



# SOUTHERN CALIFORNIA COASTAL OCEAN OBSERVING SYSTEM

**U.S. Integrated Ocean Observing System (IOOS) Implementation**  
Southern California Coastal Ocean Observing System (SCCOOS)  
FY16-21 National Oceanographic Partnership Program Report:  
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[www.sccoos.org](http://www.sccoos.org)



## I. PERFORMANCE PROGRESS REPORTS

### 1) PROJECT SUMMARY

The Southern California Coastal Ocean Observing System (SCCOOS) is one of eleven regions that contributes to the national U.S. Integrated Ocean Observing System (IOOS®). The regional observing systems work to collect, integrate, and deliver coastal and ocean observations in order to improve safety, enhance the economy, and protect the environment. The principal goal of SCCOOS is to provide observations and products to a diverse stakeholder community of managers and planners, operational decision makers, scientists, and the general public. As the regional observing system for Southern California, SCCOOS, has developed the capabilities to support short-term decision-making and long-term assessment by implementing and leveraging biological, chemical, and physical observations and models, many of which are available in near real-time. SCCOOS' priorities and objectives are aligned with the seven societal goals as outlined in the IOOS Summit Report. The focus themes, as designated by IOOS, highlight these priorities and are designed to improve safety, enhance the economy, and protect our environment. With the major disruption of the COVID-19 pandemic in this last six month window, many operations have been curtailed or entirely suspended. A detailed list of COVID-19 operational impacts can be found [here](#). However, the advantage of a functioning ocean observing system replete with autonomous instrumentation is that we did manage to catch an unprecedented and historic “red tide” event that covered the entire coastal Southern California Bight.

1. **Climate Variability and Change:** to operate and maintain a network of gliders to collect measurements of temperature, salinity, chlorophyll, current velocity, dissolved oxygen, and acoustic backscatter; deliver data to the SCCOOS website and push to modeling centers, and to continue to develop, integrate, and enhance long-term time series products for distribution.
2. **Coastal Hazards:** to provide accurate, validated inundation models and information about wave observations and run-up, total water levels, coastal erosion, and storm surge, with the long-term goal of improving coastal safety.
3. **Ecosystems, Fisheries, and Water Quality:** to monitor ocean climate trends and environmental changes in the Southern California Bight by collecting physical, chemical, and biological data and to provide monitoring, tracking, and prediction tools for harmful algal blooms, outfall and storm water plumes, and surf zone contaminants.
4. **Marine Operations:** to advance integrated, customized coastal products that are critical for safe and efficient navigation into ports and harbors, search and rescue missions, and oil spill response.
5. **Science Education and Communication:** to maintain a public, accessible website for data discovery and a portal that provides visualizations and resources for the public to learn, educate, and promote scientific research with SCCOOS data. A spreadsheet of SCCOOS education and outreach efforts can be found [here](#), as well as a spreadsheet of stakeholders can be found [here](#).

### 2) PROGRESS AND ACCOMPLISHMENTS

SCCOOS continues to achieve its milestones by providing access to high-quality integrated data and supporting regional user needs while complying with national standards and protocols for sharing and archiving data. SCCOOS leverages the [Coastal Data Information Program \(CDIP\)](#), the [HF Radar Network \(HFRnet\)](#), and the [California Underwater Glider Network \(CUGN\)](#). SCCOOS actively participates in IOOS Data Management efforts, such as the use of the UCAR community program Thematic Real-Time Environmental Distributed Data Services (THREDDS) and the NOAA NMFS Environmental Research Division's Data Access Program (ERDDAP) to facilitate distribution of most of our datasets ([SCCOOS Data Access and Services webpage](#)). SCCOOS also continues to implement QARTOD data quality control standards for all parameters for which QARTOD exists, including the chlorophyll fluorometry QARTOD manual. All data have associated ISO 19115 compliant metadata and are well catalogued in our [RICE certification documentation](#). As a result of SCCOOS listservs (e.g., [sccoos@sio.ucsd.edu](mailto:sccoos@sio.ucsd.edu), [CA.HAB.Bulletin@sccoos.org](mailto:CA.HAB.Bulletin@sccoos.org)) and social media streams (e.g., [Facebook](#), [Twitter](#)), more ocean observing

news items are now widely distributed throughout the Regional Associations, the IOOS program office and the SCCOOS user community.

## CLIMATE VARIABILITY AND CHANGE

1. Operate and maintain a network of gliders to collect measurements of temperature, salinity, chlorophyll, current velocity, dissolved oxygen, and acoustic backscatter; deliver data to the SCCOOS website and push to modeling and data archive centers.

a. Principal Investigator: Daniel Rudnick, UCSD

b. Completion date: TBD - ongoing milestone; c. Status: On-Track

d. Successes and Challenges: Real-time data are delivered to [THREDDS](#) and [ERRDAP](#) then to the national glider DAC, and then onto the GTS. Delayed mode, quality controlled data are available for download at [spraydata.ucsd.edu](#). The major recent advance has been the creation of a calibrated chlorophyll fluorescence data set, adjusted to agree with satellite color data, available at [spraydata.ucsd.edu](#). The goal is 5 sustained lines using Spray underwater gliders off the coast of California. The lines follow the CalCOFI geometry, from south to north: line 90.0 (funded by NOAA GOMO), alongshore at station 60 (SCCOOS), line 80.0 (SCCOOS), line 66.7 (NOAA GOMO), and line 56.7 (CeNCOOS). The COVID-19 pandemic interrupted the observations, with all lines except for line 90.0 having a break. Lines 80.0 and alongshore are back up. Lines 66.7 and 56.7 will likely be back up within a month with assistance from MBARI. More information on the California glider network can be found on the [SCCOOS website](#).

2. Continue to develop, integrate, and enhance long-term time series products for distribution.

a. Principal Investigator: Clarissa Anderson, UCSD

b. Completion date: TBD - ongoing milestone; c. Status: On-Track

d. Successes: Lead PI C. Anderson and Program Coordinator, Megan Medina, published six [CA HAB Bulletins](#) during the performance period. The CA HAB Bulletin is posted on the SCCOOS website, shared out on our medial platforms and goes out to 298 people registered to our [CA HAB Bulletin listserv](#). The listserv is comprised of academia (88), government (97), nonprofit (50), industry (20), and public (43) stakeholders. SCCOOS also released a special bulletin on the prolonged [Red Tide Event: Spring 2020](#). The Bulletin consolidates over 50 figures of plots, maps, images, and videos from colleagues at SIO/UCSD, NOAA, SCCWRP, City of LA, Orange County, and San Diego and more. The Red Tide Bulletin paved the path to receiving HAB Event Response funds from NCCOS to do additional analysis and ascertain the relative roles of ocean acidification, hypoxia, and toxic stress in causing a massive fish and invertebrate die-off in Southern California and Baja. NOAA NCCOS awarded SCCOOS and research at Scripps Institution of Oceanography \$11,000 to investigate the bioluminescent *Lingulodinium polydera* bloom and co-occurrence of low dissolved oxygen off the coast of Southern California, from the Channel Islands in California to Cedros Island in Mexico. An even larger team is compiling a special issue on the bloom, with partners from CICESE in Ensenada, Baja California to UC Santa Barbara. We continue to add long-term time series as they becomes available. Recently, a pH sensor was added to Scripps Pier and both pH and DO are now being measured at Newport Beach pier. Data from these sensors are being collected and made publicly available via the SCCOOS ERDDAP server.

## COASTAL HAZARDS

1. Drivers of Primary Productivity of the Shelf and Nearshore Region

a. Principal Investigators: Kristen Davis, UCI, Drew Lucas, UCSD and Uwe Send, UCSD

b. Completion date: TBD; c. Status: On-Track

d. Successes and Challenges: This is a one-year project to demonstrate an observing approach for nutrient flux triggers of phytoplankton blooms in shelf and nearshore waters in Southern California. Progress made over the performance period includes: (1) integration of a SUNA V2 optical nitrate sensor onto the Wire Walker profiler platform and (2) deployment and maintenance of the Wire Walker mooring near Uwe

Send's Del Mar mooring (100m isobath) for 22 days in late April and May 2020. Work on the initial integration of the SUNA V2 was delayed by a month because PI Davis was unable to recover a SUNA V2 from a field experiment in Panama due to COVID-19 related travel restrictions. As a work-around solution, a SUNA V2 was borrowed from a colleague (Dr. Erika McPhee-Shaw) allowing work to continue. Key outcomes of the research during the performance period include: (1) successful demonstration of the SUNA V2 integration on the Wire Walker, (2) the collection of high-frequency profiles (approximately every 11 min) of physical data and nitrate concentrations during the harmful algal bloom (*L. polyedra*) event, and (3) collection of supporting data from Del Mar mooring, including images from the Imaging Flow Cytobot (IFCB). Preliminary analyses of these novel observations indicate that optical attenuation by strongly swimming dinoflagellates (*L. polyedra*) can significantly influence the upper ocean heat budget, suggesting that biological feedbacks can be of first-order importance to the physical structure of the upper ocean. The PIs plan a second deployment of the full array in Summer 2020.

1. Shoreline inundation forecast, validation, and dissemination of warnings to select city managers.
  - a. Principal Investigator: Mark Merrifield, UCSD and Falk Fedderson, UCSD
  - b. Completion date: TBD - ongoing milestone; c. Status: On-Track
  - d. Successes and Challenges: Cardiff and Imperial Beach flooding forecasts have been passed on to be posted on the [SCCOOS website](#) for city officials and the public. The Imperial Beach flooding forecasts were available at [CCCIA website](#) this past winter for public use. This past winter (2019-2020), many overtopping events for Imperial Beach were successfully predicted multiple days in advance by the flood forecasts and gave the city advance warning and time to prepare. Prototype forecasts for Coronado and Huntington Beach are in the process of being evaluated and validated with observations. PI Merrifield participated on the panel in the IOOS Town Hall on Stakeholder Partnerships at the AGU Ocean Sciences Meeting.
  
2. Expand development and integration of inundation website.
  - a. Principal Investigator: Mark Merrifield, UCSD and Falk Fedderson, UCSD
  - b. Completion date: TBD - ongoing milestone; c. Status: On-Track
  - d. Successes and Challenges: A website for Imperial Beach is now live at [CCCIA](#) and on the [SCCOOS website](#) and includes products showcasing historic trends, latest observations, and the flood forecast. Historic products include a compilation of past events, a record of historic beach width, and a beach profiles viewer for identified flooding sites. Latest observations include wave height predictions for Imperial Beach and an elevation map of the beach based on the latest LiDAR survey. Beach products, including the beach width plot, beach profiles viewer, and LiDAR elevation map, are in the process of being improved to automatically update with the latest sand level surveys. The Imperial Beach site will serve as a template to expand to other coastal sites. A website for Cardiff beach is also on the [SCCOOS website](#) and includes historic products as well as a flood forecast. The forecast has been specifically developed for Cardiff beach and is in the process of being evaluated and improved. Other products are in development, although not live yet, and include a beach profiles viewer and record of past flooding events. Prototype websites for Huntington Beach and Coronado are currently in development with a profiles viewer and a flood forecast based on the improved runup parameterization developed at Imperial Beach. We will continue to develop these sites as well as evaluate and improve the forecasts with observations.
  
4. Develop model for Huntington and Imperial Beach inundation sites
  - a. Principal Investigator: Mark Merrifield, UCSD and Falk Fedderson, UCSD
  - b. Completion date: TBD – ongoing milestone; c. Status: On-Track
  - d. Successes and Challenges: Overtopping events were closely monitored in Imperial Beach during the 2019-2020 winter in order to collect observations to improve and refine the flood forecast. These observations, including measurements of incident wave conditions with current meters and a wave buoy, LiDAR, drone, and pressure sensor measurements of runup, and GPS sand elevation surveys were used to calibrate the improved runup parameterization and adjust the overtopping threshold for the Imperial Beach

forecasts. The Imperial Beach template has been expanded to Huntington Beach with a prototype site currently in development. A forecast for Huntington Beach has been created based on the Imperial Beach improved runup parameterization. Future observations and surveys will be used to calibrate and improve the model for the Huntington Beach location.

## ECOSYSTEMS, FISHERIES, AND WATER QUALITY

1. Monitor Harmful Algal Blooms (HABs) at five pier stations by collecting weekly measurements of temperature, salinity, chlorophyll, nutrients and potentially harmful phytoplankton species. Provide data online and distribute via the California HABMAP listserv.

a. Principal Investigators: Libe Washburn, UCSB, Mark Brzezinski, UCSB, Dave Caron, USC, Ryan Walter, Cal Poly, Alexis Pasulka, Cal Poly, Rebecca Shipe, UCLA, Mel Carter, UCSD, Clarissa Anderson, UCSD and John McGowan, UCSD.

b. Completion date: TBD - ongoing milestone; c. Status: On-Track

d. Successes and Challenges: Weekly measurements of temperature, salinity, chlorophyll, particulate domoic acid, macronutrients, and potentially harmful phytoplankton species are distributed via the California HABMAP listserv and are discoverable online via the [SCCOOS ERDDAP server](#). Interruptions in sample collection and processing occurred between March 23-May 31, 2020, with the closing of several piers, university laboratories, and shelter-in-place orders throughout California, associated with the COVID-19 pandemic. Details for each station follow:

Cal Poly Pier/Cal Poly: Cal Poly obtained an exemption to continue weekly sampling at the Cal Poly Pier during COVID-19. Counts and reports are done every other week to minimize time in the lab. PIs Walter and Pasulka, along with former undergraduate student Alex Barth and Senior Research Scientist Ian Robbins, published a paper in *Marine Ecology Progress Series* (Barth et al. 2020) describing seasonal and interannual phytoplankton variability from a decade of HAB measurements made at the Cal Poly Pier. This work was also presented by poster at the Ocean Sciences conference in San Diego in February.

Stearns Wharf/UCSB: UCSB shutdown all non-essential research on March 20, 2020. Routine weekly sampling, including new efforts to implement SPATT bag deployments for dissolved phycotoxins ceased at that time. Data processing continues from remote (home) locations.

Santa Monica Pier/UCLA: Two sampling dates in March were missed due to shelter-in-place orders. Sampling took place weekly as scheduled in April- May. Samples have been partially processed and full analyses will be completed once university laboratories are reopened.

Newport Beach Pier sampling (USC): As with other pier sampling efforts, sampling at Newport Beach was shutdown beginning in mid-March. The pier itself was closed to the public for some time, and University policy curtailed all sampling at the pier and sample processing in the lab through June 15th. On-campus research activities were restarted at USC the week of June 15th, and sampling at the Newport Beach pier is planned for restart on June 22/23. Two manuscripts were published recently that were in part or whole a result of samples and data collected at Newport Beach pier: [Busch et al., 2019](#) and [Smith et al., 2019](#).

Scripps Pier/SIO: SIO obtained an exception to continue weekly sampling throughout the UCSD campus closure. Efforts to minimize time on campus from March 18th through April 30th included freezing chlorophyll samples for later analysis and deferring cell counts until May. Starting late March, a bloom of *Lingulodinium polyedra* ramped up to be the largest bloom on record since the Scripps Pier Chlorophyll Program started in 1983. The bloom lasted for almost two months and extended from Islas de Cedros, MX to Anacapa Island, CA. M. Carter also provided a two-week advance notice to Carlsbad Desalination Plant that a *L. polyedra* bloom was forming along the San Diego county coast and had the potential to reduce or harm plant operations. At the peak of the bloom, numerous dead fish and invertebrates stranded throughout San Diego county coastal areas and lagoons. SCCOOS prepared a [Red Tide Bulletin](#) to inform the public about this event. Additional samples for yessotoxin (YTX), RNA, DNA, and HPLC were collected along with weekly HAB sampling (April 13 - May 18, 2020). M. Carter and C. Anderson were able to secure minor funding through the NOAA NCCOS MERHAB Event Response Program to evaluate the role of



toxins and hypoxia in the deaths of numerous marine animals. Collaborating colleagues on this project are Eva Ternon (SIO), Kim Prather (SIO), William Gerwick (SIO) and Jayme Smith (SCCWRP). Since the campus closure, Scripps Pier data have not been uploaded to ERDDAP due to limited time on campus and deferred analysis of chlorophyll samples and cell counts. These will be uploaded as soon as feasible. Deployment of SPATT was planned for March 2020 and was delayed due to campus restrictions. The SPATT rig was deployed 6/18/20 and the first SPATT bags will be deployed 6/22/20. Collaborations with Jules Jaffe, Peter Franks, Andrew Barton and post-doctoral scholar, Kasia Kentitz, utilizing the Scripps Pier Plankton Camera and weekly cell counts led to the following paper by [Kenitz et al., 2020](#) published in *Limnology and Oceanography*. Collaboration with Carl Carrano at San Diego State University and graduate student Kuyoko Yarimizu investigated the role of bacteria producing iron and bloom dynamics. This research utilized weekly chlorophyll and cell counts and led to the publication by [Yarimizu et al., 2019](#) published in *BioMetals*.

Data Manager, Vicky Rowley, has upgraded, standardized and automated the weekly acquisition and distribution of HAB data from seven collection sites with the data being made available via the [SCCOOS ERDDAP server](#). HABMAP information, products and data are available on the [SCCOOS HABMAP page](#) and UCSC and SCCOOS operated [HABMAP site](#). In addition, a Darwin-Core compliant version of these data is being developed to facilitate their submission to global biological data repositories such as MBON and OBIS thanks to Matt Howard Memorial supplemental funding from IOOS.

2. Continue to collect California Cooperative Oceanic Fisheries Investigations (CalCOFI) observations and measurements.

a. Principal Investigator: Ralf Goericke, UCSD

b. Completion date: TBD - ongoing milestone; c. Status: On-Track

d. Successes and Challenges: Since 2004, SCCOOS has funded nine nearshore stations in addition to CalCOFI's standard 66 stations. SCCOOS links to data that are measured in the nearshore region of Southern California as part of CalCOFI - California Current Ecosystem Long Term Ecological Research (CCE-LTER) program. These parameters include temperature, salinity, zooplankton, phytoplankton, fish eggs and invertebrate larvae. CalCOFI data, resources, and reports are posted on the [CalCOFI website](#). More information on SCCOOS-CalCOFI background, observations, data access and publications can be found on the [SCCOOS website](#). Due to COVID-19, the CalCOFI Spring 2020 cruise was canceled, and the summer 2020 cruise is highly likely to be as well. CalCOFI is tentatively planned to sample again in October 2020.

3. Conduct shipboard observations with CalCOFI and NMFS Rockfish Recruitment and Ecosystem Assessment Survey (RREAS); count seabirds; post data reports and data online.

a. Principal Investigator: Bill Sydeman, Farallon Institute

b. Completion date: TBD - ongoing milestone; c. Status: On-Track

d. Successes and Challenges: We completed the winter CalCOFI survey as planned and posted its corresponding data report online one week after the survey was completed. The spring (April) CalCOFI and spring-summer (May-June) RREAS were cancelled due to COVID concerns. Instead, we have emphasized DMAC, and in particular have been working to implement new statistically derived data products to be shared with the IOOS community in the near future. These new derived products will include a dataset of time series of 20 species' densities by season for the period May 1987-present. We are also working with NOAA's Environmental Research Division and SCCOOS to post the seabird dataset on the ERDDAP for the benefit of the marine science community and other data users including NMFS, USGS, HT Harvey and Associates and others. Finally, we are working with collaborators on a manuscript investigating the effect of climate change and fisheries on range shifts of seabirds from the subtropics into the California Current. This investigation is focusing on several species that have shifted their distributions from the Gulf of California into the Southern California Bight.

4. Publish survey reports and maps of seabird species distribution and abundance on SCCOOS web site.
  - a. Principal Investigator: Bill Sydeman, Farallon Institute
  - b. Completion date: TBD - ongoing milestone; c. Status: On-Track
  - d. Successes and Challenges: Survey reports and maps of species distribution and abundance are published on SCCOOS [website](#). As we look at adding biological data to our digital offerings, looking at a way to provide these data in a digital format is an upcoming challenge.
  
5. Display the 3-km ROMS ocean forecasting system for real-time operations statewide.
  - a. Principal Investigator: Yi Chao, UCLA
  - b. Completion date: TBD - ongoing milestone; c. Status: On-Track
  - d. Successes and Challenges: 3-km California ROMS model with data assimilation and real-time forecasting capabilities has been running continuously. This state-wide ROMS model is assimilating both the HF radar surface current data and the vertical profiles of temperature and salinity from four Spray gliders as well as other available observational data sets including satellite sea surface temperature and vertical profiles of temperature and salinity from moorings, ships and floats. The ROMS model is displayed in near-real time on the SCCOOS website (<http://sccoos.org/roms-model-output/>). In 2020, Rowley and Hepner plan to redesign the ROMS webpage to, making it consistent with other SCCOOS technology pages thereby increasing user visibility. A major challenge, and one which has represented increasing risk to this project over the years, is the need to replace the aging computers used to run this quasi-operational model. However, discussions are now in progress regarding migration of this to system to production hardware hosted in the Scripps Institution of Oceanography (SIO) data center during the summer and fall of 2020.
  
6. Validate the 3-km CA ROMS output against non-assimilated observations.
  - a. Principal Investigator: Yi Chao, UCLA
  - b. Completion date: TBD - ongoing milestone; c. Status: On-Track
  - d. Successes and Challenges: Six hourly nowcasts and 72-hour forecast files are available via OPeNDAP/THREDDS. With the migration of the model to SCCOOS and the SIO Data Center, it is expected that these files will be made available on the SCCOOS THREDDS server by the end of 2020. The validation results have been published in a journal paper ([Chao et al., 2017](#)). Over the years, we have developed a number of validation products. On a daily basis, we are comparing the ROMS nowcast against satellite SST, glider measured profiles of temperature and salinity and HF radar derived surface current. As the new SCCOOS 3-km ROMS is developed, we plan to display these real-time model validation results on that web page. Operational impacts due to COVID-19: Minimum to none. Most of our work are performed remotely, so there has been little impact on our 3-km ROMS modeling effort.
  
7. ROMS High-Resolution Shelf and Nearshore model developed to aid the evaluation of the effects of nutrient inputs on bloom formation and nutrient cycles.
  - a. Principal Investigator: Jim McWilliams, UCLA
  - b. Completion date: TBD - ongoing milestone; c. Status: On-Track
  - d. Successes and Challenges: Fine-scale simulations with a research-level, high-resolution ROMS are being analyzed in hindcast mode at UC Los Angeles to examine two circulation phenomena in particular. First, pollution effluent dispersal throughout the Southern California Bight is being assessed for augmentation of net primary productivity in the surrounding shelf regions with ancillary consequences for subsurface oxygen and carbon. Second, shelf submesoscale currents and surf-zone turbulence under various surface gravity wave and coastline shape influences are being assessed to determine their roles in along- and across-shore transports of material concentrations, biological and otherwise. This is being done using the surface wave-current interaction theory and grid-nesting capabilities of ROMS to examine cross-shore exchange of materials in the shelf and surf zone. Sites near Pt. Conception, the northern Channel Islands, Santa Monica Bay, and the Newport region are the primary locales of interest. In parallel, we are developing a coupled ROMS/biogeochemistry/ecosystem model (ROMS-BEC) that we hope to use in the future to aid

the evaluation of the effects of nutrient inputs on bloom formation and nutrient cycles, as well as variability and trends in hypoxia and acidification. The progress is both published and periodically published online. Funding for much of this work is provided by various extramural grants from the California Ocean Protection Council, NOAA, and UCLA. SCCOOS funds contribute to general model development and system maintenance but do not currently support additional product dissemination or development.

8. Continue automated shore sampling at four stations to measure temperature, pressure, salinity, chlorophyll, as well as DO and pH at Newport Beach Pier and pH at Scripps Pier.

a. Principal Investigators: Mel Carter, UCSD, Sarah Giddings, UCSD, Clarissa Anderson, UCSD and Eric Terrill, UCSD

b. Completion date: TBD - ongoing milestone; c. Status: On-Track

d. Successes and Challenges: The automated shore stations program operates and maintains four stations (Scripps Pier, Newport Pier, Santa Monica Pier, and Stearns Wharf) and provides real-time, continuous data at 4-minute intervals with limited interruptions. Automated shore station data are one of the most requested data sets provided through SCCOOS. These data are used by both the public and local state and research agencies to assess local conditions related to water quality, nearshore processes, population dynamics of coastal species and HABs, and provides long-term time series data critical for assessing ecosystem health and climate trends. SIO obtained an exception to work during the ongoing COVID-19 campus closure to maintain the Automated Shore Station (SASS) at Scripps Pier, Newport Pier, and Santa Monica Pier. Data were collected at all sites throughout the closure and captured the recent *L. polyedra* bloom (March 19-May 18, 2020). However, COVID-19 restrictions and shelter-in-place orders have kept the UCSB team from servicing the Stearns Wharf Station since March 2020. Due to the long break in cleaning and maintenance, the sensors (CTD and fluorometer) and cables at this site were damaged due to excessive biofouling and will need to be replaced at significant expense.

Additional funding for the Newport Pier SASS has been renewed by the Orange County Sanitation District for the July 2020- June 2021 period with the option for renewal up to 4 years through 2024. This funding supports the collection of oxygen and pH measurements alongside the standard automated shore station observations. The Stearns Wharf Pier station has been supplemented by funds through the University of California, Santa Barbara to support maintenance and cleaning dives in collaboration with the Santa Barbara Long-Term Ecological Research Project. This is an important and leveraged partnership. The SASS program also offers “hands-on” training and learning for graduate and undergraduates at UCSD by providing tours to learn about the ocean observations and climate change, use of SASS data in classes, and complementary data set for student projects. SIO and UCSD classes include SIO221, SIO210, SIO101, SIO87, and MAE3. All stations are now equipped with engineering controls to improve real-time measurements from underwater sensors. Date and stations when air-blaster was installed SB 2/26/18, SIO 1/25/2019, SM 6/27/2019 and NB 2/13/2020.

The Santa Monica Pier shore station was decommissioned in years past and then reinstated with City of LA funding. However, funding from the City of LA Sanitation/Hyperion Water Reclamation Plant, The Bay Foundation, and The Los Angeles Waterkeeper for the Santa Monica Pier shore station ended on July 31, 2019 and has not been renewed at this time. Due to COVID-19 and possible city and state budgetary challenges, this funding may not be renewed in the future. Since December 2019, SIO has maintained this station and PIs will have to determine if there is funding for this station to remain online.

9. SeapHOx mini-mooring operations at Carlsbad Aquafarm (CAF)

a. Principal Investigator: Todd Martz, UCSD

b. Completion date: TBD – ongoing milestone; c. Status: On-track

d. Successes and Challenges: With the permission of OAP program managers and Jan Newton, the Burkeolator was removed from CAF and sent to Tommy Moore at the Northwest Indian Fisheries Commission (NIWFC). To continue to provide real-time and essential OAH information to CAF operators,



PI Martz overhauled the SeapHOx and redeployed it in early January 2020 on a mini-mooring in the Agua Hedionda Lagoon (AHL), within 10m of the CAF growing area. The mooring operated successfully, sending real-time data to SCCOOS. Data are currently available through [ERDDAP](#) and time series plots of the real-time data are available on the SCCOOS [website](#). The SeapHOx successfully delivered data for four months (Jan - Apr), at which time the cellular modem battery died on April 7th. A battery replacement was scheduled, but, due to COVID-19 shutdown, maintenance was delayed. On June 15<sup>th</sup>, Todd was able to successfully recover the SeapHOx deployed at AHL. The data downloaded captured the low dissolved oxygen and pH levels in AHL during the recent Red Tide event, specifically anoxic levels for 9 days in May in the lagoon which likely contributed to the 80% die off of Carlsbad Aquafarm crop. A second trip is scheduled in late June to replace the modem battery and and deploy a new SeapHOx. We expect to have a real-time SeapHOx operating again by July 1. Bresnahan et al., 2020 also published in *Results in Engineering* on [Equipping smart coasts with marine water quality IoT sensors](#).

## MARINE OPERATIONS

1. Annually provide training to first responders of maritime incidents in the use of SCCOOS products.
  - a. Principal Investigators: Ryan Walter, Cal Poly, Libe Washburn, UCSB, John Heidelberg, USC and Eric Terrill, UCSD
  - b. Completion date: TBD - ongoing milestone; c. Status: On-Track
  - d. Successes and Challenges: SCCOOS participates in training and science education to a broad range of stakeholders either by request or as opportunity arises. Dr. Angelica Rodriguez presented on behalf of SCCOOS, CDIP and CCCIA on June 3<sup>rd</sup> at the Port of Long Beach/Los Angeles Harbor Safety Committee Meeting. Angelica spoke on issues surrounding ports and sea level rise, inundation and data/model products that support maritime transport. The new Captain of the Port, Captain Ore, was impressed by the presentation and sea level rise research in the region. SCCOOS and CORDC staff also attend and present at the routine US Coast Guard Area Committee Meetings, informing teams of USCG and CA OSPR staff about the HFR data products and their use in SAROPS and GNOME model systems. The spring meeting was cancelled due to COVID, but a virtual meeting is scheduled for July 2020.
  
2. Operate and maintain a network of short, medium, and long-range HF radar systems and deliver data streams to the National HFR Network.
  - a. Principal Investigators: Ryan Walter, Cal Poly, Libe Washburn, UCSB, John Heidelberg, USC and Eric Terrill, UCSD
  - b. Completion date: TBD - ongoing milestone; c. Status: On-Track
  - d. Successes and Challenges:

**Cal Poly:** Cal Poly obtained an exemption to continue accessing sites during Covid-19, although some on-campus work has been limited. Cal Poly's nine HF radar sites were calibrated on their yearly schedule. The AWG firmware at all sites was upgraded to the newest firmware. Diablo Canyon's solar batteries were all recharged and maintained to maximize their lifespan. Power was repaired at ESTR after storms damaged the power infrastructure. The computer at the Diablo Canyon LR site was replaced after the hard drive failed. The receive antenna was reinstalled at Point San Luis after it was repaired, but this site is currently down due to a failed GPS share module which was recently ordered for replacement/upgrade. Data at Fallback 22, on Vandenberg Air Force base, were backed up and a new external hard drive was replaced. Rodent damage was repaired on the satellite power supply and cables at Point Conception (PTC1). Additionally, the upgraded RX chassis with combine antenna capabilities was installed at PTC1 after it was returned from the factory. All other Cal Poly sites were maintained in a manner that maximizes their uptime and lifespan. Ongoing student research using HF-Radar data has been looking at circulation patterns and upwelling jet formation near San Luis Obispo Bay under various wind-driven upwelling regimes. Moreover, several students have been contributing to a public information display that will be installed at the Point San Luis site.

**UCSB:** The radar group at UCSB worked to meet several challenges during the review period. The principal challenge has been the shutdown of research throughout UCSB, begun in mid-March, due to the COVID-19 pandemic. The group devised and submitted a plan to resume essential maintenance operations at all sites that it operates. The plan was approved by the UCSB Office of Research and minimal maintenance operations were started under Phase 2 of the limited ramp-up of field research activities. At the time of approval, two sites (RFG1 and MGS1) had been offline for several days. With the Phase 2 approval in place, UCSB Marine Technicians Eduardo Romero and David Salazar were able to get the sites back online. Since then the sites have been operating continuously. The radar at Point Mugu (PTM1) was put back online before the shutdown after many months of down time due to a building remodel at the site. As part of the new installation, PTM1 was rebuilt using new cables, computer, conduits, and antennas along with a new automated Antenna Pattern Measurement (APM) system that incorporates an Automated Information System (AIS) receiver for vessel tracking. APMs still need to be made at PTM1. This will be done as part of Phase 3 of the UCSB research ramp-up assuming the lab's pending Phase 3 approval is granted by the Office of Research. Failure of a pole-mounted transformer knocked out power at the Mandalay Generating Station radar site (MGS1) during the reporting period. Because the power plant where the site is located has shut down, the transformer will not be replaced and grid-based power will no longer be available at the site. To restore power there, the mobile trailer with solar power was towed to the site and set up to deliver electric power to MGS1. A more permanent solution is being considered. The site is currently back online and working well, although it only operates at half power to prolong the life of the storage batteries in the trailer. The batteries are in need of replacement, but due to future budget uncertainty, the batteries are being carefully managed for their longevity. Salazar and Romero are performing ongoing maintenance procedures on the aging trailer to protect it from the local marine environment and extend its life.

**Challenges:** Many of UCSB's radar systems and ancillary equipment are old and require frequent maintenance procedures and repairs. So far these efforts have kept all radars operational with minimal downtime. Most repairs have been diagnosed and fixed in house which saved substantial repair expenses and delays. Recent tasks include trips to San Nicolas Island to repair a faulty AC unit and to Santa Cruz Island to diagnose and fix an intermittent internet connection. All radar sites were updated to the latest CODAR software R8U4 and equipped with new backup hard drives. Collaborations have continued with other HF radar groups in Canada and the US. Many of these collaborations have focused on signal sources and autonomous boogie boards for APMs; both devices are made in the lab at UCSB. For example, a signal source was recently sent to Canadian colleague, Professor Cédric Chavanne of the Institut des sciences de la mer de Rimouski, Université du Québec. Instructional documentation for drone-based APMs, also developed in the UCSB lab, is available online. UCSB has begun working with the Channel Islands National Marine Sanctuary, National Park Service, and the Anthropocene Institute to establish new radar sites on the Channel Islands; other potential sites along the mainland coast are also being evaluated.

**USC:** The radar at Dockweiler Beach Headquarters (SCDH) was reinstalled without permitting problems. The site now has an upgraded single dome antenna, GPS and new cables. A new non penetrating roof mount was used to install the new antenna which gives it more stability. Also new conduit was installed to protect the cables and increase the life expectancy of the system. An antenna pattern was planned for this site, but do to shelter in place orders access to the beach was prohibited. Power has been restored at Santa Catalina Island (SCCI), however the transmit and receive chassis were sent to CODAR for an upgrade to include a new single dome antenna and new cables. New conduit to protect the cables will be part of the re-install. Installation will take place once the items have been returned. CODAR has yet to give a ship date, but given the university's closure during the pandemic it will not accept delivery. Also, access to the campus, including the Wrigley Marine Science Center (WMSC) on the island is restricted. The radar at Torrance Beach (SCTB) remains uninstalled, the delay in reinstalling the site is do to the shelter in place orders. Given the permit was no longer an issue at Dockweiler Beach, it is assumed that there will be no permitting issues at Torrance Beach. Once access to campus and the lifeguard building is granted the radar will be re-installed. At Dan Blocker (SCDB), the enclosure door holding the air conditioning unit had a weld fail which ultimately led to the hinge coming off. The door was repaired and

additional welds were done to increase durability. Also, additional locking mechanisms were added to increase hinge support and provide security in case of hinge failure. The process of adding welds and locking mechanisms is underway and will be completed once field work can commence. All sites have been upgraded to SeaSonde Version 8.

UCSD/SIO: HF sites maintained by SIO continue to be in a good operational state but as the network ages some major repairs were required to extend their lifespan and, in some cases, restore operation. Some of the major repairs conducted include: 1) Replacing the receiver antenna at Point Loma due to water intrusion on the old-style antenna. A new style dome antenna was installed as part of an ongoing effort to retrofit the network with newer style antennas. 2) Dana Point experienced similar issues, with water intrusion shorting part of the antenna and crippling the coverage. 3) The enclosure at San Elijo was replaced with one that's better suited to withstand a corrosive environment and keeping water and dirt out. The power cable that feeds the radar station was also replaced. 4) San Clemente Island experienced some downtime due to issues with the radios after a power surge. The radios were replaced and the data link was transitioned over to Verizon Wireless while HPWREN remains as a backup. 5) Coronado Island experienced a prolonged outage due to a bad inverter, the unit from the PV system that powers the radar station. Unfortunately, this coincided with access to the island being restricted until a new permit was issued. The batteries were depleted during this time period and they seem to be having trouble maintaining a charge. Plans are in place to expand the sites battery bank but it's still pending approval by island personnel. All the sites continue to be periodically calibrated and plans for new sites in Camp Pendleton and San Clemente island continue to slowly move forward with a possible install during the first quarter of 2020. During that same time period at least two more sites will be retrofitted with upgraded receiver antennas.

Challenges: SCCOOS operators continue to identify possibilities for funding recapitalization of network hardware. Many of the oldest HFR systems in the IOOS network are located in California. SCCOOS and CeNCOOS jointly operate about 60 radars at any given time and these comprise about 40% of the overall IOOS HFR network. SCCOOS and CeNCOOS operators estimate that \$7.5 million is needed to fully recapitalize and bring the network back to its original specifications. This funding could be spread over multiple years. Operators are identifying high priority repairs using IOOS "fill the gaps" funding which will keep the network operating in the near term.

3. Maintain and expand integrated, customized products with multi-layer views of observations, nowcasts, and forecasts. Collaborate with the Port of Long Beach to maximize the benefit of SCCOOS observations.  
a. Principal Investigators: Clarissa Anderson, UCSD, James Behrens, UCSD/CDIP  
b. Completion date: TBD - ongoing milestone; c. Status: On-Track  
d. Successes and Challenges: On January 31, 2020, the CDIP 215 Long Beach Channel buoy was struck by a vessel. The damage allowed seawater to enter the hull, resulting in a total loss. The buoy was recovered and replaced on February 5, 2020. The customized, interactive map display of ocean conditions and forecasts for the Port of Los Angeles and Long Beach Harbor is used to improve navigation, safety, and efficiency for commercial vessels, harbor pilots, and port operations. SCCOOS and CDIP staff participate and present at monthly to quarterly.

4. Deliver surface current data to aid spill response, SAR real-time recovery, and post analysis trajectories.  
a. Principal Investigators: Ryan Walter, Cal Poly, Libe Washburn, UCSB, John Heidelberg, USC and Eric Terrill, UCSD  
b. Completion date: TBD - ongoing milestone; c. Status: On-Track  
d. Successes and Challenges: Near real-time surface current measurements are available for integration into common operating systems via [NOAA National Data Buoy Center](#) and the [Coastal Observing Research and Development Center](#) (CORDC) at Scripps. These data allow for harvesting, redistribution, and visualization. NOAA CoastWatch has integrated the data sets into their ERDDAP server allowing alternate access for data downloads and visualization in multiple formats - example of the west coast 6km data [here](#).

## 5. Provide HF Radar Quality Control Development.

a. Principal Investigator: Libe Washburn, UCSB

b. Completion date: TBD - ongoing milestone; c. Status: On-Track

d. Successes and Challenges: A primary goal of this project is to allow HF radar operators to quickly evaluate the consistency of radial currents measured by different radars. Work during the most recent reporting period was focused on improving the core software toolbox on which the QA/QC comparison website is built. The code calculates two types of radials for QA/QC evaluation: (1) over-water baseline radials from two radars and (2) synthetic radials formed by two radars for comparison with radial currents from a third radar. This approach provides critical tests on the consistency of radial currents measured by different radars. Toolbox improvements will also enable us to more easily operate and maintain the code base while simplifying the incorporation of new sites for the QA/QC website comparisons. Code improvements to the toolbox were tested on data sets that we have developed for objectively evaluating the performance of different HF radar processing techniques. These techniques include alternate methods for direction-finding methods and signal detection. A goal of this analysis is to see if alternate direction-finding methods are superior to the commonly used MUSIC algorithm. In addition to the code development, a plan was formulated, based on user feedback, to improve web site usability and make the website more interactive, with user-changeable date ranges in the viewing window and the ability to download data appearing in the viewing window.

### 3) SCOPE OF WORK

SCCOOS operates as a system of partnerships and projects that are facilitated by technical and programmatic staff. Organized by the five focus areas, the SCCOOS scientific and technical approach is based on a system of core ocean observing technologies and the delivery of useful data products and tools. System components include sub-surface ocean observations from underwater gliders, nearshore and coastal measurements, wave measurements and models, pier-based monitoring, satellite imagery (now served via the JPL PODACC), high frequency (HF) radar surface current mapping, and data-assimilative ocean modeling. The projects described in this report represent the highly leveraged, multi-disciplinary, and collaborative efforts of the research teams that contribute data and information to SCCOOS.

### 4) PERSONNEL AND ORGANIZATION STRUCTURE

SCCOOS governance organization chart can be found [here](#) as well as a list of governing members and Principal Investigators. Extramural funding from the Ocean Protection Council to work with CeNCOOS on California Marine Protected Area (MPA) data and model synthesis supports our new postdoctoral fellow, Florybeth La Valle, who started work at SCCOOS and California Sea Grant in February 2020 under the supervision of SCCOOS ED, Clarissa Anderson. SCCOOS and CA Sea Grant will cost share the fellow for a maximum of two years support.

### 5) BUDGET ANALYSIS

FY 2019, SCCOOS non-HFR base funds remained the same from FY18 (\$1,285,183). Directed Fill the Gaps Observations went towards gliders (\$150,000), HF radar operations and maintenance (\$150,000), Harmful Algal Bloom (HAB) and toxin monitoring (\$75,000) and SCCOOS data management (\$75,000). The Matt Howard Memorial funding (\$15,000) was directed to advance biological observations by creating new data management schemes for applying “Darwin Core” standards to SCCOOS (and CeNCOOS) HABMAP data and serving them on the ERDDAP for eventual ingestion by the global Ocean Biogeographic Information System (OBIS) database. FY19 funding has provided a valuable investment in important assets and will strengthen regional partnerships and national program planning. SCCOOS will continue providing its core observations and expanded data products when possible within budget constraints. SCCOOS is also committed to contributing to larger ocean observing efforts regionally, nationally, and internationally. USC, Cal Poly, and UCSB have low expenditure rates in their HF Radar funds. If we do not receive increased spending, we may need to request a no-cost extension after Year 5.

## **II. PERFORMANCE PROGRESS REPORT ADDENDUM**

Not required for performance period December 1, 2019 to May 31, 2020.



## **III ENVIRONMENTAL COMPLIANCE**

### **1) First Responder Training**

IOOS/NOAA determined this project has a categorical exclusion, and their statement is as follows:

The aforementioned project will not result in any changes to the human environment. As defined in Section 6.03c3(d), Administrative r Routine Program Functions, of NAO 216-6, this project involves conference room and/or classroom training activities that hold no potential for significant environmental impacts. As such, they should be categorically excluded from the need to prepare an Environmental Assessment or an Environmental Impact Statement.

### **2) Gliders**

IOOS/NOAA determined this project has No Significant Impact, and their statement is as follows:

It has been determined that this proposed activity is described in the Final U.S. IOOS Programmatic Environmental Assessment, dated June 2016. The action is covered by the analysis within the U.S. JOOS Program PEA and the signed U.S. IOOS Finding of No Significant Impact. The project and its potential impact may be limited through terms or conditions placed on receipt of NOAA funds. The action requires no further environmental review.

### **3) Shore Stations**

IOOS/NOAA determined this project has No Significant Impact, and their statement is as follows:

It has been determined that this proposed activity is described in the Final U.S. IOOS Programmatic Environmental Assessment, dated June 2016. The action is covered by the analysis within the U.S. JOOS Program PEA and the signed U.S. IOOS Finding of No Significant Impact. The project and its potential impact may be limited through terms or conditions placed on receipt of NOAA funds. The action requires no further environmental review.

### **4) Vessel Sampling – CalCOFI**

IOOS/NOAA determined this project has No Significant Impact, and their statement is as follows:

It has been determined that this proposed activity is described in the Final U.S. IOOS Programmatic Environmental Assessment, dated June 2016. The action is covered by the analysis within the U.S. JOOS Program PEA and the signed U.S. IOOS Finding of No Significant Impact. The project and its potential impact may be limited through terms or conditions placed on receipt of NOAA funds. The action requires no further environmental review.

### **5) Mooring**

IOOS/NOAA determined this project has No Significant Impact, and their statement is as follows:

It has been determined that this proposed activity is described in the Final U.S. IOOS Programmatic Environmental Assessment, dated June 2016. The action is covered by the analysis within the U.S. JOOS Program PEA and the signed U.S. IOOS Finding of No Significant Impact. The project and its potential impact may be limited through terms or conditions placed on receipt of NOAA funds. The action requires no further environmental review.

The project and its potential impact may be limited through the following terms or conditions placed on receipt of NOAA funds:

- A permit is in place to allow the mooring to reside in its location: 1) Aid to navigation application; 2) Aid to navigation addendum; and 3) FCC Experiment License valid until 2017. The applicant must provide copies of these permits to the IOOS Office for the EC File of Record prior to undertaking the Del Mar Mooring Activities under the subject award.
- SCCOOS has implemented the Essential Fish Habitat Conservation Recommendations provided by NMFS on July 7, 2014 to avoid, minimize, or offset effects of this activity.

**United States of America  
FEDERAL COMMUNICATIONS COMMISSION  
EXPERIMENTAL  
RADIO STATION CONSTRUCTION PERMIT  
AND LICENSE**

<u>EXPERIMENTAL</u> (Nature of Service)	<u>WI2XAA</u> (Call Sign)
<u>XR FX</u> (Class of Station)	<u>0539-EX-PL-2015</u> (File Number)

NAME Scripps Institution Of Oceanography

**Subject to the provisions of the Communications Act of 1934, subsequent acts, and treaties, and all regulations heretofore or hereafter made by this Commission, and further subject to the conditions and requirements set forth in this license, the licensee hereof is hereby authorized to use and operate the radio transmitting facilities hereinafter described for radio communications in accordance with the program of experimentation described by the licensee in its application for license.**

**Operation: In accordance with Sec. 5.3(d) of the Commission's Rules**

**Station Locations**

- (1) Santa Barbara Channel, within 32 km, PC - NL 34-18-31; WL 120-48-15
- (2) Pacific Ocean,, within 32 km, PC - NL 33-31-41; WL 122-30-15
- (3) Pacific Ocean, within 32 km, PC - NL 32-55-48; WL 117-18-57

**Frequency Information**

**Santa Barbara Channel, within 32 km, PC - NL 34-18-31; WL 120-48-15**

Frequency	Station Class	Emission Designator	Authorized Power	Frequency Tolerance (+/-)
161.975-162.025 MHz	FX	25K0F1D	12.5 W (ERP)	0.00015 %

**Pacific Ocean,, within 32 km, PC - NL 33-31-41; WL 122-30-15**

Frequency	Station Class	Emission Designator	Authorized Power	Frequency Tolerance (+/-)
161.975-162.025 MHz	FX	25K0F1D	12.5 W (ERP)	0.00015 %

This authorization effective **November 09, 2017** and will expire **3:00 A.M. EST** **November 01, 2019**

**FEDERAL COMMUNICATIONS COMMISSION**



**Frequency Information**

Pacific Ocean, within 32 km, PC - NL 32-55-48; WL 117-18-57

Frequency	Station Class	Emission Designator	Authorized Power	Frequency Tolerance (+/-)
161.975-162.025 MHz	FX	25K0F1D	12.5 W (ERP)	0.00015 %

**Special Conditions:**

- (1) The occupied bandwidth of the emission shall not extend beyond the band limits set forth above.