	Moderate Resolution Imaging Spectroradiometer
MOU	Memorandum Of Understanding
MPA	Marine Protected Area
MySQL	My Structured Query Language
NANOOS	Northwest Association of Networked Ocean Observing Systems
NAVAIR	Naval Air Systems Command
NAVO	Naval Oceanographic Office
NCBI	National Center for Biotechnology Information
NCBO	National Center for Biomedical Ontology
NCEI	National Centers for Environmental Information
NDBC	National Data Buoy Center
NERC	Natural Environment Research Council
NERR	National Estuarine Research Reserve
NetCDF	Network Common Data Form
NHABON	National HAB Observing Network (national)
NGDAC	National Glider Data Assembly Center
NGSS	Next Generation Science Standards
NMFS	National Marine Fisheries Service
NMS	National Marine Sanctuaries
NWS	National Weather Service
NPGO	North Pacific Gyre Oscillation
OAH	Ocean Acidification and Hypoxia
OAP	NOAA Ocean Acidification Program
OAR	NOAA Oceanic and Atmospheric Research
OBIS	Ocean Biodiversity Information System
OCSD	Orange County Sanitation District
ODI	Ocean Discovery Institute
OEHHA	Office of Environmental Health Hazard Assessment
OPC	California Ocean Protection Council
OpenDAP	Open-source Project for a Network Data Access Protocol
OR&R	NOAA's Office of Response and Restoration
OSON	Ocean Sound Observation Network
OST	California's Ocean Science Trust
OSU	Oregon State University
OTT	Ocean Technology Transition
PACE	Phytoplankton, Aerosols, Clouds, and Ecosystems
PCC	Pacific Coast Collaborative

PDO	Pacific Decadal Oscillation
PFMC	Pacific Fishery Management Council
PHP	PHP Hypertext Preprocessor
PMMC	Pacific Marine Mammal Center
POTW	Publicly Owned Treatment Works
PWA	Pacific Warm Anomaly
QA/QC	Quality Assurance/Quality Control
QARTOD	Quality Control of Real Time Oceanographic Data
RA	IOOS Regional Association
RCOOS	Regional Coastal Ocean Observing System
RICE	Regional Information Coordination Entity
ROMS	Regional Ocean Modeling System
SACNAS	Society for Advancement of Chicanos/Hispanics and Native Americans in Science
SAR	Synthetic Aperture Radar
SAROPS	USCG Search and Rescue Optimal Planning System
SASS	SCCOOS Automated Shore Stations
SBC	Santa Barbara Channel
SCB	Southern California Bight
SCCOOS	Southern California Coastal Ocean Observing System
SCCWRP	Southern California Coastal Water Research Project
SCS	Self-Calibrating SeapHOx
SDG	U.N. Sustainable Development Goals
SDSC/UCSD	San Diego Supercomputer at University of California, San Diego
SIO	Scripps Institution of Oceanography
SM	Santa Monica
SPATT	Solid Phase Adsorption Toxin Tracking
SRTM	Shuttle Radar Topography Mission
STEM	Science, Technology, Engineering, and Mathematics
TDWG	Taxonomic Databases Working Group
THREDDS	Thematic Real-Time Environmental Distributed Data Services
TMMC	The Marine Mammal Center
TR	Tijuana River
TWL	Total Water Level
UMF	Unified Modeling Framework
USCG	U.S. Coast Guard
USFW	United States Fish & Wildlife
USGS	United States Geological Survey
VIIRS	Visible Infrared Imaging Radiometer Suite
WCOA	West Coast Ocean Alliance
WCODP	West Coast Ocean Data Portal
WCOFS	West Coast Ocean Forecast System

WG	Working Group
WoRMS	World Registry of Marine Species

B. TABLES & FIGURES

Table 1: **SCCOOS Evaluation Matrix.** SCCOOS Executive Steering Committee evaluates current and future projects relative to their alignment with IOOS Strategic Goals and the four SCCOOS legacy focus areas.

IOOS Goals	SCCOOS Focus Areas: Marine Operations	Coastal Hazards	Ecosystems, Fisheries, & Water Quality	Climate Variability & Change
Sustained Observations				
Deliver Data				
Support Model Predictions				
Provide Integrated Data Products				
Partnerships, Stakeholder Engagement				

NA
Some
Medium
A lot

Example of how SCCOOS Executive Steering Committee applied the Evaluation Matrix to review our High Frequency Radar Project.

IOOS Goals	SCCOOS Focus Areas: Marine Operations	Coastal Hazards	Ecosystems, Fisheries, & Water Quality	Climate Variability & Change
Sustained Observations	A lot	A lot	Some	Some
Deliver Data	A lot	A lot	Some	Some
Support Model Predictions	A lot	A lot	Medium	Medium
Provide Integrated Data Products	Some	Medium	A lot	
Partnerships, Stakeholder Engagement	A lot	A lot	Some	

NA
Some
Medium
A lot

Table 2. **SCCOOS FY21-26 Proposed Tier 1 & Tier 2 Projects & IOOS Core Variables** (*GOOS Essential Ocean Variables & +GEO BON Essential Biodiversity Variables).

SCCOOS FY21-26 Proposed Projects		IOOS CORE VARIABLES																														
		Bathymetry	Bottom character	Currents*	Heat flux	Salinity*	Sea level*	Surface waves*	Stream flow	Temperature*	Wind speed & direction	Acidity*	Colored dissolved organic matter*	Contaminants	Dissolved nutrients*	Dissolved oxygen*	Ocean color*	Optical properties*	Pathogens	Partial pressure of CO2*	Total suspended matter	Biological vital rates	Fish spp./abun*+	Invertebrate spp./abun*+	Marine mammal spp./abun*+	Microbial spp./abun/activity+	Phytoplankton spp./abun*+	Sea birds species/abun*+	Sea turtles spp./abun*+	Submerged aq. veg spp./abun*+	Sound*	Zooplankton spp./abun*+
	HF Radar Network - SCCOOS Region - Operations, Maintenance & Recap			■				■			■																					
	California Underwater Glider Network - Operations, Maintenance & Recap			■		■				■						■	■	■														■
	HAB Monitoring and Alert Program + SPATT dissolved toxins					■				■	■			■	■		■										■					
	SCCOOS Automated Shore Stations - Operations, Maintenance & Recap		■			■	■			■			■				■	■			■											
	OAH Monitoring on SASS Stations									■		■				■																
Tier 1	Distribution and Abundance of Sea Birds and Marine Mammals					■				■													■		■			■	■			
	California Coastal Flood Network	■					■	■																								
	ROMS - 3 km Statewide Operational Model			■		■	■			■																						
	ROMS-High Resolution Shelf & Nearshore Physics	■	■	■	■	■	■	■		■	■																					
	CalCOFI/IOOS- Data Synthesis and Product Development					■				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■
	California Multivariate Ocean Climate Indicator (MOCI)						■		■	■	■																					
	Statewide Kelp Canopy Area/Biomass Dynamics																						■							■		
	Autonomous Biogeochemical & Ecological Monitoring using Gliders					■				■		■			■	■	■	■														
	Indicators of Zooplankton from CUGN																															■
	HABON: IFCB Network for an Automated HAB Alert System																■	■									■					■
	High throughput Molecular and Flow Cytometry Observations																			■						■	■					
	Marine Mammals as Indicator Species of Algal Biotoxin Production													■											■		■					
	Del Mar Mooring Reference and Development Site			■		■				■	■	■	■			■	■	■			■						■			■		
	Observing Nutrient Fluxes and their role in HAB Development			■	■			■		■	■		■		■	■	■	■			■						■					
	Network of Near-Shore Mooring stations for OAH & Water Quality					■				■		■	■			■	■	■			■	■										
Tier 2	Effect of Upwelling Intensity on Near-Shore OAH using Small-Boat Surveys			■		■				■		■				■				■												
	Develop & Maintain a Citizen-Science Based Sensor Network on Rocky Reefs									■						■																
	California Fishing Vessels of Opportunity					■				■													■		■							
	Large Scale & Long-Term Kelp Forest Monitoring for Science & Policy	■	■																				■	■						■		
	California Kelp Forest MPA OAH Network with Citizen Science					■				■		■				■				■												
	Animal Tracking Network - White Shark Acoustic Receiver Array																					■	■									
	Ocean Sound Observation Network									■												■	■	■	■						■	
	eDNA Library Development on Ichthyoplankton																						■	■			■					■
	ROMS - BEC Biogeochemical Model Development & Product	■	■	■	■	■	■	■		■	■	■	■	■	■	■	■		■	■	■	■	■	■		■	■					■
	Numerical Ocean Model Simulations as a Research Asset			■	■	■	■			■	■	■		■	■	■	■			■	■	■					■					■

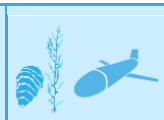
Table 3. **SCCOOS FY21-26 Proposed Tier 1 and Tier 2 Projects and their connection to IOOS "Seven Pillars" for Societal Benefits and UN Sustainable Development Goals** (square icons and SDG targets in parenthesis).

			IOOS "Seven Pillars" for Societal Benefits						
			Weather and Climate (14.2, 14.3, 14.4)	Maritime Operations	Natural and Anthropogenic Hazards (14.1, 14.2)	Homeland Security	Public Health (14.2)	Ecosystem Health (14.2, 14.3, 14.4, 14.6)	Living Resources (14.2, 14.4, 14.6)
SCCOOS FY21-26 Proposed Projects	Tier 1	HF Radar Network - SCCOOS Region - Operations, Maintenance & Recap	■	■	■	■	■	■	■
		California Underwater Glider Network - Operations, Maintenance & Recap	■	■	■	■	■	■	■
		HAB Monitoring and Alert Program + SPATT dissolved toxins	■	■	■	■	■	■	■
		SCCOOS Automated Shore Stations - Operations, Maintenance & Recap	■	■	■	■	■	■	■
		OAH Monitoring on SASS Stations	■		■			■	■
		Distribution and Abundance of Sea Birds and Marine Mammals						■	■
		California Coatal Flood Network	■		■	■			
		ROMS - 3 km Statewide Operational model	■	■	■	■	■	■	■
		ROMS-High Resolution Shelf & Nearshore Physics	■	■	■	■	■	■	■
		CalCOFI/IOOS- Data Synthesis and Product Development						■	■
		California Multivariate Ocean Climate Indicator (MOCI)	■		■			■	
		Statewide Kelp Canopy Area/Biomass Dynamics			■			■	■
	Tier 2	Autonomous Biogeochemical & Ecological Monitoring using Gliders	■		■			■	
		Indicators of Zooplankton from California's Underwater Glider Network	■		■			■	■
		HABON: IFCB Network for an Automated HAB Alert System	■		■		■	■	■
		High Throughput Molecular and Flow Cytometry Observations	■		■		■	■	■
		Marine Mammals as Indicator Species of Algal Biotoxin Production	■		■		■	■	■
		Del Mar Mooring Reference and Development Site	■		■		■	■	
		Observing Nutrient Fluxes and their Role in HAB Development	■		■		■	■	
		Network of Near-Shore Monitoring Stations for OAH & Water Quality	■		■			■	
		Effect of Upwelling Intensity on Near-Shore OAH	■		■			■	
		Develop & Maintain a Citizen-Science Based Sensor Network	■		■		■	■	
		California Fishing Vessels of Opportunity	■	■	■	■		■	
		Large Scale & Long-Term Kelp Forest Monitoring for Science & Policy	■		■			■	■
		California Kelp Forest MPA OAH Network with Citizen Science	■		■			■	■
		Animal Tracking Network - White Shark Acoustic Receiver Array	■		■			■	■
		Ocean Sound Observation Network	■		■			■	■
		eDNA Library Development on Ichthyoplankton	■		■			■	■
		ROMS - BEC Biogeochemical Model Development and Product delivery	■	■	■	■	■	■	■
		Numerical Ocean Model Simulations as a Research Asset	■	■	■	■	■	■	■

Table 4. Below is a detailed table of SCCOOS Goals, Objectives, and Tasks. The icons on the right indicate which of the four SCCOOS legacy focus areas are addressed by that objective. The tiered funding level for each task is shown in parentheses next to each task (T1=Tier 1; T2= Tier 2); Principal Investigator(s) and project period are in italics.

SCCOOS Focus Areas

 Marine Operations	 Coastal Hazards	 Ecosystems, Fisheries & Water Quality	 Climate Variability & Change

Goal 1. Sustain long-term, high-quality observations of the coastal ocean and ecosystem to address SCCOOS regional stakeholder needs	
Objective 1.1 Operate, sustain, and expand California's surface current mapping network.	
Task 1 (T1). Sustain and operate High Frequency Radar (HFR) sites comprising the SCCOOS component of the surface current mapping network in support of US Coast Guard Search and Rescue, CA Office of Spill Prevention and Response, NOAA Office of Response and Restoration, boaters, shipping and ecosystem management, in partnership with CeNCOOS. – PI: *Terrill (UCSD), Ragan (USC), Washburn (UCSB), Walters (Cal Poly SLO), FY21-26* Task 2 (T2). Update the HF Radar network via recapitalizing aging infrastructure and hardening the network, in partnership with CeNCOOS. – PI: *Terrill (UCSD), Ragan (USC), Washburn (UCSB), Walters (Cal Poly SLO), FY21-26*	
Objective 1.2 Operate, sustain, and expand the California Underwater Glider Network (CUGN) to provide near real-time observations of subsurface properties for understanding impacts of long-term climate variability and change on ecosystems.	
Task 1 (T1). Sustain and operate two operational glider lines in the CUGN (Line 80 and alongshore line) in support of improving ecosystem/ocean prediction – PI: *Rudnick (UCSD), FY21-26* Task 2 (T2). Update the CUGN via recapitalizing aging infrastructure with state-of-the-art Spray gliders. – PI: *Rudnick (UCSD), FY21-26* Task 3 (T2). Integrate biogeochemical and ecological (BioEco) sensors onto Spray Gliders in the CUGN to measure pH and dissolved oxygen in partnership with CeNCOOS. – PI: *Takeshita (MBARI), FY21-26* Task 4 (T2). Combine CUGN ADCP data, CalCOFI net data, and CalCOFI acoustic data processed for krill to create zooplankton indicators in partnership with CeNCOOS. – PI: *Dorman (Farallon Institute), FY21-26*	
Objective 1.3 Operate, sustain, and expand Harmful Algal Bloom (HAB) monitoring in support of the Cal-HABMAP program and implementation of a HAB Early Warning System for California.	

Task 1 (T1). Continue to provide weekly information to State and federal stakeholders on critical HAB taxa and toxins at HABMAP pier sites in the SCCOOS region, in partnership with CeNCOOS. – PI: *Anderson/Carter (UCSD), Shipe (UCLA), Caron (USC), Brzezinski (UCSB), Walter/Pasulka (Cal Poly SLO), FY21-26*
Task 2 (T2). Expand capacity for dissolved toxin tracking and molecular sampling at HABMAP sites in the SCCOOS region. – PI: *Anderson/Carter (UCSD), Shipe (UCLA), Caron (USC), Brzezinski (UCSB), Walter/Pasulka (Cal Poly SLO), FY21-26*
Task 3 (T2). Operate and maintain four Imaging Flow Cytobots (IFCBs) at pier and mooring sites, in support of the CA state HAB Early Warning System, in partnership with CeNCOOS. – PI: *Anderson/Barton/Carter/Send (UCSD), Shipe (UCLA), Caron (USC), Brzezinski (UCSB), Walter/Pasulka (Cal Poly SLO), FY21-26*
Task 4 (T2). Develop microbial community structure and abundance data products to rapidly assess risk of HABs and other biologically mediated events at SCCOOS pier sites in support of the CA HAB Early Warning System. – PI: *Bowman (UCSD), Pasulka (Cal Poly SLO)*
Task 5 (T2). Measure domoic acid levels in biological samples from live and fresh dead marine mammals as an objective biological indicator of HAB activity in the California coastal ocean. – PI: *Nollens (PMMC), FY21-26*

Objective 1.4 Sustain, improve, and expand coastal observing time series of Essential Ocean Variables (EOVs) in support of science, policy, and decision-making across a range of time and space scales.

Task 1 (T1). Operate and maintain four automated shore stations at nearshore pier sites in the SCCOOS region to continuously record EOVs - temperature, salinity, chlorophyll, turbidity - in support of water quality management, HAB early warning, and the public. – PI: *Anderson/Carter (UCSD), Nickols (CSUN), Washburn (UCSB), FY21-26*
Task 2 (T2). Update and recapitalize sensors on nearshore pier sites. – PI: *Anderson/Carter (UCSD), Nickols (CSUN), Washburn (UCSB)*
Task 3 (T1). Integrate, operate, and maintain innovative sensors for monitoring pH and oxygen levels at three automated shore stations in the SCCOOS region in support of water quality management and ecosystem monitoring, synergistic with CeNCOOS ocean acidification and hypoxia monitoring. – PI: *Martz (UCSD), FY21-26*
Task 4 (T2). Sustain a coastal mooring in the SCCOOS region that hosts a 14-yr time series in support of water quality management and improving ocean prediction. – PI: *Send (UCSD), FY21-26*
Task 5 (T2). Deploy high-frequency instruments at multiple sites to observe nutrient fluxes and their role in HAB development in the nearshore SCCOOS region HAB development on shelf. – PI: *Lucas/Send (UCSD), Davis (UCI), FY21-26*
Task 6 (T2). Implement a network of low-cost near-shore mini-moorings for monitoring ocean acidification, hypoxia, and water quality in the SCCOOS region. – PI: *Lankhorst/Send (UCSD), FY21-26*
Task 7 (T2). Maintain bi-weekly small-boat surveys of cross-shore and along-shore variability in biogeochemical parameters in support of nearshore OAH modeling. – PI: *Andersson (UCSD), FY21-26*
Task 8 (T2). Develop and maintain a low-cost, citizen-science based sensor network on rocky reefs for monitoring bottom temperature and oxygen in support of water quality management and improved ocean prediction. – PI: *Johnston (UCSD), FY21-26*
Task 9 (T2). Sustain industry and citizen-science partnerships for monitoring EOVs in the water column on California Fishing Vessels of Opportunity (CVOF) in support of commercial fisheries and in partnership with CeNCOOS. – PI: *Van Vranken (Bering Data Collective), FY21-26*
Task 10 (T2). Conduct ecological surveys in support of the CA MPA network in the SCCOOS region. – PI: *Casselle (UCSB), FY21-26*
Task 11 (T2). Maintain a citizen-science based ocean acidification and hypoxia sensor network at two CA Marine Protected Area (MPA) sites in the SCCOOS region, in partnership with CeNCOOS. – PI: *Friewald (ReefCheck), FY21-26*

Task 12 (T1). Continue collecting observations of seabird and marine mammal abundance on quarterly CalCOFI cruises and integrate into fisheries and ecosystem assessments. – PI: *Sydeman (Farallon Institute), FY21-26*
Objective 1.5 Incorporate innovative technologies and transition proven technologies to operational use, such as animal telemetry and biodiversity monitoring, in support of emerging national priorities and a sustained Blue Economy. 
Task 1 (T2). Build out a buoy-based network of acoustic receiver arrays for tracking tagged Great White Sharks and nearshore tagged species in the national Animal Telemetry Network (ATN), in partnership with CeNCOOS and NANOOS. – PI: *Lowe (CSULB), FY21-26* Task 2 (T2). Sustain the Ocean Sound Observation Network (OSON) in support of National Marine Sanctuaries and the U.S. Marine Biodiversity Observation Network (MBON), in partnership with CeNCOOS and NANOOS. – PI: *Peavey Reeves (ONMS), Haver (NMFS), Baumann-Pickering (UCSD), FY21-26* Task 3 (T2). Advance genomic methods for monitoring biodiversity in support of MBON and NMFS. – PI: *Thompson (SWFSC) FY21-26*
Goal 2. Deliver standardized, reliable, and accessible data to the public.
Objective 2.1 Support ongoing maintenance and operation of SCCOOS cyberinfrastructure to sustain long-term data stewardship for our partners and stakeholders. 
Task 1 (T1). Work in conjunction with SIO IT to establish and maintain SCCOOS servers in a configuration designed to facilitate optimal use of compute resources based on both the needs of SCCOOS stakeholders and IOOS requirements for RA DMAC. – PI: *Anderson (UCSD), FY21-26* Task 2 (T1). Leverage hardware refresh to improve cyberinfrastructure architecture to expand capacity of the systems that serve and provision SCCOOS data. – PI: *Anderson (UCSD), FY21-26* Task 3 (T1). Evaluate remaining legacy systems to determine the best path forward in terms of modernizing infrastructure and meeting stakeholder requirements. – PI: *Anderson (UCSD), FY21-26*
Objective 2.2 Promote data standardization, automation, discovery, and public access. 
Task 1 (T1). Continue to standardize, automate, and generalize the existing data pipeline, including data acquisition, processing and quality assurance methodologies using the NOAA Environmental Data Management Framework as a guide. – PI: *Anderson (UCSD), FY21-26* Task 2 (T1/T2). Maintain, support, and expand the SCCOOS website and portal. – PI: *Anderson (UCSD), FY21-26* Task 3 (T/T21). Collaborate with Axiom Data Science on a unified California/statewide data portal that harmonizes SCCOOS and CeNCOOS data catalogs. – PI: *Anderson (UCSD), FY21-26*

Objective 2.3 Strengthen data stewardship within the SCCOOS consortium to improve data quality, access, attribution, exchange, delivery, and storage. 
Task 1 (T1). Work with providers of biological data to further standardize data collection and processing methods to improve validity of data comparisons between sites. – PI: *Anderson (UCSD), FY21-26* Task 2 (T1). Participate in the Standardizing Marine Biological Data Working Group to facilitate adoption of data representation standards by the biological data community, including use of Darwin Core to make biological data more widely discoverable and accessible. – PI: *Anderson (UCSD), FY21-26* Task 3 (T1). Participate in working groups related to physical, chemical, and biological data to assist with "guidance, best practice documentation, training, and community building" for the U.S. biological data community. – PI: *Anderson (UCSD)*
Objective 2.4 Support the functionality of national data assembly centers through leadership in observation and product delivery, quality control methods, and capacity building. 
Task 1 (T1). Support the development of a national HAB DAC, including automated classification of organisms photographed using machine learning techniques. – PI: *Anderson (UCSD), FY21-26* Task 2 (T1). Mirror the CUGN ERDDAP and climatology page in support of pan-regional product development that increases exposure to glider technology and the National Glider DAC. – PI: *Anderson (UCSD), FY21-26* Task 3 (T1). Support the HFR team and institutional efforts to improve HFRNet. – PI: *Anderson (UCSD), FY21-26*
Goal 3. Support model predictions that address a wide range of user requirements.
Objective 3.1 Continually develop and sustain research and community models and model-based products to provide physical and biogeochemical predictions to regional stakeholders. 
Task 1 (T1). Continue to support and expand the California Coastal Flood Network. – PI: *Merrifield (UCSD), FY21-26* Task 2 (T1). Continue to support and serve real-time, data-assimilative Regional Ocean Model System (ROMS) predictions to SCCOOS and CeNCOOS end-users. – PI: *Chao (UCLA), FY21-24* Task 3 (T1). Continue to provide critical support to nearshore ROMS development for improved physics of direct relevance to water quality managers and SCCOOS partners. – PI: *McWilliams (UCLA), FY21-26* Task 4 (T2). Support development of a coupled ROMS and Biogeochemical and Lower Ecosystem (BEC) model for improved biogeochemical predictions and regional ecological forecasting in support of water quality managers, fisheries, and regional partners. – PI: *Bianchi (UCLA), FY21-26* Task 5 (T2). Serve ROMS-BEC predictions of coupled physics and biogeochemistry to the public via the SCCOOS data portal in support of state OAH modeling, water quality management, and fisheries. – PI: *Kessouri (SCCWRP), FY21-26*

Objective 3.2 Serve as a modeling testbed environment in support of R2O transitions. 
Task 1 (T1). Support real-time ROMS and evaluation as we bridge the transition to the operational NOAA West Coast Ocean Forecast System (WCOFS). – PI: *Chao (UCLA), FY21-24* Task 2 (T1). Evaluate stakeholder requirements for circulation and ecosystem models via the on-going IOOS Coastal Ocean Modeling Testbed project (Transition PI: C. Anderson) and impacts of the WCOFS transition for extant ecological forecasts. – PI: *Anderson (UCSD), FY21-22*
Goal 4. Provide integrated, user-driven information and data products that are valuable for short- and long-term decision-making.
Objective 4.1 Develop regionally relevant, user-driven analysis, decision-support, and visualization products and tools to address historic and emerging stakeholder requirements in the SCCOOS region. 
Task 1. (T1). Maintain and iterate on existing decision-support tools developed and hosted by SCCOOS. – PI: *Anderson (UCSD), FY21-26* Task 2. (T2). Increase SCCOOS DMAC capacity to develop new products and partner with industry to develop web applications that extend the reach of SCCOOS data and model products. – PI: *Anderson (UCSD), FY21-26*
Objective 4.2 Generate and disseminate pan-regional products and tools to respond to environmental issues and seasonal hazards that span varying scales of the California Current Ecosystem. 
Task 1 (T1). Data synthesis and product development in support of CalCOFI, fisheries, and National Marine Sanctuaries. – PI: *Semmens (UCSD), FY21-26* Task 2 (T1). Maintain the development and dissemination of the California Multivariate Ocean Climate Indicator (MOCI) in collaboration with CeNCOOS and in support of fisheries and National Marine Sanctuaries. – PI: *Garcia-Reyes (Farallon Institute), FY21-26* Task 3 (T1). Incorporate kelp biomass database into our portal and develop user-driven discovery tools and displays in collaboration with CeNCOOS. – PI: *Bell (WHOI), FY21-26* Task 4 (T1/T2). Collaborate with CeNCOOS, NANOOS, and AOOS on West Coast pan-regional products in support of the West Coast Regional Alliance and other partners. – PI: *Anderson (UCSD), FY21-26*
Goal 5. Increase the reach and efficacy of SCCOOS through partnerships, stakeholder engagement, and demonstrated excellence in ocean observing.
Objective 5.1 Maintain a centralized program office that oversees SCCOOS operations and effectively coordinates with all partners to expand capacity. 

Task 1 (T1). We will sustain the SCCOOS program office and governance in support of our core capabilities, provide uninterrupted product and data delivery via our DMAC system, and ensure frequent, meaningful stakeholder outreach. – PI: *Anderson (UCSD), FY21-26* Task 2 (T2). Over the next five years, we anticipate growth in the program office to adequately adapt to program expansion, particularly if projects listed as Tier 2 come to fruition. – PI: *Anderson (UCSD), FY21-26*
Objective 5.2 Engage stakeholders to gather customer feedback and refine requirements for SCCOOS products and services. 
Task 1 (T1). Develop formal mechanisms for routine stakeholder feedback via analytical tools, surveys, and digital media. – PI: *Anderson, FY 21-26* Task 2 (T2). Codify an annual schedule of workshop-based communications with targeted stakeholder groups to strategically initiate new products and leverage partner resources. – PI: *Anderson (UCSD), FY21-26*
Objective 5.3 Expand and strengthen state, federal, and industry partnerships to innovate ocean observations and information products in collaboration with CeNCOOS 
Task 1 (T1). Continue to build strategic partnerships at all regulatory levels, leveraging strengths in observing and technology development with industry. – PI: *Anderson (UCSD), FY21-26*
Objective 5.4 Foster the next generation of ocean observing and stakeholder workforce specialists through targeted collaborations advancing education, training, and research opportunities. 
Task 1 (T2). Act as a facilitator between our stakeholders and researchers and regional underserved and underrepresented K12 communities in STEM through programs showcasing ocean observing related careers and informal learning between SCCOOS and (1) Ocean Discovery Institute, (2) AltaSea, (3) Birch Aquarium, (4) Heal the Bay. – PI: *Peach (UCSD/Birch), FY22-26* Task 2 (T2). Collaborate with SciREN San Diego on data-based lesson plans that will allow local teachers to interface with SCCOOS researchers. – PI: *Anderson (UCSD), FY21-26* Task 3 (T2). Integrate undergraduate and graduate students related to our funded projects in our programmatic research and engage them in a biweekly professional development course run by the outreach personnel. – PI: *Peach (UCSD/Birch), FY22-26* Task 4 (T2). Contract an assessment and evaluation specialist from CREATE to consult on our education programs to create formative and summative assessments for our various outreach activities and programs. – PI: *Sweet (UCSD/CREATE), FY21-25*

Table 5: **The Joint Strategic Advisory Committee (JSAC)** connects ocean observing to stakeholders within the region and provides guidance for SCCOOS and CeNCOOS operation and planning efforts as one statewide ocean observing system. Working in partnership with SCCOOS and CeNCOOS staff, committee members formulate suggestions for the development of decision-making tools and products and serve as ocean observing advocates for public outreach and education efforts.

SCCOOS and CeNCOOS Joint Strategic Advisory Committee (JSAC)	
Chad Whelan	*CODAR Ocean Sensors*
Chris Mobley	*NOAA, Channel Islands National Marine Sanctuary*
Mike Conroy	*Pacific Coast Federation of Fishermen's Associations*
David Manning	*Sonoma County Water Agency*
Debbie Aseltine-Neilson	*California Department of Fish and Wildlife (CDFW)*
George Robertson	*Orange County Sanitation District*
Grant Humphries	*Farallon Institute*
Greg McGowan	*CDFW, Office of Spill Prevention and Response (OSPR)*
Heather Schlosser	*US Army Corps of Engineers*
Jeff Crooks	*Tijuana River National Estuarine Research Reserve*
John Haskins	*Elkhorn Slough Foundation*
Jon Warrick	*USGS Pacific Coastal and Marine Science Center*
Kathy Weldon	*City of Encinitas*
Krista Kamer	*California State University Coast*
Lesley Ewing	*California Coastal Commission*
Linda Duguay	*University of Southern California Sea Grant*
Liz Whiteman	*Ocean Science Trust*
Lynn Korwatch	*Marine Exchange of the San Francisco Bay Region*
Maria Brown	*NOAA, Greater Farallones National Marine Sanctuary*
Mariela de la Paz Carpio-Obeso	*State Water Resources Control Board*
Mark Gold	*CNRA California Ocean Protection Council*
Rebecca Smyth	*NOAA Coastal Services Center*
Roberto Garcia	*Naval Air Systems Command*
Samuel Shuchat	*California Coastal Conservancy*
Shauna Oh	*California Sea Grant*
Steve Goldbeck	*San Francisco Bay Conservation & Development Commission*
Susan Zaleski	*Bureau of Ocean Energy Management*
Toby Garfield	*NOAA Southwest Fisheries Science Center*
Tom Ford	*Santa Monica Bay Restoration Commission*
Vanessa Zubkowsky-White	*California Department of Public Health*
Warren Blier	*NOAA National Weather Service*
William Douros	*NOAA Office of National Marine Sanctuaries*

Table 6. **SCCOOS FY21-26 Proposed Projects for Funging Levels Tier 1 and Tier 2.**

		FY21-22		FY22-23		FY23-24		FY24-25		FY25-26	
Project	**Principal Investigator**	**Tier 1**	**Tier 2**	**Tier 1**	**Tier 2**	**Tier 1**	**Tier 2**	**Tier 1**	**Tier 2**	**Tier 1**	**Tier 2**
GOVERNANCE SUBSYSTEM											
Regional Association Organization & E&O	Terrill/Anderson (UCSD)	$401,000	$130,404	$421,500	$100,904	$420,599	$138,904	$463,601	$125,904	$463,601	$138,904
E&O with Birch Aquarium + AltaSea	Peach (Birch Aquarium)	$0	$50,000	$0	$50,000	$0	$50,000	$0	$50,000	$0	$50,000
Outreach Evaluation and Assessment Plan	Sweet (UCSD CREATE)	$0	$13,000	$0	$13,000	$0	$0	$0	$13,000	$0	$0
OBSERVING SUBSYSTEM											
MARINE OPERATIONS											
HF Radar Operations, Maintenance & Recap	Terrill (UCSD)	$379,000	$151,195	$379,000	$151,195	$379,000	$151,195	$379,000	$151,195	$379,000	$151,195
HF Radar Operations, Maintenance & Recap	Washburn (UCSB)	$310,500	$123,705	$310,500	$123,705	$310,500	$123,705	$310,500	$123,705	$310,500	$123,705
HF Radar Operations, Maintenance & Recap	Ragan (USC)	$207,000	$82,470	$207,000	$82,470	$207,000	$82,470	$207,000	$82,470	$207,000	$82,470
HF Radar Operations, Maintenance & Recap	Walter (CalPoly)	$172,500	$68,725	$172,500	$68,725	$172,500	$68,725	$172,500	$68,725	$172,500	$68,725
HF Radar Communication and Power	Terrill (UCSD)	$16,000	$0	$16,000	$0	$16,000	$0	$16,000	$0	$16,000	$0
COASTAL HAZARDS											
Shoreline Inundation Forecast and Validation	Merrifield (UCSD)	$70,200	$0	$70,200	$0	$70,200	$0	$70,200	$0	$70,200	$0
ECOSYSTEMS, FISHERIES AND WATER QUALITY											
HAB Monitoring & Alert Program + SPATT dissolved toxins	Brzezinski (UCSB)	$61,300	$47,000	$61,300	$47,000	$61,300	$47,000	$61,300	$47,000	$61,300	$47,000
HAB Monitoring & Alert Program + SPATT dissolved toxins	Caron (USC)	$81,100	$52,000	$81,100	$52,000	$81,100	$52,000	$81,100	$52,000	$81,100	$52,000
HAB Monitoring & Alert Program + SPATT dissolved toxins	Anderson (UCSD)	$56,100	$47,000	$56,100	$47,000	$56,100	$47,000	$56,100	$47,000	$56,100	$47,000
HAB Monitoring & Alert Program	Walter/Pasulka (CalPoly)	$51,100	$10,000	$51,100	$10,000	$51,100	$10,000	$51,100	$10,000	$51,100	$10,000
HAB Monitoring & Alert Program	Shipe (UCLA)	$51,100	$10,000	$51,100	$10,000	$51,100	$10,000	$51,100	$10,000	$51,100	$10,000
Automated Shore Stations - Operations, Maintenance & Recap	Anderson (UCSD)	$58,410	$121,936	$58,410	$121,515	$58,410	$115,401	$58,410	$119,683	$58,410	$121,414
Automated Shore Stations - Operations, Maintenance & Recap	Nickols (CSUN)	$29,608	$4,317	$29,608	$3,151	$29,608	$8,700	$29,608	$5,365	$29,608	$4,582
Automated Shore Stations - Operations, Maintenance & Recap	Washburn (UCSB)	$31,982	$3,747	$31,982	$5,334	$31,982	$5,899	$31,982	$4,952	$31,982	$4,004
OAH Monitoring on SASS Stations	Martz (UCSD)	$70,000	$0	$70,000	$0	$70,000	$0	$70,000	$0	$70,000	$0
Distribution & Abundance of Sea Birds & Marine Mammals	Sydeman (Farallon)	$40,000	$0	$40,000	$0	$40,000	$0	$40,000	$0	$40,000	$0
Statewide Kelp Canopy Area/Biomass Dynamics	Bell (WHOI)	$10,000	$0	$10,000	$0	$10,001	$0	$9,999	$0	$9,999	$0
California Multivariate Ocean Climate Indicator	Garcia-Reyes (Farallon)	$5,000	$0	$2,500	$0	$2,500	$0	$2,500	$0	$2,500	$0
Animal Tracking Network-White Shark Acoustic Receiver Array	Lowe (CSULB)	$0	$220,000	$0	$220,000	$0	$220,000	$0	$220,000	$0	$220,000
High throughput Molecular &Fflow Cytometry Observations	Bowman (UCSD)	$0	$215,000	$0	$215,000	$0	$215,000	$0	$215,000	$0	$215,000
eDNA Library Development on ichthyoplankton	Thompson (SWFSC)	$0	$150,000	$0	$150,000	$0	$150,000	$0	$150,000	$0	$150,000
Ocean Sound Observation Network	Baumann-Pickering (UCSD)	$0	$90,000	$0	$93,500	$0	$93,500	$0	$93,500	$0	$93,500
Ocean Sound Observation Network	Peavey Reeves (ONMS)	$0	$44,000	$0	$52,000	$0	$44,000	$0	$52,000	$0	$44,000
Ocean Sound Observation Network	Haver (NMFS)	$0	$15,000	$0	$10,000	$0	$0	$0	$0	$0	$0
Develop & maintain a citizen-science based sensor network	Johnston (UCSD)	$0	$80,000		$80,000		$80,000		$80,000		$80,000
Large scale & long-term kelp forest monitoring for science & policy	Caselle (UCSB)	$0	$80,000	$0	$80,000	$0	$80,000	$0	$80,000	$0	$80,000
California Kelp Forest MPA OAH Network	Freiwald (Reef Check)	$0	$70,000	$0	$70,000	$0	$70,000	$0	$70,000	$0	$70,000

SCCOOS Budget FY21-26 CONTINUED		FY21-22		FY22-23		FY23-24		FY24-25		FY25-26	
Project	**Principal Investigator**	**Tier 1**	**Tier 2**	**Tier 1**	**Tier 2**	**Tier 1**	**Tier 2**	**Tier 1**	**Tier 2**	**Tier 1**	**Tier 2**
Marine mammals as indicator species of algal biotoxin production	Nollens (PMMC)	$0	$54,000	$0	$54,000	$0	$54,000	$0	$54,000	$0	$54,000
HAB Monitoring on Del Mar mooring	Send (UCSD)	$0	$52,000	$0	$52,000	$0	$52,000	$0	$52,000	$0	$52,000
HAB Monitoring on Del Mar mooring	Barton (UCSD)	$0	$32,000	$0	$32,000	$0	$32,000	$0	$32,000	$0	$32,000
Indicators of Zooplankton from CUGN	Dorman (Farallon)	$0	$47,500	$0	$38,000	$0	$13,000	$0	$13,000	$0	$13,000
Observing nutrient fluxes & their role in HAB development	Lucas (UCSD)	$0	$31,667	$0	$31,667	$0	$31,667	$0	$31,667	$0	$31,667
Observing nutrient fluxes & their role in HAB development	Send (UCSD)	$0	$31,667	$0	$31,667	$0	$31,667	$0	$31,667	$0	$31,667
Observing nutrient fluxes & their role in HAB development	Davis (UCI)	$0	$31,667	$0	$31,667	$0	$31,667	$0	$31,667	$0	$31,667
CLIMATE VARIABILITY AND CHANGE											
CA Underwater Glider Network-Operations, Maintenance & Recap	Rudnick (UCSD)	$300,000	$300,000	$300,000	$300,000	$300,000	$300,000	$300,000	$300,000	$300,000	$300,000
Network of near-shore monitoring stations for OAH & water quality	Lankhorst (UCSD)	$0	$80,000	$0	$80,000	$0	$80,000	$0	$80,000	$0	$80,000
Effect of upwelling intensity on near-shore OAH w/ small boats	Andersson (UCSD)	$0	$80,000	$0	$80,000	$0	$80,000	$0	$80,000	$0	$80,000
Del Mar mooring Reference and Development Site	Send (UCSD)	$0	$58,000	$0	$58,000	$0	$58,000	$0	$58,000	$0	$58,000
Autonomous biogeochemical & ecological monitoring using gliders	Takeshita (MBARI)	$0	$30,000	$0	$100,000	$0	$100,000	$0	$100,000	$0	$100,000
California Fishing Vessels of Opportunity	Van Vranken (ODN LLC)	$0	$30,000	$0	$30,000	$0	$30,000	$0	$30,000	$0	$30,000
DATA MANAGEMENT AND COMMUNICATION SUBSYSTEM											
SCCOOS DMAC	Anderson (UCSD)	$420,450	$107,750	$418,200	$99,500	$420,000	$117,500	$420,000	$109,500	$420,000	$117,500
CalCOFI/IOOS - Data Synthesis & Product Development	Semmens (UCSD)	$70,000	$0	$70,000	$0	$70,000	$0	$70,000	$0	$70,000	$0
MODELING AND ANALYSIS SUBSYSTEM											
ROMS - 3 km Statewide Operational Model	Chao (UCLA)	$45,100	$0	$45,100	$0	$45,100	$0	$0	$0	$0	$0
ROMS - High Resolution Shelf & Nearshore Physics	McWilliams (UCLA)	$45,000	$0	$45,000	$0	$45,000	$0	$48,000	$0	$48,000	$0
ROMS - BEC Biogeochemical Model Development & Product	Bianchi (UCLA)	$0	$45,000	$0	$45,000	$0	$45,000	$0	$45,000	$0	$45,000
Numerical Ocean Model Simulations as a Research Asset	Kessouri (SCCWRP)	$0	$80,000	$0	$80,000	$0	$80,000	$0	$80,000	$0	$80,000
INDIRECT COSTS											
Indirect Costs		$17,550	$29,250	$1,800	$0	$900	$0	$0	$0	$0	$0
TOTAL		$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000

Table 7: **The SCCOOS 13-member Board of Governors (BOG)** meets once a year to discuss structure and vision and provide guidance to the Executive Director. The BOG comprises Senior Representatives (signatories on SCCOOS Memoranda of Understanding) and industry partners. In addition, the BOG approves new members proposed by SCCOOS program office staff to ensure that the four focus areas are addressed by member diversity, choosing at least one BOG member for each focus area.

SCCOOS Board of Governors	
Dr. Benjamin Holt	*NASA Jet Propulsion Laboratory*
Dr. Bruce Cornuelle	*University of California, San Diego*
Dr. Dean Wendt	*California Polytechnic State University*
Dr. Guido Marinone Moschetto	*Ensenda Center for Scientific Research & Higher Education (CICESE)*
Dr. James McWilliams	*University of California, Los Angeles*
Captain Kip Louttit	*Marine Exchange of Southern California*
Dr. Krista Kamer	*California State University Council on Ocean Affairs, Science & Technology*
Dr. Kristen Davis	*University of California, Irvine*
Kristen Koch	*NOAA, Southwest Fisheries Science Center*
Dr. Libe Washburn (Chair)	*University of California, Santa Barbara*
Dr. Mas Dojiri	*City of Los Angeles, Environmental Monitoring Division*
Michael Jones	*The Maritime Alliance- BlueTech*
Dr. Steven Weisberg	*Southern California Coastal Water Research Project*

Table 8: **The Executive Steering Committee (ESC)** is made up of seven members elected by the BOG. The ESC prioritizes recommendations, reviews Expressions of Interest, and decides which projects are recommended for funding in a transparent process and in accordance with the SCCOOS mission. The committee also meets to formulate scopes of work documented in the Operational Work Plan and advises our BOG on technical manners and strategic planning.

SCCOOS Executive Steering Committee	
Dr. William Sydeman	*Farallon Institute*
Dr. Daniel Rudnick (Chair)	*University of California, San Diego*
Dr. Dave Caron	*University of Southern California*
Dr. David Siegel	*University of California, Santa Barbara*
George Robertson	*Orange County Sanitation District*
Dr. James McWilliams	*University of California, Los Angeles*
Dr. Libe Washburn	*University of California, Santa Barbara*

Table 9. **SCCOOS FY21-26 Program Office Milestones** (Tier 2 tasks are shaded in grey).

Program Office Milestones - Governance and Management	Year 1				Year 2				Year 3				Year 4				Year 5			
	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F
Progress Reports to IOOS Program Office		■		■		■		■		■		■		■		■		■		■
Submit Descope Budget to IOOS			■				■				■				■				■	
Weekly Program Office Conference Call with ESC and BOG Elected Chair Members	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
SCCOOS Stakeholder Outreach Meetings	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
SCCOOS BOG Meeting	■				■				■				■				■			
SCCOOS ESC and BEC Meetings		■				■				■				■				■		
SCCOOS PI Meeting				■				■				■				■				■
SCCOOS and CeNCOOS JSAC Meeting			■				■				■				■				■	
IOOS Spring Meeting and Congressional Outreach		■				■				■				■				■		
Fall IOOS Meeting				■					■			■				■				■
IOOS Regional Directors Retreat			■				■				■				■				■	
Collaborate with a part-time information research assistant		■	■			■	■			■	■			■	■			■	■	
Program Office Milestones - Engagement and Outreach	**Year 1**				**Year 2**				**Year 3**				**Year 4**				**Year 5**			
Informal Education - Career Pathways	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F
Career Show and Tell Program at ODI			■	■			■	■			■	■			■	■			■	■
Ocean STEM Career Night at Birch Aquarium			■	■			■	■			■	■			■	■			■	■
Informal Education Activities	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F
Data visualizations and exhibits at Birch Aquarium and AltaSea			■	■		■	■			■	■			■	■			■	■	
Water quality sensor demos at AltaSea		■		■		■		■		■		■		■		■		■		■
Webinars on SCCOOS and data products for AltaSea	■	■			■	■			■	■			■	■			■	■		
Curriculum building	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F
Data-driven lesson plans with SciRENs San Diego		■		■		■		■		■		■		■		■		■		■
Scientist-in-Residence Program with ODI			■				■				■				■				■	
Partner with the “Hacking 4 Oceans” course spearheaded by the CORDC at SIO		■				■				■				■				■		
Evaluation and Assessments of Outreach Activities	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F
Consult with CREATE		■	■	■	■	■	■	■					■	■	■	■				
Public and Stakeholder Engagement	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F
Presentations and Panels	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Exhibit Booths (e.g., NOAA's Day, AltaSea, Heal the Bay)		■	■			■	■			■	■			■	■			■	■	
Quarterly Newsletter	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

Media and News Articles Interviews																				
SCCOOS website posts and pages																				
Website Inquiries																				
Social Media (Twitter and Facebook) posts and listserv emails																				
Provide Tours of SCCOOS Assets at SIO and Host Working Q&A Luncheon																				
Host Opportunistic Experiential Field Trips for Congressional Representatives																				
User Tutorials																				
End-User Engagement and Product Development Workshops																				
Engagement of Academics and Researchers (PIs)	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F
Publications																				
Attend Meetings, Workshops, Seminars, etc.																				
Program Office Milestones - Data Management and Cyberinfrastructure	Year 1				Year 2				Year 3				Year 4				Year 5			
DMAC Upgrades (servers, hardware, software)																				
RICE Renewal Process																				
Maintain and iterate on decision-support tools developed and hosted by SCCOOS																				
Data delivery to NCEI and other national repositories																				
Routine data delivery to national DACs																				
Migrate NDBC to ERDDAP																				
Upgrade to IOOS Metadata Profile Version 1.2																				
DMAC Working Group and DAC Support telecons																				
IOOS DMAC Meeting + Code Sprints																				
Develop and update a statewide data portal with CeNCOOS/Axiom Data Science																				
Collaborate with part-time data scientist/web developer to increase DMAC capacity to develop new products and partner with industry to develop web applications																				

Table 10: **Past SCCOOS Education and Outreach Activities and Program Summary Statistics**. A detailed spreadsheet can be found here (https://bit.ly/3eBECNA).

	2018	2019	2020
SCCOOS-Hosted Meetings	6	7	8
Presentations & Panels	31	34	35
Exhibit Booths	1	2	0
Attended Meetings, Workshops, Seminars, etc.	55	81	85
Publications (peer reviewed)	22	21	20
Media and News Articles	17	10	38
Facebook and Twitter posts	NA	49	130
Website Inquiries to info@sccoos.org	NA	NA	80
SCCOOS website views (as of 11/20/2020)	218,010	224,259	181,246

Table 11. **SCCOOS FY21-26 proposed project milestones/deliverables** for the Observing Subsystem and Modeling/Analysis Subsystem. Instrument acquisition and data/product delivery occur at a range of frequencies: hourly, daily, weekly, monthly, quarterly and/or annually. The rows shaded grey are Tier 2 projects, and deliverables with an asterisk are not supported in all five years. Federal partners are underlined.

Objective	Task #	FY21-26 Observing and Modeling/Analysis Subsystem Milestones and Deliverables (*task does not occur every year of the reward)	Hourly	Daily-Weekly	Monthly-Quarterly	Annually
1.1	1	SIO - Sustain & operate 31 High Frequency Radar in the SCCOOS Region - continuous service via HFRNet, SCCOOS, and CeNCOOS		■		
	2	SIO/USC/UCSB/CalPoly - Recapitalize aging HFR infrastructure at the $10,665/year/site level				■
1.2	1	SIO - Sustain & operate two Spray glider lines in the SCCOOS region - continuous service with 3-5 month deployments per Spray		■	■	
	2	MBARI - Integrate BioEco sensors onto Spray2 gliders each year to measure pH & nitrate on SCCOOS glider lines, followed by continous data service		■	■	■
	4	Farallon Inst - Develop & serve zooplankton abundance indicator from CUGN ADCP data, CalCOFI net data, & CalCOFI acoustic data; continuous service of index values from CUGN deployments		■	■	■
1.3	1	SIO/USC/UCLA/UCSB/CalPoly - Sustain weekly HAB species, particulate toxins, & SPATT dissolved toxin sampling at five HABMAP pier sites in the SCCOOS region; plankton classification delivered weekly, SPATT every two weeks, and DA data every 1-4months		■	■	
	2	SIO/USC/UCLA/UCSB/CalPoly - Add SPATT to two additional sites & molecular/eDNA sampling at HABMAP pier sites in SCCOOS region; molecular samples will be collected 1-2x per week with monthly taxonomic product development		■	■	
	3	SIO/USC/UCSB - Operate & maintain four Imaging Flow Cytobots (IFCBs) at SCCOOS HABMAP pier sites and Del Mar Mooring; IFCBs deliver real-time plankton classification every 30 minutes that will be incorporated into at threshold-based Early Warning System and merged with the HAB DAC (PCMHAB project; PI Anderson); instruments will be deployed for up to 6 months at a time between maintenance and servicing	■	■		
	4	SIO/CalPoly - Twice-weekly sampling of DNA and flow cytometry at HABMAP Piers to develop microbial community data products for HABs & pathogens		■	■	
	5	PMMC - Provide measured domoic acid levels from live & fresh dead marine mammals as sentinels of offshore HAB events - for CA HAB Bulletin; samples are collected as animals strand and data will be delivered to SCCOOS on a monthly basis			■	
1.4	1	SIO/CSUN/UCSB - Operate & maintain four SCCOOS Automated Shore Stations (SASS) - continous data service at a 6 min ingestion frequency, with routine (monthly) sensor cleaning and maintenance	■		■	
	2	SIO/CSUN/UCSB - Update, upgrade, & recapitalize sensors on SASS stations at an annual frequency				■
	3	SIO - Integrate, operate & maintain (SCS) pH & oxygen sensors at 3 SASS stations in the SCCOOS region; data will be provided continuously, with routine instrument cleaning and servicing (e.g. reagent replacement)	■		■	
	4	SIO - Sustain the Del Mar coastal mooring, a 14yr+ time series of water quality EOVs - continuous service with quarterly maintenance of mooring platform and sensor payloads; data will be incorporated in SCCOOS curated data views and made available to the BGC modeling community	■		■	
	5	SIO/UCI - Deploy WireWalker at multiple sites on a seasonal basis (2x per year) to observe high-frequency nutrient fluxes & evaluate role in HAB development; WireWalker data are collected at very high frequency (ever 6 seconds) and resolve processes such as internal waves; data analysis products and visualizations will be hosted on a SCCOOS project page and incorporated into the CA HAB Bulletin			■	
	6	SIO - Add 5 mini-moorings to a low-cost near-shore network of 16 total mini-moorings for monitoring OAH & water quality; SCCOOS will provide graphical visualizations of water quality/OAH data in relevant water quality curated data views and made available to the BGC modeling community	■		■	■
	7	SIO - Conduct bi-weekly small-boat surveys of cross-shore and alongshore OAH in support of model improvement/validation; SCCOOS will provide monthly graphical visualizations of water quality/OAH data in relevant water quality curated data views; data will be made available to the BGC modeling community for model improvements/validation		■	■	
	8	SIO - Develop & maintain a low-cost, citizen-science based sensor network on rocky reefs for monitoring bottom temperature & oxygen; sensors will be recovered annually; products will include maps of variability and individual time series at 1-s resolution to be incorporated into curated data views and made available to the BGC modeling community	■			■

Objective	Task #	FY21-26 Observing and Modeling/Analysis Subsystem Milestones and Deliverables (*task does not occur every year of the reward) CONTINUED	Hourly	Daily-Weekly	Monthly-Quarterly	Annually
1.4	9	Ocean Data Network - Sustain industry & citizen-science partnerships for monitoring EOVs on CA fishing vessels of opportunity (CVFOP), with CeNCOOS; CFVOP data will be made accessible in near real-time via ERDDAP, Copernicus Marine, and submitted to WMO via GTS, EMODnet Physics portal, and SCCOOS & CeNCOOS portals			■	
	10	UCSB - Conduct and sustain ecological surveys of kelp forests in support of the CA MPA Network				■
	11	ReefCheck - Maintain a citizen-science based ocean acidification & hypoxia sensor network at six kelp forest MPA sites, with CeNCOOS; ReefCheck will deploy and service sensors weekly to monthly; data are continuously delivered to SCCOOS and incorporated into relevant water quality visualizations and curated data views	■		■	
	12	Farallon Inst - Collect seabird & marine mammal abundance on quarterly CalCOFI cruises and deliver annual reports to SCCOOS for incorporating into CCIEA and NMS reports			■	■
1.5	1	CSULB - Build out a buoy-based network of 15 new acoustic receiver arrays for white shark telemetry & alerts; with CeNCOOS & NANOOS ATN	■		■	
	2	SIO/ONMS/NMFS - Sustain 3 moorings in the SCCOOS region for the Ocean Sound Observation Network, with CeNCOOS & NANOOS; data are made available after mooring deployments/recovery efforts on a quarterly basis.			■	
	3	NMFS - Advance genomic methods for monitoring biodiversity with eDNA in support of MBON & NMFS priorities; biodiversity assessments will be delivered to SCCOOS for monthly to quarterly Plumes & Blooms and CalCOFI cruises; these will inform higher level syntheses for Sanctuary condition reporting, MBON reports, and delivered to DACs such as NCBI			■	
3.1	1	SIO - Support & expand the California Coastal Flood Network, adding a new site to the threshold validation/evaluation process each year	■			■
	2	UCLA - Support & serve real-time, data assimilative ROMS predictions to SCCOOS & CeNCOOS end-users (Yr1-3); models are run on SCCOOS servers and output is provided hourly to daily to the SCCOOS portal *(FY21-24)	■	■	■	■
	3	UCLA - Support nearshore ROMS development for improved physics of direct relevance to water quality managers and SCCOOS partners; SCCOOS supports a project page with annual updates of model output/visualizations of nearshore physics developments				■
	4	UCLA - Support development of a coupled ROMS & BEC model for improved biogeochemical predictions & regional ecological forecasting; BGC model output from 10-year hindcast runs will be made available on an annual basis				■
	5	SCCWRP - Serve archived ROMS-BEC predictions/hindcast runs of coupled physics & biogeochemistry (ROMS-BEC) to the public via the SCCOOS data portal; devise stakeholder-driven vizualizations in collaboration with SCCWRP			■	■
3.2	1	SCCOOS PO/UCLA - Support real-time ROMS & evaluation as we bridge the transition to the operational NOAA WCOFS *(FY21-24)			■	■
	2	SCCOOS PO - Evaluate stakeholder requirements for circulation & ecosystem models via the on-going IOOS COMT project; workshops on-going *(FY21-22)			■	
4.2	1	SIO - Data synthesis & product development in support of CalCOFI, fisheries, & National Marine Sanctuaries; continual syntheses and automated, curated data views will be developed and vetted with crucial stakeholder partners		■	■	■
	2	Farallon Inst - Update and disseminate the Multivariate Ocean Climate Indicator (MOCI) -CeNCOOS collaboration- for incorporation into customized data synthesis products and curated data views			■	
	3	WHOI - Incorporate kelp biomass database into our portal & develop user-driven discovery tools & displays - CeNCOOS collaboration - for incorporation into customized data synthesis products, curated data views, and made available fro all relevant assessments, e.g. MPAs			■	
	4	SCCOOS PO - Collaborate with CeNCOOS & NANOOS on pan-regional products in support of the West Coast Regional Alliance & partners; Oyster Dashboards (Tier 1), OAH/Ocean Warming Pilot indicator, Beach Report Cards, etc.			■	■

Figure 1. **Where We Are**. SCCOOS and CeNCOOS employ a variety of *in situ* and remote sensing technologies to measure physical, chemical, and biological parameters as well as support ocean prediction models. SCCOOS supports five HAB Monitoring and Alert Program sites (white font) at SCCOOS Automated Shore Stations (asterisk). a) Map of existing SCCOOS and CeNCOOS FY16-21 assets and b) illustration of SCCOOS regional FY16-21 projects.

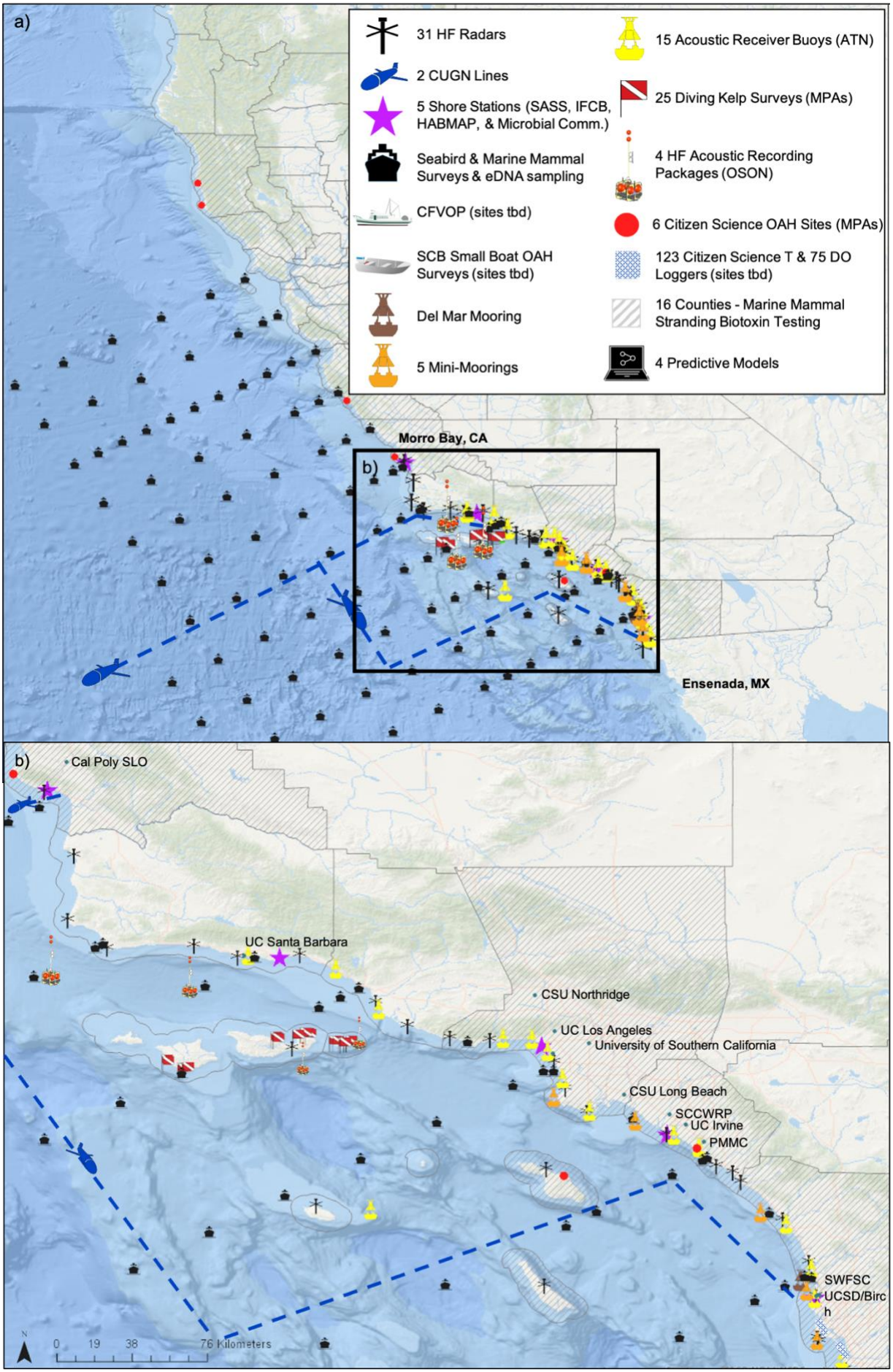


Figure 2. **Where We Want to Be in Five Years**. Map of SCCOOS FY21-26 proposed projects assets/technologies in the a) California Current Ecosystem and b) Southern California Bight. Note that seabird/mammals and eDNA observations occur at quarterly-sampled CalCOFI stations, and are thus paired with the CalCOFI station grid. Partner institutions not pictured: MBARI, Farallon Institute, NOAA/NWFSC, NOAA/ONMS, NOAA/NMFS, Ocean Data Network LLC, WHOI, and Reef Check Foundation.

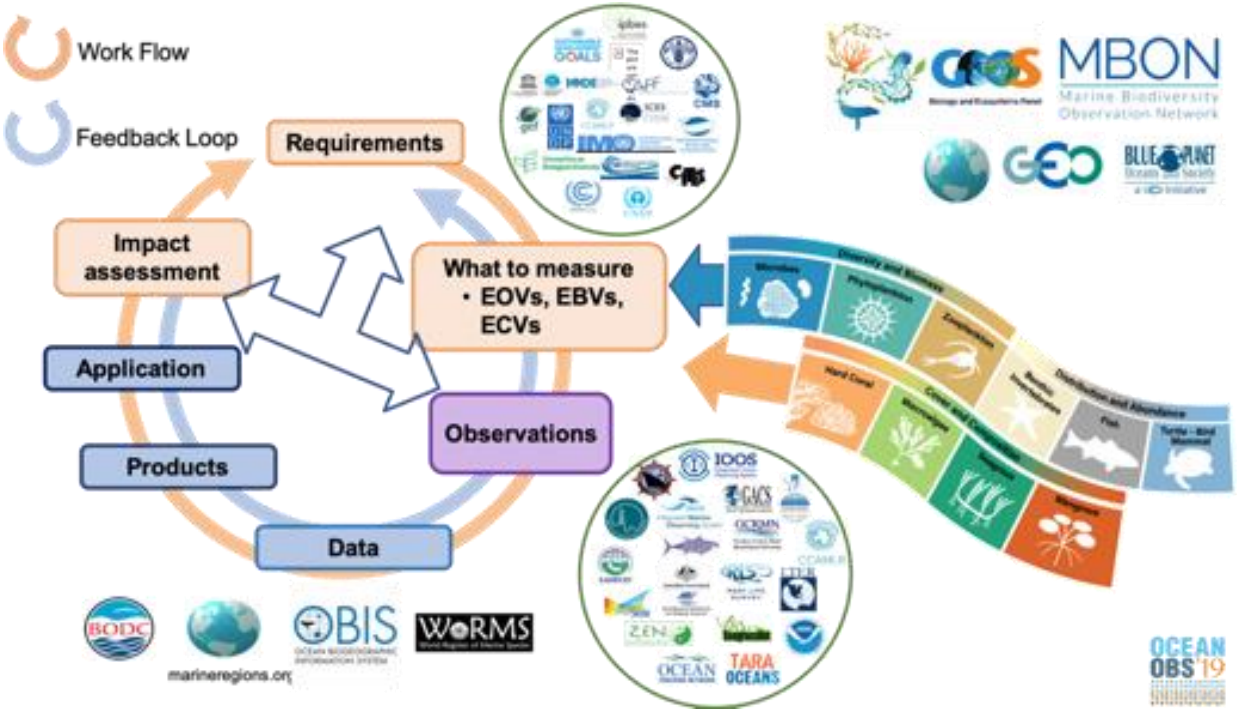


Figure 3. **Stakeholder-Driven Process**. In response to recommendations from the OceanObs'19 conference is this update of the GOOS Framework for Ocean Observing (FOO). The SCCOOS vision for the next five-years of ocean observing build-out is best captured by this representation of a feedback loop between stakeholder requirements, observing methods, product development and applications, with an increasing emphasis on monitoring living marine resources (EOVs and EBVs) in conjunction with physical and biogeochemical EOVs and ECVs in support of regional-to-global priorities. Figure from OceanObs'19 Breakout Session, Estes et al. 2019, http://www.oceanobs19.net/sessions/.

Figure 4. **Stakeholder Partners**. SCCOOS provides high-quality and reliable data, value-added information, and visualization products and tools to meet the needs of a diverse collaborative of marine stakeholders and end-users.

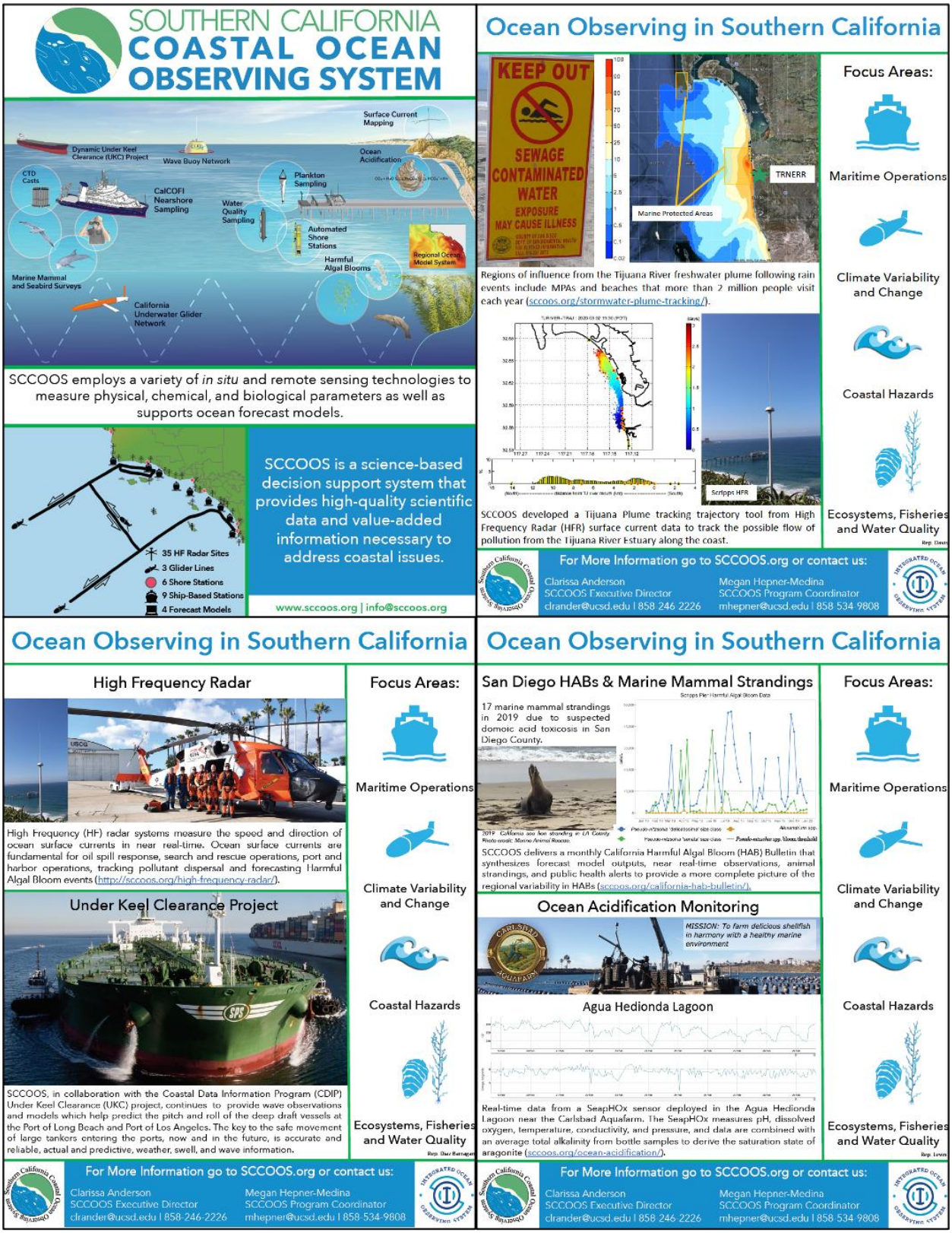


Figure 5. **Congressional Outreach Flyers.** Examples of SCCOOS Congressional Outreach flyers tailored for each of ten Southern California District Offices visited in March 2020 on Capitol Hill, Washington, D.C..

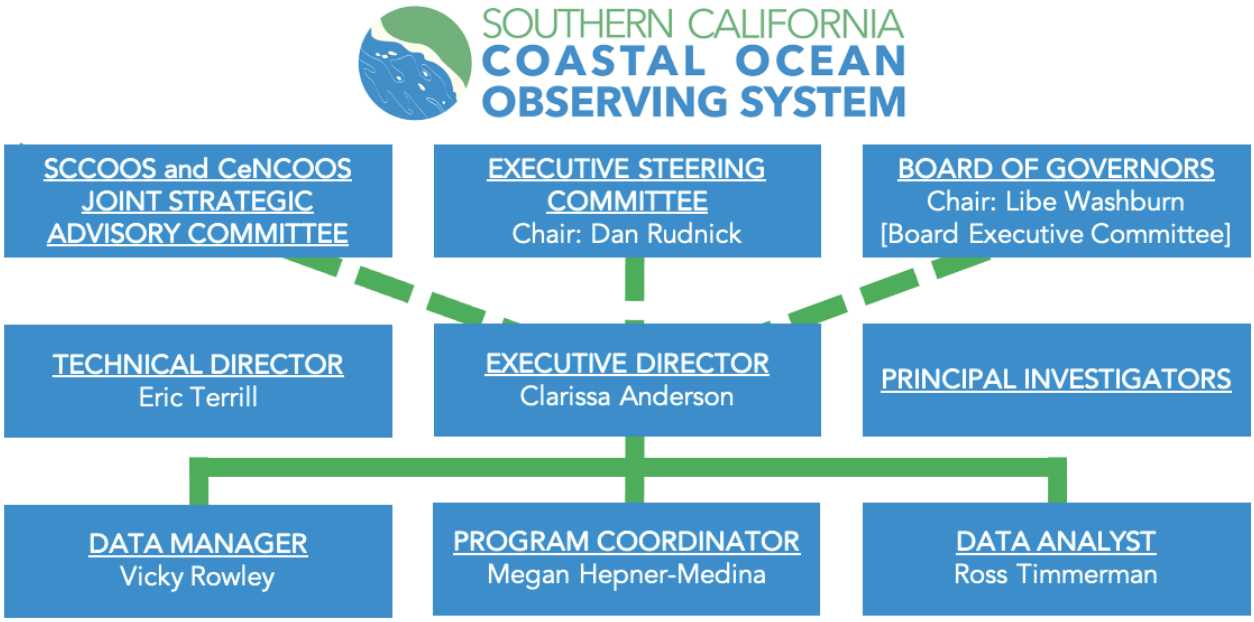


Figure 6. **SCCOOS Program Office and Governance Structure**. The Executive Director works closely with the Technical Director and Principal Investigators with guidance and oversight from the JSAC, ESC, and BOG. The Executive Director manages the Program Office Administration and DMAC staff.

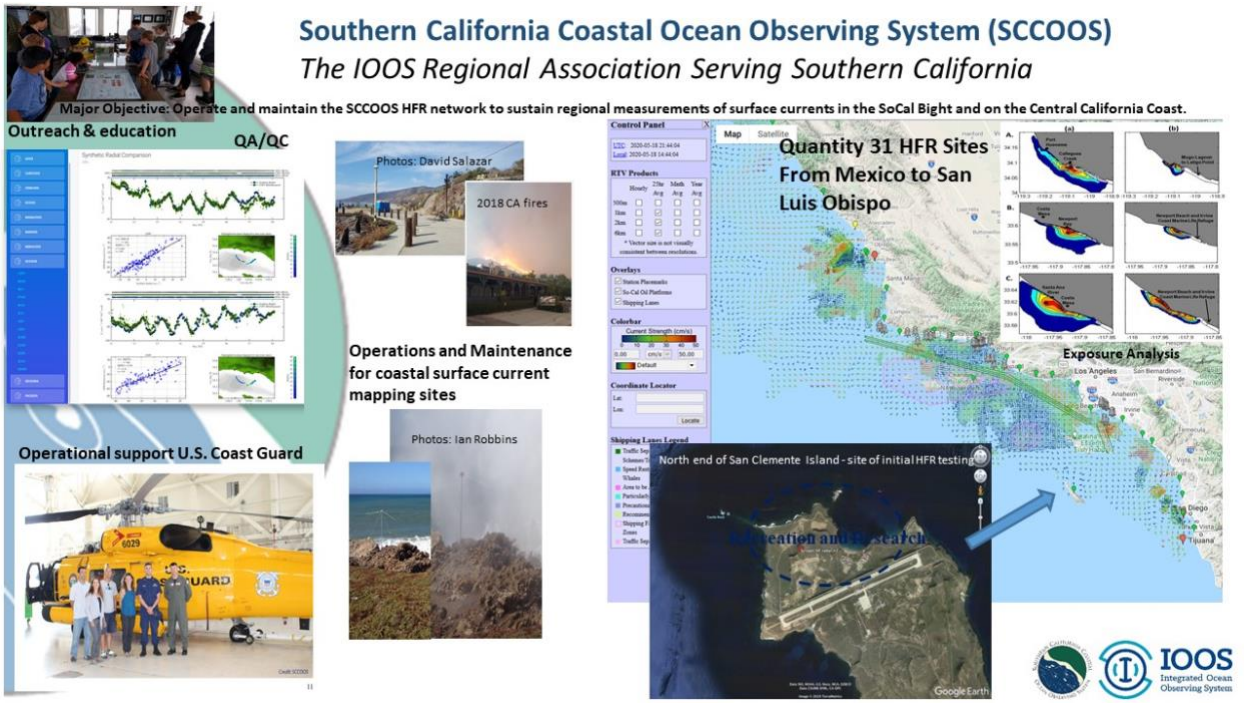


Figure 7. **High Frequency Radar (HFR) derived Surface Currents** (Obj. 1.1. Task 1, Tier 1). HFR cuts across all SCCOOS focus areas through the use of near real-time surface current data access and displays, long time series archives, and analysis products. This compilation showcases examples of HFR applications and coverage (right); exposure analysis (upper right); site expansion (lower right); operations and maintenance (middle); education and outreach (upper left); quality assurance and control (middle left), and USCG operations support.

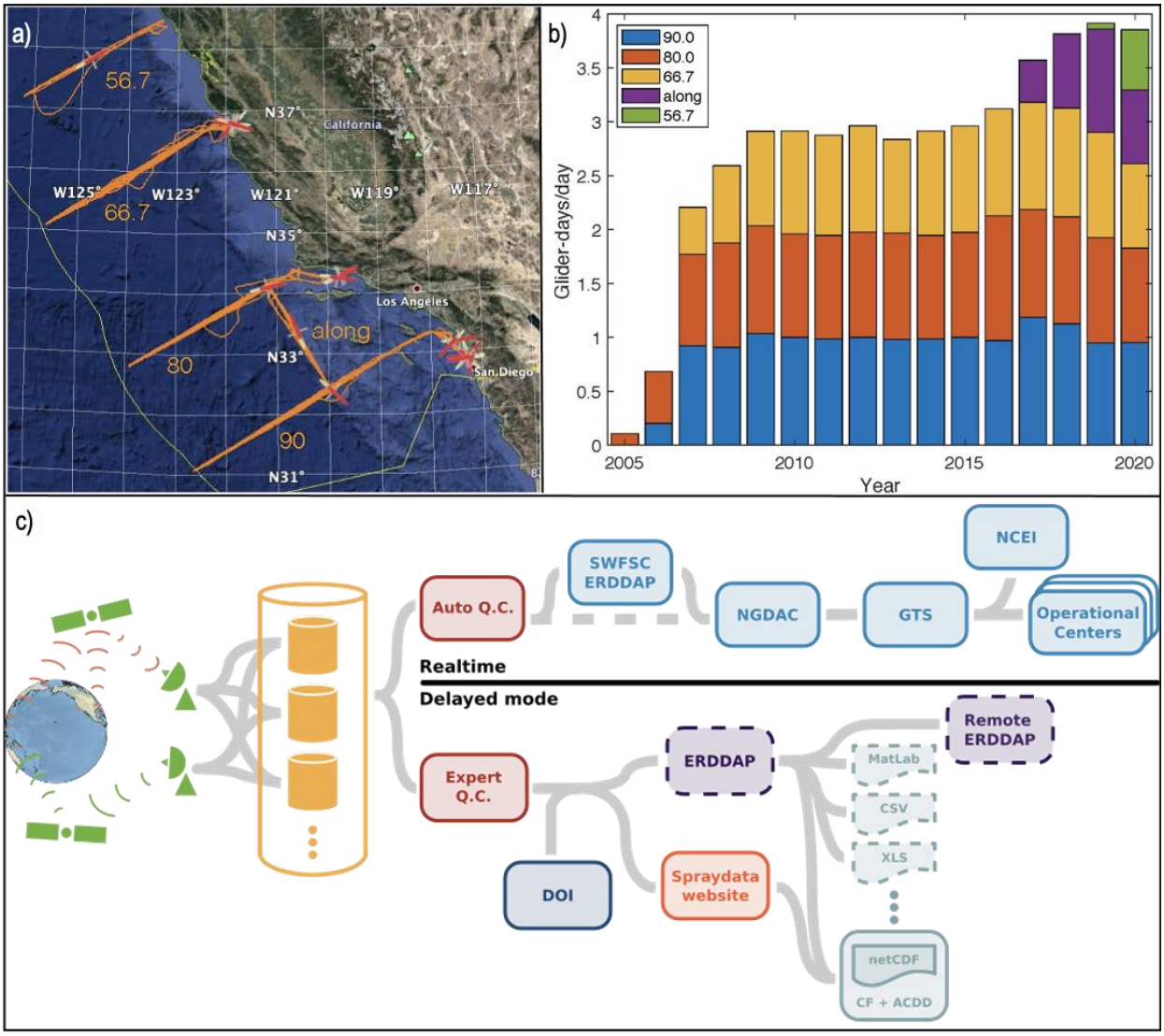


Figure 8. **California Underwater Glider Network - 2005 to 2020** (Obj. 1.2. Task 1, Tier 1). (a) The primary deliverable of the CUGN is straightforward: sustained, year-round, 24-h/day observations on the five lines (Line 90 and the alongshore line supported fully by SCCOOS). To date, the CUGN has covered 340,000 km over ground in 44 glider-years, while doing 140,000 dives. (b) A reasonable metric of performance is the number of operational glider-days/day, with the goal of having continuous coverage on each line. During 2009-2019, coverage was at least 97% of the goal on the three sentinel lines 66.7, 80.0, and 90.0. Starting in 2019, IOOS Fill the Gaps has funded an alongshore line (SCCOOS) and a line north of Bodega Bay (56.7, CeNCOOS). (c) Spray glider data flow to archival centers and data servers, such as the National Glider DAC (NGDAC), Global Telecommunication System (GTS), NCEI, and ERDDAP; dashed boxes are services and products under-development.

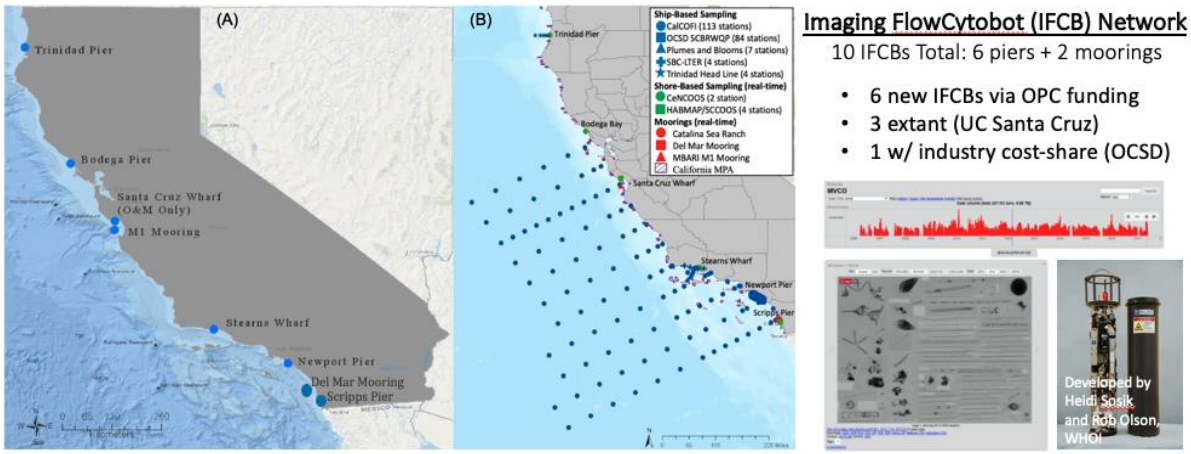


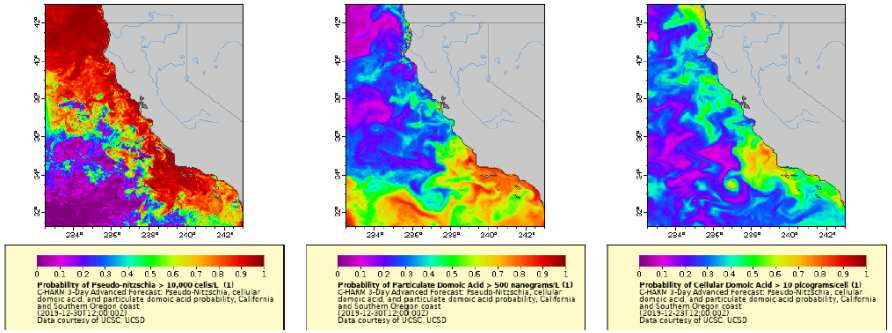
Figure 9. **California Early Warning System for HABs** (Obj.1.3. Task 3, Tier 2). The Imaging Flow Cytobot (IFCB) Network will be the largest of its kind in the world and exemplifies a public-private partnership in support of the Blue Economy and serves as a prototype for a National HAB Observing Network. THe IFCB was developed at WHOI, is manufactured by McLane Labs, Inc., and provides real-time, *in situ* automated classifications of phytoplankton community structure for detection of HABs and for fundamental planktonic studies. The full network is cost-shared by SCCOOS and CeNCOOS through various awards (including HABON), and we request funds from IOOS for operations and maintenance of the system. a) IFCBs are located at three HABMAP pier/SASS stations in the SCCOOS region and on the Del Mar mooring; CeNCOOS-supported sites include M1 Mooring and three pier stations. b) Some instruments fill a double duty role by processing monthly to quarterly cruise samples in an offline mode.

California HAB Bulletin

What is the CA HAB Bulletin?

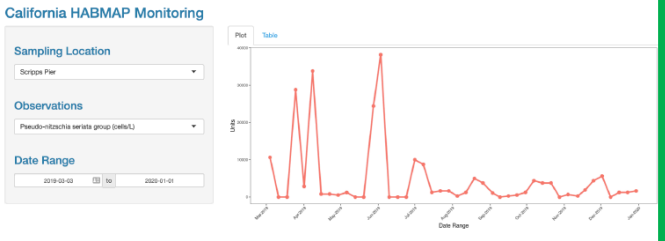
The purpose of the CA HAB Bulletin is to give the public and resource managers a quick outlook of recent toxic (marine) algal blooms in coastal California from models and aggregate data sets. Monthly reports synthesize model output, near real-time observations, marine mammal strandings and public health alerts to provide a more complete picture of the regional variability in harmful algal blooms.

California Harmful Algae Risk Mapping (C-HARM)



C-HARM system creates daily nowcasts and three-day forecasts of domoic acid risk through simulations of the physical circulation using a Regional Ocean Model System (ROMS) to predict water temperature, salinity, upwelling, advection.

CA Harmful Algal Bloom Monitoring Alert Program (HABMAP)

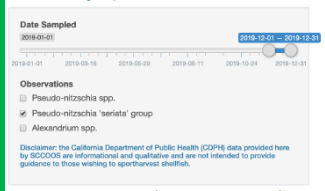


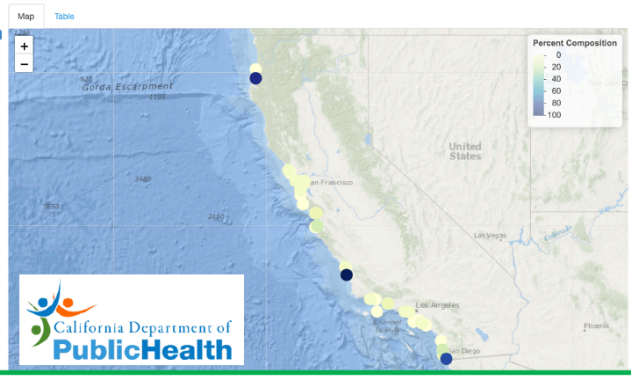
The CA HABMAP funded by SCCOOS and CeNCOOS provides a near real-time picture of which HAB species might be blooming in the very nearshore environment, if domoic acid is present as well as other water quality parameters (e.g., nutrients, chl-a, and temperature). Stearns Wharf, Newport Pier and Scripps Pier also use SPATT bags to measure for additional toxins.

SOUTHERN CALIFORNIA COASTAL OCEAN OBSERVING SYSTEM

https://sccoos.org/california-hab-bulletin/

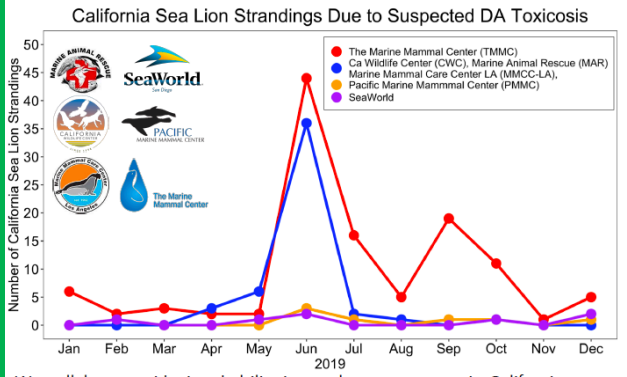
California Department of Public Health (CDPH)





SCCOOS provides maps and a summary of California Department of Public Health (CDPH) Marine Biotoxin Quarantines and Health Advisories that serve as warnings for recreational seafood harvests, as well as Health Advisories and Closures from the California Department of Fish and Wildlife.

Marine Mammal Strandings Suspected Due to DA Toxicosis



We collaborate with six rehabilitation and rescue centers in California to report monthly marine mammal and seabird strandings suspected due to domoic acid toxicosis.

What is next for the CA HAB Bulletin?

SCCOOS will soon be incorporating data from Imaging Flow CytoBots (IFCBs) to monitor HABs in near-real time with funding from the CA Ocean Protection Council and NOAA research grants from collaborating Principal Investigators. The IFCB takes high resolution images of phytoplankton and with machine learning algorithms are then used to categorize images to taxonomic groups of interest.

Imaging Flow CytoBot

sccoos.org/california-hab-bulletin/

Figure 10. **CA HAB Bulletin** (Obj. 4.1. Task 1, Tier 1). SCCOOS spearheaded the California Harmful Algal Bloom Bulletin (CA HAB Bulletin) in April 2018. The Bulletin is a monthly hindcast focused on HABs caused by the diatom *Pseudo-nitzschia* spp. and its neurotoxin, domoic acid, the cause of Amnesic Shellfish Poisoning in humans, and a more limited discussion of *Alexandrium* spp., the saxitoxin-producing dinoflagellate that causes Paralytic Shellfish Poisoning. The Bulletin summarizes data from C-HARM, HABMAP, CDPH, and DA-related stranding cases reported by TMMC, CIMWI, PMMC, MAR, CWC, MMCC-LA, and SeaWorld San Diego. The Bulletin is distributed monthly on a public listserv with over 300 members as well as on the SCCOOS website.

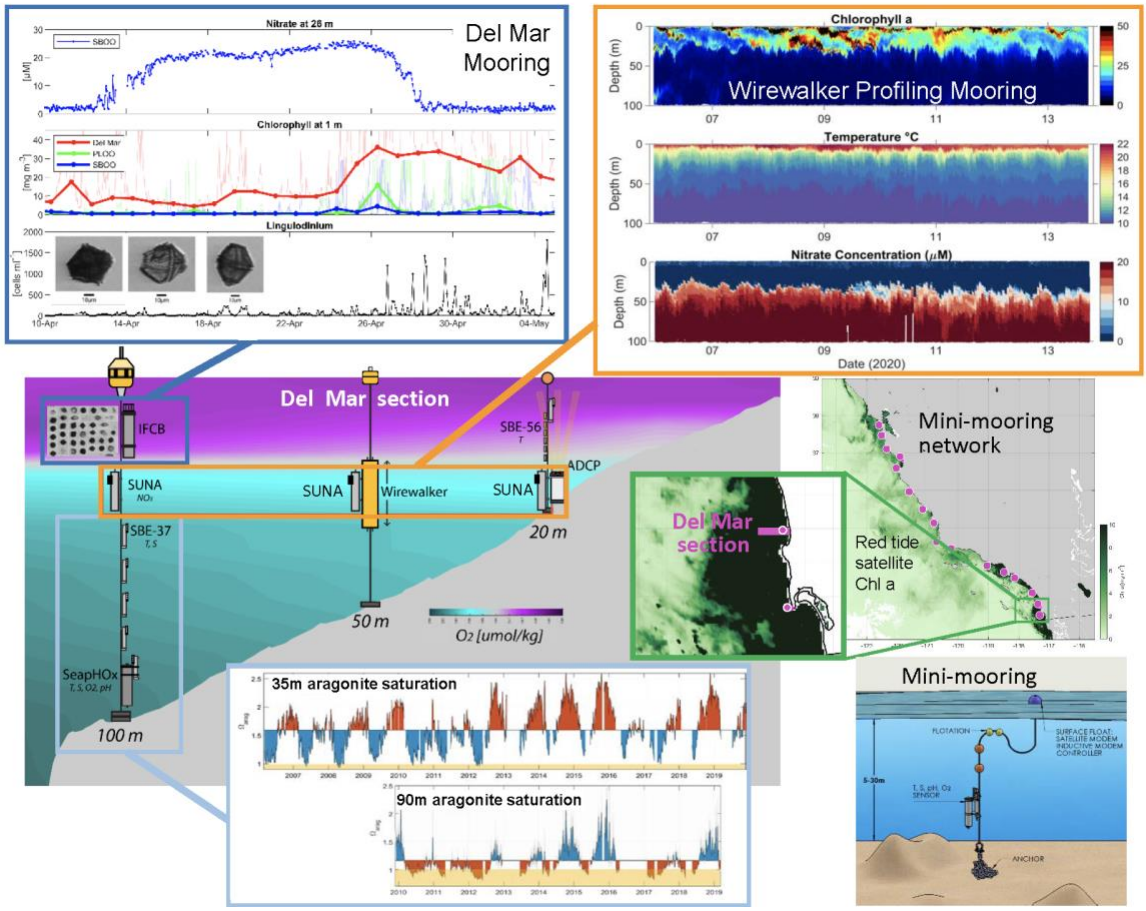


Figure 11. **Network of ecosystem moorings and moored profilers** (Obj 1.4. Tasks 4-6, Tier 2). Composite showing proposed, fixed, water column platforms and sensors complementing existing SCCOOS and stakeholder (e.g., POTW) observations. Center: Section from 100m to shore off Del Mar (see map detail) with the Del Mar (DM) mooring (100m isobath), a WireWalker mooring (50m), and a shallow mooring (20m). The three together (plus San Diego POTW moorings to the south) allow investigation of nitrate transport cross-shelf and along-shelf and of bloom triggers (top right panel shows data from a demonstration in deployment). The DM mooring provides a reference site with an existing 14-year record of physical, OAH, and ecosystem parameters – the bottom panel shows example records of aragonite saturation at 35m and 90m, which often reaches the critical value of 1 (values<1.0 shaded orange). The mooring also will carry an IFCB for real-time analysis of plankton species and HAB detection. Upper left: DM mooring time series from the HAB event in April 2020, nitrate at 26m, chlorophyll fluorescence, and *L. polyedra* concentration from a test IFCB (with some sample images; images and time series courtesy of H.Sosik/WHOI). Right: Proposed network of low-cost hand-deployable real-time mini-moorings observing at least OAH parameters along the 30m isobath to detect local and small-scale alongshore variability and impacts. A mini-mooring schematic is also shown, and the map insert gives the location of the Del Mar section in the center.

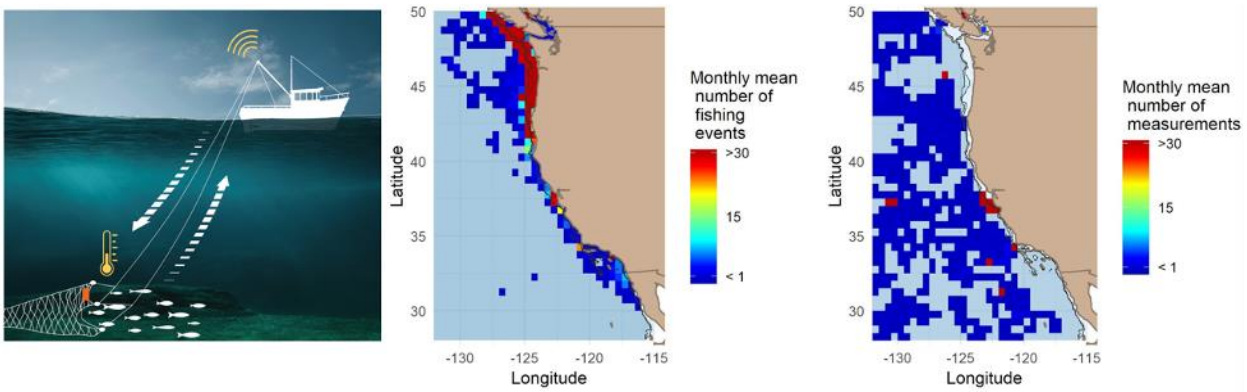


Figure 12. **California Fishing Vessels of Opportunity (CFVOP)** (Obj 1.4. Task 7, Tier 2). *Left.* Fishing gear can provide an ideal profiling platform for sensors to catch data along with fish. *Middle.* Mean monthly number of fishing events judged suitable for potential data collection. *Right.* Mean monthly number of sub-surface observations for the California region. Fishing activity concentrates potential data collection right on the shelf and shelf-break: dynamic and complex ocean regions.

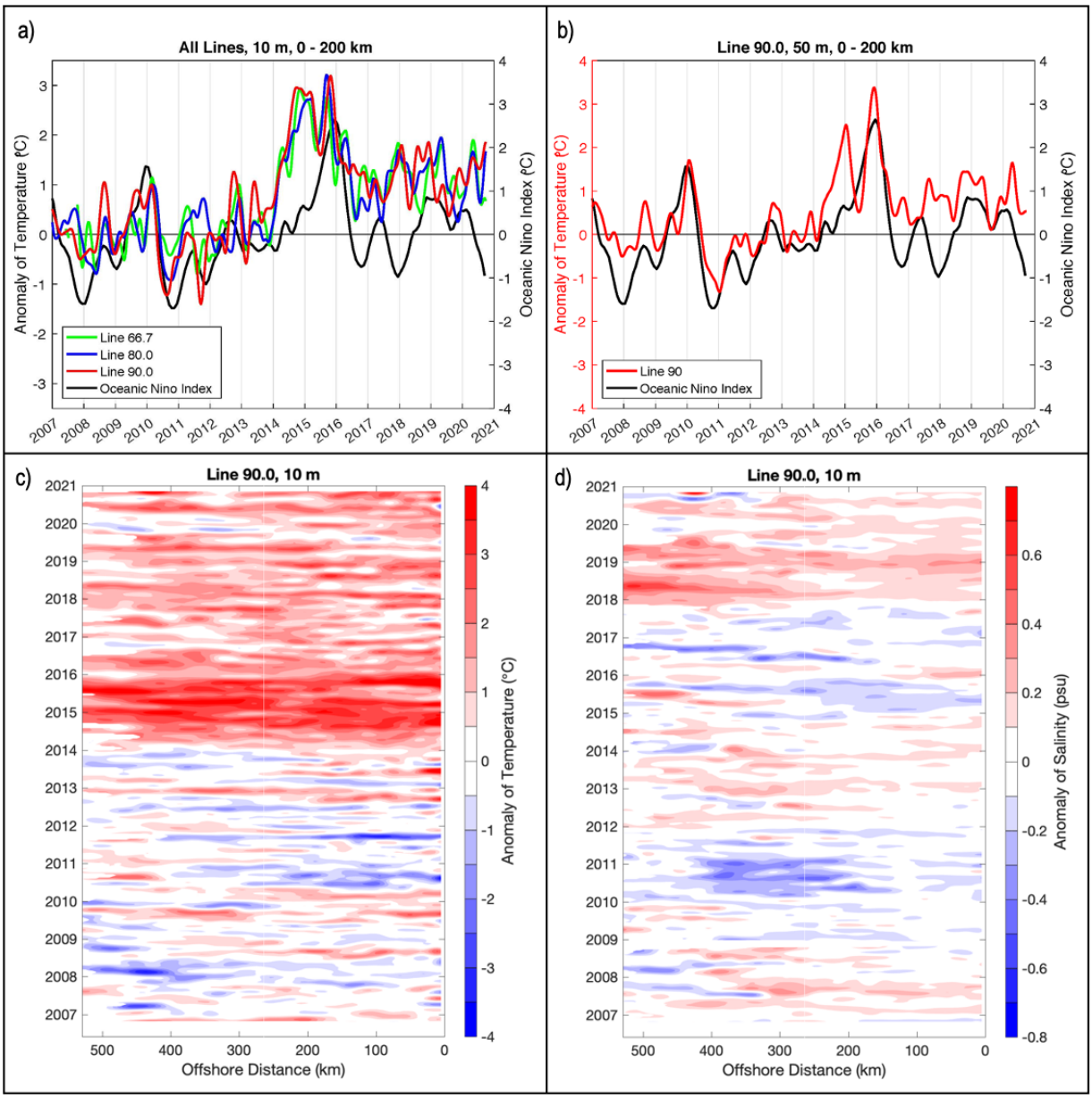


Figure 13. **CUGN and Climate Variability** (Obj. 1.2. Task 1, Tier 1). Underwater gliders are a valuable platform for monitoring climate change and variability in the CCE. a) Temperature anomalies at 10m depth plotted for three glider lines spanning Southern to Northern California closely agree with one another and are aligned with low-frequency temperature variability introduced by ENSO and shown here as the Oceanic Niño Index (ONI). b) The coupling is particularly strong between the temperature anomaly at 50m depth on Line 90 in the SCCOOS region and the equatorial ONI, such that this has become a standardized CUGN product termed the SoCal Temperature Index. ONI and the SoCal Temp index were decoupled from late 2014 to late 2015 during the height of the Pacific Warm Anomaly ("The Blob"), re-synced in 2016 during the "Godzilla" ENSO event, and then decoupled again from 2016 to 2018 as the marine heatwave lingered. c) The spatial and temporal evolution of marine heatwaves is readily observed in Hovmöller diagrams, highlighting the extremely anomalous temperatures experienced in the SCB from 2014 to 2016, and the persistence of anomalous conditions even into the present, including d) extreme salinity anomalies that have marked the SCB region from 2018 to 2020.

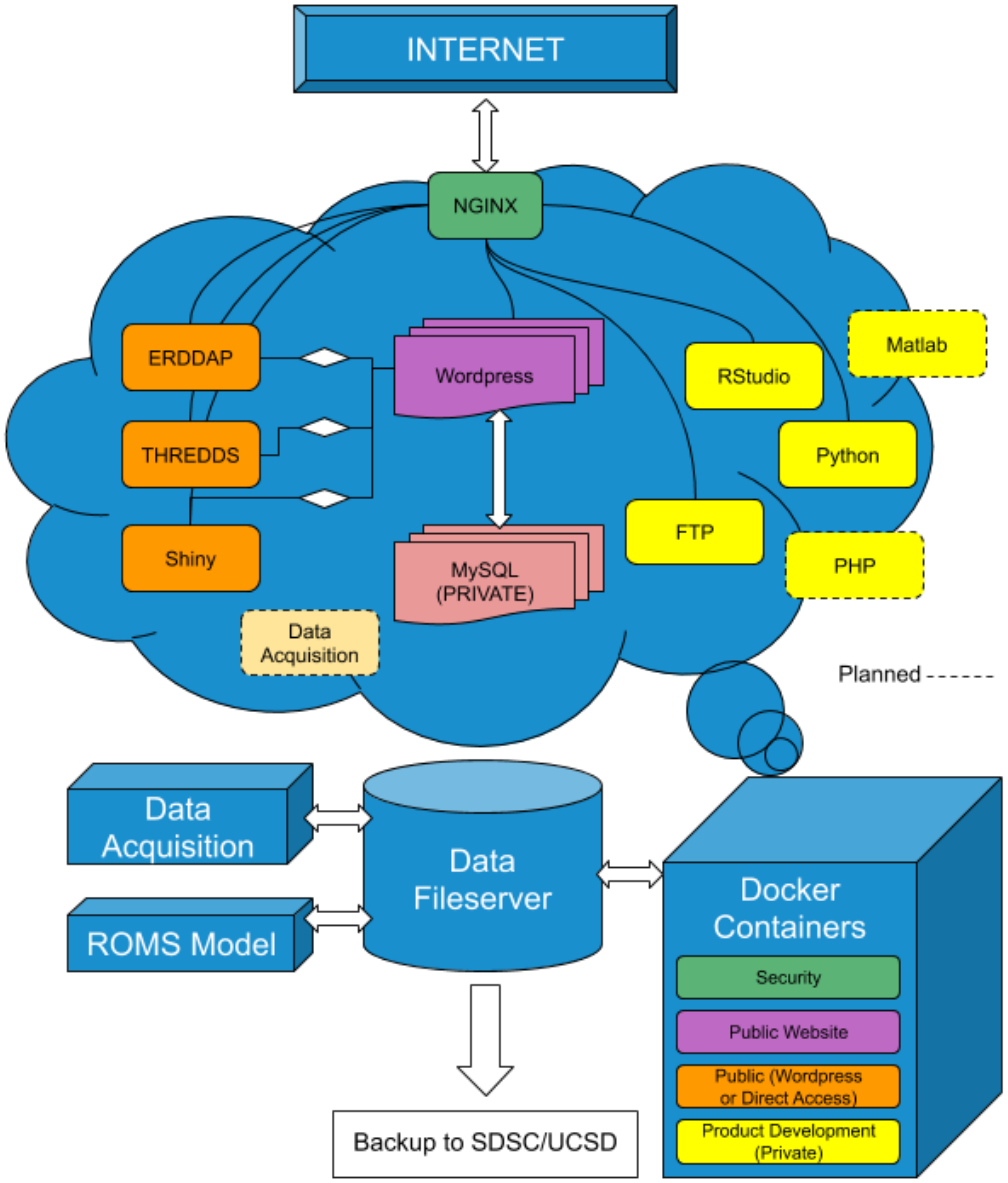


Figure 14. **DMAC Infrastructure** (Obj. 2.1, Tasks 1-2, Tier 1; Obj. 2.2. Tasks 1-2, Tier 1). The hardware, software, and policy framework needed to ingest and manage ocean observations and other derived information from multiple sources, to support environmental modeling, to allow development of data analysis and display products, to provide end-user displays, and to enable discovery of and access to Southern California ocean and coastal information.

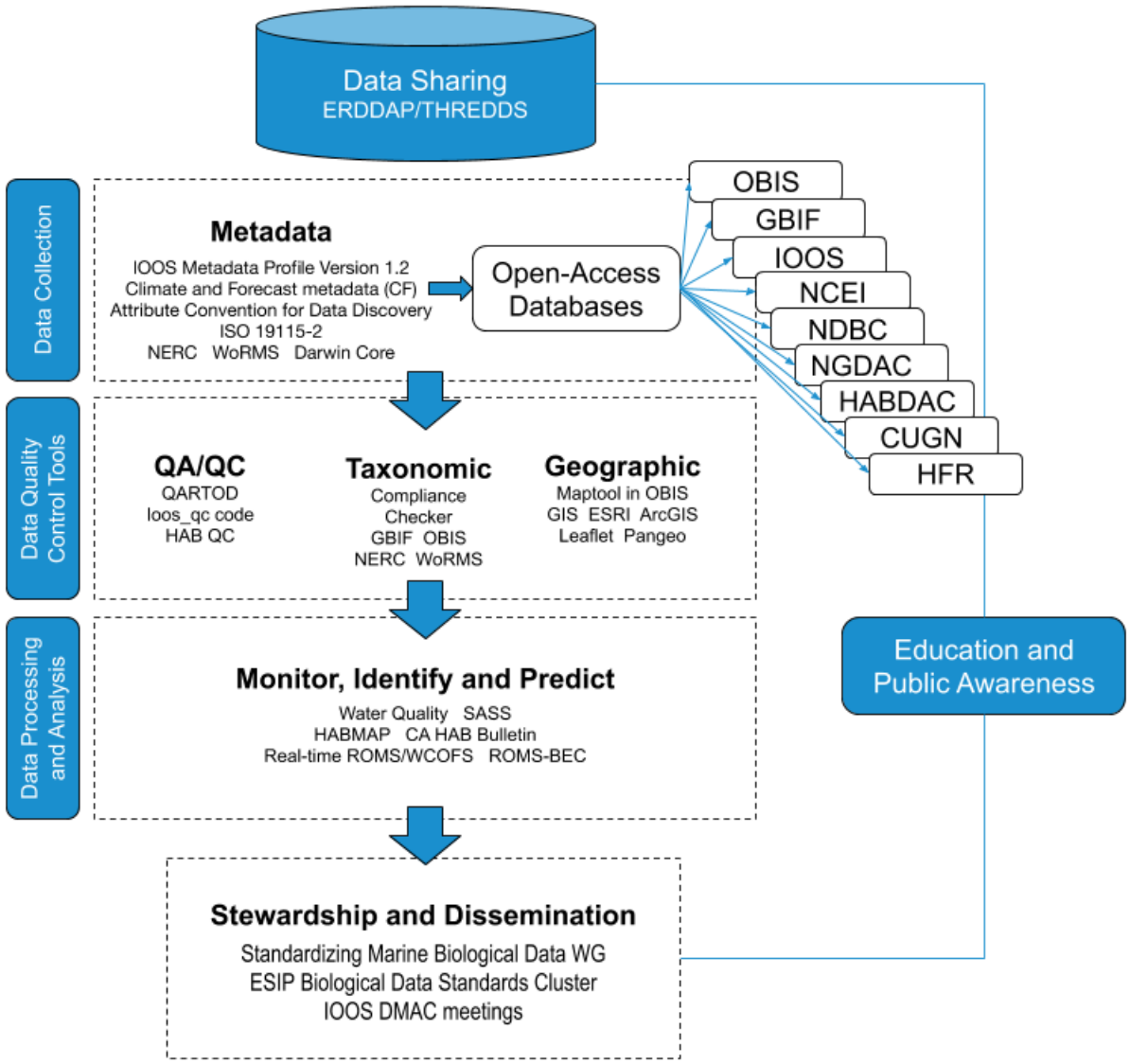


Figure 15. **DMAC Overview** (Obj. 2.3, Task 1, Tier 1; Obj. 2.4, Tasks 1-3, Tier 1). SCCOOS Data Management and Cyberinfrastructure (DMAC) handles southern California ocean and coastal information including gathering initial observations of raw data and ingesting them in the cyberinfrastructure, applying quality control measures, providing long-term and archival storage, engaging in product development to aid stakeholders and enabling public dissemination. These efforts combine to facilitate public discovery of, access to, and understanding of this important environmental information. *Figure based on Saeedi et al., 2019.*[118]

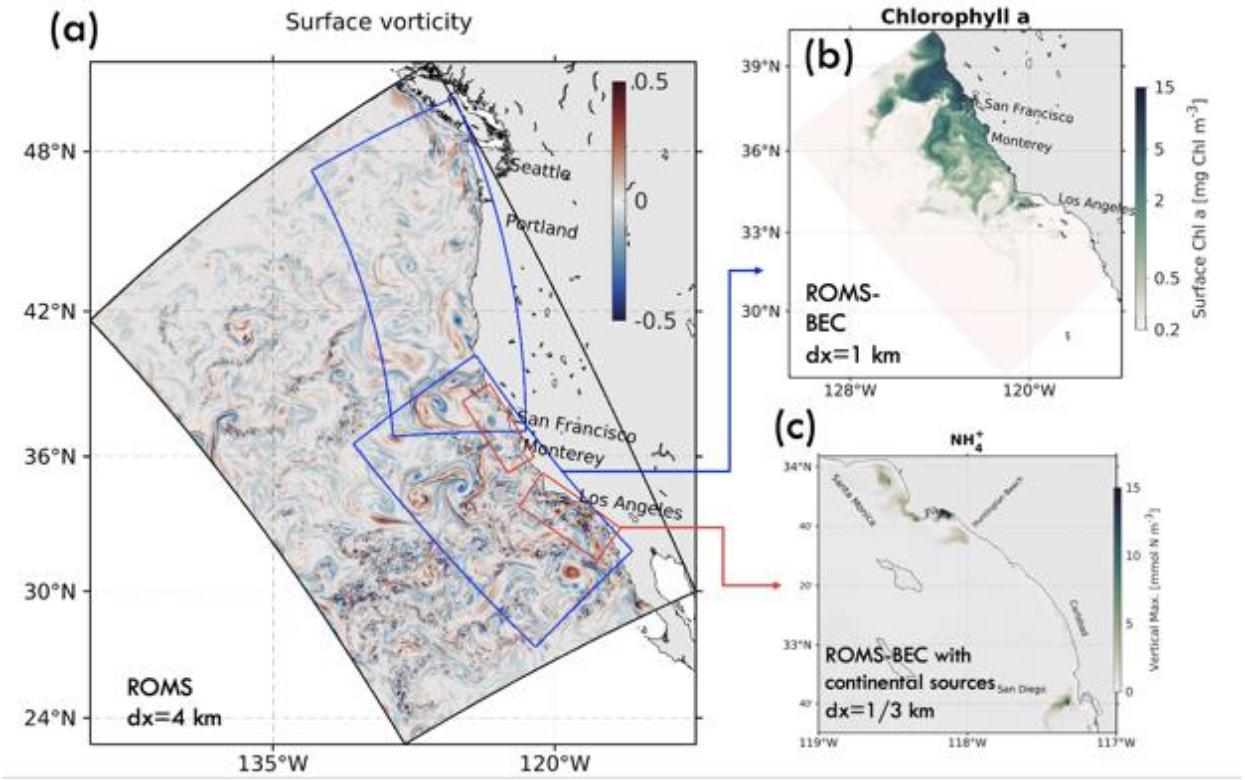


Figure 16. **ROMS-BEC Domain** (Obj. 3.1, Tasks 3 - Tier 1, Tasks 4-5 - Tier 2). (a) One-day averaged surface vorticity from a 4km resolution ROMS-BEC simulation of the US West Coast. Black box shows the 4km model domain. Blue and red boxes show 1km and 300m resolution nested domains, respectively. (b) One-day averaged surface chlorophyll from the 1km-resolution simulation, during an upwelling event. (c) Maximum ammonium concentration in the water column from a 300m-resolution simulation of the Southern California Bight that includes terrestrial anthropogenic nutrient inputs.

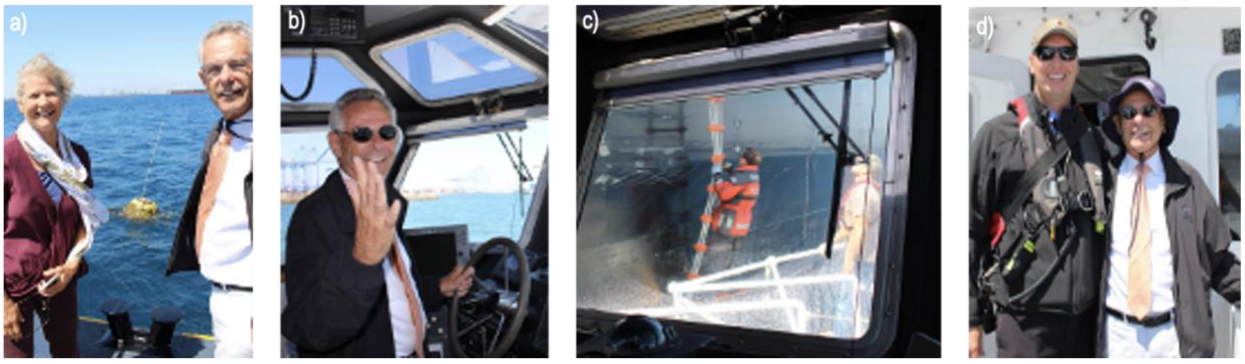


Image 1. **Representative Lowenthal Field Trip**. On August 21st, 2017, Rep. Lowenthal and his staff were briefed on the importance of wave observations at the Port of LA/Long Beach followed by a bar pilot vessel excursion. The vessel excursion passed the Long Beach Channel wave buoy (funded by NOS specifically for the Under Keel Project) but, dropped off two pilots, one on an oil tanker and another on a container ship. The event was made possible by our partners at Jacobsen Pilot Service, the Coastal Data Information Program (CDIP), The Marine Exchange of Southern California, and Marathon Petroleum (formerly Tesoro and Andeavor). a) Former SCCOOS Director, Dr. Julie Thomas, and Rep. Lowenthal. b) Rep. Lowenthal aboard Jacobsen Pilot Service ship. c) Dropping off pilot on a container ship. d) Jacobsen Pilot and Rep Lowenthal.

Image 2. **SCCOOS-CeNCOOS Joint Showcase.** The California Ocean Observing Systems hosted the "Integrated Ocean Observing for a Changing California Coastline" in Sacramento, CA on 19 November 2019. The event showcased the Systems' capabilities, communicated the value of our products and tools to the state, and promoted a shared vision for the future of ocean and coastal observing in the State of California.

C. DATA MANAGEMENT AND CYBERINFRASTRUCTURE SUBSYSTEM PLAN (Obj. 2.1-2.4)

**Details of data delivery/timing/metadata in relation to the 8 core capabilities highlighted by IOOS are provided in Section 5. Data Sharing/Management Plan*

a. Support Ongoing Maintenance, Operation, and Development of SCCOOS Cyberinfrastructure to Sustain Long-term Data Stewardship for Our Partners and Stakeholders (Obj. 2.1)

Task 1. SCCOOS leverages both on-site and cloud IT infrastructure to host a regional SCCOOS Data Assembly Center (DAC). On-site equipment is housed in the SIO data center, which provides enterprise level power, cooling, fire suppression, security and 24/7 monitoring of SCCOOS equipment, including two enterprise level servers for VMWare virtual machine and Docker hosting, a server dedicated to running the real-time 3-km ROMS model and serving ROMS-BEC hindcasts as model output on a 40TB data/file server. Along with Docker, VMWare facilitates tremendous flexibility in terms of growth and agility and also provides redundancy in the event of a server hardware failure. Capacity exists to operate models within a cloud computing or distributed platform framework in response to new NOAA-driven initiatives to improve economy of scale and support unified modeling infrastructure across the IOOS RAs. In keeping with the historically lean investment in DMAC relative to deploying and maintaining observation platforms, SCCOOS DMAC is currently led by only one central data manager (Vicky Rowley), supported by the SCCOOS award and extramural grants with regional PIs, aided by part-time personnel effort for webpage development, and will be expanded over the next five years. Accommodating communications with new partners and ingestion of new data sources will require additional DMAC effort, thus we propose to add SCCOOS DMAC personnel (data analyst/web app developers) to meet these needs. Task 2. SCCOOS utilizes a flexible, scalable, Docker-based IT infrastructure that allows for continuous growth and regular improvement of services offered, including migration or replacement legacy systems. The resulting codes are tracked and stored in cloud-based source code repositories (e.g., GitHub, BitBucket) ensuring that they are available for disaster recovery, as in the event of a natural disaster emergency or critical hardware failure. Task 3. Planned refresh of our server hardware will provide for increased capacity, while simultaneously simplifying our architecture and making more effective use of our computational hardware resources. Private cloud storage at UCSD's San Diego Supercomputer Center (SDSC) provides off-site backup storage for SCCOOS data in their 19,000 sq. ft. climate-controlled and secure datacenter that is fully equipped with 13 megawatts of power, 10-gigabit network connectivity, and a 24/7 operations staff. UCSD's GSuite provides additional cloud-based storage for applications, documentation, and data. Use of cloud resources combined with our "Infrastructure as Code (IaC)" approach means that, in an emergency, the critical pieces of SCCOOS' data management infrastructure could be reestablished on new hardware, in a new location or even in a cloud environment, like Amazon Web Services or Azure, from code stored in the cloud. This also protects SCCOOS IT operations by effectively documenting what is used and how the pieces are interconnected.

b. Promote Data Standardization, Automation, Discovery, and Public Access (Obj. 2.2)

Task 1. SCCOOS works closely with data providers (both SCCOOS-funded and unfunded regional partners) to standardize data collection and submission procedures. Where available, QARTOD manuals guide SCCOOS QC/QA efforts, and QC Tier 1 and Tier 2 flags are applied to all real-time data streams generated by *in situ* instruments (e.g., SASS sensors, with pH and O2 under development), communicating via ethernet or cellular connection with our database in an Internet of Things capacity.[119] Wherever possible, we automate ingestion and post-processing of the data, including establishing or enhancing metadata that facilitates both discovery and interoperability so that data can be made available in close to real-time over the full data lifecycle (Fig. 14). As an IOOS DAC, SCCOOS manages large numbers of continuous data feeds and makes the data accessible via both ERDDAP and THREDDS, both of which allow the end user to download the data in a number of standard formats (i.e., OpenDAP, csv, html, NetCDF, etc.). When a dataset is added to an ERDDAP server metadata must be established. These metadata are regularly extended, improved, and

adjusted to better align with standards such as ISO 19115-2, IOOS Metadata Profile Version 1.2, Climate and Forecast metadata (CF), Attribute Convention for Data Discovery (ACDD) and Darwin Core. By incorporating these standards, our data become not only accessible, but also findable and interoperable within the IOOS Enterprise. Larger data repositories such as the IOOS Catalog, NCEI, NDBC/GTS, GBIF, OBIS, IPACOA, Google Dataset Search, erddap.com, environmental modeling programs, and more can pull these datasets from the SCCOOS ERDDAP server programmatically and automatically determine how to further share and distribute the data (Fig. 15). Details of the data SCCOOS makes available, which includes Essential Ocean Variables (EOV), Essential Biological Variables (EOV) and more, as well as information on time from data acquisition to its availability from SCCOOS, can be found in the RICE Certification Sensor Data Plans on our website.[120] Task 2. We develop a variety of graphical information displays and data analysis tools that meet the needs of SCCOOS stakeholders and fulfill the Data Standards & Requirements established by IOOS. We continually assess the status of older displays and tools to evaluate how they might be improved by being redeveloped using modern technologies, and to help keep our IT systems secure and optimally utilized. These products help end users and stakeholders quickly and easily discover and access the data they need most. These products are custom made to provide access to data in whatever form is best suited to aid in specific decision-making activities. Our containerized infrastructure, described above, allows these data products to be developed in multiple languages (e.g., R, Python, MatLab, Bash, etc.), come from multiple sources (e.g., open source, DMAC community, SCCOOS researchers), leverage the most appropriate framework or technology (e.g., RStudio, Shiny, MySQL, Leaflet, PHP, NetCDF, GIS libraries) and integrate seamlessly into our Wordpress-based website, which can be quickly and easily modified and updated by anyone on the SCCOOS team. Wherever possible, system design and automated tools are created to be generally applicable so that efforts to standardize, upgrade, or automate one piece results in system wide improvements. Google Analytics and Wordpress-specific metrics are used to track usage of SCCOOS resources, and these web log metrics will be updated monthly on the SCCOOS website. Task 3. In addition to expanding and improving the SCCOOS DAC, SCCOOS will work with CeNCOOS and their DMAC lead, Axiom Data Science, to support statewide portal upgrades that merge the SCCOOS and CeNCOOS data catalogs, which already significantly overlap. This will be a critical development for meeting the needs of our inter-regional partners at the CA OPC and engaging with federal partners, such as the NOAA NMFS.

c. Strengthen Data Stewardship Within the SCCOOS Consortium to Improve Data Quality, Access, Attribution, Exchange, Delivery, and Storage (Obj. 2.3)

Task 1. SCCOOS is actively involved in the ESIP Biological Data Standards cluster, which engages with the Biodiversity Information Standards (aka TDWG) community. This helps ensure that as SCCOOS implements standardization of its biological data (e.g., HABMAP data now served in OBIS), it does so in alignment with national and global standards. Both the DMAC lead and SCCOOS ED (Co-I Anderson) attend regular working group teleconferences and workshops. Task 2. SCCOOS is an active member of the Standardizing Marine Biological Data Working Group, which draws from existing standard vocabularies such as Natural Environment Research Council (NERC), World Registry of Marine Species (WoRMS), and other ontological standards like those found in the NCBO BioPortal, to facilitate adoption of data representation standards by the biological data community. To this end, SCCOOS employs Darwin Core (D-C) to make biological data more widely discoverable and FAIR, including establishing precedents for representing complex biological data in D-C terms, documenting best practices for standardizing biological data, and bridging gaps between genomics standards and the Linnean model.[121] SCCOOS will continue to lead the way by applying D-C standards to currently served and future biological datasets from both funded and unfunded partner organizations. Task 3. SCCOOS is RICE certified and will renew this certification when it expires in 2022. Our Data Management Plan and our Sensor Data Plans can be found in our RICE documentation on our website at https://sccoos.org/certifications. SCCOOS works with all its data providers to standardize data

collection and processing methods to improve validity of data comparisons, to improve quality control of data, to extend and improve metadata (including attribution and DOI information) and to automate submission and ingestion of data in accordance with guidance provided by the NOAA's Environmental Data Management Committee so that it can be exchanged between researchers worldwide. SCCOOS current and future participation in IOOS and ESIP-sponsored workshops accelerates the pace of best practice exchange and community building. In particular, participation in monthly DMAC webinars, annual DMAC meetings, and newly developed DMAC code sprints will ensure shared solutions for issues shared by multiple regions.

d. Support the Functionality of National Data Assembly Centers Through Leadership in Observation and Product Delivery, Quality Control Methods, and Capacity Building (Obj. 2.4)

Task 1. Through extramural support via a NOAA PCMHAB grant, SCCOOS and CeNCOOS are partnering with Axiom Data Science to stand up a national HAB DAC that will ingest, store and redistribute HAB/plankton data, including developing tools that use Machine Learning (ML) techniques to automatically classify plankton imagery from IFCBs. This effort will serve as a prototype for follow-on efforts in complex automated data acquisition, distribution, ML processing and analysis (with Convolutional Neural Networks). In addition to being guided by a Technical Advisory Committee that includes industry, plankton experts, and RA Directors, the PCMHAB project stands up a HAB DAC Data Integration Group (DIG) to advise on specific protocols and metadata standards that should be considered for a national computational and archiving hub. As the National HABON framework gains traction in Congress, it is expected that the HAB DAC will serve the needs of additional programs, such as U.S. MBON, in support of observationalists and ecosystem modelers in need of nimble plankton community repositories embedded within a state-of-the-art computational environment. Task 2. Where appropriate, SCCOOS data are also made available via existing national DACs. For example, SCCOOS plans to mirror the CUGN ERDDAP and climatology page in support of pan-regional product development that increases exposure to glider technology and the NGDAC and better supports our partners in fisheries and ecosystem management. Task 3. To support increased stakeholder value of HFR data, SCCOOS will co-develop (with HFR PIs) visualizations of derived HFR products that increase understanding and utility of HFR data and the national HFRNet system (hosted at the Coastal Observing Research and Development Center at UCSD, separate from SCCOOS). Potential products include interactive tools for users to compute vorticity, convergence, and divergence data solutions from the HFR vectors in order to inform analyses that necessitate eddy detection and other mesoscale features known to force the movement of passive particles, plankton, larvae, and pollutants. In this way, it is expected that SCCOOS will foster new interest in HFR products for developing model predictions and engaging the marine ecological community.

D. ENGAGEMENT, OUTREACH, AND COMMUNICATION SUBSYSTEM PLAN (Obj. 5.2-5.4)

Obj. 5.1 was already covered in the Governance & Management Subsystem and includes SCCOOS Program Office communication and Congressional outreach activities.

SCCOOS is housed at SIO at the University of California, San Diego, an institution that has, in recent years, taken several concrete steps towards supporting equity, diversity, and inclusion, both within its academic and research programs but also in its engagement activities with the community. The SCCOOS outreach plan is informed by the recent Diversity, Equity, and Inclusion (DEI) strategic plan implemented by SIO and is our attempt to both broaden and deepen our reach with stakeholders, students in all stages of the academic pipeline, and the public. We propose to advance DEI initiatives as part of our mission by (1) bringing together our wide stakeholder and researcher network with K12 students and educators, especially engaging communities underrepresented in STEM and higher education, (2) leveraging existing infrastructure and cementing collaborations with academic programs and centers of informal education to create NGSS-aligned curricula and educational programs focused on career pathways related to ocean observing, (3) integrating undergraduate and graduate students in our programmatic research and engaging them in professional development opportunities, and (4) building a strong evaluation and assessment plan for these outreach activities and programs. A compiled list of past and proposed education and outreach efforts from 2018, 2019 and 2020 is provided in Appendix B. Tables 9 & 10. Objectives 5.2-5.4 were briefly introduced in section 3.C and are further described below. Obj. 5.4 describes an extension program developed with SCCOOS partners: Birch Aquarium, AltaSea, the Ocean Discovery Institute (ODI), Scientific Research and Education Network (SciRENs) San Diego, Center For Research On Educational Equity, Assessment & Teaching Excellence (CREATE), Heal the Bay, and CA Sea Grant (Table 4).

a. Gather Customer Feedback and Refine Requirements for Products and Services (Obj. 5.2)

The SCCOOS program office maintains stakeholder and community engagement efforts in a number of capacities: hosting regional meetings, frequent presentations at conferences and stakeholder team workshops, exhibit booths, media interviews, quarterly newsletters, social media posts (e.g., Facebook and Twitter), and website-user surveys (Table 10). SCCOOS currently funds a postdoctoral researcher, via an OPC-funded MPA Network project, who is shared with CA Sea Grant to ensure that data and model products are designed with CASG extension specialists and frequent stakeholder communication. Over the next five years: Task 1. SCCOOS staff will institute a set of formal mechanisms for routinely acquiring stakeholder feedback via Google Analytics (already in use), targeted user surveys, and digital media campaigns. This will include a tutorial webinar series that is accessible on the SCCOOS website for downloading data and interpreting products to foster an improved feedback loop. Task 2. We will codify an annual schedule of workshop-based communications with targeted stakeholder groups to strategically initiate new products and leverage partner resources. Stakeholders will be subdivided by end-user sector and data needs in order to better scope product development and encourage economies of scale across regions by collaborating on workshops with CeNCOOS (see Table 9 for workshop schedule).

b. Expand Partnerships to Innovate Ocean Observations and Information Products in Collaboration with CeNCOOS (Obj. 5.3)

Task 1. SCCOOS will continue to build strategic partnerships at all regulatory levels, leveraging strengths in observing and technology development with industry in close alliance with our host institution, SIO and its Director of Corporate Affiliates, Business Development, Industry Outreach, and Innovation. SIO affords SCCOOS frequent opportunities to connect with private entities (ocean instrument vendors, IoT start-ups, energy specialists) interested in forging partnerships that advance an ocean industrial complex. SCCOOS PIs not only provide business to at least over 100 vendors, but SCCOOS is also a member of The Maritime Alliance (TMA) and actively participates in TMA Blue Tech Week panels, exhibits, and workshops. These activities have already led to joint IOOS OTT proposals, with SCCOOS playing the role of testbed and/or stakeholder engagement partner. Given that OTT grants remain one of the rare mechanisms for IOOS RAs

to form a reciprocal relationship with industry, we propose additional means of partnering with commercial interests to add value to SCCOOS public services and encourage returns on that public investment. **Project Objectives and Deliverables**- We will: 1) Strategically communicate the value of RICE for IOOS RAs in providing national endorsement to our data pipelines and cyberinfrastructure, such that private partnerships might benefit from leveraging SCCOOS data management systems, 2) Host SCCOOS/CeNCOOS-data "hackathons" in partnership with the "Hacking 4 Oceans" course spearheaded by the Coastal Ocean Research and Development Center at SIO, and 3) Collaborate with The Ocean Foundation (Co-I Anderson on TOF Board), a community foundation that works with ocean-centric non-profits, to advance innovative ocean solutions of mutual benefit to the SCCOOS community.

c. Foster the Next Generation of STEM Specialists Through Targeted Collaborations Advancing Education, Training, and Research Opportunities, and Engaging the Future Ocean Observing and Stakeholder Workforce (Obj. 5.4)

SCCOOS will collaborate with UCSD Birch Aquarium Outreach experts on our outreach and education plan and pursue additional funding devoted to outreach in order to expand and institutionalize these programs. While engagement with tribal governments in the region is not a central part of the proposed plan, we fully embrace the state of California's Native American engagement strategy to foster meaningful relationships with local Tribal organizations and ensure that we enhance access to the best available science and traditional ecological knowledge. SCCOOS Co-I Anderson is a recent member of the Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS), and is a contributor to annual SACNAS conference panels. SCCOOS will also invest in an IOOS Association specialist to increase DEI across the IOOS RA Network. **Project Objectives and Deliverables**- Task 1. ODI uses ocean science to empower young people from underserved urban communities in the San Diego community of City Heights. They provide free year-round opportunities to provide mentoring and programming to their students involving researchers and educators. We plan on participating in ODI's Career Show & Tell Program. This involves traveling to Ocean Discovery's Living Lab science education facility in City Heights and giving a presentation on ocean observing career pathways to K-8 students. We will open this opportunity up to both SCCOOS staff and our stakeholders. We also plan on participating in the Scientist-in-Residence Program, where high school students would be mentored by our outreach staff during residential programs in California. Other venues for informal education include Birch Aquarium in La Jolla (San Diego) and the future AltaSea Aquafarm off of Cabrillo Beach (Los Angeles County). SCCOOS partners on ocean education with AltaSea (formal MOU), who maintains a primary student education service area that includes cities throughout Los Angeles County, with an emphasis on communities immediately surrounding the Los Angeles Waterfront. The port itself is located in a Disadvantaged Community (DAC), Census Tract 6037980033, with a pollution burden in the 99th percentile and asthma rates in the 70th percentile. Neighborhoods immediately adjacent to the port have poverty rates in the 70-95th percentile. Birch Aquarium, AltaSea, and SCCOOS are established collaborators, with SCCOOS supporting touchscreen displays at both locations for visitors to peruse local ocean and beach conditions. We plan to update existing exhibits with our new data products geared towards the public (e.g., MPA ecological indicators and curated data views) and integrate these with ongoing larger data visualizations projects the aquarium is hosting (i.e., ARGO data visualizations). The outreach staff will liaise with stakeholders to invite them to the aquarium's Ocean STEMS Career Night. Informational webinars on SCCOOS and SCCOOS products and datasets will be recorded by staff and distributed to the public by AltaSea both at their Port of Los Angeles location and at the new aquafarm they plan on building in the near future. We foresee workshop opportunities on water quality and sensor functionality-related informal education at this site. Funding will be pursued in order to continue these programs built to increase scientific literacy and integrate technology in new educational ways. SCCOOS will also work with the other IOOS RAs and the IOOS Program Office on workforce development initiatives to expand and diversify the ocean, coastal and Great Lake workforces and to improve our ability to provide relevant ocean and coastal data and

information to underserved or underrepresented communities. Task 2. SciREN is a non-profit organization that connects educators with researchers. Their focus is in helping researchers develop lesson plans that incorporate their own cutting-edge research and target NGSS. The SCCOOS RA and Birch outreach staff will work, under SciREN staff's guidance, to create data-based lesson plans for middle- and high-school students and be paired with local teachers to execute the lessons. The lesson plan repository for SciREN San Diego is scirenplans.com and SCCOOS-related lesson plans will be highlighted in a delineated section. Task 3. To date, SCCOOS has had little involvement with the undergraduate and graduate students funded through SCCOOS awards. We will develop and implement a peer support group to facilitate networking, career coaching and other professional development activities as part of our program's larger initiative to advance DEI objectives. This model is already being used by California Sea Grant. Mentorship and community-building is important at every stage of the pipeline and is especially important in supporting minority students, whom we hope to attract and retain in the IOOS workforce. Task 4. UCSD CREATE prides itself on providing quality and cost-effective research and evaluation services, with a particular focus on understanding efforts supporting the success of students underrepresented in higher education. CREATE's evaluation and research group is dedicated to providing independent and rigorous evaluation of educational programs. We will work with an evaluation and assessment consultant from CREATE in Years 1, 2, and 4 to design and analyze summative and formative assessments of our outlined outreach activities. The information gathered from this work will be used to set goals and priority areas for our continued outreach efforts.

E. REFERENCES

1. U.S. Integrated Ocean Observing System. (2018). *Strategic Plan 2018-2022*. U.S. Integrated Ocean Observing System.
2. U.S. Integrated Ocean Observing System. (2013). *U.S. IOOS Summit Report: A New Decade for the Integrated Ocean Observing System*. U.S. Integrated Ocean Observing System.
3. Bojinski, Stephan, Michel Verstraete, Thomas C. Peterson, Carolin Richter, Adrian Simmons, and Michael Zemp. (2014). The concept of essential climate variables in support of climate research, applications, and policy. *Bulletin of the American Meteorological Society* 95, no. 9: 1431-1443.
4. Southern California Coastal Ocean Observing System. (2016). *By-Laws*. Integrated Ocean Observing System.
5. Kessouri, F., McLaughlin, K., Sutula, M. A., Bianchi, D., Ho, M., McWilliams, J. C., ... & Leinweber, A. (2020). Configuration and validation of an oceanic physical and biogeochemical model to investigate coastal eutrophication: case study in the Southern California Bight.
6. Deutsch, C., Emerson, S., & Thompson, L. (2006). Physical-biological interactions in North Pacific oxygen variability. Journal of Geophysical Research: Oceans, 111(C9).
7. Deutsch, C., Penn, J. L., & Seibel, B. (2020). Metabolic trait diversity shapes marine biogeography. *Nature*, *585*(7826), 557-562.
8. Di Lorenzo, E., & Mantua, N. (2016). Multi-year persistence of the 2014/15 North Pacific marine heatwave. *Nature Climate Change*, *6*(11), 1042-1047.
9. Anderson, C. R., Kudela, R. M., Kahru, M., Chao, Y., Rosenfeld, L. K., Bahr, F. L., ... & Norris, T. A. (2016). Initial skill assessment of the California harmful algae risk mapping (C-HARM) system. *Harmful Algae*, *59*, 1-18.
10. McCabe, R. M., Hickey, B. M., Kudela, R. M., Lefebvre, K. A., Adams, N. G., Bill, B. D., ... & Trainer, V. L. (2016). An unprecedented coastwide toxic algal bloom linked to anomalous ocean conditions. *Geophysical Research Letters*, *43*(19), 10-366.
11. Howard, M. D., Sutula, M., Caron, D. A., Chao, Y., Farrara, J. D., Frenzel, H., ... & Sengupta, A. (2014). Anthropogenic nutrient sources rival natural sources on small scales in the coastal waters of the Southern California Bight. *Limnology and Oceanography*, *59*(1), 285-297.
12. Hauri, C., Gruber, N., Plattner, G. K., Alin, S., Feely, R. A., Hales, B., & Wheeler, P. A. (2009). Ocean acidification in the California current system. *Oceanography*, *22*(4), 60-71.
13. Mantyla, A. W., Bograd, S. J., & Venrick, E. L. (2008). Patterns and controls of chlorophyll-a and primary productivity cycles in the Southern California Bight. *Journal of Marine Systems*, *73*(1-2), 48-60.
14. The Port of Los Angeles. (2020). *Facts and Figures*.
15. Port of San Diego. (2019). *An Economic Engine for the San Diego Region* [Brochure].
16. California Ocean Protection Council Science Advisory Team. (2020). *Position Statement*. California Natural Resources Agency. State of California.
17. FAO. (2020). *The State of World Fisheries and Aquaculture 2020*. *Sustainability in action*. Rome.
18. Ocean Protection Council. (2020). *Consideration of Authorization to Disburse Funds to Develop a Statewide Aquaculture Action Plan*.
19. Griggs, G., Cayan, D., Tebaldi, C., Amanda Fricker, H., Arvai, J., DeConto, R., ... & Fox, J. (2017). Rising Seas in California-An Update on Sea-Level Rise Science.
20. Proposition 40: The California Clean Water, Clean Air, Safe Neighborhood Parks, and Coastal Protection Act of 2002. 2002 Resources Bond Act.
21. Proposition 50: Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002. Water Bond Act.

22. Organisation for Economic Co-operation and Development. (2019). Rethinking Innovation for a Sustainable Ocean Economy. OECD iLibrary.
23. The Global Ocean Observing System (GOOS). (2020).
24. California Ocean Protection Council. (2020). *Strategic Plan to Protect California's Coast and Ocean 2020-2025*. California Natural Resources Agency. State of California.
25. NMFS 2017. Fisheries Economics of the United States, 2015. U.S. Dept. of Commerce, NOAA Tech. Memo. NMFS-F/SPO-170, 247p.
26. Laird, J., Whitman, R., Nichols, B., Newton, J., Rosenfeld, L., Thomas, J. (2012). *Memorandum of Understanding West Coast Governors Alliance on Ocean Health & West Coast Ocean Observing Systems*.
27. Intergovernmental Oceanographic Commission of UNESCO. (2020). *United Nations Decade of Ocean Science for Sustainable Development 2021 - 2030 Implementation Plan. V 2.0*.
28. MacKenzie, B., L. Celliers, K. Larkin, L.P.F. Assad, J.J. Heymans, N. Rome, J. Thomas, C.
29. Southern California Coastal Ocean Observing System. (2020). *CA HAB Bulletin*.
30. IOOS. (2020). Advancing the West Coast Ocean Forecasting System.
31. Showcase Summary: Integrated Ocean Observing for a Changing California Coastline. (2019). Sacramento, CA.
32. Intergovernmental Oceanographic Commission of UNESCO. (2020). *United Nations Decade of Ocean Science for Sustainable Development 2021 - 2030 Implementation Plan. V 2.0*.
33. United Nations Development Programme. (2020). *Goal 14: Life Below Water*.
34. Ocean Observations 2019. (2019). *Session Recommendations*.
35. Southern California Coastal Ocean Observing System. (2003). *Memorandum of Understanding*. Integrated Ocean Observing System.
36. AltaSea and Southern California Coastal Ocean Observing System. (2017). *MOU Between AltaSea and SCCOOS.*
37. Northwest Association of Networked Ocean Observing Systems (NANOOS), Central and Northern California Ocean Observing System, Southern California Coastal Ocean Observing System. (2011). *MOU Between NANOOS, CeNCOOS and SCCOOS.*
38. U.S. Integrated Ocean Observing System and Southern California Coastal Ocean Observing System. (2017). *MOU Between IOOS and SCCOOS.*
39. West Coast Governors Alliance (WCGA) on Ocean Health (2012). *Memorandum of Understanding West Coast Governors Alliance on Ocean Health & West Coast Ocean Observing Systems*.
40. Southern California Coastal Ocean Observing System Operational Plan. (2016).
41. Southern California Coastal Ocean Observing System Strategic Plan FY16-21. (2016).
42. The Ocean Enterprise: A study of US business activity in ocean measurement, observation and forecasting. (2015). Integrated Ocean Observing System. Prepared by ERISS Corporation The Maritime Alliance.
43. A Plan to Meet the Nation's Needs for Surface Current Mapping. (2015). Integrated Ocean Observing System. Prepared for the Interagency Working Group on Ocean Observations.
44. Chao, Y., Farrara, J. D., Zhang, H., Armenta, K. J., Centurioni, L., Chavez, F., ... & Walter, R. K. (2018). Development, implementation, and validation of a California coastal ocean modeling, data assimilation, and forecasting system. *Deep Sea Research Part II: Topical Studies in Oceanography*, 151, 49-63.
45. Southern California Coastal Ocean Observing System. (2020). *Ports and Harbors.*
46. Southern California Coastal Ocean Observing System. (2020). *The Under-Keel Clearance Project.*
47. Southern California Coastal Ocean Observing System. (2020). *Naval Air Systems Command.*
48. Southern California Coastal Ocean Observing System. (2020). *Automatic Identification System (AIS).*

49. U.S. Integrated Ocean Observing System. (2016). Manual for Real-Time Quality Control of Water Level Data Version 2.0: A Guide to Quality Control and Quality Assurance of Water Level Observations. 46 pp.
50. NOAA Tides and Currents. (2020). *The Coastal Inundation Dashboard*.
51. NOAA Integrated Ocean and Coastal Mapping. (2020). https://iocm.noaa.gov/
52. The Nippon Foundation-GEBCO Seabed 2030 Project. https://seabed2030.org/
53. Southern California Coastal Ocean Observing System. (2020). *Imperial Beach Flood Forecasts*.
54. U.S. Integrated Ocean Observing System. (2009). *A National Operational Wave Observation Plan*.
55. Southern California Coastal Ocean Observing System. (2020). *Storm Photo*.
56. Coastal Data Information Program. (2020). *CDIP Coastal Flooding Report Tool*.
57. Ramirez-Reyes, C., Brauman, K. A., Chaplin-Kramer, R., Galford, G. L., Adamo, S. B., Anderson, C. B., ... & Cord, A. F. (2019). Reimagining the potential of Earth observations for ecosystem service assessments. *Science of the Total Environment*, *665*, 1053-1063.
58. Living Action Plan. OceanObs 2019.
59. Anderson CR, Berdalet E, Kudela RM, Cusack CK, Silke J, O'Rourke E, Dugan D, McCammon M, Newton JA, Moore SK, Paige K, Ruberg S, Morrison JR, Kirkpatrick B, Hubbard K and Morell J. (2019). Scaling Up From Regional Case Studies to a Global Harmful Algal Bloom Observing System. *Front. Mar. Sci*. 6:250. doi: 10.3389/fmars.2019.00250
60. Bax, Nicholas J., Patricia Miloslavich, Frank Edgar Muller-Karger, Valerie Allain, Ward Appeltans, Sonia Dawn Batten, Lisandro Benedetti-Cecchi et al. (2019). A response to scientific and societal needs for marine biological observations. *Frontiers in Marine Science*, 6, 395.
61. Muller-Karger, F. E., Miloslavich, P., Bax, N. J., Simmons, S., Costello, M. J., Sousa Pinto, I., ... & Best, B. D. (2018). Advancing marine biological observations and data requirements of the complementary essential ocean variables (EOVs) and essential biodiversity variables (EBVs) frameworks. *Frontiers in Marine Science*, 6, 250.
62. Estes, M., Anderson C., Appeltans W., Bax N., Bednarsek N., Canonico, G. & … Fietzek P. (2020). Monitoring Life in the Sea is a Critical Component of Sustainable Blue Economies. Submitted to *Nature Communications*
63. Miloslavich, P., Bax, N. J., Simmons, S. E., Klein, E., Appeltans, W., Aburto-Oropeza, O., ... & Chiba, S. (2018). Essential ocean variables for global sustained observations of biodiversity and ecosystem changes. *Global Change Biology*, 24(6), 2416-2433.
64. Lombard, F., Boss, E., Waite, A. M., Vogt, M., Uitz, J., Stemmann, L., ... & Pearlman, J. (2019). Globally consistent quantitative observations of planktonic ecosystems. *Frontiers in Marine Science*, 6, 196.
65. Canonico, G., Buttigieg, P. L., Montes, E., Stepien, C. A., Wright, D., Benson, A., ... & Saeedi, H. (2019). Global observational needs and resources for marine biodiversity. *Frontiers in Marine Science*, 6, 367.
66. Attaining an Operational Marine Biodiversity Observation Network (MBON) Synthesis Report. (2010).
67. U.S. West Coast Biological Observations Workshop Summary Report: Identifying Regional Needs and Priorities for Animal Telemetry and Biodiversity Observations of Aquatic Species. (2018).
68. California Ocean Protection Council and California Ocean Science Trust. (2018). *State of California Ocean Acidification Action Plan*. State of California.
69. Weisberg, S.B, Chan, F., Barry, J.P., Boehm, A.B., Busch, S., Cooley, S.R., Feely R.A., Levin, L.A. Enhancing California's Ocean Acidification and Hypoxia Monitoring Network. California Ocean Science Trust, Sacramento, California, USA. June 2020

70. Harada, A. E., Lindgren, E. A., Hermsmeier, M. C., Rogowski, P. A., Terrill, E., & Burton, R. S. (2015). Monitoring spawning activity in a Southern California marine protected area using molecular identification of fish eggs. *PloS one*, *10*(8), e0134647.
71. Emery, B. M., Washburn, L., Love, M. S., Nishimoto, M. M., & Ohlmann, J. C. (2006). Do oil and gas platforms off California reduce recruitment of bocaccio (Sebastes paucispinis) to natural habitat? An analysis based on trajectories derived from high-frequency radar. *Fishery Bulletin*, *104*(3), 391-400.
72. Nishimoto, M. M., Washburn, L., Love, M. S., Schroeder, D. M., Emery, B. M., & Kui, L. (2019). Timing of juvenile fish settlement at offshore oil platforms coincides with water mass advection into the Santa Barbara Channel, California. *Bulletin of Marine Science*, *95*(4), 559-582.
73. Zelenke, B., Moline, M. A., Crawford, G. B., Garfield, N., Jones, B. H., Largier, J. L., ... & Washburn, L. (2009, October). Evaluating connectivity between marine protected areas using CODAR high-frequency radar. In *OCEANS 2009* (pp. 1-10). IEEE.
74. Southern California Coastal Ocean Observing System. (2020). *Tijuana River Plume Trajectories*.
75. U.S. Underwater Glider Workshop Report. (2017). Infinity Science Center, MS.
76. California HABMAP. (2020).
77. California Ocean Protection Council. (2020). *Strategic Plan to Protect California's Coast and Ocean 2020-2025*. California Natural Resources Agency.
78. *Framing the Science Around Harmful Algal Blooms and California Fisheries: Scientific Insights, Recommendations and Guidance for California.* (2016). California Ocean Science Trust, Oakland, CA.
79. U.S. Integrated Ocean Observing System. (2020). *U.S. IOOS FY20 National Harmful Algal Bloom Observing Network Awards*.
80. NOAA National Centers for Coastal Ocean Science. (2020). *NCCOS FY20 Harmful Algal Bloom Program Awards*.
81. NOAA. (2020). *NOAA Artificial Intelligence Strategy: Analytics for Next Generation Earth Science*.
82. NOAA. (2015). *A Strategic Vision For Noaa's Ecological Forecasting Roadmap 2015-2019*.
83. NOAA. (2020). *NOAA 'Omics Strategy: Strategic Application of Transformational Tools*.
84. Anderson, C. R., Kudela, R. M., Kahru, M., Chao, Y., Rosenfeld, L. K., Bahr, F. L., ... & Norris, T. A. (2016). Initial skill assessment of the California harmful algae risk mapping (C-HARM) system. *Harmful Algae*, *59*, 1-18.
85. Bresnahan, P. J., Wirth, T., Martz, T., Shipley, K., Rowley, V., Anderson, C., & Grimm, T. (2020). Equipping smart coasts with marine water quality IoT sensors. *Results in Engineering*, *5*, 100087.
86. NOAA National Weather Service. (2019). *Building a Weather-Ready Nation: 2019-2022 Strategic Plan*.
87. Weisberg, S.B, Chan, F., Barry, J.P., Boehm, A.B., Busch, S., Cooley, S.R., Feely R.A., Levin, L.A. Enhancing California's Ocean Acidification and Hypoxia Monitoring Network. California Ocean Science Trust, Sacramento, California, USA. June 2020
88. NOAA. (2017). *National Strategy for a Sustained Network of Coastal Moorings*.
89. NOAA. (2020). *Our mission and vision: Science, service and stewardship*.
90. U.S. Integrated Ocean Observing System. (2018). *IOOS 2018-2022 Strategic Plan*.
91. CA OPC 2020-2025 strategic plan
92. NOAA Cetacean & Sound Mapping. (2020). *NOAA Ocean Noise Strategy Roadmap*.
93. NOAA. (2020). *NOAA 'Omics Strategy: Strategic Application of Transformational Tools*.
94. Gold, Z., Choi, E., Kacev, D., Frable, B., Burton, R., Goodwin, K., Thompson, A., Barber, P. (2020) FishCARD: Fish 12S California Current Specific Reference Database for Enhanced Metabarcoding Efforts. Molecular Ecology Resources - under revision.
95. Integrated Ocean Observing System (n.d.) *MBON Data Portal*.

96. Southern California Coastal Ocean Observing System. (2020). *Marine Protected Area Ecological Indicators*.
97. Bond, N. A., Cronin, M. F., Freeland, H., & Mantua, N. (2015). Causes and impacts of the 2014 warm anomaly in the NE Pacific. *Geophysical Research Letters*, 42(9), 3414-3420.
98. Di Lorenzo, E., & Mantua, N. (2016). Multi-year persistence of the 2014/15 North Pacific marine heatwave. *Nature Climate Change*, 6(11), 1042-1047.
99. Zaba, K. D., & Rudnick, D. L. (2016). The 2014–2015 warming anomaly in the Southern California Current System observed by underwater gliders. *Geophysical Research Letters*, 43(3), 1241-1248
100. 2015 Pacific Anomalies Science and Technology Workshop. Scripps Institution of Oceanography La Jolla, CA, USA May 5-6, 2015.
101. Newton, J.A., M. Jimenez Urias, L. Li, L. Li, K. O'Brien Beaumont, A. Shao, and H.B. Stone. (2016) Pacific Anomalies Workshop 2 Report: Summary and Recommendations of the Second Pacific Anomalies Science and Technology Workshop. Seattle, WA.
102. Bojinski, Stephan, Michel Verstraete, Thomas C. Peterson, Carolin Richter, Adrian Simmons, and Michael Zemp. "The concept of essential climate variables in support of climate research, applications, and policy." Bulletin of the American Meteorological Society 95, no. 9 (2014): 1431-1443.
103. Bograd, Steven J., Mercedes Pozo Buil, Emanuele Di Lorenzo, Carmen G. Castro, Isaac D. Schroeder, Ralf Goericke, Clarissa R. Anderson, Claudia Benitez-Nelson, and Frank A. Whitney. "Changes in source waters to the Southern California Bight." *Deep Sea Research Part II: Topical Studies in Oceanography* 112 (2015): 42-52.
104. Rudnick, D. L., Zaba, K. D., Todd, R. E., & Davis, R. E. (2017). A climatology of the California Current System from a network of underwater gliders. *Progress in Oceanography*, *154*, 64-106.
105. Schmidt, J. O., Bograd, S. J., Arrizabalaga, H., Azevedo, J. L., Barbeaux, S. J., Barth, J. A., et al. (2019). Future Ocean Observations to Connect Climate, Fisheries and Marine Ecosystems. *Front. Mar. Sci.* 6. doi:10.3389/fmars.2019.00550.
106. Litzow, M. A., Hunsicker, M. E., Bond, N. A., Burke, B. J., Cunningham, C. J., Gosselin, J. L., et al. (2020). The changing physical and ecological meanings of North Pacific Ocean climate indices. *Proc. Natl. Acad. Sci.*, 201921266. doi:10.1073/pnas.1921266117.
107. Jacox, M. G., Alexander, M. A., Bograd, S. J., & Scott, J. D. (2020). Thermal displacement by marine heatwaves. Nature, 584(7819), 82-86.
108. Di Lorenzo, Emanuele, Niklas Schneider, Kim M. Cobb, P. J. S. Franks, K. Chhak, Arthur J. Miller, James C. McWilliams et al. "North Pacific Gyre Oscillation links ocean climate and ecosystem change." Geophysical Research Letters 35, no. 8 (2008).
109. Wilkin, J., Rosenfeld, L., Allen, A., Baltes, R., Baptista, A., He, R., ... & Schwab, D. (2017). Advancing coastal ocean modelling, analysis, and prediction for the US Integrated Ocean Observing System. *Journal of Operational Oceanography*, *10*(2), 115-126.
110. NOAA. (2015). *A Strategic Vision for NOAA's Ecological Forecasting Roadmap: 2015 – 2019*.
111. NOAA. (2020). *NOAA Cloud Strategy: Maximizing the Value of NOAA's Cloud Services*.
112. NOAA. (2020). *NOAA Artificial Intelligence Strategy: Analytics for Next Generation Earth Science*.
113. Southern California Coastal Ocean Observing System. (2020). *North American Development Bank Border 2020: Evaluating the 2017 Cross-Border Wastewater Spill*.
114. Chao, Y., Farrara, J. D., Zhang, H., Armenta, K. J., Centurioni, L., Chavez, F., ... & Walter, R. K. (2018). Development, implementation, and validation of a California coastal ocean modeling, data assimilation, and forecasting system. *Deep Sea Research Part II: Topical Studies in Oceanography*, 151, 49-63.

115. Link, J., Tolman, H., Bayler, E., Brown, C., Burke, P, Carman, J… Robinson, K. (2017). *High-level NOAA Unified Modeling Overview.*
116. Anderson, C., Newton, J., Ruhl, H., Garfield, T., DeVogelaere, A., Moore, T., Edwards, C. (2019). West Coast Ocean Forecast System (WCOFS) – Coastal Ocean Model Testbed (COMT) Stakeholder Engagement Workshop Summary Report.
117. NOAA. (2015). *A Strategic Vision For Noaa's Ecological Forecasting Roadmap 2015-2019*.
118. Saeedi, H., Reimer, J. D., Brandt, M. I., Dumais, P. O., Jażdżewska, A. M., Jeffery, N. W., ... & Costello, M. J. (2019). Global marine biodiversity in the context of achieving the Aichi Targets: ways forward and addressing data gaps. *PeerJ*, *7*, e7221.
119. Bresnahan, P. J., Wirth, T., Martz, T., Shipley, K., Rowley, V., Anderson, C., & Grimm, T. (2020). Equipping smart coasts with marine water quality IoT sensors. *Results in Engineering*, *5*, 100087.
120. Southern California Coastal Ocean Observing System. (2020). *Certifications and Documents*.
121. Benson, Abigail & Brooks, Cassandra & Canonico, Gabrielle & Duffy, Emmett & Muller-Karger, Frank & Sosik, Heidi & Miloslavich, Patricia & Klein, Eduardo. (2018). Integrated Observations and Informatics Improve Understanding of Changing Marine Ecosystems. Frontiers in Marine Science. 5. 428. 10.3389/fmars.2018.00428.
122. Bushnell, M., Bailey, K., Bosch, J., Burge,r E. , Dorton J., Easley, R. , Heitsenrethe,r B. , King, J., Grissom K.,... Waldmann, C. (2020). QARTOD - Prospects for Real-Time Quality Control Manuals, How to Create Them, and a Vision for Advanced Implementation. U.S. IOOS Program Office.
123. https://coastwatch.pfeg.noaa.gov/erddap/information.htm

F. LETTERS OF SUPPORT

SCCOOS provides high-quality and reliable data, value-added information, and visualization products and tools to meet the needs of a diverse collaborative of marine stakeholders and users, including regional, state, and federal agencies as well as academia, businesses, and non-profit organizations. The following institutions have submitted a Letter of Support (LOS) and/or support statement enthusiastically endorsing the valuable data and services provided by the Southern California Coastal Ocean Observing System (SCCOOS) at the Scripps Institution of Oceanography, University of California San Diego.

In an effort to condense the LOS provided to SCCOOS, the key elements of the formal LOS are listed below. Links to the full LOS are provided and can also be found on the SCCOOS Partners Program Page (https://sccoos.org/partner-programs/). We have also enclosed some of our strongest LOS, such as those from the City of Los Angeles, The Marine Exchange of Southern California, and the Southwest Fisheries Science Center.

1. AltaSea at the Port of Los Angeles
2. Baja Aqua Farms
3. Birch Aquarium at Scripps
4. Bureau of Ocean Energy Management
5. California Coastal Commission
6. California Department of Fish and Wildlife, Office of Spill Prevention and Response - Thomas Cullen
7. California Department of Fish and Wildlife, Office of Spill Prevention and Response - David Lyons
8. California Department of Fish and Wildlife, Office of Spill Prevention and Response - Alice Nash
9. California Department of Fish and Wildlife, Office of Spill Prevention and Response - Corinne Gibble
10. California Environmental Protection Agency (EPA), Office of Environmental Health Hazard Assessment
11. California Natural Resources Agency, California Ocean Protection Council
12. California Ocean Science Trust
13. California Sea Grant
14. California Shore and Beach Preservation Association
15. California Wildlife Center
16. Carlsbad Aquafarm
17. Carnival Cruise Line
18. Center for Research on Educational Equity, Assessment and Teaching Excellence
19. Channel Islands Marine and Wildlife Institute
20. City of Del Mar
21. City of Imperial Beach
22. City of Los Angeles, LA Sanitation and Environment
23. City of Newport, Newport Beach Fire Department
24. City of San Diego
25. City of Santa Barbara
26. City of Santa Barbara, Santa Barbara Harbor Patrol
27. City of Santa Monica, Santa Monica Police Harbor Patrol
28. Coastal Data Information Program
29. CODAR Ocean Sensors

30. Desert Research Institute, Western Regional Climate Center
31. Elkhorn Slough National Estuarine Research Reserve
32. Heal the Bay
33. Jacobsen Pilot Service Inc.
34. Los Angeles Waterkeeper
35. Marine Animal Rescue
36. Marine Exchange of Southern California
37. Marine Mammal Care Center Los Angeles
38. Monterey Abalone Company
39. National Marine Sanctuary Foundation
40. Naval Air Weapons Station China Lake
41. NOAA, Channel Islands National Marine Sanctuary
42. NOAA, National Geodetic Survey
43. NOAA, National Marine Fisheries Service
44. NOAA, National Weather Service
45. NOAA, Office of National Marine Sanctuaries, West Coast Region
46. NOAA, Office of Response and Restoration, Emergency Response Division
47. NOAA, Southwest Fisheries Science Center
48. Ocean Discovery Institute
49. Ocean Rainforest, Inc.
50. One Health Institute and Karen Drayer Wildlife Health Center
51. Orange County Sanitation District
52. Pacific Coast Federation of Fishermen's Associations
53. Pacific Coast Shellfish Growers Association
54. Pacific Marine Mammal Center
55. Port of San Diego
56. San Diego Coastkeeper
57. San Diego County MPA Collaborative
58. San Diego Regional Water Quality Control Board
59. Santa Barbara Adventure Company
60. Scientific Research and Education Network (SciRen) San Diego
61. SeaTactics LLC
62. SeaWorld San Diego
63. Southern California Coastal Water Research Project
64. Surfrider Foundation
65. The Marine Mammal Center
66. The Ocean Foundation
67. Tijuana River National Estuarine Research Reserve
68. TMA BlueTech
69. United States Coast Guard, District Eleven
70. United States Coast Guard, Office of Search and Rescue

71. United States Sailing Team
72. University of San Diego, Environment, Health and Safety
73. University of Southern California Sea Grant Program
74. West Coast Ocean Data Portal
75. WiLDCOAST
76. Wild Neighbors Database Project

AltaSea at the Port of Los Angeles (MOU & Support Statement)

SCCOOS is an essential educational partner of AltaSea at the Port of Los Angeles; we share a mission to inspire and create a strong ocean-STEM workforce and accelerate young leaders in the Blue Economy, especially in underserved communities. The comprehensive resources of SCCOOS, AltaSea, and our other partners provide strong ocean science content and connections for a range of K-12 education experiences, including in-class instruction, workshops, training, internships and other learning resources. Currently, AltaSea and SCCOOS are joining efforts to create opportunities in STEM for underserved and underrepresented K-12 communities through programs showcasing ocean observing related careers and informal learning. Through this collaboration, we are aspiring to introduce these students to unique learning opportunities with AltaSea tenants and partners, and create lasting connections to Ocean-STEM.

Meredith Brooks, Strategic Grants & Special Projects Manager
AltaSea at the Port of Los Angeles 11/14/2020

Baja Aqua Farms (LOS 2019)

We are a company that fattens Bluefin Tuna, we have 19 consecutive years of operation. To satisfy the market we keep tuna throughout the year, solving the challenges that this brings. We currently operate in Isla Coronado South Mexico at 17.5 nautical miles from San Diego CA. We have 350 permanent jobs, 1,200 suppliers with an important social impact in California and Baja California. Every day, we consult on SCCOOS website information to monitor temperature, ocean currents, chlorophyll we cross their indicators with ours. With this information, we project our operation and even modify it. We also use the monthly summaries of HAB and El Nifio as a reference. It is very important for the actual mariculture the constant monitoring of the ocean, it is no longer possible to operate in a responsible way without it. Not having this information tool would stop an industry that has continued growth for 20 years and could result in a significant social impact, worryingly negative. What affects the Southern California Coast directly affects the Baja California Coast.

Not only do we need information from SCCOOS, it is extremely important to add it to other institutions. As acompany, we are doing everything possible to help SCCOOS and Baja California institutions like CICESE and UABC together consolidate the monitoring network for HAB.

Javier Vivanco Ocampo, Deputy Director of Operations
Baja Aqua Farms 2/5/2019

Birch Aquarium at Scripps (LOS 2020)

For the past ten years, the UCSD Birch Aquarium has displayed a touch screen kiosk with real-time, local SCCOOS data, making a direct connection with the general public. With so much usage, the hardware is worn out and the software needs updating. With SCCOOS, we hope to create new ways to invite people to explore oceanographic data. Knowing what's happening along our coast supports human livelihoods and leisure.

At Birch Aquarium, we connect understanding to protecting our ocean planet. We draw on scientific and cultural knowledge to inform action, so we can co-create a healthy planet. Public engagement with SCCOOS data advances these goals.

Nan Renner, Ph.D.
Senior Director of Learning Design and Innovation
Birch Aquarium at Scripps Institution of Oceanography
Learning Sciences Advisor, CREATE 11/11/2020

Bureau of Ocean Energy Management (LOS 2020)

BOEM, in the Pacific Region, has responsibilities for leasing and plans for energy development on the outer continental shelf (OCS) in Washington, Oregon, California and Hawaii. As part of the leasing and plans processes BOEM conducts environmental analysis to meet the requirements of the National Environmental Policy Act (NEPA) and consultations for the Endangered Species Act (ESA). Subject matter experts within BOEM utilize data provided by SCCOOS for these environmental analyses for the OCS off of California. It is important that BOEM continues to have access to Ocean Observing data for our ongoing operations.

SUSAN ZALESKI Digitally signed by SUSAN ZALESKI Date: 2020.11.10 14:17:16 -08'00'

Susan F. Zaleski, Marine Ecologist
BOEM Pacific Regional Office 11/10/2020

California Coastal Commission (LOS 2020)

The California Coastal Commission is a small State agency that is charged with protection and managing coastal resources in California. The mission of the Commission is to implement the Coastal Act, to provide for balanced use of the coastal zone, and to provide for balanced use of the coastal zone and to protect, restore and enhance coastal and marine resources for the continued benefit of current and future generations. It is important that staff has awareness of and access to a broad range of scientific information to help inform the Commission's planning and regulatory processes. The work supported through SCCOOS and CeNCOOS greatly helps by providing the best available science on oceanographic conditions. Information from these OOS partners has helped with the understanding of shoreline change, and rapid identification of resources that might be at-risk from oil spills, to name but a few.

Kate Huckelbridge

Kate Huckelbridge, Ph.D., Deputy Director
California Coastal Commission 11/16/2020

California Department of Fish and Wildlife, Office of Spill Prevention and Response (LOS 2020)

In the event of a significant marine oil spill, and in support of drills and exercises to maintain preparedness for such events, OSPR and the National Oceanic and Atmospheric Administration (NOAA) utilize the HF radar data as a tool to understand and forecast the movement of spilled oil based on the local currents in the spill area. Currents and wind are the primary influences of the trajectory of spilled oil in a marine setting. High quality HF radar data helps OSPR and NOAA to: 1) more accurately forecast where spilled oil will be carried; 2) develop and implement appropriate response strategies to protect our natural resources; and 3) effectively contain and recover spilled oil. While large offshore oil spills are fortunately very rare events, when they do happen it is important that we are able to rely upon the SCCOOS HF radar to better predict trajectories and plan response operations.

Thomas M. Cullen Jr., Administrator
CDFW, Office of Spill Prevention and Response 11/12/2020

California Department of Fish and Wildlife, Office of Spill Prevention and Response (LOS 2020)

At CDFW-OSPR, the Ocean Observing data within Southern California is an extremely valuable resource for oil spill preparedness and response. Common practice for our staff is to use NOAA's Environmental Response Management Application for viewing real time buoy and high frequency radar wind data from SCCOOS to develop an oil spill trajectory during an exercise or actual spill. End users such as Surfline and Magicseaweed use SCCOOS data to generate their surf and weather forecasts which are helpful for oil spill response planning. In addition to this, that same SCCOOS data is useful for evaluating real time weather and safety conditions for on-water equipment deployments.

David Lyons, Environmental Scientist
CDFWe, Office of Spill Prevention and Response 11/25/2020

California Department of Fish and Wildlife, Office of Spill Prevention and Response (Support Statement 2020)

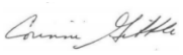
I use SCCOOS data regularly. When I receive a dispatch notification of an oil spill in the ocean, I use SCCOOS data and products to calculate a back-of-the-envelope trajectory. This trajectory is used to make tactical decisions for resource protection, and I couldn't do my job well without it.

Alice Nash, Environmental Scientist
CDFW, Office of Spill Prevention and Response

California Department of Fish and Wildlife, Office of Spill and Response, Marine Wildlife Veterinary Care & Research Center (LOS 2020)

The OSPR-CDFW Seabird Health Program at the Marine Wildlife Veterinary Care and Research Center, employs a goal to monitor the health and pathology of marine birds to support the best achievable care of oiled wildlife and detect emerging threats to seabird populations. Because seabird health and population trends often track in tandem with oceanographic conditions, we believe SCCOOS and CeNCOOS provide invaluable tools to aid our investigations. The benefits of public-facing ocean observing information is vast, and our uses are multifaceted. We regularly have a need for oceanographic hindcasting, nowcasting, and

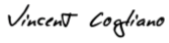
forecasting to examine seabird mortality events and oiling events statewide. This type of information is also crucial to other regional state biologists and non-profit organizations that examine the causes of morbidity and mortality in marine wildlife populations.



Dr. Corinne M. Gibble, Environmental Scientist
Seabird Program, Marine Wildlife Veterinary Care & Research Center, CDFW 10/22/2020

California Environmental Protection Agency (EPA), Office of Environmental Health Hazard Assessment (OEHHA) (LOS 2020)

The Office of Environmental Health Hazard Assessment has most recently used ocean observations in California to provide general context for our work on assessing health risks and control measures for domoic acid in our fishery program. We are now relying on these ocean observations for harmful algal bloom-related illnesses in marine mammals and birds.



Vincent Cogliano, Deputy Director of Scientific Programs
CA EPA, OEHHA 11/3/2020

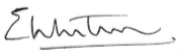
California Natural Resources Agency, California Ocean Protection Council (LOS 2020)

The mission of the OPC is to ensure that California maintains healthy, resilient, and productive ocean and coastal ecosystems for the benefit of current and future generations. The OPC is committed to basing its decisions and actions on the best available science, and to promoting the use of science among all entities involved in the management of ocean resources. SCCOOS and CeNCOOS provide the OPC with data that enables us to make better natural resources management decisions, in particular in the areas of the impacts of sea level rise, fate and transport of contaminant plumes, and harmful algal blooms. As an example, the HAB network, which uses OOS data, is used to make fisheries management (Dungeness crab – our number one fishery in the state) and public health decisions. Also, as we see the growing impacts of ocean acidification and hypoxia, the use of the ocean observing system and the need for additional monitoring has become even more critical.

Mark Gold, D.Env., Executive Director
California Ocean Protection Council, CNRA 2/3/2020

California Ocean Science Trust (LOS 2020)

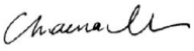
The California Ocean Science Trust is more effective in delivering information on the state of our oceans to policy-makers and managers because of the data collected by programs such as CeNCOOS and SCCOOS. As science-based decision support programs, the California Ocean Observing Systems (CeNCOOS and SCCOOS) collaborate with local, state and federal agencies, tribes, resource managers, industry, policy makers, educators, scientists and the general public to provide data, models and products that advance our understanding of the current and future state of our coastal and global ocean. SCCOOS and CeNCOOS focus on high-priority regional requirements to provide the information necessary to address marine operations, coastal hazards, climate variability and change, and ecosystems, fisheries, and water quality.



Liz Whiteman, Executive Director
California Ocean Science Trust 11/16/2020

California Sea Grant (LOS 2020)

I am writing this letter of support in my role as the Director of California Sea Grant (CASG), a multifaceted program funded by the National Oceanic and Atmospheric Administration (NOAA) with a broad series of mandates which include supporting research, extension and outreach, work-force development, education and communication throughout the state of California to increase the understanding of, responsible interaction with, and use of coastal and marine resources. CASG is jointly supporting an Ecological Model and Indicator Postdoctoral Researcher with the California Ocean Observing Systems, who is supporting the curation of datasets (Seascapes, C-HARM, EcoCAST) that provide the backbone of automated data and model output delivery to the longterm MPA monitoring network. The postdoctoral researcher's contributions will generate the development of spatially explicit view of potential risk to a multitude of stressors and changing conditions (sea surface temperatures, variations in acidity, dissolved oxygen, nutrients, harmful algal blooms and marine disease) at an MPA. This very innovative and collaborative project, which includes managers at California Department of Fish and Wildlife and the California Ocean Protection Council and other marine scientists at California universities, aims to integrate data from various investigators, locations, habitats and methods to produce robust assessments of change in key indicators that are useful for MPA management.



Shauna Oh, Director
California Sea Grant 11/10/2020

California Shore and Beach Preservation Association (LOS 2020)

On behalf of the California Shore & Beach Preservation Association (CSBPA) Board of Directors, I enthusiastically endorse the valuable data and services provided by the Southern California Coastal Ocean Observing System (SCCOOS) at the Scripps Institution of Oceanography, University of California San Diego. Our Board members are from along the entire California coast and are very much in support of the entire state-wide collaborative, i.e. including the Central & Northern California Ocean Observing System (CeNCOOS).

CSBPA is an educational and professional association with members from government, academia, industry, and individuals – all of whom are interested in the coast of California. We promote the prudent management of our coast and preserving, protecting, and enhancing our coasts by merging science and public policy. SCCOOS data are fundamental to our science-based decision making and highly utilized by CSBPA members and affiliates.

Kim Garvey, President
California Shore and Beach Preservation Association 10/6/2020

California Wildlife Center (LOS 2020)

On behalf of California Wildlife Center, I enthusiastically endorse the valuable data and services provided by the Southern California Coastal Ocean Observing System (SCCOOS) at the Scripps Institution of Oceanography, University of California San Diego. California Wildlife Center rescues, rehabilitates and returns to their natural environment, marine mammals in the Southern California Bight. Pinnipeds, particularly California sea lions, are rescued suffering from exposure to the neurotoxin causing domoic acid toxicity. We respond to the greatest number of California sea lions each year. Additional information warning of potentially hazardous blooms aids us when planning and allocating resources necessary for their care.

Jennifer Brent, Executive Director
California Wildlife Center 9/30/2020

Carlsbad Aquafarm (LOS 2020)

Carlsbad Aquafarm has been sustainably farming shellfish since 1991. Our farm's operating principle is "Restoration Aquaculture," where priority is given to restoring the ecological health of the lagoon where we grow our shellfish. We also participate in Living Shoreline Restoration projects throughout Southern California. The success of these projects depend on oyster settlement, which are impacted by changes in ocean chemistry and nutrient levels. We have found the SCCOOS data to be invaluable in providing real time data on the highly dynamic ocean chemistry in establishing healthy oyster reefs in these vital estuaries and helping inform our farm's shellfish operations.

I truly believe in the great work SCCOOS does, and their undaunted, relentless vigilance in helping tradesmen, such as myself and others who work and farm sea, become more aware of the otherwise invisible threats and challenges and rapidly changing conditions of the modern urban, coastal environment. SCCOSS posts the vital signs of the living ocean, much like the monitors in an OR, except your patient straddles miles of square miles.

Thomas Grimm, CEO and President
Carlsbad Aquafarm 10/29/2020

Carnival Cruise Line (LOS 2020)

On behalf of Carnival Cruise Line, I enthusiastically endorse the valuable data and services provided by SCCOOS. We are a major Cruise line, operating in Long Beach and lately from San Diego and San Francisco. At present we have four vessels operating in the area. Our terminal in Long Beach is exposed to Ocean ground Swell, at certain time of the year. Your data helps tremendously to plan for a safe approach and mooring. Since we use your data, we have reduced the number of mooring lines breakage and unsafe situations, during docking, people transfer on/off the ship and during bunkering operation. We also connect to shore power (clean energy) in Long Beach and San Diego, therefore you can imagine how critical is a safe mooring in presence of ground swell.

SALVATORE RASSELLO

Salvatore Rassello, Director of Nautical Planning
Carnival Cruise Line 1/15/2020

Center for Research on Educational Equity, Assessment and Teaching Excellence (CREATE) (LOS 2020)

CREATE's Research & Evaluation team has clear and demonstrated expertise in both qualitative and qualitative education-focused research and evaluation. We have successfully served as evaluators on a long list of projects, including grants from agencies such as the National Science Foundation, the Office of Naval Research, the Department of Defense Education Activities, the U.S. Department of Education, the Carnegie Corporation, the Howard Hughes Foundation, and the Spencer Foundation. I am CREATE's Co-Director of Research and Evaluation, and am a quantitative and developmental psychologist with a long history of education-related research. I also have over 20 years of evaluation experience, and have successfully led dozens of evaluations of externally funded STEM-related education programs and have served in a consulting capacity on dozens more.

The SCCOOS team has asked me, as CREATE's Co-Director of Research and Evaluation, to act in a consulting capacity on their expanded work plan—or more specifically, to consult on their education and outreach assessment and evaluation efforts. I'm excited to do so, and look forward to building a stronger collaborative relationship between SCCOOS and CREATE in the future.

In sum, should the current proposal be selected for funding, it is my intent to act on CREATE's behalf in an evaluation and assessment consulting capacity on the education and outreach components of the project…"

Monica A Sweet, Co-Director of Research and Evaluation
CREATE 11/3/2020

Channel Islands Marine and Wildlife Institute (LOS 2020)

CIMWI, a 501c3 nonprofit, is the only organization permitted to rescue and rehabilitate marine mammals along the Southern coast of California's Santa Barbara and Ventura counties which includes 155 miles of coastline. CIMWI sends a monthly report to SCCOOS with marine mammal stranding information regarding suspected domoic acid cases with details including stranding sight, GPS, species, age class and severity of illness. Domoic acid is of particular interest and concern because it can cause sickness and fatality in humans. Marine mammals are sentinels of both local and widespread ocean environments. They eat what we eat, so information regarding domoic acid strandings and animal health has important implications to public health.

SCCOOS provides a one-of-a-kind service by collecting and making ocean data public knowledge benefiting scientists, researchers and public health officials. CIMWI uses the domoic acid data provided by the monthly SCCOOS report to monitor domoic acid along the California coast in order to be at the ready for heightened stranding volumes and put resources in place to respond to these animals. CIMWI plans to use additional data compiled by SCCOOS in the future to explore trends in local ocean conditions in relation to high stranding events (non-domoic acid related) to enable us to better predict when and where our resources would be most needed.

Ruth Dover, Director
Channel Islands Marine and Wildlife Institute 11/18/2020

City of Del Mar (Support Statement 2020)

In my dual roles as policymaker for a coastal California city and as Professor at Scripps Institution of Oceanography, I have great appreciation for the importance of accurate and timely data gathered up and down the California coastline. High quality data gathered over many years provides firm foundations for good policy decisions and long-term planning. High quality data access tools and analytics gives broad access to pose questions and extract predictive patterns. SCCOOS makes both available -- data and data access -- reliably. I strongly endorse SCCOOS's application for renewal funding.

Terry Gaasterland, Deputy Mayor / Professor
City of Del Mar / University of California San Diego 10/15/2020

City of Imperial Beach (LOS 2020)

The City of Imperial Beach helped establish the San Diego Coastal Ocean Observing System in 2005 with funding provided by the California Clean Beach Initiative. The coastal monitoring supported by SCCOOS helps the City monitor and respond to impacts of pollution from the Tijuana River and other discharges that occur south of the border. Local government agencies rely on this data to make critical decision about when it is necessary to close the beach or post advisories when elevated pollution impacts public health. Understanding the impacts from pollution plumes also helps inform the development of binational solutions to control the discharge of pollution from Mexico.

Serge Dedina, Mayor
City of Imperial Beach 11/16/2020

City of Los Angeles, LA Sanitation and Environment (LOS 2020) - please see full LOS enclosed

"...Our monitoring effort greatly benefited from surface current information provided through SCCOOS. The real-time current information provided by SCCOOS enabled us to adaptively modify our sampling grid to better track the discharge plume and to predict the dispersion of the surface plume by the use of a trajectory model developed by SCCOOS researchers using high frequency radar (HFR) data...The services that SCCOOS provided in 2006 and 2015 were invaluable to our monitoring efforts. We believe improved understanding of dispersion in the surfzone and offshore may similarly benefit our monitoring efforts in the future, as well as those of other monitoring agencies in southern California, for example, the LACSD, Orange County Sanitation Districts (OCSD), and the Southern California Coastal Water Research Project (SCCWRP), academic institutions, among several others..."

Massahiro Dojiri, PhD, BCES, Assistant General Manager
LA Sanitation and Environment, City of Los Angeles 10/27/2020

City of Newport, Newport Beach Fire Department (Support Statement 2020)

The Southern California Coastal Ocean Observation System (SCCOOS) has been a valuable partner for the Newport Beach Fire Department - Lifeguards and lifeguards up and down the California coast. The information provided by the SCCOOS Automated Shore Station assists our data-driven decisions for staffing and expected activity levels.

Ocean water temperature is a significant driver of activity, and the SCCOOS data gives our lifeguards up to the minute information to help determine appropriate staffing levels. The chlorophyll levels allow us monitor the precursors of red tide conditions before the condition becomes noticeably visible. The SCCOOS program is significant to the Lifeguards and ocean users, and we support the continuation of this valuable program.

Michael Halphide, Assistant Chief Lifeguard Operations
Newport Beach Fire Department 11/3/2020

City of San Diego (LOS 2020)

Briefly, the City conducts a comprehensive ocean monitoring program in order to monitor water quality conditions along the southern California and northern Baja California coasts. Although the program is specifically designed to assess the effects of wastewater discharged to the ocean via the Point Loma Ocean Outfall and South Bay Ocean Outfall, the City engages in additional enhanced monitoring activities to evaluate the influences of other anthropogenic factors or natural climatic events on regional ocean conditions. For example, the City has recently embarked on a multi-year project in collaboration with the Scripps Institution of Oceanography to deploy and operate new real-time ocean observing systems moored near the Point Loma and South Bay outfalls in order to further understand wastewater dispersion and emerging issues such as increasing levels of ocean acidification. Consequently, SCCOOS has become a vital resource to the City's monitoring program and interests, by providing standardized methods support, as well as context and reference for the data we are collecting, and opportunities for collaboration.

R Kempster

Ryan Kempster, PhD
Ocean Monitoring Program Manager 11/24/2020

City of Santa Barbara (Support Statement 2020)

The City of Santa Barbara fully supports the SCCOOS program. The data generated from the Stearns Wharf Automated Shore Station has assisted the City in determining the severity of algae blooms occurring near the desalination facility. Algae blooms cause difficulty in operating the desalination facility and having real time monitoring data available allows the City and its contract operators to make decision on the operations of the plant.

Gaylen Fair, Water Quality Superintendent
City of Santa Barbara 11/11/2020

City of Santa, Santa Barbara Harbor Patrol (Support Statement 2020)

The SCCOOS program provides the SB Harbor Patrol with historic and real time water temperature, chlorophyll and salinity. This information is valuable to the Waterfront and its users, most especially the

commercial fishing industry. The long term nature of the program provides valuable insight into environmental changes which cannot be measured or seen in a moment in time.

Monica Broumand, Santa Barbara Harbor Patrol Officer
City of Santa Barbara, Harbor Patrol 11/9/2020

City of Santa Monica, Santa Monica Police Harbor Patrol (Support Statement 2020)

We at the Santa Monica Harbor Patrol currently actively use the data SCCOOS (Southern California Coastal Ocean Observing System) provides. This data is useful when we conduct our dive operations around the Santa Monica Pier and Santa Monica Breakwall. For example, knowing the current temperature of the ocean allows us to prepare and plan for our dive(s), whether it is a maintenance dive, training, or rescue dive operation.Having this data is also beneficial because it allows us to answer questions regarding the ocean from the public. If SCOOS could post the times of the tides during the day, it would be greatly appreciated. We hope to continue to have this data available to us.

Philip Loy, Pier and Harbor Service Officer
City of Santa Monica, Santa Monica Police Harbor Patrol 11/24/2020

Coastal Data Information Program (LOS 2020)

CDIP is a wave observing network operated out the Scripps Institution of Oceanography, primarily funded by the US Army Corps of Engineers and California State Parks Division of Boating and Waterways. Quality controlled CDIP wave buoy data are released from each observing station every 30 minutes, including wave height, period, direction, and sea surface temperature. Our partnerships with SCCOOS and CeNCOOS are important for us to disseminate this information to government agencies, stakeholders and the general public effectively, and add value to our observations by placing them in context with other environmental data.

Dr. James Behrens, Program Manager
Coastal Data Information Program 9/30/2020

CODAR Ocean Sensors (LOS 2020)

CODAR Ocean Sensors specializes in the research, design, manufacturing and support of SeaSonde® high-frequency (HF) radar systems primarily for ocean current measurement, wave monitoring and tsunami detection. The SeaSonde HF radar system is the backbone of many regional ocean observing systems, including SCCOOS. Representing over 80% of the global oceanographic HF radar market, the SeaSonde has captured and quantified ocean response to many extreme weather events including hurricanes and winter storms, and also provides valuable data in emergency situations such as search and rescue and spill response. SeaSondes operate in over 30 countries with more than 140 in the U.S.. The close collaboration CODAR has with PI's and SeaSonde operators in SCCOOS has helped improve the data quality of the HFR network as well as develop tools to better manage and operate a large, regional scale HFR network.

Chad Whelan, Chief Technology Officer 11/4/2020

CODAR Ocean Sensors

Desert Research Institute, Western Regional Climate Center (LOS 2020)

The Western Regional Climate Center is one of six centers funded by the National Oceanic and Atmospheric Administration (NOAA) with a mission of delivering climate services and improving the coordination of climate-related activities at the national, state, and regional scales. Both CeNCOOS and SCCOOS have been regular contributors to the NOAA West Watch webinar series since 2016 with valuable ocean monitoring updates and insight to the latest research on marine and coastal systems. Stakeholders of the NOAA West Watch such as the National Weather Service, state climatologists, California Department of Water Resources, and universities across the region benefit greatly from these contributions as coastal and marine conditions strongly impact regional weather and climate. Another benefit of the partnership with CeNCOOS and SCCOOS has been learning about where and how to access ocean and coastal data that are unfamiliar to most in the weather and climate communities.

Dan McEvoy, Assistant Research Professor, Regional Climatologist
DRI/WRCC 11/2/2020

Elkhorn Slough National Estuarine Research Reserve (LOS 2020)

Here at ESNERR we are at the heart of the Monterey Bay where so many institutions, industries, and communities live, work and play in and among these precious waters. We not only provide space for individuals seeking a quiet stroll among the oaks on the shores of Elkhorn Slough but contribute in many ways to the local community such as professional development workshops for teachers, regional managers, researchers, and the like. Both CeNCOOS and SCCOOS play a vital role in our Coastal Training Program, our Research Program as well as our Education program. All three of our programs have benefited greatly from information provided by CeNCOOS. Our Research Program not only provides data to the system but also is also able to benefit from other sources of data within the system. For example we are often using data from local stations to investigate oceanographic phenomena to what we see in the estuary, in terms of higher water levels causing marsh dieback, warmer southern currents bringing southern species, etc

John Haskins, Water Quality Monitoring Scientist
Elkhorn Slough National Estuarine Research Reserve 11/9/2020

Heal the Bay (LOS 2020)

Heal the Bay and the Heal the Bay Aquarium actively rely on ocean water analysis to support our mission in creating healthy waters for both the surrounding human population and the displayed local marine life, respectively. Through a collaboration with SCCOOS and the proposed monitoring upgrades, we would be able to provide even more comprehensive data to support in these goals. The SCOOS scientific data ever further supports our core missions in advocating and educating about critical environmental issues such as ocean acidification and climate change.

Laura Rink

Laura Rink 11/24/2020

Associate Director of Aquarium Operations

Jacobsen Pilot Service Inc. (LOS 2020)

Our Pilots have been using this valuable information for many years now. We navigate some of the largest Very Large Crude Carriers (VLCC) that come into American waters and it's critical for us to monitor the swells closely so we can reduce the chance that the vessel will pitch or roll to a point of touching bottom. Also, during storm conditions we use the offshore wave data to predict the wave patterns at our Pilot Boarding area to ensure we can transfer our pilots onto the ships safely.

A successful project that we have completed is the PROTIDE program. This predictive modeling program takes information from CDIP offshore wave buoys and calculates if it is safe for us to bring in deep draft (VLCC's). This project is a partnership between SCCOOS/CDIP, Port of Long Beach, State of California (OSPR), Marathon Oil Company, the Marine Exchange, and our piloting company. The goal is to assure that our under keel clearance along the entire route into the port is safe at any given swell condition. PROTIDE has proven effective and is used continuously on VLCC's and will most likely be expanded to other type of vessels soon.

Captain Thomas A. Jacobsen, President/CEO
Jacobsen Pilot Service Inc. 11/15/2020

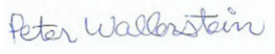
Los Angeles Waterkeeper (Support Statement 2020)

Los Angeles Waterkeeper would encourage a more in depth water monitoring station be put in place at the Santa Monica Pier. LA Waterkeeper was disappointed in the execution of and the termination of the monitoring program we were enthusiastically involved in at the pier. We have not actually been notified of any plans or updated on the situation there since we took part in a maintenance dive last year and hope to hear more at some time.

Michael Quill, Marine Programs Director
Los Angeles Waterkeeper 11/12/2020

Marine Animal Rescue (LOS 2020)

Marine Animal Rescue Specialists respond to and rescue marine mammals in Los Angeles County. We use the Ocean Observing data. to confirm what we sec in the field, which adds a valuable tool to our rescue organization. It is useful to MAR as it helps us respond to the calls, sometimes up to 500 responses/rescues in one year.



Peter Wallerstein, President
Marine Animal Rescue 9/30/2020

Marine Exchange of Southern California (LOS 2020) - please see full LOS enclosed

"...More than 28,000 vessels participated in the Vessel Traffic Service in 2019 and 4,550 large vessels arrived in the Los Angeles and Long Beach port complex. Each day, there are there are approximately 45

movements of some of the largest vessels in the world, and they are getting bigger. Container ships that are 1,300 feet long and carrying 14,000-18,000 containers are now common. Tankers that are 1,100 feet long, weigh 330,000 tons, and have a draft of up to 69 feet have been arriving routinely at the port of Long Beach since April 2017 due to SCCOOS/CDIP products.

In addition to the ports of Los Angeles and Long Beach, 274 vessels arrived at the Chevron Offshore Terminal in El Segundo, 461 arrived in San Diego, and 409 arrived in Port Hueneme in 2019. Bringing these ships safely into port is only possible if there is extremely accurate and reliable wave information such as provided by SCCOOS…"

J. Kipling Louttit, Captain, U.S. Coast Guard, Retired
Executive Director, Marine Exchange of Southern California and VTS LA/LB 10/20/2020

Marine Mammal Care Center Los Angeles (LOS 2020)

The Marine Mammal Care Center Los Angeles receives on average 350-400 stranded marine mammals each year. These animals suffer from a variety of maladies, but one of the most debilitating is domoic acid toxicity. The monthly report by SCCOOS on marine mammal strandings associated with confirmed or suspect cases of domoic acid exposure has been invaluable in helping us keep abreast of regional trends associated with harmful algal blooms. This timely assessment and informative format is helpful in our communication and engagement with the public to try to increase understanding and awareness of this environmental condition that has important implications for human and animal health.

Lauren Palmer, Hospital Director, Veterinarian
Marine Mammal Care Center Los Angeles 9/30/2020

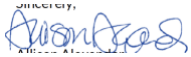
Monterey Abalone Company (LOS 2020)

Monterey Abalone Company is an in the ocean abalone farm located on Monterey's Commercial Wharf. Our abalone grow-out cages are suspended in the bay and are subject to the tides, storms, swells, algae blooms and temperature swings of the natural environment. Ocean observing information is crucial for us to have some advance notice of weather and oceanographic conditions. Parameters such as water temperature, pH, dissolved oxygen are very important locally. Because we harvest kelp to feed our abalone, imagery to estimate kelp biomass is very important to us locally and to Fish and Wildlife statewide (CDFW regulates kelp harvesting statewide). While satellite imagery is helpful, the resolution does not enable one to distinguish giant from bull kelp while drone imagery does. Your knowledge of benefits provided by CeNCOOS and SCCOOS to regional marine stakeholders and end-users. Recent concerns about kelp biomass and the explosion of the purple urchin populations have impacted our business and at least a dozen other businesses statewide. Without satellite imagery to assess stands of canopy forming kelps DCFW would not have had the necessary information to regulate the fishery.

Arthur Seavey, Partner
Monterey Abalone Company 10/19/2020

National Marine Sanctuary Foundation (LOS 2020)

The National Marine Sanctuary Foundation is the national non-profit partner to the National Marine Sanctuary System, and supports research and related activities in sanctuaries. Efforts to monitor underwater soundscapes in sanctuaries are already connected to the Foundation in several ways, including through funding from a cooperative agreement between NOAA and the Foundation that supports the West Coast Soundscapes Coordinator staff position (as of November 2020), and in other areas. The West Coast Soundscapes Coordinator is supported through funding awarded through a cooperative agreement with NOAA/NOS/Office of National Marine Sanctuaries (NA17NOS4290190 and NA19NOS4290190A). The Foundation also holds an MOA with NOAA/NOS/ONMS (MOA-2019-075) that states that the two organizations will work collaboratively to "[a]dvance conservation of national marine sanctuaries including through the support and development of scientific research, data collection and monitoring, and use of innovative technologies."



Allison Alexander, Vice-President
National Marine Sanctuary Foundation 11/30/2020

Naval Air Weapons Station China Lake (Support Statement 2020)

SCCOOS provides dedicated web space for personnel to get current weather data for the NAWS China Lake range. For customers who are not military affiliated this service is ideal for these people to get weather information for their tests.

Tamera Walters

Tamera Walters, Meteorologist
Naval Air Weapons Station China Lake 10/25/2020

NOAA, Channel Islands National Marine Sanctuary (LOS 2020)

While we engage a lot of partners in our own sanctuary-centric research and monitoring projects to understand what is happening in the sanctuary, we and our partners rely heavily on SCCOOS data to understand how physical oceanographic changes across the Southern California Bight are impacting the sanctuary. For example, these changes drive species distributions in space and time, the frequency and intensity of harmful algal blooms, the propensity for successful establishment of noxious invasive species, and the growth and productivity of key species.

We appreciate SCCOOS and CeNCOOS' ability to collaborate with us and to provide data, models and products that advance our understanding of the current and future state of our coastal and global environment. Sustained funding for SCCOOS and CeNCOOS is crucial to the maintenance of the program's ocean observing network and to the continuity of the important data products and services that these observations enable. The expansion of monitoring beyond physical and chemical oceanography to indicators of marine biodiversity trends via MBON is also a very important initiative that is critical to understanding ecosystem trajectories.

I sent a similar letter of support to SCCOOS in January of 2020, but I wanted to update this support with a note regarding some specific Tier 2 proposals that we hope IOOS supports. This includes the Ocean Sound Observation Network proposed along with our west coast regional partners (including other sanctuaries). It

also includes other proposed Tier 2 projects that are particularly relevant to CINMS including CalCOFI, telemetry, and UAS. We strongly support funding of all of these Tier 2 components because they will provide valuable information to support sanctuary research, monitoring, and management. By working together and leveraging our respective core strengths we can deliver timely, accurate, and cutting edge data products and services to the nation.

Chris Mobley, Superintendent
NOAA, Channel Islands National Marine Sanctuary 10/30/2020

NOAA, National Geodetic Survey (LOS 2020)

As NOAA's National Geodetic Survey's (NGS) Pacific Southwest Region Geodetic Advisor, I assist the geospatial communities throughout the Pacific South-West—including public- and private-sector ports, surveyors, GIS professionals, engineers, and scientists—with the National Spatial Reference System's proper application. Ocean Observing data within Southern California is tied to our mission through the National Spatial Reference System (NSRS) and has tangible, far-reaching societal benefits. The services provided by these programs are superb outreach programs, as their science and support are easily understandable and community inspiring, for both NOAA's National Ocean Service, as well as Scripps Institution of Oceanography, University of California San Diego.

Dana J. Caccamise II, Pacific Southwest Regional Advisor (CA, NV)
NOAA, National Geodetic Survey (NGS) 11/18/2020

NOAA, National Marine Fisheries Service, CCIEA Program (LOS 2020)

Information collected by NANOOS, CeNCOOS and SCCOOS is ideal for the work we do, and is already being incorporated into our efforts, including annual ecosystem status reporting to the Pacific Fishery Management Council and supporting National Marine Sanctuaries with their place based condition reports. Additional information of the sort proposed by the West Coast IOOS RAs would add considerable value to monitoring and ecosystem status and risk assessment: for example, expanded information on anthropogenic sound profiles at the scale of Sanctuaries would enhance their ability to assess conditions within their waters for species such as marine mammals, and may also support CCIEA scientists' assessments of risk for marine mammals that are also being affected by other stressors such as coastal habitat quality change and variability in forage. Further, developing good baselines of sound levels and variability is imperative to assessing changes and impacts that may be brought about by offshore renewable energy projects, deep sea mining, and other potential ocean uses that may affect fishery species and protected species.

Chris Harvey, Research Fisheries Biologist
Co-lead, California Current Integrated Ecosystem Assessment team
NOAA, National Marine Fisheries Service 11/13/2020

NOAA, National Weather Service (LOS 2020)

The National Weather Service in San Diego is responsible for protecting lives and property that are impacted

by weather, oceanic conditions, hydrological and other natural hazards across extreme Southern California. The products we receive from CDIP and Southern California Coastal Ocean Observing System (SCCOOS) greatly enhance our mission of saving lives and protecting property. The data assists NWS for daily coastal flooding, beach hazards, ocean temperature, ocean currents, wave height, surf, wind, tidal, and tsunami forecasts and warnings for the maritime and beach community. NWS forecasters monitor the online websites and the data directly ingested at our office on a daily basis.

Alex Tardy
Alex Tardy, Warning Coordination Meteorologist
NOAA, National Weather Service, San Diego 11/5/2020

NOAA, Office of National Marine Sanctuaries, West Coast Region (LOS 2020)

While we engage many partners in our sanctuary-centric research and monitoring projects, we and our partners rely heavily on SCCOOS and CeNCOOS data to understand how physical oceanographic, and increasingly biological, changes along the west coast are impacting sanctuary resources and ocean health (e.g., sanctuary condition reports). For example, these 2 physical changes drive species distributions in space and time, the frequency and intensity of harmful algal blooms, the propensity for successful establishment of introduced species, and the growth, distribution and productivity of key species.

We appreciate SCCOOS's and CeNCOOS's ability to collaborate with us and to provide data, models and products that advance our understanding of the current and future state of our coastal and global environment. Sustained funding for SCCOOS and CeNCOOS is crucial to the maintenance of the program's ocean observing network and to the continuity of the important data products and services that these observations enable. The expansion of monitoring beyond physical and chemical oceanography to indicators of marine biodiversity trends via MBON is also a very important initiative that is critical to understanding ecosystem trajectories.

Specific Tier 2 proposals that we encourage the Integrated Ocean Observing System (IOOS) to support include the Ocean Sound Observation Network proposed along with our west coast regional partners; CalCOFI; animal telemetry; UAS surveys; kelp canopy cover assessments by satellite; zooplankton, mammal and bird surveys and CTD cast data; development of climate indicators and other critical data for sanctuary Condition Reports; and outreach and engagement initiatives to diverse user group communities.

William J. Douros, West Coast Regional Director
NOAA ONMS West Coast Region 11/9/2020

NOAA, Office of Response and Restoration, Emergency Response Division (LOS 2019)

Our office provides scientific support to the US Coast Guard during marine spills of oil and hazardous materials to inform time-critical response decisions. A key element of that support is contaminant fate and transport modeling. Our staff, including oceanographers and regionally based Scientific Support Coordinators, have worked with SCCOOS and the larger JOOS community for many years to efficiently access coastal ocean observations for incorporation into our response modeling efforts. The SCCOOS'

network of established data sources and technical expertise in the fields of surface currents (HF radar), nearshore and subsurface transport, water quality, wave monitoring, telemetry buoys, and unmanned aerial systems have also been instrumental in strengthening our spill response efforts.

Amy MacFadyen, Oceanographer
NOAA, Office of Response and Restoration

Jordan Stout, Scientific Support Coordinator
NOAA, Office of Response and Restoration

2/7/2019

NOAA, Southwest Fisheries Science Center (LOS 2020) - please see full LOS enclosed

SWFSC monitors and reports on environmental conditions for the Pacific Fisheries Management Council (PFMC) by providing an annual ecosystem status report (ESR). In collaboration with the Northwest Fisheries Science Center, the ESR summarizes eastern north Pacific ecosystem indicators, from large scale atmospheric impacts down to regional and local ecosystem influences and includes human impacts. Data are collected from all available sources, and the west coast IOOS Regional Associations (RA) are important partners in this effort. The RA provided surface currents from HF radar, environmental data from the glider array and shore stations data that are important time series data. These data are also helping the SWFSC to move from single species stock assessments to ecosystem-based fishery management.

There are a number of joint efforts between SWFSC and the RA that will strengthen in future years. The RA shore stations extend the inshore CalCOFI sampling lines and a shared data catalog will provide better data access. During this COVID-19 pandemic, SWFSC has had to cancel most of its survey cruises. The glider network has allowed Fisheries to maintain time series and monitor coastal conditions. Bird surveys and the SCCOOS C-HARM HABs tracking software (hosted on SWFSC servers) are examples of other collaborations that benefit both groups.

Going forward, enhancements to the glider and shore station suite of instruments, expansion of eDNA sampling and the proposed addition of Flow Cytobots to the shore stations will all expand the suite of ecosystem data and syntheses that will be incorporated into the ESR. In addition, the proposed west coast Ocean Sound Observation Network (OSON), an effort including NANOOS, will provide the first coast-wide data on ocean noise, an important environmental parameter that presently isn't monitored in a consistent manner.

As a science-based decision support program, the California Ocean Observing Systems (CeNCOOS and SCCOOS) collaborate with local, state and federal agencies, tribes, resource managers, industry, policy makers, educators, scientists and the general public to provide data, models and products that advance our understanding of the current and future state of our coastal and global ocean. SCCOOS and CeNCOOS focus on high-priority regional requirements to provide the information necessary to address marine operations, coastal hazards, climate variability and change, and ecosystems, fisheries, and water quality.

Newell Garfield, Director, Environmental Research Division
NOAA Southwest Fisheries Science Center

10/26/2020

Ocean Discovery Institute (LOS 2020)

At Ocean Discovery Institute, we use ocean science to empower young people from underserved urban communities of color to transform their lives, their community, and our world as science and conservation leaders. We integrate real science data into our curriculum to inform our students about relevant coastal and oceanographic issues. We use ocean observing data to teach students about multiple STEM topics, such as physical oceanography and math. Furthermore, discussions about ocean observing data also expose our students, all of whom are from backgrounds historically underrepresented in STEM fields, to a variety of STEM career types. The continued availability of this data is crucial to our ongoing efforts to provide science opportunities to young people from underserved backgrounds.

Joel Barkan, Research and Restoration Manager
Ocean Discovery Institute 10/30/2020

Ocean Rainforest, Inc. (LOS 2020)

I have been using the data that SCCOOS currates for more than 5 years. This program has been instrumental for my work as an environmental scientist and manager in the region of the Southern California Bite. I fully support SCCOOS's initiative to integrate pH and dissolved oxygen monitoring into more of their partnered platforms. It's a much needed and sadly lacking addition to environmental and ocean monitoring, particularly in this region. That data would serve to support a great deal of more sound policy decisions especially surrounding our blue economy.

Courtney Schatzman, Ocean Operations Manager
Ocean Rainforest, Inc. 10/22/2020

One Health Institute and Karen Drayer Wildlife Health Center (LOS 2020)

At the Karen Drayer Wildlife Health Center, University of California, we monitor wildlife morbidity and mortality events through an online application developed in partnership with a network of wildlife rehabilitation centers across the state. As part of the effort, we collaborate with the California Department of Fish and Wildlife to detect and investigate unusual health events in live sea birds stranding along the coast of California. Access to HAB data made available through SCCOOS and CeNCOOS and domoic acid toxicosis risk predicated by C-HARM has been beneficial in our investigations of factors potentially influencing these morbidity and mortality events in sea birds.

Terra Kelly DVM, PhD, Dipl. ACZM - Senior Scientist
One Health Institute and Karen Drayer Wildlife Health Center, UC Davis 2/8/2020

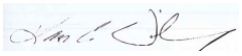
Orange County Sanitation District (LOS 2020)

QC San is the third largest Publicly Owned Treatment Works in Southern California and as an ocean discharger we have considerable interests in research and monitoring of the coastal waters of California, especially those within the Southern California Bight (SCB). OC San conducts an extensive federally and state mandated ocean monitoring program off Orange County, California, but we recognize the interconnectedness of our local monitoring area to the rest of the SCB and, indeed, the entire California

Current System. SCCOOS and CenCOOS data and information are used to fill knowledge gaps within our study area and to provide regional context to our local monitoring data.

OC San has collaborated and partnered with SCCOOS since its inception in the early 2000s. The value we see in California's two ocean observation systems justifies our contribution of funding and staff time. Working with SCCOOS to leverage local dollars with federal funding allows both groups to collect data and provide valuable information products applicable to local, state, and national scales more efficiently and cost effectively.

With increasing attention on projected global climate change impacts to California's highly urbanized coast and to its coastal marine ecosystems, continued high-level federal funding of science-based decision support programs-like the CeNCOOS and SCCOOS-is critical to ensuring that local, state and federal decision makers and the public have the best information available as we move into the future.



Lan C. Wiborg, Director of Environmental Services
Orange County Sanitation District 11/18/2020

Pacific Coast Federation of Fishermen's Associations (LOS 2020)

PCFFA is a 501(c)(5) nonprofit trade association representing the commercial fishermen and women of the West Coast, advancing on their behalf the sustainability of the fishing way of life and the resources on which they depend. Our members rely on the data generated by SCCOOS and CeNCOOS every day to inform their fishing operations and improve the safety of their operations. The precise weather and oceanographic data generated by these programs as well as the research programs they lead provide a high degree of value as we explore the impacts of ocean warming to fisheries, including the factors that lead to harmful algal blooms that can close crustacean fisheries.

Noah Oppenheim, Executive Director
Pacific Coast Federation of Fishermen's Associations 2/7/2020

Pacific Coast Shellfish Growers Association (LOS 2020)

The PCSGA was founded in 1930 and represents approximately 100 private and tribal farms, providing c 3,000 jobs in Alaska, California, Hawaii, Washington, and Oregon. PCSGA's members are diverse in both f size and location where oysters, clams, mussels, and geoduck are grown for both domestic and export mark at a value of nearly $300 million.

The work of SCCOOS contributes significantly to the region's shellfish industry which in turn supports coa economies dependent on the industry for jobs. Shellfish have been an essential part of the West Cc communities for over a century. During this time, farming techniques have evolved in response to environme do citizens and market demands. This current generation of shellfish farmer is reliant upon data and servi from SCCOOS.

11/18/2020

Margaret A. Pilaro, Executive Director
Pacific Coast Shellfish Growers Association

Pacific Marine Mammal Center (LOS 2020)

Collaborating with institutions, such as SCCOOS, has been incredibly helpful as we evolve from a reactionary-based organization that solely responds to animal stranding calls to an organization that provides a broad base of services, including being a research partner that supports the scientific community with answering difficult questions that can broadly impact the sustainable health of our marine mammals, the ocean waters that they live in, and the eco-systems that affect us all.

Specifically, we greatly appreciate SCCOOS's collaborative work with CeNCOOS, along with local, state and federal agencies, resource managers, industry, policy makers, educators, scientists and the general public to provide data, models and products that advance our understanding of the current and future state of our coastal and global environment. SCCOOS focuses on coastal observations and science-based decision support products to provide information necessary to address marine operations, coastal hazards, climate variability and change, and ecosystems, fisheries, and water quality, making them a valued partner to so many organizations, including PMMC.

Peter Chang, Chief Executive Officer
Pacific Marine Mammal Center 11/5/2020

Port of San Diego (Support Statement 2020)

The Port of San Diego supports the important work, observations, and data that are produced from the SCCOOS program. We support a range of maritime industries that have a nexus to the Port from military, shipping/cargo operations, commercial and recreational fishing and many other types of commerce, all of which benefit from the information collected from the SCCOOS program.

Paula Sylvia
Paula Sylvia, Program Director-Aquaculture and Blue Technology
Port of San Diego 11/12/2020

San Diego Coastkeeper (LOS 2020)

Founded in 1995, San Diego Coastkeeper (Coastkeeper) is a non-profit organization working to protect and restore the San Diego region's bays, beaches, watersheds, and ocean. The data produced as a result of SCCOOS assists us in tracking, and protecting, our coastal resources and planning for sea level rise and the impacts of climate change here in San Diego.

Matt O'Malley
Executive Director and Managing Attorney 11/17/2020

San Diego County MPA Collaborative (LOS 2020)

The San Diego County MPA Collaborative is a group of more than 120 stakeholders, representing over 60 affiliations. We advance the management of San Diego County's 11 MPA that make up 17,779 acres of our

offshore environment through strategic partnerships, education and outreach, creation of policy and dissemination of accurate science and information. SCCOOS allows our collaborative to remain scientifically accurate and up-to-date with important environmental data that are required for the management of Southern California MPAs.

Cory Pukini, Co-Chair
San Diego County MPA Collaborative 2/4/2020

San Diego Regional Water Quality Control Board (Support Statement 2020)

I work for the San Diego Water Board and use the SCCOOS data and products to monitor ambient, natural Ocean conditions. This monitoring data are used as a reference to measure potential impacts such as ocean acidity, hypoxia, nutrients, and salinity from wastewater discharges to the Pacific Ocean. The SCCOOS Automated Shore Stations easily provides us with the important data on ocean conditions at the four southern California piers. The salinity data from SCCOOS Scripps Pier is a reference site used to compare ocean salinity offshore of the Carlsbad Desalination Plant. I support the SCCOOS program to continue providing this important and valuable data of ambient ocean conditions.

Ben Neill, Water Resource Control Engineer
San Diego Regional Water Quality Control Board 10/15/2020

Santa Barbara Adventure Company (LOS 2020)

The Santa Barbara Adventure Company offers tours to guests in the local Santa Barbara area as well as within the Channel Islands National Park. We also offer multi-day outdoor education trips for local schools. Many of the guests & students who participate in our programs have little exposure to the ocean and marine environments. A large part of our mission is educating guests about how they help protect our marine environments and make a difference. We heavily rely on ocean observing data to ensure risk management and safe operations. Additionally, we rely on successful and abundant marine ecosystems to be able to help guests see wild seals, sea lions, dolphins and underwater invertebrates. These sightings on tours help us showcase the personal need to protect and defend marine environments for the animals that rely on & thrive in our oceans. It is invaluable information we need to have to continue to be able to operate tours for guests.

Michael Cohen

Michael Cohen, President
Santa Barbara Adventure Company 10/1/2020

Scientific Research and Education Network (SciRen) San Diego (LOS 2020)

Our regional-focused approach not only fosters relationships within our local community but also can result in lesson plans relevant to our own “backyards.” We believe that in addition to bringing modern STEM research examples into classrooms, providing connections to research relevant to student’s communities can build curiosity and excitement about STEM. Lesson plan development based on SCCOOS research and data is a perfect fit for this approach, and we are extremely excited to coordinate with SCCOOS on developing these plans.

Dr. Molly A Matty, Postdoctoral Fellow, Salk Institute for Biological Sciences
Co-organizer for Scientific Research and Education Network (SciRen) San Diego 11/6/2020

SeaTactics LLC (Support Statement 2020)

My organization uses the data provided by SCCOOS to provide accurate wind, weather, and current forecasts to sailors on the coast, including the US Olympic Team. The SCCOOS data are invaluable to my organization due to its high resolution and accuracy - we couldn't provide recreational, commercial, and Olympic forecasts without it.

Chelsea Carlson, Owner, Meteorologist, Sailor
SeaTactics, LLC 10/23/2020

SeaWorld San Diego (LOS 2020)

SeaWorld San Diego has been rescuing marine life since its inception in 1964; this includes over 20,000 animals of over 100 varying species. We have seen a change in the ocean's health in these last 56 years, and the telltale sign is in the animals we rescue, especially those that suffer from ever increasing naturally occurring toxins. The SCCOOS is valuable for us to see trends in algal blooms impacting local wildlife and where they may be impacted. This helps us to prepare to respond to these greater stranding needs and gather the most up to date biological data to help future populations. We are very aware that what impacts marine wildlife will eventually impact human health.

Jody A. Westberg, Stranding Coordinator
SeaWorld San Diego 10/1/2020

Southern California Coastal Water Research Project (LOS 2020)

SCCWRP is a research institute formed by 14 California water quality management agencies to develop the scientific foundation for their water-quality management. Since its founding in 1969, SCCWRP has been a champion of sound interdisciplinary approaches to solving complex challenges in water management. In a similar capacity, SCCOOS is actively engaged in identifying needs of Southern California's water-quality management community by providing data, models and products that advance our understanding of the current and future state of our coastal and global environment.

Beyond providing this letter of support, SCCWRP will continue to assist SCCOOS through participation on the SCCOOS Board of Governors, collaborations with SCCOOS to support coastal water quality monitoring, and facilitation of communication among scientists and the water-quality managers that comprise my organization's membership. It is my hope that NOAA will also continue to support SCCOOS, as sustained funding is crucial to the maintenance of the program's ocean observing network and to the continuity of the important data products and services that these observations enable.

Stephen B. Weisberg, Executive Director 10/26/2020

Southern California Coastal Water Research Project

Surfrider Foundation (Support Statement 2020)

The Surfrider Foundation, a national 501(c)3 environmental nonprofit organization dedicated to the protection and enjoyment of our ocean, waves and beaches for all people, is a sincere supporter of the thorough work that SCCOOS accomplishes. Our vast California network depends on the SCCOOS Harmful Algal Bloom (HAB) monitoring and reporting efforts to keep their coastal communities and volunteers informed about the presence of HABs. We also use this data to inform our advocacy efforts for policies that reduce pollution that exacerbate bloom events and protect public health. We look forward to seeing future data regarding pH and ocean acidification collected during their upcoming proposal, as this will contribute to the global knowledge of changes to our ocean chemistry and will inform our policy and advocacy efforts to protect and enhance the marine environment under a changing climate.

Katie Day, Staff Scientist
Surfrider Foundation 10/21/2020

The Marine Mammal Center (LOS 2020)

The Center is a non-profit ocean conservation organization that is an internationally recognized leader in advancing the science of marine mammal health, training veterinary and scientific professionals, and inspiring the public towards great ocean stewardship. In its 45-year history, the Center has treated more than 23,000 marine mammals. Many of these animals traverse the Southern California Bight and are exposed to health and disease threats within the SCCOOS region. Our organization relies on data provided by SCCOOS to better understand how these threats impact marine mammal and ocean health. Most notably, the California Harmful Algal Bloom Bulletin and California Harmful Algae Risk Mapping (C-HARM) data products are incredibly valuable to the Center's scientists and veterinarians because many of our sea lion patients are affected by domoic acid-producing algal blooms.

Dr. Jeff Boehm, Executive Director
The Marine Mammal Center 11/3/2020

The Ocean Foundation (LOS 2020)

The Ocean Foundation is a unique community foundation with a mission to support and strengthen those organizations dedicated to reversing the trend of ocean destruction. Our organization has projects and partners on all seven continents and understands and advocates for the value of ocean observations in promoting and ensuring resilient coastal communities and a sustainable blue economy. A number of our projects rely directly on the ocean observing data provided by SCCOOS to inform their research and planning.

Alexis Valauri-Orton, Program Officer
The Ocean Foundation 11/24/2020

Tijuana River National Estuarine Research Reserve (LOS 2020)

As the Research Coordinator of the Tijuana River National Estuarine Research Reserve (TRNERR), I enthusiastically endorse the valuable data and services provided by the Southern California Coastal Ocean Observing System (SCCOOS) at Scripps Institution of Oceanography. For our work at TRNERR, SCCOOS continues to be a key resource helping us fulfill our mission. One of our core programs is monitoring of water quality, weather, and biotic indicators within the Tijuana River Estuary, and SCCOOS provides a critical larger context for the information we generate. I especially appreciate the degree to which SCCOOS has been responsive to the needs and ideas voiced by myself and others in helping us further our goals. Such partnerships will be especially useful as we move forward with efforts to better understand the role of oceanic forcing on our estuarine system.

Dr. Jeffrey Crooks, Research Coordinator and Lead Scientist
Tijuana River National Estuarine Research Reserve 10/7/2020

TMA BlueTech (LOS 2020)

TMA is the organizer of the San Diego ocean tech community – the largest BlueTech cluster in the U.S. We have approximately 100 member organizations – the vast majority companies in southern California developing innovative technology and services. As the saying goes "you can't manage what you can't measure" and the work of SCCOOS provides a baseline of high-quality data that is useful for many of our companies. In addition, TMA member companies consider SCCOOS as a valued partner that can provide science-based confirmation of capabilities in those circumstances when it makes sense to collaborate.

Michael B. Jones, President
TMA BlueTech 10/4/2020

United States Coast Guard, District Eleven (Support Statement 2020)

The USCG relies on NOAA to provide oil spill trajectories during nearshore and offshore incidents. Trajectory modeling is vital to decision making and equipment deployment during pollution response cases and the SCCOOS system contributes to our ability to safely and effectively remove oil product from the environment.

Denny Ernster
LCDR Denny Ernster, Supervisor, District Response Advisory Team
Coast Guard District Eleven 11/17/2020

United States Coast Guard, Office of Search and Rescue (LOS 2020)

The USCG employs the Search And Rescue Optimal Planning System (SAROPS) operationally for search and planning. The measured and forecasted ocean currents, produced by the California Ocean Observing Systems (SCCOOS and CeNCOOS) and accessed by SAROPS through the Environmental Data Server (EDS), are of enormous benefit to the USCG's SAR program. The USCG has been using the real-time prediction system for the California state-wide ocean circulation over the past decade. The surface current nowcast and forecast fields from your forecasting system provide key information for reliable and accurate drift modeling during our search for survivors and survivor crafts lost off the California coast.

Furthermore, the expanded data network and advanced numerical ocean modeling system supported by SCCOOS and CeNCOOS have greatly improved the Coast Guard's ability to optimally plan searches for lost mariners and crafts in the California coastal region, thus saving time and lives. Our ability to accurately and consistently predict trajectories for search and rescue depends on the invaluable uninterrupted delivery of observational data and state-of-the-art predictive modeling and tools.

Dr. Cristina Forbes, Oceanographer
U.S. Coast Guard, Office of Search and Rescue 11/24/2020

United States Sailing Team (Support Statement 2020)

The US Olympic Sailing Team is using SCCOOS data to understand the currents and environment in Long Beach, California, the sailing venue for the LA2028 Olympics. Detailed knowledge of the currents during racing will give American sailors an advantage and help the US Sailing Team win medals in 2028.

Riley Schutt, Innovation, Research, and Development Performance Analyst
United States Sailing Team 10/20/2020

University of San Diego, Environment, Health and Safety (LOS 2020)

Integrated information management systems are a critical tool to efficiently assess and manage regulatory programs. Information management systems are needed for integration and public data dissemination so that interrelated biological-physical-chemical processes present in the watershed and marine environment can be assessed and available to a wide range of users. These data requirements span both regulatory and non-regulatory based data collection efforts.

UC San Diego EH&S has worked closely with SCCOOS for many years to develop information management tools required for long-term assessment of Area of Special Biological Significance (ASBS) water quality and related management decisions. An example of this vital collaboration is the ASBS website developed by SCCOOS that allows for various data layers to be viewed together spatially via a central map while providing metadata, specific data values and time series. Data layers are grouped by near-real time observations, static point observations, and spatial observations/models. Meteorological stations along the coast provide wind speed, wind direction, air temperature, relative humidity, barometric pressure, solar radiation, rainfall, and water temperature data. Data is also provided on seawater and storm water outfalls at Scripps Institution of Oceanography that are monitored in accordance with the California Ocean Plan. Data from weekly bacteria monitoring in the surf zone of the ASBS, weekly water samples and net tows to monitor for HAB (Harmful Algal Blooms) species, naturally occurring algal toxins, water temperature, salinity, nutrients, as well as the boundaries of the 34 designated ASBS regions are shown.

Staff from SCCOOS have worked with EH&S for more than 10 years to maintain a seamless flow of data. The programmers continually adapt and respond to the changing requirements and data formats. A long-term goal of this partnership is to promote local and regional information sharing on ASBS water quality and ecosystem health to guide future management decisions.

Sustained funding for SCCOOS will be crucial to the maintenance of the program's ocean observing network and to the continuity of the important data products and services that these observations enable.

Kimberly O'Connell

Kimberly O'Connell, Clean Water Utility Manager
University of San Diego, Environment, Health and Safety 11/19/2020

University of Southern California Sea Grant Program (LOS 2020)
USC Sea Grant contributes to solving the problems of the Urban Ocean, while recognizing the opportunities for coastal commerce, recreation and improving the quality of life in coastal regions such as Southern California. We fund research on the critical issues associated with the influence of massive cities on the sea, promote connections between scientists and the policy-makers who must craft solutions, and broadly distribute information to the electorate through public education outreach efforts. Our staff, researchers, and stakeholders use ocean observing information within California provided by CeNCOOS and SCCOOS to inform research, decision making and even our formal calls for research proposals. The information provided is invaluable to our staff, researchers and stakeholders in multiple ways on a daily basis. The current data is invaluable to the Ports of Los Angeles and Long Beach for the safe movement of their ships. The harmful algal bloom network informs stakeholders of potential contamination of seafood as well as the potential health of marine mammals.

Linda C. Duguay

Linda Duguay, Director
USC Sea Grant Program 11/6/2020

West Coast Ocean Data Portal (LOS 2020)
The West Coast Ocean Data Portal (WCODP) seeks to increase access to and discovery of critical ocean and coastal data for resource managers and policymakers on the West Coast. The ocean observing information provided by CeNCOOS and SCCOOS are important resources for us to highlight in our data catalog, so that our users (namely the state, tribal and federal agencies represented in the West Coast Ocean Alliance, or WCOA) can access the most up-to-date data and models to inform their decision-making at local and regional levels. The WCODP and WCOA both feel that comprehensive ocean data is extremely important in meeting the needs of this management community. The marine economy contributes over 500,000 jobs and over $40 billion to California's GDP (OceanReports 2020), and the data provided by CeNCOOS and SCCOOS help decision-makers understand how to make tradeoffs between important ocean uses, and provide context to those decisions. Additionally, as the WCODP works on several upcoming data-derived products, the expertise of those at CeNCOOS and SCCOOS has been invaluable, and we expect to continue this working relationship and utilize data from the observing systems they support and maintain well into the future.

Andy Lanier, Co-Chair
West Coast Ocean Data Portal

Stephen B. Weisberg

Stephen Weisberg, Ph.D., Co-Chair
West Coast Ocean Data Portal 11/10/2020

WiLDCOAST (LOS 2020)
WILDCOAST is an international team that conserves coastal and marine ecosystems and addresses climate

change through natural solutions. Committed to establishing and managing protected areas and advancing strong policies for coastal and ocean protection, WILDCOAST utilizes SCCOOS tools and observation systems to track issues regarding climate change, water quality, and coastal hazards. Our on-the-ground projects benefit tremendously from the collaboration, data, models and products that SCCOOS provides as they help advance our understanding of the current and future state of the coast and ocean.

Zach Plopper, Associate Director
WILDCOAST 9/30/2020

Wild Neighbors Database Project (LOS 2020)

The Wild Neighbors Database Project is a US 501 (c)3 non-profit organization which promotes international wildlife rehabilitation by developing online data management software and helping implement its use worldwide to gather and exchange wildlife data. We are a small team of dedicated wildlife rehabilitators with the intent of supporting and improving the lives of wild patients everywhere. To date, we have 3 major projects that we have developed including The Wildlife Morbidity and Mortality Alert System (WMME Alert System). In coordination with the Ocean Observing network, our WMME Alert System integrates wildlife incident data in near-real time in order to enable early detection of a number of wildlife morbidity and mortality events in California. Primary data are provided by wildlife rehabilitators, however data from the Ocean Observing network is crucial in confirming unusual coastal wildlife morbidity events.

Devin Dombrowki and Rachel Avilla, Co-Founders
The Wild Neighbors Database Project 2/5/2020

HYPERION WATER RECLAMATION PLANT
12000 VISTA DEL MAR
PLAYA DEL REY, CA 90293
TEL: (310) 648-5000
FAX: (310) 648-5539
WWW.LACITYSAN.ORG

October 27, 2020

ELECTRONIC MAIL

Dr. Clarissa Anderson, Executive Director
Southern California Coastal Ocean Observing System
Scripps Institution of Oceanography
9500 Gilman Drive, 0206
La Jolla, CA 92093-0214

LETTER OF SUPPORT: SOUTHERN CALIFORNIA COASTAL OCEAN OBSERVING SYSTEM

Dear Dr. Anderson:

On behalf of the City of Los Angeles' LA Sanitation and Environment (LASAN), I enthusiastically endorse the valuable data and services provided by the Southern California Coastal Ocean Observing System (SCCOOS) at the Scripps Institution of Oceanography, University of California San Diego. SCCOOS provides critically needed coastal and ocean observations and generates extremely valuable products for environmental managers, regulators, and non-governmental agencies (e.g., environmental groups). The City conducts extensive monitoring in the coastal ocean of Southern California, primarily in Santa Monica Bay (SMB). A significant portion of this effort involves tracking the Hyperion Water Reclamation Plant's (HWRP) effluent plume as it is discharged from the 5-Mile Outfall pipe offshore in SMB, as well as estimating bacterial concentrations in the surfzone due to the potential for pathogens to adversely impact public health. The effluent plume has the potential for traveling considerable distances, as consistently observed by conductivity-temperature depth (CTD) profilers, with metal and organic pollutant deposition into the sediment localized around the HWRP 5-Mile Outfall. Storm drains are the major source of bacteria and other pollutants to these waters and discharge into the surfzone.

Southern California beaches and nearshore waters are world famous, and nearly 80 million people engage in water contact recreational activities at Los Angeles and Orange County beaches every year. This is not only an important component of the Southern California lifestyle, but also an important economic engine for the region. Unfortunately, it has been estimated that between 627,800 and 1,479,200 "excess" cases of gastrointestinal illness occur at these beaches each year, with estimated healthcare costs of $21 million to $414 million annually (Given et al. 2006); therefore, ensuring

good, safe water quality along our coast is an extremely high priority. In addition, the deposition of pollutants and their subsequent accumulation have adverse impacts on the benthic macrofaunal and demersal fish and invertebrate communities. Some of the seafood, e.g., white croaker, have been issued fish advisory notices and may not be safe for consumption. Both Los Angeles County and the City of Los Angeles are very interested in the nearshore current data and SCCOOS' s surfzone model to help shed light on the dispersion of legacy pollutants, i.e., DDT and PCBs that were discharged from the Los Angeles County Sanitation Districts' (LACSD) outfall at White Point and onto the Palos Verdes shelf.

Knowledge of circulation patterns in the coastal region are only now emerging, especially from a regional perspective. A better understanding of circulation in the shallow and nearshore regions is extremely valuable because it holds the potential to forecast the fate of surfzone and nearshore pollutants that increases our ability to protect public health and the environment.

The work conducted by SCCOOS is vital because their focus on improving our understanding and potential for modeling dispersion within a few hundred meters of the shoreline, which is where most water-contact recreation occurs, as well as the nearshore waters. This information is useful in studying stormwater dispersion and fate, as well as discharges from wastewater treatment plants. The data served publicly greatly benefits monitoring efforts aimed at protecting public health and the environment.

In 2006, the City of Los Angeles' Hyperion Water Reclamation Plant diverted the flow of its wastewater from a pipe with an outfall that is five miles from the shoreline to one that is only one mile from the shoreline in order to inspect the interior of the 5-Mile Outfall pipe. The diversion lasted approximately three days and approximately 800 million gallons of secondary-treated effluent was discharged through the 1-Mile Outfall. The City of Los Angeles' Environmental Monitoring Division, in conjunction with other researchers, conducted an extensive monitoring effort during this diversion. Our monitoring effort greatly benefited from surface current information provided through SCCOOS. The real-time current information provided by SCCOOS enabled us to adaptively modify our sampling grid to better track the discharge plume and to predict the dispersion of the surface plume by the use of a trajectory model developed by SCCOOS researchers using high frequency radar (HFR) data. The 2006 5-Mile Outfall pipe inspection determined that important preemptive repairs were required in the Effluent Pumping Plant Header instigating a more extensive six-week diversion of 9,363,000,000 gallons (35,438,955,000 L) into the shallow, nearshore environment and comprehensive monitoring program in fall 2015. Again, the HFR data and related particle dispersion model were extremely critical to our adaptive monitoring and plume tracking effort during 2015, which spanned nearly eight weeks, including pre- and post-diversion monitoring.

SCCOOS also developed and provided a dedicated website for this 1-Mile Diversion Monitoring Program, which operated 24 hours a day, and allowed seven days a week group communication, both scientific partner-restricted and publicly accessible. The website provided a centralized platform to share data from all assets and partners (in most cases real-time), which was critical to developing daily sampling strategies, documenting daily boat-based activities, facilitating project decisions, and functioning as a data archival clearinghouse. The SCCOOS public-access postings consisted of HFR, wind forecasts, plume trajectories, drifter tracks, shoreline (beach) fecal indicator bacteria data, and CTD and Wirewalker graphics. The SCCOOS password-protected postings included scientist contact

list, field data sheets, daily notes, various monitoring documents, wave height data, satellite images, and Wirewalker raw data.

The services that SCCOOS provided in 2006 and 2015 were invaluable to our monitoring efforts. We believe improved understanding of dispersion in the surfzone and offshore may similarly benefit our monitoring efforts in the future, as well as those of other monitoring agencies in southern California, for example, the LACSD, Orange County Sanitation Districts (OCSD), and the Southern California Coastal Water Research Project (SCCWRP), academic institutions, among several others.

SCCOOS also works with the California Department of Public Health Marine Biotoxin Monitoring Program to assist in production of the monthly California harmful algal bloom (HAB) bulletin that synthesizes results and issues public health alerts, providing a more complete picture of the regional variability of HABs. Because HWRP's 5-Mile Outfall effluent currently has significant levels of ammonia (i.e., nutrients), the potential for HABs and phytoplankton blooms and their associated adverse impacts on the environment and biological communities are a concern to LASAN.

As a science-based decision support system, SCCOOS works interactively with local, state and federal agencies, resource managers, industry, policy makers, educators, scientists, and the general public to provide data, models, and products that advance our understanding of the current and future state of our coastal and global environment. SCCOOS focuses on coastal observations and product development to provide information necessary to address issues regarding marine operations, coastal hazards, climate variability and change, and ecosystems, fisheries, and water quality.

In summary, the City of Los Angeles shares an interest in better understanding the dynamics of water transport in the surfzone, nearshore, and offshore waters, which may increase our understanding of the fate of flow from storm drains and other sources into the surfzone, as well as the flow from offshore sources into nearshore waters. Because of this, in addition to its work on ocean acidification, HABs, and temperature anomalies, the City believes it will continue to directly benefit from the ocean observing activities proposed by SCCOOS; the City wholeheartedly endorses SCCOOS and recommends it be funded. Sustained funding will be crucial to the maintenance of the program's ocean observing network and to the continuity of the important data products and services that these observations enable.

Please feel free to contact me at either (213) 485-2210 or at mas.doiiri@lacity.org if you have any questions.

Sincerely,

MAS DOJIRI, PHD, BCES
Assistant General Manager
LA Sanitation and Environment

MAD/cc:cc

c: Farhana Mohamed, LASAN Stacee Karnya, LASAN Curtis Cash, LASAN

Post Office Box 1949
San Pedro, CA 90733
Phone: 310.519.3134
24-Hr. 310.832.6411
FAX: 310.241.0300
info@mxsocal.org
www.mxsocal.org

A non-profit organization providing vessel traffic and maritime information service for Southern California

20 October 2020

Dr. Clarissa Anderson
Executive Director
Southern California Coastal Ocean Observing System (SCCOOS)
Scripps Institution of Oceanography
9500 Gilman Drive, 0206
La Jolla, CA 92093-0214

SUBJECT: Letter of Support of Southern California Coastal Ocean Observing System

Dear Dr. Anderson:

On behalf of the Marine Exchange of Southern California, which operates the Vessel Traffic Service (VTS) for the ports of Los Angeles and Long Beach, I enthusiastically endorse the valuable data and services provided by the Southern California Coastal Ocean Observing System (SCCOOS) at the Scripps Institution of Oceanography, University of California San Diego.

Very deep draft tanker inbound and container ship outbound the Port of Long Beach.

Both need SCCOOS information to transit safely.

The Marine Exchange, in partnership with federal, U.S. Coast Guard, state, and local port partners, is a private, non-profit firm that provides maritime information and vessel traffic services for the maritime community in the waters of Southern California and the ports of Los Angeles and Long Beach. Our firm continually works to anticipate and fully meet the maritime information and vessel traffic requirements necessary to promote a safe, secure, efficient, reliable, and environmentally sound maritime transportation system.

SUBJECT: Letter of Support of Southern California Coastal Ocean Observing System

More than 28,000 vessels participated in the Vessel Traffic Service in 2019 and 4,550 large vessels arrived in the Los Angeles and Long Beach port complex. Each day, there are there are approximately 45 movements of some of the largest vessels in the world, and they are getting bigger. Container ships that are 1,300 feet long and carrying 14,000-18,000 containers are now common. Tankers that are 1,100 feet long, weigh 330,000 tons, and have a draft of up to 69 feet have been arriving routinely at the port of Long Beach since April 2017 due to SCOOOS/CDIP products.

MSC MIA Arriving Port of Los Angeles 1 April 2020.
The biggest ship to ever enter the Ports of Los Angeles and Long Beach.
23,756 TEUs, 1,300 feet long, and 52-foot draft.

In addition to the ports of Los Angeles and Long Beach, 274 vessels arrived at the Chevron Offshore Terminal in El Segundo, 461 arrived in San Diego, and 409 arrived in Port Hueneme in 2019. Bringing these ships safely into port is only possible if there is extremely accurate and reliable wave information such as provided by SCCOOS.

The ports of Los Angeles and Long Beach are the #1 and #2 container ports in the country and together we are ninth in the world for the past two years. Together, the two ports moved 16.9 million containers in 2019. The value of all cargo moving through the ports is $1.3 billion per day. California only has a 5-day supply of oil ashore, so keeping the tankers moving in and out of the ports and the offshore terminal in El Segundo is critical to preventing fuel shortages.

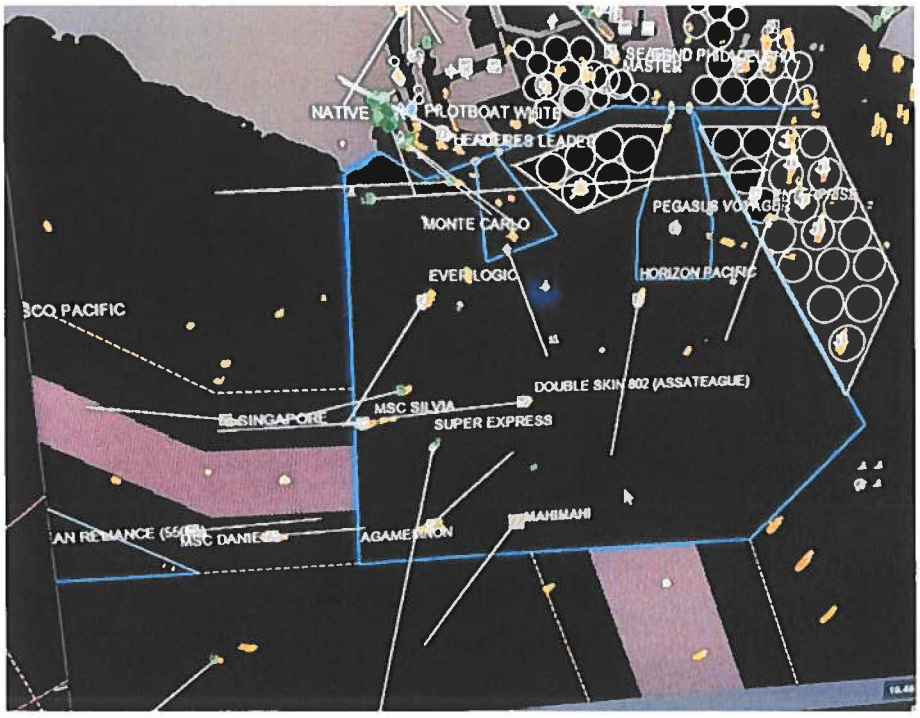
SCCOOS's products are used by the Marine Exchange and a wide variety of port partners.

1. Water observations such as temperature can help predict and analyze the movements of fish and mammals, which can be used to help prevent whale strikes by ships and other harmful impact to marine life.

SUBJECT: Letter of Support of Southern California Coastal Ocean Observing System

2. Flooding and Storm surge models are used to plan future developments in the ports and adjacent coastal waters.
3. Wave buoy information from the Coastal Data Information Program is used by tugboats, barges, ferries, recreational vessels, harbor pilots, very deep draft tankers and container ships, all 5 large Southern California Ports, and the Coast Guard to plan marine construction and conduct safer vessel movements, from the smallest pleasure boats, ferries, and fishing boats to the largest tankers and container ships.
4. Beach Erosion and Inundation information is used to analyze vulnerable areas, plan preventative and protective measures, plan responses, and plan where to best pre-stage equipment to keep it safe.
5. The products of the Center for Climate Change Impacts and Adaptation are critical to making good, science-based decisions based on climate change and resulting impacts such as sea level rise. Do we build sea walls, flood gates, or buildings on stilts? How tall? How strong? What is the impact to the environment for each alternative? There may be lots of good ideas, but all have pros and cons. The Center provides information that can help guide good decisions.

As a science-based decision support system, the Ocean Observing System interactively works with local, state and federal agencies, resource managers, industry, policy makers, educators, scientists, and the general public to provide data, models and products that advance our understanding of the current and future state of our coastal and global environment. SCCOOS focuses on coastal observations and product development to provide the information necessary to address issues such as marine operations, coastal hazards, climate variability and change, ecosystems, fisheries, and water quality.



Saturday 26 Sep 2020
Vessel Traffic Service
Radar Screen picture.

Typical morning
rush hour.

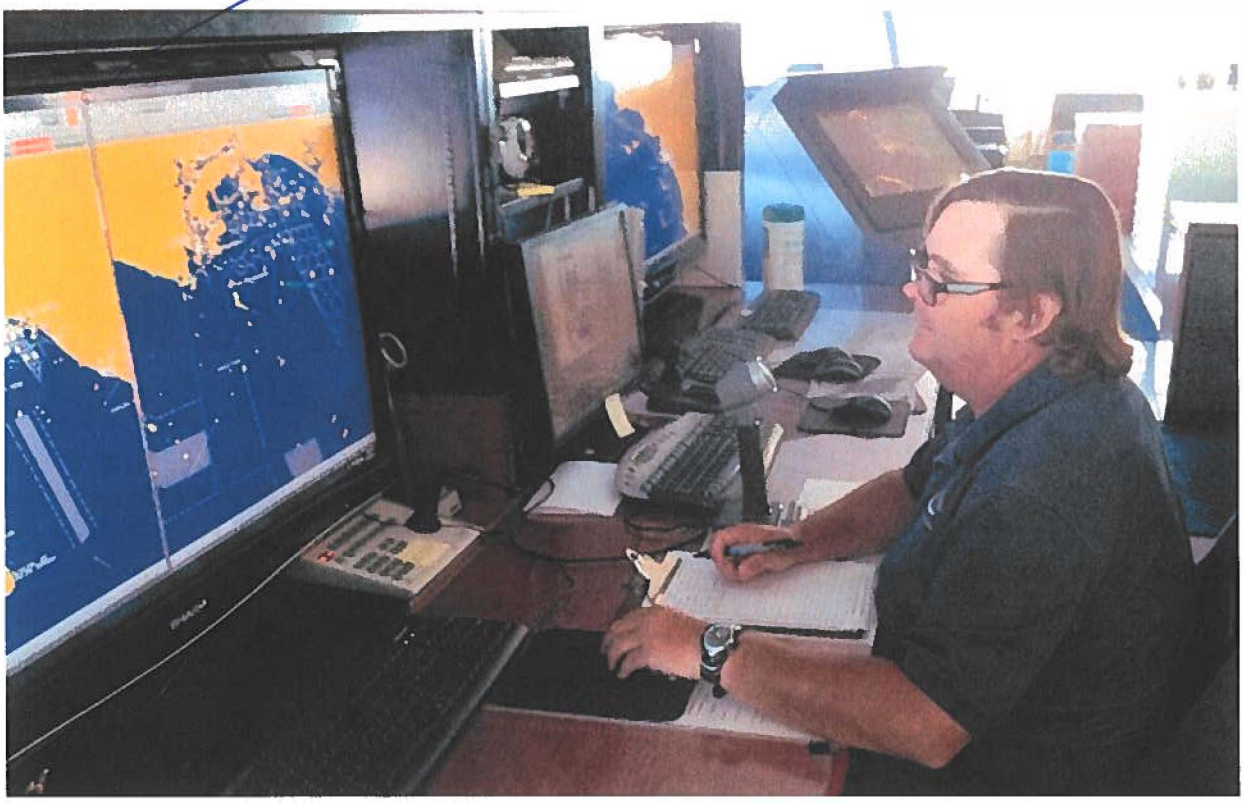
Each vessel,
big and small,
pleasure and
commercial, transited
more safely and
had reduced risk of
collision, grounding,
accident, or injury due
to SCCOOS
information.

SUBJECT: Letter of Support of Southern California Coastal Ocean Observing System

I understand that SCCOOS is funded primarily by the National Oceanic Atmospheric Administration (NOAA). Sustained funding for SCCOOS is crucial to the maintenance and modernization of the program's ocean observing network and the continuity of the critical data products and services that these observations enable. Please feel free to contact me if you have any questions.

Sincerely,

J. Kipling Louttit
Captain, U.S. Coast Guard, ~~Retired~~
Executive Director
Marine Exchange of Southern California and VTS LA/LB



MX VTS Watchstanders are on duty providing maritime peace of mind and vessel traffic service 7/24/365 in part due to programs such as SCCOOS.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Science Center
8901 La Jolla Shores Drive
La Jolla, CA 92037-1508

October 26, 2020

Dr. Anderson and Dr. Ruhl
The California Ocean Observing Systems
Southern California Coastal Ocean Observing System
Central and Northern California Ocean Observing System

Dear Drs. Anderson and Ruhl:

On behalf of NOAA NMFS Southwest Fisheries Science Center (SWFSC), I enthusiastically endorse the valuable data and services provided by the Southern California Coastal Ocean Observing System (SCCOOS) and the Central and Northern California Ocean Observing System (CeNCOOS), located at the Scripps Institution of Oceanography, University of California San Diego (UCSD) and the Monterey Bay Aquarium Research Institute (MBARI), respectively.

SWFSC monitors and reports on environmental conditions for the Pacific Fisheries Management Council (PFMC) by providing an annual ecosystem status report (ESR). In collaboration with the Northwest Fisheries Science Center, the ESR summarizes eastern north Pacific ecosystem indicators, from large scale atmospheric impacts down to regional and local ecosystem influences and includes human impacts. Data are collected from all available sources, and the west coast IOOS Regional Associations (RA) are important partners in this effort. The RA provided surface currents from HF radar, environmental data from the glider array and shore stations data that are important time series data. These data are also helping the SWFSC to move from single species stock assessments to ecosystem-based fishery management.

There are a number of joint efforts between SWFSC and the RA that will strengthen in future years. The RA shore stations extend the inshore CalCOFI sampling lines and a shared data catalog will provide better data access. During this COVID-19 pandemic, SWFSC has had to cancel most of its survey cruises. The glider network has allowed Fisheries to maintain time series and monitor coastal conditions. Bird surveys and the SCCOOS C-HARM HABs tracking software (hosted on SWFSC servers) are examples of other collaborations that benefit both groups.

Going forward, enhancements to the glider and shore station suite of instruments, expansion of eDNA sampling and the proposed addition of Flow Cytobots to the shore stations will all expand the suite of ecosystem data and syntheses that will be incorporated into the ESR. In addition, the proposed west coast Ocean Sound Observation Network (OSON), an effort including NANOOS, will provide the first coast-wide data on ocean noise, an important environmental parameter that presently isn't monitored in a consistent manner.

As a science-based decision support program, the California Ocean Observing Systems (CeNCOOS and SCCOOS) collaborate with local, state and federal agencies, tribes, resource managers, industry, policy makers, educators, scientists and the general public to provide data, models and products that advance our understanding of the current and future state of our coastal and global ocean. SCCOOS and CeNCOOS

focus on high-priority regional requirements to provide the information necessary to address marine operations, coastal hazards, climate variability and change, and ecosystems, fisheries, and water quality.

Sustained funding for SCCOOS and CeNCOOS is crucial to the maintenance of the State's ocean observing network and to continue the delivery of important data products and services that these observing systems enable. Please feel free to contact me if you have any questions.

Sincerely,

Newell Garfield
Director, Environmental Research Division, SWFSC
and
co-lead, California Current Integrated Ecosystem Assessment
https://www.integratedecosystemassessment.noaa.gov/regions/california-current

G. RESUMES

Enclosed are resumes for the proposal lead Principal Investigators (PI). Project lead PI resumes are available upon request.

Project Lead PIs

1. Dr. Andreas Andersson, UCSD/SIO
2. Dr. Andrew Barton, UCSD/SIO
3. Dr. Simone Baumann-Pickering, UCSD/SIO
4. Dr. Thomas Bell, WHOI
5. Dr. Daniele Bianchi, UCLA
6. Dr. Jeffrey Bowman, UCSD/SIO
7. Dr. Mark Brzezinski, UCSB
8. Dr. David Caron, USC
9. Dr. Jennifer Caselle, UCSB
10. Dr. Yi Chao, UCLA
11. Dr. Kristen Davis, UCI
12. Dr. Jeffrey Dorman, Farallon Institute
13. Dr. Jan Freiwald, Reef Check Foundation
14. Dr. Marisol Garcia-Reyes, Farallon Institute
15. Samara Haver, NOAA/NMFS
16. Dr. Shaun Johnston, UCSD/SIO
17. Dr. Fayçal Kessouri, SCCWRP
18. Dr. Matthias Lankhorst, UCSD/SIO
19. Dr. Christopher Lowe, CSULB
20. Dr. Andrew Lucas, UCSD/SIO
21. Dr. Todd Martz, UCSD/SIO
22. Dr. James McWilliams, UCLA
23. Dr. Mark Merrifield, UCSD/SIO/CCCIA
24. Dr. Kerry Nickols, CSUN
25. Dr. Hendrik Nollens, PMMC
26. Dr. Alexis Pasulka, Cal Poly SLO
27. Dr. Cheryl Peach, Birch Aquarium at Scripps
28. Dr. Lindsey Peavey Reeves, NOAA/ONMS
29. Mathew Ragan, USC
30. Dr. Daniel Rudnick, UCSD/SIO
31. Dr. Brice Semmens, UCSD/SIO
32. Dr. Uwe Send, UCSD/SIO
33. Dr. Rebecca Shipe, UCLA
34. Dr. Monica Sweet, UCSD/CREATE
35. Dr. William Sydeman, Farallon Institute
36. Dr. Yui Takeshita, MBARI
37. Dr. Andrew Thompson, NMFS/SWFSC
38. Cooper Van Vranken, Ocean Data Network
39. Dr. Ryan Walter, Cal Poly SLO
40. Dr. Libe Washburn, UCSB

Eric J. Terrill, Ph.D.
Director, Coastal Observing R&D Center
Marine Physical Laboratory, Scripps Institution of Oceanography - UCSD
(619)-302-4135 (cell), (858) 822 – 3101 (office), eterrill@ucsd.edu

Education

- Ph.D. Physical Oceanography - Applied Ocean Sciences

Scripps Institution of Oceanography, University of California, San Diego. February 1998.

- B.S. Applied Mechanics and Engineering Science (*magna cum laude*),

University of California, San Diego, March 1993.

- graduate coursework in coastal and ocean engineering , University of New South Wales, Sydney Australia. 1991.

Professional Interests

- Applied ocean sciences and technology development: unmanned systems and sensors, coastal and ocean measurement systems, naval hydrodynamics, sensor development, underwater acoustic sensors including Doppler-based high frequency sonar, EM (radar) and EO (lidar, imaging) sensing of the air-sea interface, ocean measurement platforms (HF radar, moorings, buoys, autonomous and towed vehicles, fixed platforms), coastal and ocean engineering. Marine hydrodynamics. Development of, and analysis of data from X-band and HF radar. Use of radar to sense the marine environment. Development of algorithms for interpretation of radar signals. Natural and man made marine signatures. Diver technologies and wide area search systems such as sidescan and multibeam sonar.
- Operational Oceanography: Use of environmental data for decision making – realtime data systems, sensor networks, development of products, and validation of forecast models.
- Air-sea and air-sea-land interaction processes: surface waves, wave breaking, near-surface turbulence and bubbles, coastal oceanography, riverine dynamics, extreme forcing events (hurricanes)
- Acoustical oceanography: application of high-frequency acoustics to nearshore, coastal, upper ocean studies, and large scale vessel flows; sound propagation through bubbly flows, acoustic signatures of natural and man made sources.
- Naval Hydromechanics: Flow fields around and near at-sea platforms. Model validation. Full-scale trials.

Project Experience:

Founder and director of the Coastal Observing R&D Center (CORDC) at Marine Physical Laboratory, Scripps Institution of Oceanography. CORDC presently employs a 30+ person technical staff of programmers, scientists, and engineers. Terrill serves as principal investigator for funded research projects in a diverse set of applied and technical disciplines with sponsorship from the Office of Naval Research (ONR), USN, Army, National Science Foundation (NSF), National Oceans and Atmospheric Administration (NOAA), USN-Carderock, International Boundary Water Commission, City of Imperial Beach, County of San Diego, State of California, as well as contracts with private industry. Joint research programs are conducted with various DOD agencies and federal laboratories.

Employment History

Director of CORDC	Scripps Institution of Oceanography, UCSD	2003-present
Assistant Research Oceanographer	Scripps Institution of Oceanography, UCSD	2003
Assistant Project Scientist (50%)	Scripps Institution of Oceanography, UCSD	1999-2003
Principal Development Engineer (50%)	Scripps Institution of Oceanography, UCSD	1999-2003

Publication/Impacts -complete list available

Project Recover: Extending the Applications of Unmanned Platforms and Autonomy to Support Underwater MIA Searches Terrill, E.J., M.A. Moline, P.J. Scannon, E. Gallimore, T. Schramek, A. Nager-, R. Hess, M. Cimino, P.L. Colin, A. Pietruszka, and M.R. Anderson. 2017. Project Recover: Extending the applications of unmanned platforms and autonomy to support underwater MIA searches. Oceanography 30(2):150–159,

Gallimore, Eric, Roger Stokey, and Eric Terrill. "Robot Operating System (ROS) on the REMUS AUV using RECON." 2018 IEEE/OES Autonomous Underwater Vehicle Workshop (AUV). IEEE, 2018.

Gallimore, Eric, et al. "Integration and Evaluation of a Next-Generation Chirp-Style Sidescan Sonar on the REMUS 100." 2018 IEEE/OES Autonomous Underwater Vehicle Workshop (AUV). IEEE, 2018.

Cimino, Megan, et al. "Oceanographic, acoustic, and remote approaches reveal the spatio-temporal dynamics of blackfin snapper at an aggregation site in Palau." Marine Ecology Progress Series 601 (2018): 185-201.

Cimino, Megan A., et al. "Jellyfish distribution and abundance in relation to the physical habitat of Jellyfish Lake, Palau." Journal of Tropical Ecology 34.1 (2018): 17-31.

Cimino, M. A., Anderson, M., Schramek, T., Merrifield, S., & Terrill, E. J. (2019). Towards a Fishing Pressure Prediction System for a Western Pacific EEZ. Scientific reports, 9(1), 461.

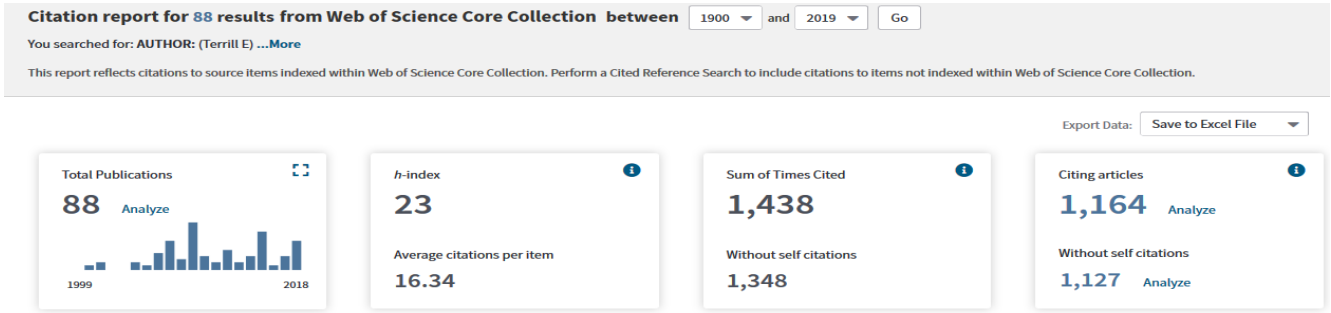
Pagniello, C. M., Cimino, M. A., & Terrill, E. (2019). Mapping Fish Chorus Distributions in Southern California Using an Autonomous Wave Glider. Frontiers in Marine Science, 6, 526.

Cimino, M., Cassen, M., Merrifield, S., & Terrill, E. (2018). Detection efficiency of acoustic biotelemetry sensors on Wave Gliders. Animal Biotelemetry, 6(1), 16.

Schramek, T. A., Colin, P. L., Merrifield, M. A., & Terrill, E. J. (2018). Depth-dependent thermal stress around corals in the tropical Pacific Ocean. Geophysical Research Letters, 45(18), 9739-9747.

Merrifield, S., Otero, M., & Terrill, E. (2018). Observations of Shelf Exchange and High-Frequency Variability in an Alaskan Fjord. Journal of Geophysical Research: Oceans, 123(7), 4720-4734.

Garcia-Moreno, C., Cook, T., Terrill, E., Merrifield, S., & Celona, S. (2018, December). HF Radar Observations in Palau. In AGU Fall Meeting Abstracts.



CLARISSA R. ANDERSON
Executive Director
Southern California Coastal Ocean Observing System
Scripps Institution of Oceanography
PH: 858.246-2226
EMAIL: clrander@ucsd.edu

EDUCATION

Ph.D. University of California, Santa Barbara, Marine Science, 2007
B.A. University of California, Berkeley, Integrative Biology *with honors*, Art History, 1999

HONORS AND AWARDS

2013 California Sea Grant New Investigator Award
2007-2008 National Research Council Postdoctoral Fellowship, NOAA
2004-2007 NASA Earth System Science Graduate Fellowship
2000 Departmental Scholarship, Ecology, Evolution, and Marine Biology University of California, Santa Barbara
1998 Gompertz Undergraduate Research Fellowship, Integrative Biology, University of California, Berkeley

RELEVANT POSITIONS HELD IN LAST FIVE YEARS

2017- Executive Director, Southern California Coastal Ocean Observing System
2016-2017 Deputy Director, Southern California Coastal Ocean Observing System
2015- Research Faculty (Asst Researcher II) – Institute of Marine Sciences, UC Santa Cruz

MOST RELEVANT PUBLICATIONS (13 of 24)

Bresnahan, P., T. Wirth, T. Martz, K. Shipley, V. Rowley, C.R. Anderson, T. Grimm. (**2020**) Equipping smart coasts with marine water quality IoT sensors. ***Results in Engineering***. 5. 10.1016/j.rineng.2019.100087.

MacKenzie, B., L. Celliers, K. Larkin, L.P.F. Assad, J.J. Heymans, N. Rome, J. Thomas, C. Anderson, J. Behrens, M. Calverley, K. Desai, P. DiGiacomo + 21 authors (**2019**) The role of stakeholders in creating societal value from coastal and ocean observations. ***Frontiers in Marine Science*** 6:137. 10.1016/j.rineng.2019.100087

Anderson, C.R., E. Berdalet, R.M. Kudela, C. Cusack, J. Silke, E. O'Rourke, D. Dugan, M. McCammon, J.A. Newton, S.K. Moore, et al. (**2019**) Scaling up from regional case studies to a global harmful algal bloom observing system. ***Frontiers in Marine Science,*** 6: 250. doi: 10.3389/fmars.2019.00250

C. Ramirez-Reyes, K. Brauman, R. Chaplin-Kramer, G.L. Galford, S.B. Adamo, C.B. Anderson, C. Anderson, G.R.H. Allington, KJ. Bagstad, + M.T. Coe, A.F. Cord + 16 authors. (**2019**) Reimagining the potential of Earth observations for ecosystem service assessments. ***Science of the Total Environment***. 665: 1053-1063. 10.1016/j.scitotenv.2019.02.150

Anderson, C.R., K.G. Sellner, and D. M. Anderson (**2017**) Bloom Prevention and Control. Invited chapter for **UNESCO Manual: Desalination and Harmful Algal Blooms: A Guide to Impacts, Monitoring, and Management,** Eds: D. Anderson, S. Boerlage, and M. Dixon, 205-222.

Anderson C.R., R.M. Kudela, M. Kahru, Y. Chao, F. Bahr, L. Rosenfeld, D. Anderson, and T. Norris, Initial skill assessment of the California Harmful Algae Risk Mapping (C-HARM) system, ***Harmful Algae,*** 59, 1-18, doi: 10.106/j.hal.2016.08.006

Anderson, C.R., S. Moore, M. Tomlinson, J. Silke, and C. Cusak (**2015**) Living with harmful algal blooms in a changing world: Strategies for modeling and mitigating their effects in coastal marine ecosystems. Invited chapter for ***Coastal and Marine Hazards, Risks, and Disasters*** volume, Eds: J. Ellis and D. Sherman, Elsevier B.V., http://dx.doi.org/10.1016/B978-0-12-396483-0.00017-0

Bograd, S., M.M. P. Buil, E. Di Lorenzo, C. Castro, I.D. Schroeder, R. Goericke, C.R. Anderson, C. Benitez-Nelson, and F. Whitney (**2015**) Changes in source waters to the Southern California Bight, ***Deep-Sea Research II***, Special Issue on CCE-LTER, 112:42-52.

Anderson, C.R., R.M. Kudela, C.R. Benitez-Nelson, E.S. Sekula-Wood, C. Burrell, Y. Chao, G. Langlois, J. Goodman, D.A. Siegel (**2011**) Detecting toxic diatom blooms from ocean color and a regional model. ***Geophysical Research Letters***, 38, L04603, doi:10.1029/2010GL045858.

Anderson, C.R., M.R.P. Sapiano, M.B.K., Prasad, W. Long, P.J. Tango, C.W. Brown, R. Murtugudde, (**2010**) Predicting toxigenic *Pseudo-nitzschia* blooms in the Chesapeake Bay. ***Journal of Marine Systems***, GEOHAB Modeling Special Issue, doi 10106/j.jmarsys.2010.04.003.

Anderson, C.R., D.A. Siegel, R.M. Kudela, M.A. Brzezinski (**2009**) Empirical habitat models of toxigenic *Pseudo-nitzschia* spp.: Potential use as a remote detection tool in the Santa Barbara Channel. ***Harmful Algae***, 8: 478-492, doi: 10.1016/j.hal.2008.10.005

Anderson, C.R., D.A. Siegel, N. Guillocheau, M.A. Brzezinski (**2008**) Controls on temporal patterns in phytoplankton community structure in the Santa Barbara Channel, California, ***Journal of Geophysical Research-Oceans***, 113: C04038, doi:10.1029/2007JC004321.

Anderson, C.R., M.A. Brzezinski, L. Washburn, R. Kudela (**2006**) Circulation and environmental conditions during a toxigenic *Pseudo-nitzschia australis* bloom in the Santa Barbara Channel, California. ***Marine Ecology Progress Series***, 327: 119-133.

SELECT SERVICE FROM LAST FIVE YEARS

***ongoing**

2020 Panelist for E.U. JERICO-S3 Transnational Access to Coastal Observatories/Supporting Facilities
2020 IOC-SCOR GlobalHAB Scientific Steering Committee, elected member
2020 Advisory Board Member, The Ocean Foundation*
2020 NASA PACE Mission- Early Adopter Program for Applications, Science PI*
2019 SIO representative for the Western Association of Marine Laboratories (WAML)*
2019 Science Advisory Team to California Ocean Protection Council, elected member*
2019 Technical Advisory Team for a MERHAB project, PI: Raphael Kudela, invited member*
2019 OceanObs'19 Regional Coordination Network Committee, Active Collaborator*
2019 Organizing Committee for GlobalHAB Modeling Workshop (2021, Glasgow, Scotland)
2019 IOOS Association - HAB Committee, elected member*
2019 IOOS Association - Policy Committee, elected member*
2019 IOOS Association - Foundation Support Committee, elected member*
2018 IOOS Association - Modeling Committee, elected member*
2018 Elected M National Harmful Algal Bloom Committee (HNC), elected member*
2018 Science Advisory Group (SAG), Southern California Bight Ocean Acidification & Hypoxia Modeling Project (SCCWRP, UCLA, UW); SAG Model Validation Subcommittee, invited member*
2018 Steering Committee for the E.U. Horizon 2020 Project- CoCliMe: Adapting to a Changing Marine Ecosystem, invited member*
2017 West Coast Ocean Forecast System Oversight Committee, invited member*
2017 President Elect of the Eastern Pacific Ocean Conference, EPOC (501c3)*
2017 Marine Modeling Working Group, Unified Modeling Framework Strategic Implemental Plan, NOAA NCEP, invited member*
2016 Ocean Acidification and Hypoxia Monitoring Inventory Task Force for the U.S. West Coast, Pacific Coast Collaborative (PCC) and the Interagency Working Group on Ocean Acidification (IWG-OA), invited member
2015 Cal-HABMAP Steering Committee, elected member*

H. NAMES AND LOCATIONS OF ALL ENTITIES RECEIVING FUNDS AND PRIMARY PLACES OF PERFORMANCE UNDER THE SUB-CONTRACT/SUB-AWARD.

Institution	City, State	Congressional District
UCSD Birch Aquarium	La Jolla, CA	52
California Polytechnic State University, San Luis Obispo	San Luis Obispo, CA	24
California State University Long Beach	Long Beach, CA	47
California State University Northridge	Northridge, CA	30
Farallon Institute	Petaluma, CA	2
Monterey Bay Aquarium Research Institute	Moss Landing, CA	20
NOAA, National Marine Fisheries Service	Vancouver, WA	3
NOAA, Office of National Marine Sanctuaries	Santa Barbara, CA	24
NOAA, Southwest Fisheries Science Center	La Jolla, CA	52
Ocean Data Network LLC	Peaks Island, ME	1
Pacific Marine Mammal Center	Laguna Beach, CA	48
Reef Check Foundation	Marina Del Rey, CA	33
Southern California Coastal Water Research Project	Costa Mesa, CA	48
University of California, Irvine	Irvine, CA	45
University of California, Los Angeles	Los Angeles, CA	33
University of California, San Diego	La Jolla, CA	52
University of California, Santa Barbara	Santa Barbara, CA	24
University of Southern, California	Los Angeles, CA	37
Woods Hole Oceanographic Institution	Woods Hole, MA	9

5. DATA SHARING/MANAGEMENT PLAN

More detailed information regarding SCCOOS RICE Certification and data management, including sensor plans detailing types and quantity of data, can be found at https://sccoos.org/certifications.

1. Open Data Sharing - SCCOOS adheres to FAIR and GEO Data Sharing Principles, and our data can be found via IOOS, NDBC, NCEI, GBIF, OBIS, Google Dataset Search, erddap.com and more. We continually work to improve and extend metadata and to make our data easier to find and more widely available. Rich metadata also facilitates reuse of SCCOOS data. For example, after overhauling the HABMAP data pipeline to make those data programmatically available via ERDDAP, we went one step further and modified the format to conform with Darwin Core and submitted them to GBIF. From there, data were pulled into OBIS, giving the HABMAP data global visibility. Future plans for non-biological datasets include upgrading to IOOS Metadata Profile Version 1.2, which will keep us compatible with NDBC as they switch from pulling data by FTP to pulling it via ERDDAP. As a certified NOAA IOOS Regional Information Coordination Entity (RICE), SCCOOS has a mandate to collect, organize, and provide access to regional oceanographic and biological data using community-developed standards. These data need to be easily understood, electronically accessible and well-organized to allow policy makers, researchers, managers, and the general public to make informed decisions. This project will leverage the data management infrastructure, developed by SCCOOS and funded by IOOS, to aggregate, manage and share data from its data providers with minimum time delay and at no cost. This system meets the core data requirements as defined in IOOS Data Standards and Requirements, as well as the RICE Certification Requirements Guidance. Details of the data SCCOOS makes available, which includes Essential Ocean Variables (EOV), Essential Biological Variables (EBV) and more, as well as information on time from data acquisition to its availability from SCCOOS, can be found on the SCCOOS website at https://sccoos.org/certifications. **2. Data Management Planning and Coordination** - Involvement in the IOOS DMAC community helps us stay apprised of new technologies and best practices related to data management. Monthly webinars on related topics and technologies bring together DMAC members from all nine regions, giving them a chance to discuss issues and develop solutions for things common across regions. SCCOOS DMAC and RA personnel attend annual meetings where presentations are given updating attendees on the best practices, new tools and techniques, changes to IOOS requirements, etc. and IOOS sponsored “code sprints” where members of the DMAC community come together to work on common problems. We reference the publicly available collection of source-controlled software and reuse code whenever possible. We will continue to maintain existing code for QC of Semi-Automated Shore Station (SASS) data. As we implement additional QC on SCCOOS regional datasets, QARTOD manuals[122] will guide these efforts and we will utilize open-source code in the ioos_qc GitHub code repository to accelerate these efforts. In the coming year, we will add QC for newly added variables (e.g., pH and O2) and develop QC tests for HABMAP data.As biological data become increasingly important, standards are being developed for representation of these data and national and global repositories are being created to archive and provide access to these data. Our involvement with the newly formed ESIP Biological Data Standards Cluster and the Standardizing Marine Biological Data Working Group will inform the IOOS DMAC community regarding progress in these groups, ensure that IOOS interests are represented as these standards are developed, and make these data easier to find, share and aggregate in the future. **3. Data Access Services** - SCCOOS currently operates both ERDDAP and THREDDS servers, with plans to operate an additional, private ERDDAP server for use by our NAVAIR stakeholders in early 2021. SCCOOS continues to make data available over SOS via an installed THREDDS extension. Both ERDDAP and THREDDS allow data to be downloaded programmatically and both supply metadata that allow the data to be further shared and distributed accordingly. In addition, the SCCOOS ERRDAP server allows data to be downloaded in numerous formats, allows sensitive datasets to be password protected, provides basic plotting and graphing functionality, allows federation of independent ERDDAP data collections, and facilitates searching for data across multiple ERDDAP data repositories.[123] **4. Metadata and Data Formats** - Metadata are regularly

updated, extended, improved and adjusted to better align with standards such as ISO 19115-2, IOOS Metadata Profile Version 1.2, Climate and Forecast metadata (CF), Attribute Convention for Data Discovery (ACDD) and Darwin Core. Metadata can be used by national and international data repositories to aggregate similar data from multiple regions. **5. Catalog Registration** - Data from SCCOOS funded SASS are registered with the IOOS Catalog. As we upgrade SASS metadata to be compliant with IOOS Metadata Profile Version 1.2, we will take the opportunity to evaluate metadata for other datasets, including our HABMAP dataset, so that those can also be made compliant and be added to the IOOS catalog. As metadata for new datasets are made compliant, those datasets are registered with the IOOS catalog.**6**. **Provision of Data to the NOAA National Data Buoy Center (NDBC)** - SASS data from SCCOOS are harvested by NDBC and relevant information is forwarded from NDBC to the GTS network. Our SASS data, which are currently fed to NDBC via FTP, will be upgraded to the latest IOOS Metadata Profile, allowing NDBC to pull the data via ERDDAP and automatically detect, from updated metadata, which information should be passed on to the GTS. **7. Storage and Archiving** - SCCOOS data are stored both on-site and in the cloud. On-site equipment is housed in the SIO data center, which provides enterprise level power, cooling, fire suppression, security and 24/7 monitoring of SCCOOS equipment, including 2 enterprise level servers for VMWare virtual machine and Docker hosting, a server dedicated to ROMS modeling and a 40TB data/file server. Private cloud storage at UCSD's San Diego Supercomputer Center (SDSC) provides off-site backup storage for SCCOOS data in their 19,000 sq. ft. climate-controlled and secure datacenter that is fully equipped with 13 megawatts of power, 10-gigabit network connectivity, and a 24/7 operations staff. Additionally, SCCOOS data are archived at NCEI and GBIF/OBIS. Select SCCOOS data are also made available via national DACs. Most notably 1) the glider data, which are submitted to the NGDAC, 2) the HFR data, which are archived at NDBC and within the HFRNet, 3) HABMAP data from manual water sampling, which are being archived at GBIF, and HAB/plankton data from the CA IFCB Network (OPC and NHABON, and funding), which will be used to establish the new HAB Data Assembly Center (HABDAC, PCMHAB funding). **8. Sustained Operations** - SCCOOS is investing heavily in modernizing and future-proofing its computational infrastructure. Our entire software infrastructure has been rebuilt in order to take advantage of new technologies and techniques that represent best practices for building, maintaining and growing technical infrastructure for both managing data and providing services to stakeholders. Automation, modularity, and repeatability are the cornerstones of the new architecture. Technologies that SCCOOS is now able to leverage because of this new approach include infrastructure as code (IoC), containerization (i.e. Docker), collaborative development (i.e. use of open source software and organized code sprints) and reuse of software products by designing for modularity, generality and reuse. We continually assess the status of older displays and tools to evaluate how they might be improved by being redeveloped using modern technologies, and to help keep our IT systems secure and optimally utilized. Our containerized infrastructure allows SCCOOS data products to be developed in multiple languages (e.g., R, Python, MatLab, Bash, etc.), come from multiple sources (e.g., open source, DMAC community, SCCOOS researchers, etc.), leverage the most appropriate framework or technology (e.g., RStudio, Shiny, MySQL, Leaflet, PHP, NetCDF, GIS libraries) and integrate seamlessly into our Wordpress-based website, which can be quickly and easily modified and updated by anyone on the SCCOOS team. Wherever possible, system design and automated tools are created to be generally applicable so that efforts to standardize, upgrade or automate one component results in system wide improvements. Our physical hardware infrastructure is also undergoing modernization.

6. NATIONAL ENVIRONMENTAL POLICY ACT (NEPA)

Responses to the National Environmental Policy Act (NEPA) questions listed in the NOFO on all proposed assets/technologies can be found in the SCCOOS Environmental Compliance for New and Existing Projects spreadsheet (https://bit.ly/SCCOOS-NEPA) provided by Mequela Thomas, IOOS Environmental Compliance Coordinator.