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Regional Coastal Ocean Observing System

Strategic Operational Plan

2021-2026

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# 1. Overview

## 1.1 Purpose

This document presents the Southeast Coastal Ocean Observing Regional Association (SECOORA) priorities for contributing to our improved understanding, management, and sustainment of valued coastal ocean resources. It will serve as a guide for future investments in SECOORA’s regional coastal ocean observing system (RCOOS). SECOORA is organized to provide ocean data, tools, and services in the following focus areas, which correspond with U.S. Integrated Ocean Observing System (IOOS®) societal goals and are important to Southeast stakeholders: Ecosystems: Water Quality and Living Marine Resources; Marine Operations; Coastal Hazards and Climate Variability. SECOORA has developed this plan based on the needs of the region, as identified by our membership and other stakeholders, and the ability to make significant progress in specific areas.

This *Regional Coastal Ocean Observing System - Strategic Operational Plan* is intended to inform:

1. SECOORA staff and Board of Directors, to establish priorities for funding decisions;
2. The IOOS Program Office, to inform and meet certification requirements;
3. SECOORA members, to articulate priorities and provide guideposts for future activities;
4. Regional stakeholders and potential members, to demonstrate capabilities and describe connections to regional needs and priorities.

There are 3 main sections of this document.

1. **Overview** provides regional and national context for SECOORA’s work.
2. **Focus Areas** describes the focus areas that guide our work. SECOORA will invest in data collection, product development, and research to better understand the environmental and societal concerns identified within each of the focus areas. Our purpose is to describe SECOORA’s role in addressing these challenging issues. We describe briefly the work of key partners and stakeholders and concentrate on how SECOORA contributions complement and leverage these ongoing programs and efforts. Additional opportunities for investment are highlighted in each focus area.
3. **RCOOS Subcomponents** identifies current investments and previously identified stakeholder needs for observing system, modeling, data management and communications, products, and outreach and education efforts.

The combination of the additional investment opportunities to support the focus areas (section 2) and the previously identified gaps and build out needs (section 3) provide a guide for where SECOORA will invest in the future.

## 1.2 SECOORA’s Regional Coastal Ocean Observing System

SECOORA invests in end-to-end RCOOS activities that are responsive to societal needs. SECOORA transforms data and analyses into value-added products and services. SECOORA also recognizes that meeting stakeholder needs requires a sound scientific approach. We therefore place emphasis on coordinating a multidisciplinary suite of coastal ocean observations with suitably-chosen simulation models so that societally important phenomena may be described, understood, and ultimately predicted via applications of best science practices.

The SECOORA RCOOS consists of:

* **Observing platforms** and sensors including fixed stations, such as buoys and coastal stations, mobile platforms such as gliders and ships, and remote sensing instruments and platforms such as High Frequency Radar (HFR). Detailed information about assets supported by SECOORA is in Section 3.
* **Data management and communications (DMAC)** supports seamless access to regional data. Additionally, DMAC ensures that data are archived, recorded and transmitted in standardized ways that are consistent in content and format with other providers of the same data. Real-time data are provided to stakeholders via the [SECOORA data portal.](https://portal.secoora.org/)
* **The modeling component** supports a numerical modeling framework (sub-regional to regional scale models) to provide validated modeling products for managers and other users. Observations from HFR, coastal and oceanographic moorings, and gliders are being linked to predictive models and decision-making tools.
* **Products** transform raw and/or processed data into useful and meaningful decision-making and information products.
* **Outreach and education** efforts connect stakeholders to SECOORA data products and services.

The RCOOS priorities for the 2021-2026 period are to sustain critical observing, modeling, and product service activities while also seeking opportunities to add new multidisciplinary observing assets, all while continuing to refine activities to improve upon our effectiveness in meeting stakeholders needs. Specifically, SECOORA seeks to:

* Effectively engage stakeholders to prioritize investments.
* Provide DMAC infrastructure and expertise that supports the RCOOS enterprise.
* Sustain and expand the HFR network distributed from Cape Hatteras to West Florida and continue to fill priority HFR gaps.
* Sustain and expand in situ stations and work with stakeholders to leverage opportunities to fill gaps in coastal and ocean stations.
* Sustain and expand modeling efforts and engage with stakeholders to increase the use of models for management and decision-making.
* Sustain and expand an autonomous vehicle program specifically targeted to address fisheries research, hurricane intensity forecasting, and characterization of the shelf waters in the South Atlantic Bight and West Florida Shelf.
* Continue delivery of automated model nowcast/forecast products and other products based on stakeholder needs and utilization of data collected through the observation network.

## 1.3 Coastal Oceanography Drivers in the Southeast

The SECOORA footprint spans the four-state region of North Carolina (NC), South Carolina (SC), and Georgia (GA), and Florida (FL). Our ocean and coastal waters reach from the eastern side of the Gulf of Mexico to the South Atlantic Bight and are connected by the Loop Current-Florida Current-Gulf Stream continuum.

**South Atlantic Bight**

The NC, SC, and GA region extends from estuaries to the coast, across the continental margin to the Gulf Stream, and from the GA/FL border to the NC/Virginia border. Here the confluence of the tropical and sub-tropical oceanic, atmospheric, and ecosystem domains, stretching from the Mid-Atlantic Bight through the Georgia Bight, influence a range of sub-to super-regional physical and biogeochemical phenomena. Despite its broad geographic extent, the dynamics of this region exhibit unifying aspects. The shelf is wide and shallow, and the physical dynamics are dominated by interactions with the Gulf Stream and the overlying atmosphere. Water movement is dominated by tidal, 2-day to 2-week synoptic scale atmospheric events, and 2- to 12-day Gulf Stream frontal waves. Within Long Bay, situated in NC and SC, buoyancy also plays an important role in the inner shelf. In these areas, river plumes not only deliver sediment, nutrients, and pollutants to coastal waters but may also provide chemical cues that affect recruitment of estuarine-dependent fishery species. River plumes, especially those comprised of waters from black-water streams, may also influence rates of coastal acidification in nearshore waters.

The NC, SC, and GA coastal zone supports a range of essential economic activities, including coastal development, shipping and commerce, fishing, boating and tourism. This area is vulnerable to a variety of hazards which range from severe beach erosion to inundation from storms and hurricanes. There is a compelling need to understand and predict estuarine and coastal maritime conditions in the region, which requires the establishment of a comprehensive observational network providing real-time and archived information on ocean and weather conditions. This information is needed to develop accurate predictions of shelf circulation in response to wind and Gulf Stream forcing, inform search and rescue, rip current, and marine hazards forecasts, and provide operationally-useful information on the status of ecosystem health and living marine resources.

**East Florida and Florida Keys**

The coastal ocean along the east coast of FL is characterized by a very narrow, shallow shelf, which is dominated by Gulf Stream variability and wind forcing. The southernmost stretch varies from 5 to 25 km width, from 25° to 27° N latitude, widening northward to ~130 km width off the Florida-Georgia border. From the Florida Keys to approximately Cape Canaveral, the East-West envelope of Gulf Stream meander is largely confined by the narrowness of the Florida Strait, while from Canaveral northward, the offshore bathymetry constraint eases, and the meander envelope widens significantly. In addition, the slope separating the coastal ocean from the deeper ocean is steep along the East Florida Shelf. This bathymetry, along with the strong horizontal and vertical shears associated with the Florida Current immediately offshore, makes this a difficult region to model accurately. Yet, accurate prediction of shelf circulation response to varying wind and Florida Current forcing is critical to a variety of interests in the coastal ocean here, including search and rescue efforts, anticipation of rip current hazards, planning for mitigation of man-made hazards, and developing an understanding of circulation pathways between vital habitats along the coastline to inform fisheries interests. The East Florida Shelf and coastline encompasses several important ports and supports significant tourism and recreational fishing industries. Furthermore, the east coast of FL and GA has the fewest number of coastal ocean stations within the SECOORA region.

**West Florida**

SECOORA overlaps with the Gulf of Mexico Ocean Observing System (GCOOS) along the west coast of FL. The Gulf of Mexico is a semi-closed basin connected to the Caribbean Sea and the Atlantic Ocean. The major current system is the Loop Current, which enters the Gulf through the Yucatán Channel, circulates clockwise in the eastern Gulf, and exits through the Florida Strait to eventually form the Florida Current and then the Gulf Stream along the eastern seaboard. Portions of the Loop Current break off forming eddies that affect regional current patterns throughout the Gulf[[1]](#footnote-1).

The West Florida Shelf is most influenced by the Loop Current and its associated eddies and major river discharges. The Gulf is suitable habitat for a diversity of harmful algae. The most notable Harmful Algal Bloom (HAB) species in the Gulf of Mexico is *Karenia brevis*; it forms what is known as “Florida Red Tide”. This species, because of coastal currents and winds, and is found throughout the Gulf at varying concentrations and on occasion is transported to the east coast by the Florida Current.2”

The Gulf of Mexico ecosystems support recreationally and commercially important fish species. Industry drivers in the Gulf include oil and gas, tourism, fishing, and shipping. The impacts of the Deepwater Horizon Oil Spill and frequent HAB events highlight the need to better understand how Gulf of Mexico ocean circulation patterns disperse HABs and pollutants and affect fish and critical habitats.

## 1.4 National and Regional Partnerships and Priorities

### 1.4.1 National

SECOORA is one of eleven Regional Associations (RAs) supported through cooperative agreements from [IOOS](https://ioos.noaa.gov/), the national-regional partnership working to provide new tools and forecasts to improve safety, enhance the economy, and protect our environment. SECOORA will continue efforts to ensure a strong and sustained IOOS. In partnership with the National Oceanic and Atmospheric Administration (NOAA), the IOOS Program Office, and other federal programs and offices, SECOORA addresses critical national priorities through initiatives such as the [Animal Telemetry Network](https://ioos.noaa.gov/project/atn/) (ATN), [Marine Biodiversity Observation Network](https://ioos.noaa.gov/project/bio-data/) (MBON), [Coastal Ocean and Modeling Testbed](https://ioos.noaa.gov/project/comt/) (COMT), and [Ocean Technology Transition](https://ioos.noaa.gov/project/ocean-technology-transition/) (OTT) projects.

As of May 2017, SECOORA is a certified Regional Information Coordination Entity (RICE). This certification by NOAA acknowledges SECOORA as meeting federal standards for data gathering and management. In simple terms, this means that ocean and coastal data and information from SECOORA can now be used with the same confidence and assurances as federal data.

SECOORA is a member of the [IOOS Association](http://www.ioosassociation.org) (IA), working with ten other RAs to assure the needs and positions of on-the-ground users in the regions are adequately reflected in national policy and priority setting. SECOORA is actively engaged with other RAs, especially the neighboring RAs in the Gulf of Mexico, Caribbean, and on the East Coast. These collaborations across regions help ensure efficient pooling of expertise and resources, limit redundancy, and improve effective transfer of knowledge.

### 1.4.2 Regional

SECOORA’s mission is to observe, understand, and increase awareness of our coastal ocean and to promote knowledge, and economic and environmental health through strong regional partnerships. Where possible, SECOORA partners with and supports other regional networks to leverage expertise and expand observing capacity within the focus areas. A few examples follow:

* [Southeast Ocean and Coastal Acidification Network (SOCAN)](https://www.socan.secoora.org/): interdisciplinary network of scientists, resource managers, industry, non-profit, and government representatives dedicated to supporting and encouraging discussions on ocean and coastal acidification.
* [Southeast Disaster Recovery Partnership (SDRP)](https://secoora.org/sdrp/): affiliation of public, private, and nongovernment organizations (NGO) organizations that provides training, resources, and relationships that coastal communities need to recover after a disaster.
* Regional Ocean Planning efforts: SECOORA engages in efforts aimed at meeting at the [Administration’s Ocean Policy](https://www.whitehouse.gov/presidential-actions/executive-order-regarding-ocean-policy-advance-economic-security-environmental-interests-united-states/). It also engages in [regional discussions](https://www.sad.usace.army.mil/RSM-RCX/) about sand management with the US Army Corps of Engineers (USACE) and the Bureau of Ocean Energy Management (BOEM) state task forces for offshore energy planning.
* [NOAA Southeast and Caribbean Regional Collaboration Team (SECART)](https://www.regions.noaa.gov/secar/index.php/regional-team/): a means for NOAA and partners to engage at a regional scale (NC, SC, GA, FL, Puerto Rico (PR), and US Virgin Islands) and invites new approaches to develop products and services that are responsive to the region’s changing economy and environment.
* [FACT Network](https://secoora.org/fact/): a grassroots collaboration of marine scientists from the Bahamas to the Carolinas using acoustic telemetry and other technologies to better understand and conserve our region’s important fish and sea turtle species.

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# 2. Focus Areas

For each focus area, the following information is provided:

* Challenges: defines key management challenges in the region
* Priority Geographic Area(s): identifies the most critical geographic areas
* Partner Activities: examples of related efforts by state, federal, and NGO partners
* Core Variables Required: [core variables](http://www.iooc.us/ocean-observations/variables/core-ioos-variables/) as defined by NOAA IOOS with other variables identified as needed
* Current SECOORA Investments: funded RCOOS components
* Additional SECOORA Investment Opportunities: needs defined by stakeholder engagement, subject matter expert discussion, and previous observing platform gap analyses

## 2.1 Ecosystems: Living Marine Resources and Water Quality

Marine ecosystems are dynamic and function through complex physical, chemical, geological, and biological interactions that change over time and space. Coastal ocean ecosystems in the southeast region are dominated by the Loop Current, Florida Current, and Gulf Stream. Our estuaries, coral reefs, and coastal ocean support numerous important fisheries by providing larval habitat for shrimp, shellfish, crabs, and many species of fin fish which are managed under state and federal fishery management plans. These areas are influenced by coastal development and tourism, both of which contribute to anthropogenic impacts (e.g. run-off, pollution), and tidal rivers, which export nutrients into the estuarine and coastal ocean environment. Eutrophic conditions, resulting from anthropogenic impacts and nutrient overload, can lead to HABs and cyanobacteria blooms. These blooms can cause significant fish kills and negative effects on human health which detrimentally impact local economies.

### 2.1.1 Fisheries

Fish, fishing, and fisheries are major components of the ecology, heritage, and economy that support and sustain the unique culture of the southeastern states. Recruitment, population density, and movement of fishes are driven in part by ocean circulation, climate, and weather. However, the integration of these drivers in population models and the management process is lacking. SECOORA is qualified to provide, organize, and supplement real-time and historic ocean data to help inform fisheries management decisions.

**Challenges:**

* Limited availability of fish acoustic tag detections (i.e. tag detection data is held by tag owners) for visualization or broader research purposes.
* Limited characterization and evaluation of fish movement, habitat use, site fidelity, and stock structure for many species.
* Lacking integration of marine environmental variability (including climate change) impacts on stock abundance, migration, and species richness.
* Changes to critical habitat are not well researched.
* Insufficient data management and modeling capabilities to link biological, oceanographic, and meteorological processes.

**Priority Geographic Area(s):** Ocean waters with a primary focus on the Managed Areas as defined by South Atlantic Fishery Management Council ([SAFMC](http://safmc.net/safmc-managed-areas/)) and Gulf of Mexico Fisheries Management Council ([GOM FMC](http://gulfcouncil.org/)) as well as National Marine Sanctuaries.

**Partner Activities:**

* The SAFMC and GOM FMC are charged with conservation of fish stocks and fish habitat and management of recreational and commercial fisheries dependent on those resources in the U.S. Exclusive Economic Zone (3-200 miles) off NC, SC, GA, and FL.
* The National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center ([SEFSC](https://www.sefsc.noaa.gov/)) conducts multi-disciplinary research programs to provide management information to support national and regional programs.
* NOAA NMFS, through the Southeast Fishery Independent Survey, and South Carolina Department of Natural Resources (SCDNR) [Marine Resources Monitoring, Assessment, and Prediction (MARMAP) and Southeast Area Monitoring and Assessment Program South Atlantic (SEAMAP-SA)](https://www.google.com/url?q=http://www.dnr.sc.gov/marine/mrri/CoastalResearch/ReefFishSurvey/index.html&sa=D&ust=1551272816923000&usg=AFQjCNHNmInxuvoUv40xz4m-HGGlCBzw5A) determine distribution, relative abundance, and essential habitat of economically and ecologically important fishes in Atlantic waters off the Southeastern coast.
* NOAA’s [MBON](https://mbon.ioos.us/) collects biological data and shares the data through the MBON Portal. MBON supports groups to develop and document best practices associated with marine biodiversity observations, including methods for data collection and data management. MBON plans to integrate biodiversity data collection with physical and biogeochemical observations as the network matures.
* The [FACT Network](https://secoora.org/fact), covering the southeast Atlantic coast, and the Integrated Tracking of Aquatic Animals in the Gulf of Mexico ([iTAG](https://myfwc.com/research/saltwater/telemetry/itag/network/)) are collaborative organizations who’s partners agencies and institutions use acoustic telemetry to resolve the movements of aquatic species.
* State fishery management agencies, often in collaboration with federal, regional, and academic partners conduct assessments for key fisheries in state waters.

**Core Variables Required:**

* Physics: wind speed and direction, air temperature, water temperature, salinity, surface waves, currents
* Biogeochemistry: acidity, dissolved oxygen (DO), optical properties (chlorophyll), total suspended matter
* Biology and Ecosystems: fish abundance

**Other Variables Required:**

* barometric pressure
* fish movement information (e.g. site fidelity, spawning migration timing, habitat use)
* fish occurrence, fish distribution patterns, diet, reproduction, early life history, age, and growth
* bottom habitat topography and substrate characterizations

**Current SECOORA Investments:**

* Ocean moorings, coastal stations, HFR and gliders collect core variables that support fisheries management and research.
* Acoustic receivers are deployed on four SECOORA funded moorings in NC coastal waters. These receivers record movements of nearby acoustically tagged fish.
* Gliders are outfitted with acoustic receivers to detect tagged fish. Two gliders also have hydrophones for ocean sound recording (i.e. detection of marine mammals and soniferous fish).
* The Big Carlos Pass sensor array project in southwest FL was funded as a demonstration site for the deployment of acoustic receivers and hydrophones to track of fish sounds and behavior and to integrate these biological data with other measurements of atmospheric and oceanographic conditions.
* Through funding from the Curtis and Edith Munson Foundation, SECOORA is working with FACT Network partners to install temperature sensors at acoustic receiver locations and install an additional three receivers in the Florida Keys and Biscayne Bay.
* FACT [website](http://secoora.org/fact) and the FACT data sharing system are hosted by SECOORA. SECOORA also actively participates in FACT meetings to support data management activities.
* Advancing the IOOS MBON through biological data stewardship in the region. This includes working with regional data providers to align biological datasets to the Darwin Core standard and make them available through publicly accessible data portals.
* Pilot visualization tool in development with GA Department of Natural Resources to help better understand fish movement patterns based acoustic tag detections coupled with physical and ecosystem data.
* Coupled Northwest Atlantic Prediction System (CNAPS) model provides a three-dimensional marine environment nowcast and forecast.

**Additional SECOORA Investment Opportunities:**

* Support continued acoustic tagging and tracking of key species, for example Atlantic Sturgeon, Tripletail, Red Drum, Cobia, and various shark species, to increase data from fish tagging efforts for visualization or broader research purposes.
* Collect temperature, chlorophyll, turbidity, pH, and oxygen data at key FACT acoustic receiver locations, as recommended by members of the FACT network, to better understand temperature and water quality impacts on fish habitat use.
* Create a process for incorporating oceanographic and biogeochemical data into fish movement studies and provide visualizations on the SECOORA data portal.
* Develop coupled biophysical models to link the current single species stock assessments with ecosystem information and oceanographic processes to develop more comprehensive stock assessment tools.
* Support training for fisheries managers in using SECOORA supported data visualization, models and model products.
* Develop prediction and data analysis tools to quantify seasonal variation of surface and subsurface temperature, salinity, circulation, chl-a, NO3, DO, and other marine environmental variables.
* Invest in ecosystem moorings in key locations such as Pensacola Bay, the FL Middle Grounds, and at the Conch Reef/Aquarius Reef Base Station as identified in the the [Build Out Plan Addendum](http://secoora.org/wp-content/uploads/2017/12/SECOORA-BOP-addendum_Final.pdf).
* Leverage Fishery Independent Research Programs capabilities in the South Atlantic region (MARMAP and SEAMAP) by providing technology (i.e., autonomous vehicles, conductivity, temperature, and depth, (CTD), fixed mapping systems) that will take advantage of existing vessel platforms and planned cruises to collect oceanographic, biological and mapping information.
* Support a minimum of six autonomous vehicle missions annually to collect water quality data and define oceanographic conditions in key locations such as the Florida Middle Grounds, Florida Keys National Marine Sanctuary, Gray's Reef National Marine Sanctuary, and natural and artificial reef habitats (both Atlantic and Gulf of Mexico).

### 2.1.2 Ocean Sound

Many marine animals depend on sound for their most basic needs—food, communication, protection, reproduction, and navigation[[2]](#footnote-2). For example, soniferous fish species produce sounds associated with reproductive behavior[[3]](#footnote-3). Soundscape ecology is an emerging field which studies biological, geophysical, and anthropogenic sounds that are produced in a landscape in order to better understand the coupled nature-human system[[4]](#footnote-4). Hydrophone recordings are used to document sounds and the recorded information can help us better understand behavior in fish and marine mammals based on sounds. Anthropogenic sounds that now impact our marine environment include noise from global shipping, oil and gas exploration, construction activity, and naval exercises. There is a need to better understand the breadth of the impacts humans are having on ocean fauna.

**Challenges:**

* There are few established long-term passive acoustic stations.
* Researchers need to better understand and separate human-based sound impacts on biodiversity from “natural” dynamics of ecosystems (Montie pers comm[[5]](#footnote-5)).

**Priority Geographic Area(s):** Ports, estuaries, natural and artificial reef habitats, offshore energy lease blocks, sand borrow areas, Essential Fish Habitat-Habitat Areas of Particular Concern and managed areas.

**Partner Activities:**

* NOAA NMFS has an [Ocean Noise Strategy](https://cetsound.noaa.gov/ons), and is currently working toward implementation of the strategy. They have deployed two hydrophones in the SECOORA region as part of their ocean noise reference stations, one near the FL panhandle and one off the east coast of FL (NOAA 2019).
* BOEM funds studies on [impacts of human-generated noise on marine life](https://www.boem.gov/Fact-Sheet-on-Sound-Studies/) through its Environmental Studies Program.
* Academic partners conduct research to assess the spatial and temporal patterns of fish in rivers, estuaries, reefs, and the coastal zone.

**Core Variables Required:**

* Physics: wind speed and direction, air temperature, water temperature, salinity, currents
* Biogeochemistry: None
* Biology and Ecosystems: sound

**Other Variables Required:**

* underwater video
* fish movement patterns identified through telemetry data from tagged fish
* barometric pressure

**Current SECOORA Investments:**

* The Big Carlos Pass sensor array project in southwest FL was funded as a demonstration site for the deployment of acoustic receivers and hydrophones to track of fish sounds and behavior and to integrate these biological data with other measurements of atmospheric and oceanographic conditions.
* Via a competitive mini-proposal process, SECOORA is supporting an effort monitor ocean sounds in coastal South Carolina. The goal is to increase ocean sound observations and research, provide outreach to stakeholders (e.g., state agencies, local communities), and disseminate project results via the SECOORA website and portal.
* Two gliders are outfitted hydrophones for ocean sound recording (i.e. detection of marine mammals and soniferous fish).

**Additional SECOORA Investment Opportunities:**

* Support passive acoustic sensor (e.g., hydrophones) deployments to inform ocean noise research to develop both baseline conditions of acoustic habitats and changes in their status through time.
* Invest in the personnel and data management infrastructure required to analyze and share processed acoustic data with partners.
* Leverage Fishery Independent Research Programs capabilities in the South Atlantic region (MARMAP and SEAMAP) by deploying hydrophones in areas where offshore surveys occur.

### 2.1.3 Public Health

According to the [U.S. Census Bureau](https://www.census.gov/library/stories/2018/08/coastal-county-population-rises.html), “America’s coastline counties - those directly adjacent to the Atlantic, Ocean, Pacific Ocean, or Gulf of Mexico - were home to about 94 million people in 2016, or about 29% of the total U.S. population.[[6]](#footnote-6)” Coastal areas of NC, SC, GA, and FL are seeing high rates of population growth and urbanization. At the same time, these coastal areas are also visited by millions of tourists annually. Coastal managers within the SECOORA region are concerned about public health risks associated with HABs, Vibrios and other pathogens, microplastics, contaminants of emerging concern (CEC), recreational beach water quality and shellfish water quality. SECOORA and its partners are working with federal and state agencies as well as municipal governments to address public health concerns in the region.

**Challenges:**

* Increasing HABs (which include cyanobacteria blooms) and hypoxic events threaten local economies and ecosystems.
* Populations at risk of contact with *Vibrio* spp. and *E. coli* in recreational swimming waters and beaches and shellfish harvesting waters.

**Priority Geographic Area(s):** Areas within the SECOORA domain are impacted by HABS, cyanobacteria, *Vibrio*, and other harmful bacteria in coastal and estuarine waters.

**Partner Activities:**

* The United States Environmental Protection Agency (US EPA) Virtual Beach is a software package designed for developing site-specific statistical models for the prediction of pathogen indicator levels at recreational beaches (EPA 2019[[7]](#footnote-7)).
* [NOAA National Centers for Coastal and Ocean Science](https://coastalscience.noaa.gov/research/stressor-impacts-mitigation/) (NCCOS) advances the scientific understanding and ability to detect, monitor, assess, and predict HAB and hypoxia events. They also provide satellite imagery and analyses for HABS and cyanobacteria blooms.
* NOAA’s Center for Operational Oceanographic Products and Services (CO-OPS) provides a [Gulf of Mexico HAB Forecast](https://tidesandcurrents.noaa.gov/hab/gomx.html).
* Mote Marine Laboratory has designed a [user-friendly app](https://visitbeaches.org/) that provides beach condition reports that alert you when dead fish are present, whether there is respiratory irritation among beachgoers, provide water color, the wind direction, and what flags are currently flying at lifeguard-monitored beaches.
* Arnold School of Public Health at the University of South Carolina (USC) has a National Institute of Environmental Health Sciences-funded center on oceans and human health that is looking at HABs, bacteria, increased virulence of Vibrios and microplastics and their impact on public health.
* FL Fish and Wildlife Conservation Commission (FL FWC) reports on the current status of *Karenia brevis* blooms using tables, static maps, and interactive Google Earth maps. FWC provides a [statewide *K. brevis* map](https://myfwc.maps.arcgis.com/apps/View/index.html?appid=87162eec3eb846218cec711d16462a72) that breaks down coastal areas to highlight when concentrations are not present, very low, low, medium, and high.

**Core Variables Required:**

* Physics: wind speed and direction, air temperature, water temperature, salinity, surface waves, currents
* Biogeochemistry: colored dissolved organic matter, acidity, DO, optical properties (chlorophyll), total suspended matter, dissolved nutrients, pathogens, contaminants
* Biology and Ecosystems: None

**Other Variables Required**

* barometric pressure
* precipitation
* airborne particulate matter

**Current SECOORA Investments:**

* Coastal moorings and stations that collect key core variables; HFR which provides hourly surface current data; and, glider missions to identify HABs and other nutrient related issues, hypoxia, and other water quality concerns.
* Support “[How's the Beach](http://howsthebeach.org/),” a tool that provides water quality nowcasts using an ensemble modeling approach based on the relationships between bacteria level and a suite of environmental conditions including rainfall, salinity, wind conditions, tide, and water temperature as well as lunar phase and anthropogenic activities and influences.
* Supporting the operation of red tide tracking and forecast models, the Tampa Bay Circulation Model (TBCOM) and the West Florida Coastal Ocean Model (WFCOM). Both provide short-term (4.5 day) HAB trajectory forecasts used by FL FWC for HAB bulletins.
* Maintain the [Red Tide Data Resources for Florida page](https://secoora.org/red-tide-data-resources-for-florida/).

**Additional SECOORA Investment Opportunities:**

* Deliver regional-scale water quality data, analyses, and models to support hindcast, nowcasts, and forecasts for the fishing, aquaculture, and coastal tourism industries.
* Invest in nearshore ecosystem moorings and onshore stations to collect water temperature, salinity, nearshore currents, water levels, wind speed and direction, and precipitation required for water quality monitoring and forecasts.
* Install water quality sensors at major river entrances and ports, specifically, the Savannah River, GA, Cape Fear River, NC, Tampa Bay, FL, and Charlotte Harbor, FL.
* Support event-driven glider missions and cruises to collect water quality data and define oceanographic conditions (both Atlantic and Gulf of Mexico).
* Invest in unmanned aircraft systems (referred to as drones) which can be used for detection and tracking of HABs and pollutants, and water quality monitoring.
* Support satellite-based analyses of HABs.

### 2.1.4 Coral Health

Florida’s coral reef system is the third largest living reef on the planet and the only barrier reef system in the continental U.S. The entire system is situated in the SECOORA domain. It underpins the state’s marine ecosystems and protects our coastlines from major storms. Worldwide, coral species are facing severe threats from warming ocean waters, ocean acidification, and disease. For example, corals in FL and the Caribbean are experiencing a multi-year outbreak of coral disease for which the pathogen has yet to be identified.

**Challenges:**

* [Climate change impacts to corals](https://oceanservice.noaa.gov/facts/coralreef-climate.html), including bleaching and ocean acidification, are difficult to mitigate.
* Possible damage or destruction to reefs due to commercial and recreational fishing within reef ecosystems.
* Increase in population, coastal development, and recreational use of coral reef ecosystems are contributing to an increase in pollutants (e.g., run-off, oil/fuel from boats).

**Priority Geographic Areas(s):** Southeast Florida and Florida Keys

**Partner Activities:**

* NOAA’s Atlantic Oceanographic and Meteorological Laboratory (AOML) conducts studies related to [coral bleaching](https://www.aoml.noaa.gov/keynotes/keynotes_0518_cheecarocks.html), [sea level rise impacts to coral reefs](https://www.aoml.noaa.gov/keynotes/keynotes_0618_corals_sealevelrise.html), and supports the [Coral Health and Monitoring Program](https://www.coral.noaa.gov/).
* The Florida Keys National Marine Sanctuary conducts [research and monitoring](https://floridakeys.noaa.gov/research_monitoring/welcome.html?s=science) to study the effectiveness of its marine zones and the health of its marine resources.
* Mote Marine Laboratory is implementing the [Florida Keys strategic coral disease response and restoration initiative](https://mote.org/news/article/mote-battles-unprecedented-threat-to-floridas-coral-reefs). This 10-year plan will be implemented through a consortium of coral research and restoration institutions.
* Aquarius Reef Base in Key Largo, operated by FIU, supports a variety of [coral reef ecosystem science](https://aquarius.fiu.edu/dive-and-train/missions/coral-reef-missions/index.html) missions annually.
* The University of Miami [Benthic Ecology and Coral Restoration Lab](https://www.marine-biology-ecology.rsmas.miami.edu/research-themes/centers-and-labs/benthic-ecology-coral-restoration-lab/) works to protect and recover the depleted coral populations on Miami reefs through coral propagation, active restoration, and citizen science.

**Core Variables Required:**

* Physics: wind speed and direction, air temperature, water temperature, salinity, surface waves, currents, heat flux, sea level
* Biogeochemistry: colored dissolved organic matter, optical properties (chlorophyll), pCO2, acidity, DO, dissolved nutrients, pathogens, contaminants
* Biology and Ecosystems: coral species and abundance

**Other Variables Required:**

* eDNA
* barometric pressure
* key coral species genetics, growth, disease identification, recovery

**Current SECOORA Investments:**

* Through funding from the Curtis and Edith Munson Foundation, SECOORA is working with FACT Network partners to install temperature sensors at acoustic receiver locations in the Florida Keys and Biscayne Bay. These data will help monitor temperature near coral reefs in south Florida.

**Additional SECOORA Investment Opportunities:**

* Test emerging technologies that may be useful in studying coral reef ecosystems, specifically in-situ pathogen testing.
* Increase HFR coverage in the Florida Keys to identify how currents may carry disease-causing pathogens throughout the reef track.
* Work with partners to deploy WaveGliders and/or profiling gliders at deep water coral reefs, Oculina Bank, and the FL Keys reef tract for physical oceanographic and biogeochemical measurements.
* Invest in drone technology for coral reef habitat mapping, detection of coral bleaching, and marine debris detection in coral reef ecosystems.
* Develop high-resolution coupled biophysical models to link coral reef ecosystem information with oceanographic processes to enable predictive capability of coral health assessment.

### 2.1.5 Coastal and Ocean Acidification

Ocean acidification (OA) is a term that describes the change in the carbonate chemistry of ocean waters, largely due to increased carbon from the atmosphere entering the ocean. In addition, coastal acidification can occur from changes to river discharge (e.g., from increased precipitation and land use change), warming and nutrient inputs. These changes can reduce the buffering capacity of coastal waters and enhance respiration-driven acidification through organic carbon and nutrient loading. These changes in ocean and coastal water chemistry can have significant impacts on marine calcifiers, including coral and shellfish, and the economic and ecosystem services they provide. It is necessary to establish baselines of carbonate chemistry, monitor and identify sources of acidification and characterize its broader impacts in the Southeast so we can adapt these changes and their potential effects on marine ecosystems. Scientists, resource managers, and industry experts are beginning to untangle the sources of changing chemistry and evaluate the consequences of extreme events superimposed on long-term trends.

**Challenges:**

* Current monitoring and research for OA in the Southeast is limited, particularly in coastal areas.
* Extreme events have both immediate and lasting impacts on carbonate chemistry that are difficult to quantify given limited monitoring.
* There are no monitoring stations directly associated with industry (e.g., shellfish farms and hatcheries).

**Priority Geographic Areas(s):**

* Estuarine waters in the SECOORA domain that support the shellfish aquaculture industry.
* Additional priority locations for OA monitoring in the Southeast identified through SOCAN stakeholder workshops in 2017-2018[[8]](#footnote-8).
* Coral reef ecosystems in the Southeast including the FL Reef Tract and deep sea corals from NC to FL.

**Partner Activities:**

* [NOAA’s Ocean Acidification Program](https://oceanacidification.noaa.gov/) (OAP) funds research nationally to monitor acidification and understand its impact on marine ecosystems, societies and economies.
* The Rosenstiel School of Marine and Atmospheric Science at University of Miami has a [Coral Reef Futures Laboratory](https://coralreeffutures.rsmas.miami.edu/index.html) and an [Ocean Acidification Coral Laboratory](https://www.marine-biology-ecology.rsmas.miami.edu/research-themes/centers-and-labs/ocean-acidification-coral-lab/) both focused on understanding the impacts of climate change on corals.
* NOAA’s AOML [Ocean Carbon Cycle Group](https://www.aoml.noaa.gov/ocd/ocdweb/occ.html) operates ships of opportunity and conducts repeat hydrographic surveys to track ocean carbon.
* The [Ocean Acidification Program at Mote](https://mote.org/research/program/ocean-acidification) researches responses of ecologically important species — like corals — to projected levels of ocean acidification.

**Core Variables Required:**

* Physics: wind speed and direction, air temperature, water temperature, salinity, surface waves, currents, sea level
* Biogeochemistry: pCO2, acidity, DO
* Biology and Ecosystems: coral species and abundance, invertebrate species and abundance

**Other Data:**

* total alkalinity
* dissolved inorganic carbon
* river discharge
* upwelling
* dissolved inorganic nutrient (NO3, NH4)

**Current SECOORA Investments:**

* SOCAN was established in fall 2014 through a partnership between NOAA’s OAP and SECOORA.
* Support ocean acidification monitoring at the Gray’s Reef National Marine Sanctuary. The sensors deployed at this station include pCO2, pH, DO, turbidity, chlorophyll, salinity and water temperature.

**Additional SECOORA Investment Opportunities:**

* Test emerging technologies that may be useful in studying coral reef and coastal ecosystems. Examples include dissolved inorganic carbon and alkalinity sensors, which will provide better measures of ocean acidification[[9]](#footnote-9).
* Fund additional OA observations in the region, focusing on priority areas defined in the [SOCAN Monitoring Workshop Report](https://docs.wixstatic.com/ugd/17544c_7b10c400708f4d1d8f4c545c326d251d.pdf) and illustrated in this [Story Map](https://www.arcgis.com/apps/MapJournal/index.html?appid=2e5a2d67ca1d4fba8e3f960bf59c02e7).
* Equip a subset of existing SECOORA moorings operated in NC and SC with OA sensors.
* Work with a NOAA partner to equip National Data Buoy Center (NDBC) stations 41013 (Frying Pan Shoals) and 41010 (Canaveral East) with OA sensors.
* Develop high-resolution coupled physical-biogeochemical models to link marine carbonate ecosystem information with oceanographic processes to enable predictive capability of OA assessment.

## 2.2 Marine Operations

Meteorological and in-situ physical oceanographic observations collected in real-time are critical to a wide user community including federal, state, and local governments, academic and industry partners, and public stakeholders (e.g., commercial and recreational boaters and fishermen, beachgoers). These observations allow SECOORA and other users of these observations to: monitor, prepare, and respond to weather events threatening coastal communities; support efficient and safe marine transportation; provide information for search and rescue response[[10]](#footnote-10); and inform offshore resource use and siting.

### 2.2.1 Marine Safety

Data obtained from buoys and HFR are accessed daily by stakeholders across the southeast. These real-time observations support safe boating, shipping and commerce, mitigation of man-made (e.g., oil spill) and natural (e.g., HABs) hazards. Marine safety at sea is dependent on marine weather and oceanographic conditions. SECOORA contributes data from real-time moorings and HFR that assist the U.S. Coast Guard (USCG) with search and rescue efforts and NOAA’s National Weather Service (NWS) with marine and coastal zone forecasts. Additionally, SECOORA’s Marine Weather Portal (MWP) was developed specifically to address safety at sea concerns for the recreational boating and fishing communities.

**Challenges:**

* No new funding to expand mooring coverage to priority gap locations.
* Due to the size of the SECOORA domain, there are still large gaps in HFR coverage.
* The SECOORA MWP is not reaching all possible users.

**Priority Geographic Areas(s):** Myrtle Beach, SC, Georgia coastline, east coast of FL, key locations on the West Florida Shelf

**Partner Activities:**

* NOAA nowCOAST maintains both land-based and marine based observations and forecast data on the national scale.
* NOAA NWS maintains land-based weather stations and a marine [weather forecast website](https://www.nws.noaa.gov/om/marine/home.htm) with access to many resources.
* NOAA NDBC operates and maintains weather buoys for use in operational forecasting, warnings, and atmospheric models.
* NOAA Physical Oceanographic Real-time System (PORTS) has been deployed to support port activities in Charleston, SC, Savannah, GA, Jacksonville, FL, Miami, FL, Port Everglades, FL, and Tampa Bay, FL. The PORTS support safe and cost-efficient navigation by providing ship masters and pilots with data required to avoid groundings and collisions.
* USACE and the Coastal Data Information Program (CDIP) operate wave buoys deployed in coastal and offshore waters in NC and FL. These buoys primarily measure waves and sea surface temperature.
* USCG leads ocean search and rescue operations nationwide. They depend on data from buoys and HFR for the Search and Rescue Optimal Planning System (SAROPS) which helps to better delineate the search area. Additionally, water temperature data is used for hypothermia modeling.
* NOAA’s Office of Response and Restoration (ORR) Emergency Response Division provides 24-hour, 7 day a week response to spill events.

**Core Variables Required:**

* Physics: wind speed and direction, air temperature, water temperature, surface waves, currents, sea level, bathymetry
* Biogeochemistry: contaminants
* Biology and Ecosystems: None

**Other Data:**

* barometric pressure
* visibility

**Current SECOORA Investments:**

* Operate and maintain 20 in situ stations along the coasts of the Carolinas and West Florida Shelf, several of which have been operational for almost 20 years.
* Operate 13 HFRs distributed from Cape Hatteras, NC to the west coast of FL, with plans to add seven more by the end of 2020.
* North Carolina State University (NCSU) operates a nowcast/forecast regional scale ocean model that provides predictions of the following parameters: wind, air pressure, waves, sea level, three-dimensional ocean temperature, salinity, and currents.
* University of South Florida (USF) operates West Florida Shelf nowcast/forecast and hindcast circulation models and oil spill trajectory models for the Gulf of Mexico.
* The [MWP](http://mwp.secoora.org/) meets the marine weather nowcast and forecast needs of boaters, mariners, and beachgoers in the southeast and Gulf of Mexico.

**Additional SECOORA Investment Opportunities:**

* Add a station 10-12 miles offshore of the entrance to the Charleston Harbor based on needs identified by the Port to increase safety into and out of the harbor. Variables required: air temperature, barometric pressure, wind speed, gust, direction, surface water temperature and salinity, waves, currents.
* Previous work has been done to identify mooring location priorities for the SE in the [Build Out Plan Addendum](http://secoora.org/wp-content/uploads/2017/12/SECOORA-BOP-addendum_Final.pdf). Work with stakeholders to verify those priority locations and fill as funds allow.
* Continue to fill priority HFR gaps identified in the [High Frequency Radar Observing Systems: SECOORA Gap Analysis](http://secoora.org/wp-content/uploads/sites/default/files/webfm/members/documents/SECOORAHFRadar.pdf).
* Develop better connections with USCG and USACE for use of HFR to include providing training opportunities as needed.
* Develop local to regional scale marine environment (ocean circulation, wave, marine meteorology) models to produce nowcasts and forecasts to address marine transportation, flood, and ecological forecasting needs.
* Foster partnerships with marinas, fishing and tackle shops, and others to broaden the use of the MWP.

### 2.2.2 Rip Currents

A rip current is a narrow, fast-moving channel of water that starts near the beach and extends offshore through the line of breaking waves[[11]](#footnote-11). The United States Lifesaving Association estimates that the annual number of deaths due to rip currents on our nation's beaches exceeds 100. Rip currents account for over 80% of rescues performed by surf beach lifeguards[[12]](#footnote-12). NWS Weather Forecast Offices issue daily rip current forecasts alerting beachgoers when rip current probabilities are low, medium, or high. These forecasts are often manually generated based on tide cycle and meteorological conditions[[13]](#footnote-13). WFOs are transitioning to the probabilistic NOAA rip current forecast model, however the transition has slowed in part due to a lack of rip current and nearshore wave observations.

**Challenges:**

* Further development and improvement of rip current probabilistic models12.
* Beaches without lifeguards do not have a warning mechanism for hazardous rip currents nor do they provide observations to inform WFOs of rip current occurrence.
* Lack of surfzone or nearshore observations. Rip current, bathymetry and shallow water wave observations are needed to identify when conditions are favorable for rip current formation and to validate numerical wave models.
* Web cameras are available at many area beaches; however, there is a lack of standardization in camera deployment, data storage and image processing for rip current detection[[14]](#footnote-14).

**Priority Geographic Areas(s):** Swimming beaches in the Southeast

**Partner Activities:**

* NOAA NOS CO-OPS sponsored the development of a statistical rip current forecast model12 and is supporting the operationalization of the model with NWS. The model predicts the likelihood of hazardous rip currents occurring given wave and water level inputs from the numerical wave and water level model Nearshore Wave Prediction System (NWPS)[[15]](#footnote-15) .
* The United States Lifesaving Association, in partnership with [NWS](http://www.ripcurrents.noaa.gov/) and National Sea Grant Program, work to raise awareness about the dangers of rip currents. New [outreach materials and signage](https://www.weather.gov/safety/ripcurrent) have been developed based on the most recent scientific research.
* NC Sea Grant, SC Sea Grant, and FL Sea Grant conduct outreach to improve rip current identification and increase swimmer safety.

**Core Variables Required:**

* Physics: wind speed and direction, surface waves, nearshore/surfzone bathymetry, currents, water level
* Biogeochemistry: None
* Biology and Ecosystems: None

**Other Data:**

* camera imagery

**Current SECOORA Investments:**

* Surfline and SECOORA partnered for the Web Camera Applications Testbed (WebCAT), launched in 2017, as a public-private partnership to install and operate seven web cameras in the SECOORA region. This project brought stakeholders together to use Surfline webcams for coastal process and biological research.
* The [2019 SECOORA Data Challenge](https://secoora.org/meet-the-2019-data-challenge-winners/) focused on using the WebCAT cameras to address environmental concerns. Two projects were funded. The first project uses video imagery to monitor water level throughout an ensuing hazard, providing continuous data about the maximum water-level and insights into storm processes. The second project created a publicly-available software tool to transform camera imagery into quantitative coastal monitoring tools through a remote camera calibration.

**Additional SECOORA Investment Opportunities:**

* Work with NWS and NOS CO-OPS offices to install instrumentation (e.g. wave sensors, cameras) that will enable more accurate rip current forecasts and probabilistic model development.
* Continue working with private sector partners to standardize camera installations and image processing in order to use existing and new webcams for rip current detection.
* Support research to aid in the continued improvement of rip current models (e.g. how to incorporate bathymetry data; use of the rip current model to identify other surf zone hazards).

### 2.2.3 Offshore Resources

The 2018 SECOORA Annual Meeting hosted a panel on offshore resources in the Southeast that included sand, renewable energy, and non-renewable energy. There other active offshore initiatives including include offshore finfish aquaculture, sand resources for beach nourishment, natural gas pipelines, potential drilling for hydrocarbons, and alternative energy efforts to harness wind and currents. Through active partnerships with BOEM, state Departments of Energy, state and local permitting authorities, port operators, industry, and other stakeholders, SECOORA can provide a network of expertise to support investigation, installation, and monitoring of offshore resource-based projects.

**Challenges:**

* The offshore space is becoming more active each year with increased shipping, military use, and offshore energy and mineral exploration. It is often difficult to find or access data from Federal agencies, state agencies, and academic institutions.

**Priority Geographic Areas(s):**

* Offshore areas identified in the National Outer Continental Shelf (OCS) Oil and Gas Leasing Draft Proposed Program and [OCS Renewable Energy Leases](https://www.boem.gov/Renewable-Energy-Lease-Map-Book/).
* Sand and borrow areas, particularly OCS Aliquots with Sand Resources
* Areas with high potential for aquaculture activities such as the West Florida Shelf.

**Partner Activities:**

* BOEM is the lead federal agency for siting related to oil and gas, renewable energy, and marine minerals, but partners with other federal (e.g. NASA, NOAA) and state agencies and academic partners to conduct [environmental studies](https://www.boem.gov/Studies/).
* BOEM convenes partners to coordinate offshore wind activities through intergovernmental task forces in NC and SC. There is one renewable energy project underway offshore North Carolina.
* USACE and BOEM have a [memorandum of understanding](https://www.boem.gov/Signed-MOU-Army-Corps-of-Engineers/) to coordinate on offshore sand, gravel, and shelf resources. They also [partner](https://www.boem.gov/MMP-Federal-State-and-Other-Stakeholder-Partners/) with various state and local agencies through regional sand management working groups.
* NOAA National Centers for Coastal Ocean Science (NCCOS) is working with private industry groups to site finfish aquaculture pens on the West Florida Shelf.

**Core Variables Required:**

* Physics: wind speed and direction, air temperature, water temperature, salinity, surface waves, bathymetry, bottom character, currents, sea level
* Biogeochemistry: DO, dissolved nutrients, optical properties (chlorophyll)
* Biology and Ecosystems: sound, coral species/abundance, phytoplankton species/abundance, zooplankton species/abundance, invertebrate species and abundance, fish species/abundance

**Other Data:**

* isotopes
* barometric pressure
* telemetry data from tagged fish
* habitat mapping and habitat classification

**Current SECOORA Investments:**

* Operate and maintain in situ stations along the coasts of the Carolinas and WFS, several of which have been operational for almost 20 years.
* Operate HFRs distributed from Cape Hatteras, NC to west Florida.
* Support the [FACT Network](https://secoora.org/fact), a collaboration of over 45 partners agencies and institutions using acoustic telemetry to resolve the movements of aquatic species.
* Data management structure allows for integration and sharing of multiple data types through SECOORA’s data portal and data catalog.

**Additional SECOORA Investment Opportunities:**

* Work with partners to test newer technologies that are easier to deploy from shore and small boats for beach nourishment projects. Examples include the use drones for shoreline assessments, LiDAR data collection, etc. Also, NASA WaveGliders are being used for BOEM projects where impacts to fish and sharks must be quantified.
* Develop nowcasts and forecasts of near real-time winds, waves, currents to meet resource assessment and support operational activities of offshore resource exploration and utilization.
* Work with partners to provide integrated, readily accessible, spatially explicit data and information to support evaluation and monitoring for offshore resource projects (e.g., aquaculture, sediment resources, alternative energy).

## 2.3 Coastal Hazards and Climate Variability

The Southeast experiences severe weather- and climate-related events that cause significant hardships for the economic, environmental, and social well-being of residents and visitors. Major storm events such as Hurricanes Irma, Florence, and Michael caused damage across the southeast from heavy rain and winds. The collection of environmental data by in-situ and mobile assets are required to establish baseline scenarios of coastal system function. Long-term data are needed to assess changing environment or ecosystem conditions, regime shifts, and the impacts of severe weather events. These long-term data will enable better understanding of climate variability and lead to the ability to forecast, adapt to, and mitigate changes.

### 2.3.1 Storm Tracking and Forecasting

**Challenges:**

* No new funding to expand mooring coverage to priority gap locations.
* Need to collect observations necessary to develop better hurricane intensity models.
* Coupling hydrologic, hydrodynamic and atmospheric models to improve predictions of storm surge and inundation.

**Priority Geographic Areas(s):** Entire domain

**Partner Activities:**

* NOAA AOML is working with the U.S. Navy and IOOS and RAs to improve hurricane intensity forecasts with observations from underwater gliders.
* USACE’s Wave Information Study collects directional wave data to drive nearshore wave transformation models, perform research and development on existing wave modeling technologies, perform climate trend analyses, monitor coastal projects, and evaluate satellite based remote sensing systems (2020-2025), where onboard altimeters and software will provide better estimates of the wave conditions much closer to the coastline.
* [USGS Surge, Wave, and Tide Hydrodynamics (SWaTH) Network](https://www.usgs.gov/mission-areas/water-resources/science/surge-wave-and-tide-hydrodynamics-swath-network?qt-science_center_objects=0#qt-science_center_objectshttps://www.usgs.gov/mission-areas/water-resources/science/surge-wave-and-tide-hydrodynamics-swath-network?qt-science_center_objects=0) covers NC to Maine and monitors and documents the height, extent, and timing of storm surge.

**Core Variables Required:**

* Physics: wind speed and direction, air temperature, water temperature, salinity, surface waves, surface waves, currents, sea level, heat flux, bathymetry
* Biogeochemistry: None
* Biology and Ecosystems: None

**Other Data:**

* satellite sea surface temperature
* barometric pressure

**Current SECOORA Investments:**

* Maintain long-term sustained observations to address local and regional storm tracking, forecasting, and decision support needs.
* Invest in additional moorings and coastal stations that collect key core variables to support storm forecasting and tracking and total water level modeling. Previous work has been done to identify mooring location priorities for the SE in the [Build Out Plan Addendum](http://secoora.org/wp-content/uploads/2017/12/SECOORA-BOP-addendum_Final.pdf). Work with stakeholders to verify those priority locations and fill as funds allow.
* Continue to conduct glider missions during hurricane season to track water temperature and salinity stratification before and during storms. Share data through the Glider DAC for incorporation into operational models and forecasting.
* Strategically locate webcam and/or capture drone footage at regular intervals to monitor shoreline change.Support continued development of hurricane forecast models.
* Develop data assimilation capability to link RA in situ observations with regional-scale forecasting model to generate better marine environment predictions before, during, and after storm events.

**Additional SECOORA Investment Opportunities:**

* Moorings and coastal stations that collect key core variables to support total water level modeling.
* Continue to conduct glider missions during hurricane season to track water temperature and salinity stratification before and during storms. Share data through the Glider DAC for incorporation into operational models and forecasting.
* Develop data assimilation capability to link RA in situ observations with regional-scale forecasting model to generate better marine environment predictions before, during, and after storm events.
* Strategically locate webcam and/or capture drone footage at regular intervals to monitor shoreline change.
* Support model development to create subseasonal to seasonal forecasts (2 weeks - 3 months) for short-term and long-term weather outlooks for specific industries (e.g., agriculture, tourism).
* Foster relationships with decision makers to operationalize SECOORA funded models, with specific focus on the National Water Center and other offices in the NWS.
* Long-term sustained observations and down-scaled models to address local and regional planning needs.

### 2.3.2 Coastal Flooding and Sea Level Rise

High tide flooding, sometimes referred to as nuisance flooding, is coastal flooding that leads to public inconveniences such as road closures. It is becoming increasingly common as sea levels rise[[16]](#footnote-16). SECOORA’s role in addressing localized flooding and longer term issues related to sea level rise lie in our experience in operating observing platforms to provide community-level data necessary to improve the accuracy of inundation forecasts and models[[17]](#footnote-17).

**Challenges:**

* Meet demand for water level data (i.e. NOAA NOS CO-OPS operates a limited number of water level stations).
* There are large gaps between many NOAA NOS CO-OPS water level stations; therefore, additional monitoring is needed.
* Assuring appropriate management agencies and personnel (e.g., emergency managers, county officials) have access to and understand how to use SECOORA data.
* Calibration of webcams to accurately determine water level and flood extent.
* Fully coupling terrestrial water inputs and coastal ocean dynamics to understand storm surge impacts.

**Priority Geographic Areas(s):** Region-wide

**Partner Activities:**

* NOAA’s [CO-OPS](https://tidesandcurrents.noaa.gov/) has released an [outlook on coastal high tide flooding](https://tidesandcurrents.noaa.gov/HighTideFlooding_AnnualOutlook.html) with NOAA’s National Centers for Environmental Information every year since 201415 and provides [seasonal bulletins](https://oceanservice.noaa.gov/news/high-tide-bulletin/) to inform of the days and locations high tide flooding is most likely.
* NOAA CO-OPS operates [water level stations](https://tidesandcurrents.noaa.gov/stations.html?type=Water+Levels) along the east coast and Gulf of Mexico which provide shore based water level and meteorological data collection to support sea level and inundation monitoring.
* NOAA CO-OPS developed the [Inundation Dashboard](https://tidesandcurrents.noaa.gov/inundationdb/) to provide localized flooding reports for locations where water level stations are available.
* [NOAA Water Initiative](https://www.noaa.gov/water/explainers/noaa-water-initiative-vision-and-five-year-plan) is working to couple land surface and coastal estuary models to improve the prediction of total water level in the coastal zone[[18]](#footnote-18).
* [USACE Field Research Facility](http://www.frf.usace.army.mil/) in Duck, NC has instrumented an 560m (1840 ft) long pier and nearby coastal ocean waters to constantly record changing waves, winds, tides, and currents to understand coastal processes.
* The NWS and the USGS update forecasts for some areas several times a day using real-time water levels from the NWS Nearshore Wave Prediction System. The team’s [Total Water Level and Coastal Change Forecast Viewer](https://coastal.er.usgs.gov/hurricanes/research/twlviewer/) displays results from a new model that currently covers about 1,865 miles of coastline in select areas from Florida through Maine.

**Core Variables Required:**

* Physics: wind speed and direction, currents, sea level, water temperature, salinity, bathymetry
* Biogeochemistry: None
* Biology and Ecosystems: None

**Other Data:**

* barometric pressure, shoreline mapping, camera imagery

**Current SECOORA Investments:**

* SECOORA and Fathom Science are partners on a 2019 COMT project designed to link the NOAA National Water Center National Water Model to a suite of coastal ocean models run by NCSU and Fathom Science. The goal is to accurately quantify interactions between terrestrial hydrology (water run-off and riverine input) and the coastal ocean. This will allow for more accurate models of storm surge during extreme (e.g. hurricane) events.
* USF coastal stations monitor water level and meteorological data.

**Additional SECOORA Investment Opportunities:**

* Partner with NOAA NOS CO-OPS, National Water Center and other partners to help fill gaps in water level data.
* Partner with organizations and communities to install inexpensive water level sensors, modeled after the [Smart Sea Level Sensors project](https://www.sealevelsensors.org/) in GA, to help address information gaps related to chronic flooding and storm surge related flooding.
* Use webcam images and drone footage to identify flooding hotspots to inform county emergency managers and other local organizations. This same imagery can be used to correlate in situ observed water level with inundation impacts and the development of localized flood thresholds.
* Support development of improved models and forecasts for flooding and inundation.
* Develop specific model products tailored to stakeholder needs for subseasonal to seasonal forecasts (2 weeks - 3 months).

#

# 3. RCOOS Subcomponents

A RCOOS is a comprehensive operation that includes all the components necessary to collect observations and turn them into useful and meaningful information products. They include the following core components that are integrated into a unified system as summarized below:

* **Observing platforms** and sensors including fixed stations, such as buoys and coastal stations, mobile platforms such as gliders and ships, and remote sensing instruments and platforms such as High Frequency Radar (HFR).
* **Data management and communications (DMAC)** supports seamless access to regional data. Additionally, DMAC ensures that data are archived, recorded and transmitted in standardized ways that are consistent in content and format with other providers of the same data. Real-time data are provided to stakeholders via the [SECOORA data portal.](https://portal.secoora.org/)
* **The modeling component** supports a numerical modeling framework (sub-regional to regional scale models) to provide validated modeling products for managers and other users. Observations from HFR, coastal and oceanographic moorings, and gliders are being linked to predictive models and decision-making tools.
* **Products** transform raw and/or processed data into useful and meaningful decision-making and information products.
* **Outreach and education** efforts connect stakeholders to SECOORA data products and services.

## 3.1 National Efforts

Many national efforts are underway to collect information on U.S. and global observing system capacities. While we will not detail every partner related technology or effort here, it is recommended that users review the following national plans:

NOAA’s National Ocean Service (NOS) and NWS released [The National Strategy for a Sustained Network of Coastal Moorings](https://cdn.ioos.noaa.gov/media/2017/12/NationalStrategyforSustainedNetworkofCoastalMoorings_FINAL.pdf) in January 2017. There are 370 existing coastal moorings within the scope of the Strategy intended for sustained operations and located within the U.S. Exclusive Economic Zone. Of these, 90% are operated by NOAA and IOOS RAs; 215 are operated by federal entities (NOAA and USACE) and 155 by non-federal entities (IOOS RAs and the National Science Foundation (NSF) Ocean Observatories Initiative). The Strategy evaluates this existing inventory and provides ten recommendations towards development of an implementation plan. The primary recommendation is to identify regional observing gaps best addressed with coastal moorings, using a targeted stakeholder engagement approach to integrate stakeholder input. This effort will be led jointly by NOAA mooring operators and IOOS RAs. This regional stakeholder input will ensure that the network addresses real needs and utilizes available resources efficiently and effectively.

In the report from the [National Coastal Ecosystem Mooring Workshop](http://www.act-us.info/Download/Workshops/2018/Ecosystem_Mooring_Workshop_Report.pdf), convened by the Alliance for Coastal Technologies in March 2018, the workshop participants identified the need for a backbone of core biogeochemical and physical measurements that are required to inform societal issues. Impediments to the deployment of these sensors include the cost/price for the sensors and the lack of suitability for deployment on moorings (e.g. wet chemistry sensors, biofouling concerns).

A [Plan to Meet the Nation’s Needs for Surface Current Mapping](https://cdn.ioos.noaa.gov/media/2017/12/national_surface_current_planMay2015.pdf) presents the uses of HFR, the requirements that drive the measurement of ocean surface currents, and the implementation design for a five-year, national build-out effort. This document was last updated in May of 2015.

[NOAA's Center for Operational Oceanographic Products and Services](https://tidesandcurrents.noaa.gov/mission.html) (CO-OPS) provides accurate, reliable, and timely tides, water levels, currents, and other oceanographic information. CO-OPS operates the National Water Level Observation Network (NWLON) and the Physical Oceanographic Real Time System (PORTS). The data, products and services provided by CO-OPS support safe and efficient navigation, ecosystem stewardship, coastal hazards preparedness and response, and a better understanding of climate change. Unfortunately, there are gaps in CO-OPS NWLON stations that need to be filled. These gaps are identified in [A Network Gaps Analysis for the National Water Level Observation Network (NWLON)](https://tidesandcurrents.noaa.gov/publications/Technical_Memorandum_NOS_COOPS_0048_Updt.pdf).

The National Academies of Science [Gulf Research Program](http://www.nationalacademies.org/gulf/index.html) (GRP) is an independent, science-based program founded in 2013, as part of legal settlements with the companies involved in the 2010 *Deepwater Horizon* disaster. Beginning in 2018, the GRP has announced a series of funding opportunity aimed at improving understanding and prediction of the Gulf of Mexico Loop Current System (LCS). Through this endeavor, HFRs are being deployed along the southern Florida Keys and moorings are being deployed along the West Florida Shelf.

## 3.2 SECOORA efforts

### 3.2.1 Moored stations

**Background**

The National Strategy for a Sustained Network of Coastal Moorings (2017) states, “meteorological measurements and in-situ oceanographic observations of physical, chemical, and biological conditions throughout the water column...provide the backbone of coastal intelligence.” Moored stations, frequently referred to as buoys, are typically defined as an asset that is anchored to the seabed which provides time-series measurements at the water surface or at one or multiple depths within the water column. These are platforms that can be used to deploy sensors which allow scientists and other stakeholders to monitor environmental conditions. A single coastal mooring may be used to support the sensors for multiple scientific studies (add citation 2017[[19]](#footnote-19)). Additionally, moorings can provide baseline long-term observations to support climate change assessments, including tracking sea surface temperature changes over time (climatology) and ocean acidification.

**Current Capacity**

SECOORA, with partners at the University of North Carolina Wilmington (UNCW) and USF, maintains ocean moorings in coastal and offshore NC, SC, and FL. Fixed moorings operated by SECOORA augment the NOAA NDBC mooring array with regional observations for the marine environment. The SECOORA funded mooring data are used by NOAA NWS for nowcasts/forecasts of weather and ocean conditions; USCG to initiate their SAROPS model, and NOAA spill response teams to assist with estimating oil or particle trajectories.

**Core Variables Collected**

Data collected by sensors on moorings directly address the need to document variability in the nearshore and offshore environments. The SECOORA real-time moorings measure meteorological and ocean surface conditions. There are several non-real-time stations in the SECOORA footprint that measure subsurface conditions. See Table 1 for a list of SECOORA moorings and the variables collected.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Wind Speed, Gust, Direction | Air Temp | Barometric Pressure | Relative Humidity | SW/LW Radiation | Water Temp | Currents | Waves | Cond/ Salinity | Fish Acoustic Sensors |
| UNCW Moorings |
| LEJ3 - Outer Onslow Bay | X | X | X | X |  | X |  |  | X | X |
| LEJ3Wave |  |  |  |  |  | X |  | X |  |  |
| ILM3 - Outer Onslow Bay | X | X | X | X |  | X |  |  | X | X |
| ILM2 - Inshore Onslow Bay | X | X | X | X |  | X |  |  | X | X |
| ILM2Wave |  |  |  |  |  | X |  | X |  |  |
| SUN2 - Northern Long Bay | X | X | X | X |  | X |  |  | X | X |
| SUN2Wave |  |  |  |  |  | X | X | X |  |  |
| CAP2 - Inshore Capers Island | X | X | X | X |  | X |  |  | X |  |
| FRP2 - Inshore Fripp Island | X | X | X | X |  | X |  |  | X |  |
| OB27 - Onslow Bay\* |  |  |  |  |  | X | X | X | X | X |
| USF Moorings |
| C10 - WFS Central nearshore | X | X | X |  | X | X |  |  |  |  |
| C12 - WFS Central offshore | X | X | X |  | X | X |  |  |  |  |
| C13 - WFS South | X | X | X |  | X | X |  |  |  |  |
| C11 - WFS Subsurface\* |  |  |  |  |  | X | X | X |  |  |
| C15 - WFS Subsurface\* |  |  |  |  |  | X | X | X |  |  |
| C21 - Tower\* | X | X | X | X |  | X | X | X |  |  |
| \*Non real-time station |
| Table 1. SECOORA moorings and variables collected |

**Build out plan (new or upgrades)**

A consistent array of moorings that provide surface and subsurface data (i.e. atmospheric, physical oceanographic, and biogeochemical) are needed throughout the SECOORA domain. During the 2017 SECOORA Members Meeting, members and stakeholders reviewed locations of currently deployed moorings. They then identified locations where new moorings should be deployed and identified existing moorings that could benefit from the addition of new sensor suites (e.g., pH and pCO2 for OA, acoustic sensors for fish tracking). The overall goal of this activity was to identify how SECOORA can better address significant regional issues related to fisheries management, water quality, climate variability, coastal and marine hazards, and environmental threats such as OA.

To gather targeted information on mooring gaps, the SECOORA principal investigators (PI) and stakeholders participated in a gap analysis exercise during the 2017 SECOORA Members meeting. The SECOORA domain was broken into three sub-regions and in situ observing priorities were identified by sub-region. The sub-regions included: 1) NC, SC, and GA; 2) east coast of FL; and, 3) west coast FL/Gulf of Mexico. The outcomes from this session are found in the [SECOORA Build-out Plan addendum](http://secoora.org/wp-content/uploads/2017/12/SECOORA-BOP-addendum_Final.pdf).

The NC, SC, and GA region includes real-time moorings established by the UNCW Coastal Ocean Research and Monitoring Program (CORMP), NOAA NDBC, SCRIPPS/USACE CDIP moorings, University of Georgia (OA monitoring), and project related moorings that provide a short term increase in observation (e.g., NSF funded project moorings). The mooring priorities for the NC, SC, and GA region range from low-cost options, such as adding additional sensors to existing moorings, to higher cost options of deploying new real-time or non-real-time moorings in key locations (e.g., nearshore within river plumes and seafloor instruments under the Gulf Stream). The priorities for the fixed platforms in the coastal and ocean region offshore of NC, SC, and GA are as follows:

* Equip a subset of the existing SECOORA moorings operated by UNCW with full sensor suites (Table 1, specifically ILM2, ILM3, LEJ3, SUN2, CAP2, FRP2). Additional sensors that could be added to the moorings include pH and pCO2 (for OA research), chlorophyll, CTDs throughout the water column, and water column currents.
* Add mid-shelf (20-50 m) and outer-shelf (60 m) moorings in Long Bay, SC offshore of the Myrtle Beach region and within the Caswell/Georgetown HFR coverage area.
* Add moorings near the shipping channels at entrances to the Charleston Harbor, Savannah River, and Cape Fear River that provide air temperature, barometric pressure, wind speed, gust, direction, surface water temperature and salinity, waves, currents, and potentially visibility to increase safety into and out of the ports.
* Extend Long Bay mooring line with 2-3 [CPIES](http://www.po.gso.uri.edu/dynamics/IES/index.html) deployed on the seafloor, under the Gulf Stream. These stations will also be within the Caswell/Georgetown HFR coverage area.
* Equip NDBC stations 41013 (Frying Pan Shoals) and 41010 (Canaveral East) with OA sensor suites.

The SCRIPPS/USACE CDIP program deployed four Waverider buoys on the east coast of FL and one offshore of Key West, which have helped fill some data gaps. Additionally, SECOORA and its partners successfully petitioned NOAA to maintain the Cape Canaveral NDBC mooring (41009) which provides vital information to NASA, SpaceX, and Port Canaveral. The CDIP and NDBC moorings provide valuable data for marine safety and transportation sectors and coastal process modeling; however, since the CDIP moorings only provide spectral wave and surface water temperature data, they do not provide the meteorological and additional in-water data required by many SECOORA stakeholders .

Moorings deployed off the east coast of FL, within the 10 – 50 meter isobaths, are required to fill data gaps for marine safety and transportation, to better understand ecosystems, fisheries, and water quality (productivity and to capture upwelling events), and address public health concerns and coastal hazards (HAB tracking and rip current forecasting). Moorings with meteorological and surface and subsurface physical sensors are needed. In addition 1-2 of these moorings should also include biogeochemical sensors to allow for OA and water quality monitoring. Moorings are needed in the following locations off the east coast of FL (ranked by importance) as few stations exist in these areas:

* Miami
* Sebastian Inlet
* Jacksonville
* Delray Beach
* Fort Pierce

The west coast FL region has coastal stations and ocean moorings already established by the USF COMPS, NOAA NDBC, SCRIPPS/USACE CDIP moorings, and the Tyndall Air Force Base Tower. While there are seemingly a large number of stations on the Gulf Coast, most are shore-based stations supporting water level and meteorological data collection. The offshore moorings, operated and maintained by COMPS, NDBC, CDIP, and the Air Force, provide valuable data for marine safety and transportation sectors and coastal process modeling; however, more stations are required in the following priority locations to support fisheries management, water quality, climate variability, coastal and marine hazards, and environmental threats such as OA and HABs. The following locations off the west coast of FL were identified as the priority locations for mooring deployments:

* Southwest corner of west FL shelf, northwest of the Pulaski Shoals Light (PLSF1). Needs meteorological data, in-water currents, waves, salinity, and temperature.
* Pensacola Bay and the Middle Grounds are major fisheries areas within the Gulf of Mexico that need moorings with a full suite of biological, oceanographic, and meteorological parameters.
* Shallow southwest FL shelf at 10 m isobath, north of Key West, FL. Needs meteorological data, water temperature, salinity, chlorophyll, nutrients, OA sensor, acoustics to support fisheries, wave heights, currents. This location drives ecological conditions in Florida Keys National Marine Sanctuary, Everglades National Park, and the Florida Keys.
* DeSoto Canyon, shelf break, south of Destin, FL. This is an important upwelling area and meteorological data as well as in water data such as waves, currents, temperature, and salinity are needed.
* Northeast of mooring 42036, West Tampa NDBC buoy. This location, south of Tallahassee, requires surface meteorological data.
* East of 42036, West Tampa NDBC buoy at the 20 m isobath. Identified needs for this location include meteorological data, waves, water temperature and salinity.
* Florida Bay on the 20 m isobath, east of the COMPS C13 mooring. This location needs meteorological data, waves, and water temperature.
* Upgrade the Conch Reef/Aquarius Reef Base Station (operated by FIU) to include meteorological, water temperature, salinity, currents, waves, chlorophyll, nutrients, OA sensors, and acoustics to support fisheries and ecosystem monitoring.

The overwhelming need for nearshore and offshore moorings highlights stakeholder desire for traditional observing stations that contain a suite of instruments that can cater to more than one stakeholder need. As funding levels have remained consistent, SECOORA has been able to maintain many of the stations that are currently deployed. New stations have required SECOORA and is members to leverage funds with other state and federal agencies, and even employ a crowdsource funding campaign, to fill data gaps. The long list of priority moorings, and sensor additions to existing moorings identified by SECOORA stakeholders and members, will not be achievable through SECOORA efforts alone. Therefore, it is essential for SECOORA to work with stakeholders and members to identify additional funding mechanisms to fill gaps within the region.

### 3.2.2 Coastal stations

**Background**

Coastal stations are operated by federal, state, local and academic partners. Coastal stations can be configured with sensor suites to meet a variety of stakeholder needs. Many of the sensors for coastal stations are attached to piers, pilings, or other structures. While more easily accessible than offshore moored stations, coastal stations often require more routine maintenance. SECOORA partners who operate coastal stations include:

* [NOAA CO-OPS](https://tidesandcurrents.noaa.gov/) operates water level stations in NC, SC, GA, and FL. CO-OPS also works with partners to operate Physical and Oceanographic Real Time System ([PORTS](https://tidesandcurrents.noaa.gov/ports.html)) stations at major port locations in the SECOORA region including Charleston, SC, Savannah, GA, Jacksonville, FL, Miami, FL, Port Everglades, FL, and Tampa Bay, FL.
* [NOAA’s National Estuarine Research Reserve System](https://coast.noaa.gov/nerrs/) (NERRS) has seven sites in the Southeast. They collect water quality and meteorological stations, and other meteorological, physical, and biogeochemical shore and estuarine stations. SECOORA has previously funded instrumentation for deployment at the North Inlet - Winyah Bay NERR in order to expand water quality monitoring.
* [Indian River Lagoon Observatory Network of Environmental Sensors (IRLON)](https://fau.edu/hboi/irlo/irlon.php) operates ten sites in the Indian River Lagoon and St. Lucie Estuary on the East Coast of Florida.

**Current Capacity**

SECOORA, with partners at USF and SCDNR, maintains 6 coastal stations that provide water quality, water level, and meteorological data. Five of the stations are on the west coast of FL and one station is in the Charleston, SC area.

**Core Variables Collected**

Data collected by sensors at coastal stations directly address the need to document variability in the nearshore environments. The SECOORA real-time moorings measure meteorological conditions as well as water level and, in Charleston Harbor and Clam Bayou, water quality. See Table 2 for a list of SECOORA coastal stations and the variables collected.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Wind Spd, Gust, Dir. | Air Temp | Barometric Pressure | Water Temp | Cond/ Salinity | Water Level | Fish Acoustic Sensors | DO | pH | Chl | Turbidity | Precip |
| USF Coastal Stations |  |
| Shell Point, FL | X | X | X |  |  | X |  |  |  |  |  |  |
| Aripeka, FL | X | X | X |  |  | X |  |  |  |  |  |  |
| Fred Howard State Park, FL | X | X | X |  |  | X |  |  |  |  |  |  |
| Clam Bayou, FL\* | X | X | X | X | X | X |  | X | X | X | X | X |
| Big Carlos Pass, FL | X | X | X |  |  | X | X |  |  |  |  |  |
| SCDNR Coastal Stations |  |
| Charleston Harbor, SC |  |  |  | X | X | X |  | X | X | X | X |  |
| Table 2. SECOORA coastal stations and variables collected\*Also has water pressure, blue green algae-phycoerythrin concentration, FDOM |  |

**Build out plan (new or upgrades)**

* Install water quality sensors at inshore locations at major river entrances, specifically, the Savannah River, GA and the Cape Fear River, NC. These could be piling stations or SECOORA could work with the USCG to instrument aids to navigation within the river entrances. These stations should be instrumented, at a minimum, to match the Charleston Harbor station.
	+ Stations should measure water quality parameters: water temperature, salinity, DO, pH, turbidity, chlorophyll fluorescence and fluorescence of dissolved organic matter (FDOM, a proxy for total dissolved organic carbon).
* Work with partners to establish:
	+ Meteorological and water quality stations at beach and shellfish harvest areas
	+ Meteorological and water quality stations located on commercial ocean fishing piers
	+ Physical and water quality stations near key acoustic receiver locations
	+ Water level stations to address coastal flooding and inundation
	+ Visibility sensors at port entrances

### 3.2.3 Autonomous Vehicle Observatory

**Background**

Autonomous vehicles such as gliders and surface vehicles collect high spatial density data that augment moored buoy arrays, HFR, and satellite data. Most autonomous vehicles are easy to deploy, and all are flexible in terms of mission objectives and event response, the only such observing resource with these capabilities. Additionally, the use of autonomous vehicles is often more cost effective than ship-based, crewed surveys, especially for long duration missions or repetitive tasks. Gliders are now used by all IOOS RAs to help characterize the vertical and horizontal structure of the water column, providing important observations for assimilation into numerical models, and to support many focus areas ([Price and Rosenfeld, 2012](http://www.ioosassociation.org/sites/nfra/files/documents/ioos_documents/regional/BOP%20Synthesis%20Final.pdf)). Additionally, autonomous surface vehicles, such as Wave Gliders, are being used by some RAs (e.g., PacIOOS), and by academic and federal programs in support of research projects (e.g., BOEM WaveGliders provide fisheries and physical data at shoals designed as borrow sites for beach nourishment projects; researchers at FAU’s Harbor Branch Oceanographic Institute have used sensors deployed from a Wave Glider to identify fish spawning locations).

**Current Capacity**

SECOORA invested funds from the [2016-2021 SECOORA](http://secoora.org/wp-content/uploads/sites/default/files/webfm/IOOS%20Proposal/IOOSCertification/OrganizationDocs/Proposal%20Final%20FINAL_aw%20copy.pdf) IOOS award to establish a glider observatory for sustained monitoring of shelf circulation and water properties in the South Atlantic Bight (SAB). Profiling gliders are self-propelled (buoyancy driven), autonomous underwater vehicles (AUVs) that are deployed for days-to-months and profile the water column collecting environmental data (IOOS 2016). The SAB is affected by a variety of processes and characteristics that are unique to the region (i.e., broad and shallow shelf, influence of strong boundary currents due to the Gulf Stream, strong tidal forcing, distributed river input, passage of powerful tropical storms and hurricanes). These processes have wide ranges of spatial and temporal scales not easily observed with traditional technology, which has led to a historic lack of information on density stratification(Castelao, 2011) and horizontal and vertical structure of biologically relevant variables. The SECOORA glider observatory is working to spatially and temporally characterize the SAB, with plans to add the West Florida Shelf as soon as funding allows.

The SECOORA funded glider observatory consists of [Slocum](https://www.whoi.edu/main/slocum-glider) autonomous profiling gliders as these gliders were already in operation by the SECOORA glider PIs. Many of these gliders were over 10 years old and maintenance issues were a concern since spare parts and sensors were being phased out for the older systems. Additionally, through the IA’s [Fill the Gaps Campaign](https://secoora.org/growing-observations-with-the-closing-the-gaps-campaign/) from 2017-18, SECOORA received funding to purchase a new G3 Slocum glider. This new glider was incorporated into the SECOORA glider fleet in Spring 2019. The glider is housed at Skidaway Institute of Oceanography (SkIO) and is operated by SkIO and USF. SECOORA provides insurance coverage for the full value of the glider. With the incorporation of the new glider into the glider fleet, SECOORA should be able to fulfill its mission to achieve three 25-day glider missions annually.

Glider Fleet: Gliders currently being used for the SECOORA Glider Observatory are owned by SECOORA (operated and maintained by SkIO and USF), SkIO, UNCW (operated and maintained by SkIO), USF, and NCSU. Gliders are only being deployed along the east coast of the SECOORA domain due to funding constraints.

Glider Piloting: SECOORA glider operators are working with GCOOS and using the GCOOS glider tool named GANDALF. GANDALF provides the required specifications for glider operators, including: ability to overlay position data with satellite, HFR, and modeled data. Additionally, partnering with GCOOS leverages existing relationships between SECOORA and GCOOS PIs and reduces duplication of efforts, thereby allowing IOOS funding to go farther.

**Core variables collected**

Sensors on gliders measure physical variables such as pressure, temperature, salinity, currents, biological variables relevant to the abundance of phytoplankton and zooplankton, and ecologically important chemical variables such as DO and nitrate. As pH sensors mature, gliders will provide excellent platforms for monitoring ocean acidification.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Glider Name | Conductivity | Temp. | Salinity | DO | Chlorophyll-a | CDOM | Backscatter | Water column biomass | Acoustic receiver (tags) | Hydrophone (sound) |
| Franklin | X | X | X | X | X | X | X |  | X |  |
| Bass | X | X | X | X | X | X | X |  | X | X |
| Sam | X | X | X | X | X | X | X | X |  | X |
| Stella | X | X | X | X |  |  |  | X |  |  |
| Ganset | X | X | X | X |  |  |  | X |  |  |
| Angus | X | X | X | X | X | X | X |  | X |  |
| Pelagia | X | X | X | X | X | X | X |  |  |  |
| Salacia | X | X | X |  |  |  |  |  |  |  |
| Table 3. SECOORA gliders and variables collected |

**Build out plan**

SECOORA’s priorities for its autonomous vehicle observatory include: expanding operations to include other vehicle technologies (e.g., WaveGliders, Saildrones, Spray Gliders); expanding existing operations in the SAB and establishing autonomous vehicle tracks in the Gulf of Mexico; expanding capabilities for the SECOORA data portal to support visualization of autonomous vehicle tracking and data; working with the IOOS Glider DAC to ingest more types of autonomous vehicle data (e.g., Wavegliders) and delayed-mode glider data. Existing and near-term uses for autonomous vehicle operations include the following:

* Water column profiling to validate oceanographic models and contribute to hurricane intensity forecasting.
* Assessment of HABs to help better understand bloom dynamics and enable modeling/forecasting of bloom trajectories.
* Fisheries and marine mammal tracking through acoustic monitoring.
* Acoustic telemetry surveys for tagged animals to better understand habitat use and spawning locations.
* Oil spill or other harmful chemical monitoring and tracking.

The 2014 IOOS white paper, [Toward a U.S. IOOS Underwater Glider Network Plan: Part of a comprehensive subsurface observing system](https://cdn.ioos.noaa.gov/media/2017/12/glider_network_whitepaper_final.pdf), notes that expansion of the glider observatory will allow for more robust subsurface ecosystem and physical oceanographic observations, and enhance modeling efforts around the nation.

SECOORA’s goal is to expand from three mapping missions per year (two shelf, one slope) to six mapping missions per year (two shelf, four seasonal slope missions). SECOORA will endeavor to incrementally expand glider operations so that we can work toward achieving greater spatial and temporal data coverage along the southeast U.S. coastal and ocean region. Opportunities to expand mapping missions include SECOORA participation in the collaborative effort between NOAA IOOS and AOML to fly hurricane “picket lines” whereby gliders conduct additional surveys during the active Atlantic hurricane season. In 2018, with assistance from IOOS, SECOORA was able to participate in the hurricane glider work being conducted by NOAA AOML and IOOS, Navy, CariCOOS, MARACOOS, and Rutgers to provide valuable glider data during Hurricane Florence’s transit to landfall near Wilmington, NC.

In the future, SECOORA would like to work with GCOOS to coordinate glider deployments in the Gulf of Mexico as both RAs work in the West Florida Shelf. SECOORA, GCOOS, and mutual stakeholders have an interest in using gliders along shelf missions to better forecast hurricane intensity and monitor HABs and hypoxia events. GCOOS has identified priority glider tracks along the west coast of Florida in its [Build Out Plan](http://gcoos.tamu.edu/BuildOut/BuildOutPlan-V2-1.pdf) (version 2.1). Collaboration will insure efficient, and hopefully robust, data collection and sharing as well as collaborative research, monitoring, and modeling opportunities.

SECOORA and FACT partners are actively using autonomous surface vehicles (ASVs) for fisheries, HABs, and water quality projects. ASVs represent a field of emerging, integrated, marine observing technologies that includes hardware, software, platforms, sensors, data acquisition, storage, processing and transfer technologies, on a vessel moving across the water surface in an intelligent manner. The [Liquid Robotics](https://www.liquid-robotics.com/) Wave Glider (in use by NASA and FAU’s Harbor Branch Oceanographic Institute), Saildrone ([www.saildrone.com](http://www.saildrone.com)), and Autonaut (<http://www.autonautusv.com>) are three ASVs that are capable of long range, multi-month deployments, and carry comprehensive scientific instrument suites (atmospheric, ocean surface, and subsurface sensors). For example the Wave Glider science payload for NASA deployments at Cape Canaveral include acoustic receivers for detecting acoustically-tagged animals, plus sensors for measuring water temperature, turbidity, chlorophyll, CDOM, DO, ambient biological noise, and meteorological sensors. Partnering with members and other agencies/institutions for ASV deployments can expand SECOORA observing capabilities for targeted research projects as well as routine ecological monitoring.

### 3.2.4 High Frequency Radar

**Background**

Just as the winds in the atmosphere provide information about where and when weather systems occur, ocean currents determine the movement of oceanic events[[20]](#footnote-20). HFR is used to measure the speed and direction of ocean surface currents. HFR can measure currents over a large region of the coastal ocean, from a few kilometers offshore up to about 200 km, and can operate under any weather conditions. They are located near the water’s edge, and need not be situated atop a high point of land (IOOS [website](https://ioos.noaa.gov/project/hf-radar/)). Monitoring coastal current speed and direction is essential for oil spill and point source pollution tracking and prediction, search and rescue (SAR), marine navigation, HAB forecasts, marine protected area and ecosystem management, effects of climate change on coastal ecosystems, and coastal zone management[[21]](#footnote-21).

**Current Capacity**

SECOORA’s highest priority is to maintain the existing SECOORA HFR assets which provide detailed surface current data (i.e. current speed and direction) from 20 stations throughout the SECOORA region. See Table X (to be populated for final version) for a list of HFR locations, operators, and frequency for each station.

**Build out plan (new or upgrades)**

In 2014, Shay et al. completed the [High Frequency Radar Observing Systems: SECOORA Gap Analysis](http://secoora.org/wp-content/uploads/sites/default/files/webfm/members/documents/SECOORAHFRadar.pdf), which outlined a plan for expanding the HFR network across the SECOORA domain. Recommendations from this document were included in the [National Surface Current Plan](https://www.ioos.noaa.gov/wp-content/uploads/2015/12/national_surface_current_planMay2015.pdf) (NOAA IOOS, 2015) which provides an overview of HFR needs within the U.S. and also identifies gaps within each RA. Based on information found within these documents, 39 HFRs are needed to provide full coverage for the SECOORA domain. Currently there are 15 existing SECOORA stations; however, FAU has installed and is operating two stations near Miami, FL. These stations do not receive IOOS or SECOORA funding but they do help fill gaps within the HFR network. Therefore, 22 stations are needed within the SECOORA domain to fill coverage gaps identified in the 2014 plan. SECOORA’s HFR installations have evolved through a combination of research funding and state agency investment. SECOORA will continue to support both CODAR and WERA HFR within the region.

SECOORA has worked with partners to successfully increase the number of HFR stations within the region. HFR expansion since 2018 includes:

1. Two 12.7 MHZ WERA operated by Florida Institute of Technology deployed at Patrick Air Force Base and Sebastian Inlet State Park.
2. One 12.7 MHz WERA operated by the University of Miami deployed in Key Largo, FL. This station provides radar coverage across the Florida Straits to measure the Florida Loop Current/Gulf Stream.
3. Four used 13 MHz WERA HFR that were part of the NSF funded “Processes driving Exchange at Cape Hatteras” project were purchased by SECOORA and SkIO. These HFR are being deployed in NC Outer Banks, near Myrtle Beach, SC and along the coasts of GA and northeastern FL.

### 3.2.5 Web Cameras

**Background**

Shore based web cameras are becoming more readily available to the science community and they are transforming coastal environmental monitoring. Improvements in camera technology and image processing capabilities, paired with decreases in cost, enable widespread use of camera systems by researchers and for a growing range of environmental monitoring applications (Dusek et al, in press). Dusek et al (in press) describes how web camera video imagery can help with coastal monitoring and these uses fall into the following categories: coastal morphological change, hydrodynamics, human impacts on coastal resources, recreation and weather observations, and ecological, environmental, and water quality observations.

**Current Capacity**

The NOAA WebCAT was launched in 2017 in partnership with SECOORA and Surfline, Inc., as a public-private partnership. The goal of WebCAT was to address the need to standardize observations made by web cameras. Camera operators often follow unique installation procedures and collect, store, and process imagery data in various ways. These inconsistencies significantly limit the ability for imagery data to be shared and used across research and operational disciplines. The WebCAT project relied on the expertise of the private industry partner Surfline, Inc. to install and operate seven web cameras. Project partners from NOAA, U.S. Geological Survey, USACE, state agencies, and academia conducted projects with the web cameras to highlight their utility for a range of needs. (Dusek et al, in press; WebCAT[[22]](#footnote-22)). The WebCAT project team developed best practices on web camera installation so that future camera installations are installed to meet standards for scientific use.

**Build out plan**

The WebCAT team identified specific recommendations for the web camera operation in order to continue to standardize data delivery (Dusek et al, in press; WebCAT final report):

* standardize imagery products (e.g., time-exposure images, variance images, time-stacks);
* develop common data collection methods, quality assurance/quality control (QA/QC) procedures, and data and metadata formats;
* attach metadata to all camera video or images;
* have personnel to maintain and calibrate each camera;
* make camera coordinates available for research personnel

Additionally, SECOORA should continue partnering with private, local, and state entities who operate webcams and explore ingesting and storing web cam imagery from this wide range of sources in the SECOORA WebCAT portal. Private industry groups have expertise in the deployment and video footage processing and archival. This expertise can be leveraged for continued research and application development with SECOORA PIs. SECOORA can work with partners to standardize practices and storage approaches in order to use the data to meet stakeholder needs.

### 3.2.6 Unmanned Aircraft Systems

**Background**

Unmanned aircraft systems (UASs) are commonly referred to as drones. UAS technology is rapidly advancing and payloads can include red, green, and blue (RGB) cameras and video, lidar, infrared sensors, and multispectral and hyperspectral sensors. In some cases, UASs can collect geospatial data faster, at higher resolution, and at lower cost than conventional platforms (e.g., aircraft, ships, satellites). UASs may also provide a lower impact alternative to traditional data collections methods, such as marsh transects which may harm sensitive species and habitats. Operation of UASs and processing of UAS data for scientific data collection is a complex undertaking requiring specific skills, knowledge of best practices, and an understanding of the limitations of UAS platforms, sensors, and data[[23]](#footnote-23). SECOORA supports the use of UASs to help address management needs, including monitoring shoreline change, storm damage assessments, elevation mapping, monitoring HAB in the nearshore, and marine species monitoring/counts.

**Current Capacity**

SECOORA members operate UASs for their specific research needs. Academic and government partners are operating drones in a range of sizes and capabilities. For example, researchers at NC State University have a fleet of UASs; one of which is the EagleRay XAV, an experimental USA that can transition operations from the air to underwater16. Drone data has not yet been incorporated into the SECOORA data management system.

**Build out plan**

In 2020, SECOORA, NOAA SECART, Duke University, and NOAA Office for Coastal Management are sponsoring a Drone workshop. This event will highlight regulatory oversight for UAS use, on-board sensor selection, operational policies and procedures (e.g. mission planning and execution), data analysis workflows, and software and data management requirements. Next steps for routinely utilizing drones for coastal and ocean observing in the region have yet to be determined.

### 3.2.7 Emerging Technologies

NOTE: Staff will be working on this section during the review period. It will include the following items. Please list any additional ideas so we can build out this section.

* eDNA
* OMICS
* AI/Machine Learning

## 3.3 Modeling

**Background**

A central goal of SECOORA is to develop, in partnership with end users, models that will support decision-making. SECOORA is implementing a robust strategy to acquire atmospheric and oceanographic observations from HFR, coastal and oceanographic stations, and autonomous vehicles. Despite SECOORA's robust strategy, we cannot collect observations everywhere so we support predictive models to fill the gaps. The observations are being linked to predictive models essential to improving ocean circulation modeling and other marine environment conditions. SECOORA supports a numerical modeling framework (sub-regional to regional scale models) to provide validated modeling products for managers and other users.

**Current Capacity**

From 2016-2021 SECOORA funded modeling efforts by NCSU and the USF. NCSU has developed the [Coupled Northwest Atlantic Prediction System](http://oomg.meas.ncsu.edu/index.php/product/coupled-northwest-atlantic-prediction-system-cnaps/) (CNAPS). CNAPS is an advanced regional marine environment assessment and prediction capability for SECOORA by using a suite of fully coupled ocean-atmosphere-wave-marine ecosystem prediction models informed and updated continuously through data assimilation. This system is designed to predict coastal ocean conditions over the entire SECOORA footprint with a high degree of scientific accuracy and provide detailed sub-regional information though relocatable grid refinement and nesting technology, and update and transmit such information to stakeholders in a timely and clear fashion.

The West Florida Coastal Ocean Model (WFCOM) model was developed, and is maintained, by the USF College of Marine Science. WFCOM, with focus on the eastern Gulf of Mexico, downscales from the deep ocean, across the continental shelf and into the major estuaries by nesting the Finite Volume Coastal Ocean Model (FVCOM) in the HYbrid Coordinate Ocean Model (HYCOM). WFCOM provides daily, automated ocean circulation nowcast/forecasts from just west of the Mississippi River Delta to just south of the Florida Keys. The model simulations include real time river inflows versus climatology and are quantitatively gauged against in situ observations for the region. By further nesting a higher resolution version of FVCOM in WFCOM, the Tampa Bay Coastal Ocean Model (TBCOM) provides daily automated nowcast/forecasts for Tampa Bay, Sarasota Bay, the Intracoastal Waterway, and all of the inlets connecting these with the Gulf of Mexico. Both WFCOM and TBCOM in collaboration with the FL FWC, Florida Wildlife Research Institute provide short-term (4.5-day) HAB trajectory forecasts for both the surface and the near bottom waters that are used by local, state and public entities for HAB tracking.

SECOORA and Fathorm Science were also funded through a NOAA Coastal and Ocean Modeling Testbed award. This modeling project focuses on the land-sea boundary where multiscale, two-way model coupling methodology which accurately describes interactions between terrestrial hydrology (i.e. river input, precipitation, and run-off) and the coastal ocean is needed. The goal of this project is to develop an integrated coastal water predictive capability to deliver new water intelligence products and information vital for decision making both during high-impact events, such as hurricanes and nor’easters, and for routine water management for transportation and agriculture. The project team will address this need by developing a prototype prediction system that couples coastal ocean predictions with NOAA’s National Water Model (NWM) forecasts.

**Build out plan**

SECOORA plans to continue advancing modeling/prediction sub-systems that may include: regional-scale models of the atmosphere, ocean circulation, and surface waves nested within nationally-provided models; nesting of very high-resolution inner shelf and estuarine models; the coupling of dynamical models (coastal mesoscale meteorological, coastal circulation, coastal hydrological, and coastal wave models); the coupling of application models (e.g., ecosystem and sediment transport); and the utilization of advanced numerical modeling methods (e.g., data assimilation schemes, non-hydrostatic models, and unstructured and adaptive grids). The modeling framework will encompass both comprehensive baroclinic operational circulation models (essential for water column transport, storm prediction, water quality and marine ecosystem models) and integrated barotropic operational tide, storm surge, and wave models (essential for coastal inundation estimates). Model applications in Observing System Simulation Experiment (OSSE) provides a scientific and cost-effective approach to testing of different designs of the new observing subcomponents before their instruments are actually built or deployed. Regional-scale OSSE capability should be developed to help guide the new design or refinement of existing RA observing network.

## 3.4 Data Management and Communications

**Background**

A coherent strategy that enables the integration of marine data streams across disciplines, institutions, time scales, and geographic regions is central to the success of IOOS and other regional, national, and international ocean and coastal observing systems. One of the primary goals of DMAC is making discovery, access, and understanding of ocean, coastal, and Great Lakes information easy for the public (IOOS [website](https://ioos.noaa.gov/project/dmac/)). To this end, SECOORA has a mandate to collect, organize, and provide access to regional coastal and oceanographic data. These data need to have QA/QC standards, metadata, the data must be easily understandable, electronically accessible, and well organized to allow researchers, policy makers, industry, and the general public to make well-informed decisions. To satisfy this mandate, SECOORA supports a web-based data portal for the entire region providing ocean, coastal, and relevant interior environmental data and information products.

**Current Capacity**

SECOORA is [certified as a RICE](https://secoora.org/all-ioos-regional-associations-are-now-noaa-certified/), which recognizes that SECOORA meets federal standards and opens doors for greater collaborations. SECOORA’s data management expertise and capacity provides a solid foundation to support [member](http://secoora.org/about/membership/) and stakeholder efforts – private, local, state or federal – to develop products and services for decision makers. SECOORA is implementing recommended and standard practices as defined by the IOOS DMAC committee. This will ensure that data collected by SECOORA and member entities and distributed on the SECOORA web portal are managed according to best practices identified by IOOS. This also ensures that appropriate metadata and QA/QC practices are followed and that the data are of a known quality to the end user. These practices apply to data standards, metadata and data formats, transport and access, archival, information technology security, QA/QC, and are described in the [NOAA IOOS Program Office DMAC White Paper (v1.0)](http://www.iooc.us/wp-content/uploads/2011/04/Guidance-for-Implementation-of-the-IOOS-DMAC-Subsystem.pdf), These DMAC requirements apply to all IOOS RAs and other IOOS grant recipients who are providing data to IOOS.

SECOORA has a detailed [DMAC Plan](https://secoora.org/wp-content/uploads/2018/09/SECOORA-Data-Management-and-Communications-DMAC-Plan.pdf) for a period of five years from 2016-2021. Any data collection or product development that is proposed to SECOORA should consider all of the documented requirements outlined in the DMAC plan. Additionally, each SECOORA funded observing asset has its own data management [plan](http://secoora.org/wp-content/uploads/2017/11/APPENDIX-E-FundedDataStreamsInventory.pdf) that describes how the data is collected, data QA/QC procedures, and how the data are passed to the SECOORA data management system. These data management plans are updated by the observing asset operators annually.

**Build out plan (new or upgrades)**

Revise SECOORA [DMAC Plan](https://secoora.org/wp-content/uploads/2018/09/SECOORA-Data-Management-and-Communications-DMAC-Plan.pdf) to plan for 2021-2026.

## 3.5 Products

**Current Capacity**

The [SECOORA Data Portal](https://portal.secoora.org/) is a data exploration tool with a customized public web interface that allows scientists, managers, and the general public to discover and access coastal and ocean data. The Portal integrates datasets from many different sources. You can search or browse real-time conditions, operational and research forecasts, satellite observations, and other spatially referenced datasets that describe regional biological, chemical, and physical characteristics. The portal and associated [data catalog](https://portal.secoora.org/#search?type_group=all&page=1) are the key access points for SECOORA data.

SECOORA directly supports other data products that meet specific stakeholder needs, such as the [Marine Weather Portal (MWP)](http://mwp.secoora.org/?quality=Off&units=English&duration=3%20days&maps=nws_wwa,storm_tracks&legend=Off&forecast=Point&hti=&nhc=undefined&sst=&datum=MLLW&windPrediction=wind%20speed%20prediction&region=MWP&bbox=-104.85351562500001,17.5602465032949,-66.70898437500001,40.3130432088809&iframe=null&skipState=true) and [How’s the Beach](http://howsthebeach.org/). The MWP is designed specifically to meet the marine weather and forecasting needs of boaters, mariners, and beachgoers in the southeast. The project team closely collaborates with NWS Weather Forecast Offices from NC around to Texas. The goal is to provide 24/7 access to real-time ocean data, marine forecast and hazards products, and models.

How’s the Beach was developed to forecast Enterococci levels at popular swimming beaches. Enterococci are bacteria that normally inhabit the intestinal tract of humans and animals. Their presence in coastal waters can be an indicator of fecal pollution, which may come from stormwater runoff, pets and wildlife, and human sewage. The project team is working with environmental quality in NC, SC, and FL to identify beaches of concern and tailor forecasts based on specific conditions in the area to include meteorological, physical and biological data.

**Build out**

SECOORA continues to work with stakeholders to identify product development opportunities based on user needs and evaluating existing products to determine ongoing support and expanding geographic coverage. These products should fit within the identified SECOORA and IOOS focus areas and provide environmental and/or economic benefit to our stakeholders.

## 3.6 Outreach and Education

**Current Capacity**

SECOORA uses formal and informal communications to engage members, stakeholders and students. Outreach activities and products include an annual report, informational one-pagers, presentations at meetings, news stories, e-newsletters and content for the website and various social media outlets. SECOORA also spends considerable time meeting with legislators’ staff to educate them on the importance of coastal and ocean observing. Public engagement occurs through public forums, generally held twice a year around hot topics; annual member and stakeholder meetings; and regularly scheduled topical webinars. SECOORA also involves the public through campaigns to help fund buoys or vote on names for gliders. These efforts increase stakeholders’ awareness of observing activities and their relevance.

SECOORA sponsors two annual educational award opportunities. The Vembu Subramanian Ocean Scholars Award is a yearly award in remembrance of Vembu Subramanian, a former colleague who lived a life dedicated to uplifting others. The award is provided to one undergraduate student, graduate student, or early career professional to support their research and to provide travel support to present at a regional or national meeting or conference. The Data Challenge Award encourages applicants to use data from SECOORA combined with technologies, tools, videos, and creativity to visualize, analyze, and apply to tackle real-world questions or problems. SECOORA also supports other educational opportunities that include: science festivals, funding college level students through our PIs, taking undergraduates on field trips to learn more about the water quality and meteorological stations, and maintaining online educational resources.

**Build out plan (new or upgrades)**

To increase public awareness and interest in observing, SECOORA is assessing stakeholder needs for educational products as well as learning from successful outreach campaigns launched by other RAs in the IOOS network. Potential outreach and educational activities include:

* A Text-A-Buoy system, where users can get the latest ocean and weather information from their favorite buoy in the region.
* A video library of short, news style videos introducing topics of interest. These could focus on technology, data, tools, or articulating one of the focus area challenges.
* Work with partners to create new or enhance existing citizen science programs in the southeast.

SECOORA also plans to increase its focus on education through small awards for educators to update existing educational resources with a focus on observing data access, analysis and utilization. Also, neighboring RAs have developed teacher tool boxes full of lesson plans and required equipment. Leveraging this work will increase SECOORA’s educational offerings.

# List of Reviewers to Date

Draft plan sent to the following reviewers. Bold text indicates the reviewer provided feedback and it was integrated as appropriate.

Reviewers for RCOOS Plan 1st Draft

Jim Fourqurean

**Dennis Hanisak**

Dr. M.P. Crosby

**Dwayne Porter**

**Mitchell Roffer**

**Marcel Reichert**

**Roger Pugliese**

**Leslie Wickes**

**Joy Young**

**Stacey Buckelew**

**Kyle Wilcox**

Reviewers for RCOOS Plan 2nd Draft

SECOORA Board: **Rick DeVoe**

**SAFMC May 22, 2019 Meeting attendees** (Fisheries sub-focus area)

**Greg Dusek**

**Ruoying He**

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