



Southeast Coastal Ocean Observing Regional Association (SECOORA):  
Supporting Resilient Ecosystems, Communities and Economies

**Revised Scope of Work - Year 5**

TOPIC AREA 1: Continued Development of Regional Coastal Ocean Observing Systems  
AWARD TYPE: Cooperative Agreement  
PROJECT DURATION: June 1, 2016 – May 31, 2021

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Continued Development of Regional Coastal Ocean Observing Systems  
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## Project Summary

SECOORA is part of the US Integrated Ocean Observing System (IOOS®), and evolved out of several earlier sub-regional programs. Its footprint covers both the eastern Gulf of Mexico (GOM) and the South Atlantic, which are connected by the Loop Current- Florida Current- Gulf Stream continuum. Our members include a cross-section of regional interests from private industry, academia, non-governmental organizations and state and federal government. SECOORA integrates observations, models, data management and outreach to sustain and advance an end-to-end, regional coastal ocean observing system (RCOOS) responsive to societal needs. An information management system transforms and delivers value-added products and services consistent with priorities identified through stakeholder needs assessments. SECOORA emphasizes coordinating a multidisciplinary suite of coastal ocean observations with numerical models so that societally important phenomena may be described, understood and ultimately predicted via applications of best science practices. This work provides foundational observing, modeling and data management capabilities to predict and support preparedness to changing conditions, thus enabling resiliency.

US IOOS recognizes the importance of the coasts and ocean for their economic and ecosystem services values. SECOORA is a region where hurricane landfalls are prevalent and where consequences from oil and gas operations are significant. The region is also a major tourist destination and a commercial and recreational fishing hub. Through performance, SECOORA has demonstrated both a vision and set of accomplishments toward meeting the US IOOS goal of societally relevant applied science. SECOORA sustains observations consisting of High Frequency radars (HFR) for surface currents and waves; moored buoys for surface meteorology and water temperature, salinity and in some instances waves and currents; coastal stations for surface meteorology, water level and some water quality parameters; and, glider surveys, including bio-optical measurements, temperature, and salinity. These observational components inform and support models across multiple scales and applications. SECOORA-related modeling is used to explain phenomena in the region, including harmful algal blooms (HABs), storm surges, oil spill trajectories, fisheries recruitment, and beach water quality. SECOORA funding, therefore, supports an array of coastal ocean observations in addition to benefitting society across a spectrum of coastal ocean applications. This proposal seeks funding for the period from June 1, 2020– May 31, 2021.

Priorities for SECOORA are to sustain critical observing, data management and modeling activities, build upon successes with users, seek new leveraging opportunities and add new multidisciplinary RCOOS components. With the **\$4,151,154.67** funding, SECOORA specifically seeks to:

- Continue governance and management for the Regional Association (RA);
- Effectively engage users and other stakeholders to prioritize investments;
- Provide data management and communication (DMAC) infrastructure;
- Continue operation of the existing HFRs in the region, presently consisting of sites distributed from Cape Hatteras, NC to west Florida, and continue coordination with the national network;
- Continue operation of 21 *in situ* stations along the NC and SC coasts and the West Florida Shelf (WFS);
- Sustain modeling and other product efforts, including: 1) SECOORA-wide daily nowcast/forecast (N/F) system for currents, waves, and primary production, 2) statistical beach and shellfish water quality predictions; 3) a high resolution WFS circulation modeling system directly linking shelf seas with estuaries; 4) development of Python analysis tools for oceanographic services; and 5) support for several special projects.
- Address spatial observing gaps by: 1) continuing a glider observatory for the South Atlantic Bight (SAB) and 2) installing a coastal water quality and meteorological station in Charleston Harbor, SC.
- Via funding from the Fill the Gaps campaign:

- Collect acoustic data and develop machine learning processes to analyze the data; and create data products based on user need.
- Conduct Harmful Algal Bloom (HAB) data collection and analysis activities in the eastern Gulf of Mexico in conjunction with state agency, academic, and GCOOS partners to better predict HAB locations and trajectories.
- Provide O&M support for HFRs purchased through Year 3 Fill the Gaps funding and support for Florida Atlantic University (FAU) CODAR.
- Additional Observations Initiative: Via a competitive mini-proposal process, SECOORA will solicit proposals for:
  - Biological data management (Matt Howard biology funds)
  - Product development to fill gaps identified in SECOORA's RCOOS Strategic Operational plan.
  - Observing projects to fill gaps identified in SECOORA's RCOOS Strategic Operational plan.

SECOORA works closely with partners to achieve our goals. Below are contributors to this effort:

- Federal: NOAA National Weather Service (NWS), Ocean Acidification Program (OAP), National Estuarine Research Reserve System (NERRS), National Marine Fisheries Service (NMFS), National Ocean Service (NOS), National Centers for Coastal Ocean Science (NCCOS), and Gray's Reef National Marine Sanctuary (GRNMS), US Army Corps of Engineers (USACE), US Geological Survey (USGS).
- State: NC Department of Environment Quality (NCDEQ), SC Department of Health and Environmental Control (DHEC), GA Department of Natural Resources (DNR), FL Department of Environment Protection (FDEP), FL Fish and Wildlife Commission (FWC).
- NGOs: South Atlantic Fisheries Management Council (SAFMC), The Nature Conservancy.
- Emergency managers at Federal, state and local levels: NOAA NWS Weather Forecast Offices (WFOs), county emergency managers.

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## Introduction / Background

SECOORA seeks to leverage and augment existing observational, modeling, data management and product assets in the region; capitalizing on nearly two decades of RCOOS experience. This work provides foundational observing, modeling and data management capabilities to predict and support preparedness to changing conditions, thus enabling resiliency. RCOOS assets are used to characterize marine conditions, identify responses to stochastic events, validate existing and developing models, support decision-making and predict and verify short and long-term coastal ocean ecological and physical trends, all of which are necessary to achieve resilient ecosystems, communities and economies. SECOORA will continue engagement with regional partners and end users in the development and enhancement of products and services consistent with priorities identified by assessing their needs.

SECOORA's highest priorities are to continue supporting coastal ocean observing assets and models that provide real-time information to users, and generate long-term datasets necessary to detect, analyze and predict environmental and ecosystem changes in the SE coastal ocean. RCOOS assets to be supported with the funding include:

- Continue governance and management for the Regional Association (RA);
- Effectively engage users and other stakeholders to prioritize investments;
- Provide data management and communication (DMAC) infrastructure;
- Continue operation of the existing HFRs in the region, presently consisting of sites distributed from Cape Hatteras, NC to west Florida, and continue coordination with the national network;
- Continue operation of 21 *in situ* stations along the NC and SC coasts and the West Florida Shelf (WFS);
- Sustain modeling and other product efforts, including: 1) SECOORA-wide daily nowcast/forecast (N/F) system for currents, waves, and primary production, 2) statistical beach and shellfish water quality predictions; 3) a high resolution WFS circulation modeling system directly linking shelf seas with estuaries; 4) Develop Python data analysis tools for oceanographic services; and 5) support several special projects.
- Address spatial observing gaps by: 1) continuing a glider observatory for the South Atlantic Bight (SAB) and 2) installing a coastal water quality and meteorological station in Charleston Harbor, SC.
- Via funding from the Fill the Gaps campaign:
  - Collect acoustic data and develop machine learning processes to analyze the data; and create data products based on user need.
  - Conduct Harmful Algal Bloom (HAB) data collection and analysis activities on the west coast of Florida in conjunction with state agency, academic, and GCOOS partners to better predict HAB locations and trajectories.
  - Provide O&M support to HFRs purchased through Year 3 Fill the Gaps funding and support for Florida Atlantic University (FAU) CODAR.
- Additional Observations Initiative: Via a competitive mini-proposal process, SECOORA will solicit proposals for:
  - Biological data management (Matt Howard biology funds)
  - Product development to fill gaps identified in SECOORA's RCOOS Strategic Operational plan.
  - Observing projects to fill gaps identified in SECOORA's RCOOS Strategic Operational plan.

SECOORA's proposed activities are structured on IOOS system design and will continue SECOORA's contributions to national and regional components of IOOS (Appendix 1, Figure 1). The full-

time Executive Director coordinates RA governance and management with a Board comprised of representatives from multiple sectors. Stakeholders are regularly engaged through formal and informal mechanisms that inform SECOORA's priorities. Sixty-four percent of the proposal budget is devoted to observing infrastructure and operations that include HRF systems, gliders, and moored and coastal stations, some of which have been in continuous operation for almost 20 years. The investment in DMAC functions assures IOOS DMAC requirements and standards are met and incorporated into operations. The planned modeling activities are tightly linked to the observing subsystem and support a suite of integrated products and forecasts that address priority stakeholder needs for decision support tools. The proposal team, comprised of 22 principal investigators, represents a broad range of scientific and technical expertise and experience, and are fully capable of implementing the proposed objectives. SECOORA activities are highly leveraged and supported by many partners and stakeholders assuring the available federal funding will have maximum impact, both regionally and nationally. To summarize, the goals, objectives and supporting information of this proposal demonstrates SECOORA's alignment with the requirements of this funding opportunity as well as US IOOS program goals.

### **Connections to Users/Stakeholders and Benefits**

Regional and national stakeholders benefit from an enhanced and sustained RCOOS through easy access to data and information required for safety, commerce, public health and ecosystem management. Our major partners are identified in the Project Summary, and SECOORA also engages stakeholders through participation in regional and national teams, meetings, conferences, science fairs, newsletters, webinars and focused workshops as well as collaborations with the other RAs. Several students are directly supported as part of this proposal and many others are engaged by PIs, resulting in significant contribution to development of future scientists. Additionally, SECOORA actively participates in regional groups such as NOAA's Southeast and Caribbean Regional Team (SECART), the Southeast Disaster Recovery Partnership, the Southeast Ocean and Coastal Acidification Network (SOCAN), and the Florida Atlantic Coast Telemetry (FACT) Network which represent key stakeholder groups. Finally, a new interactive exhibit on fish acoustics is being installed in the Mote Aquarium, which has 350,000 visitors a year. This exhibit makes significant use of this SECOORA funded work. All of these collaborations further leverage SECOORA work and outreach.

### **Goals, Objectives, and Workplans**

With the **\$4,151,154.67** funding award, SECOORA will implement Goals 1 through 6 (as identified in our original proposal) to support SECOORA's base capacity and enhance the RCOOS. SECOORA will maintain existing infrastructure and, barring significant accidents or failures, will target system uptime of 85%. SECOORA is working with PIs to finish installing infrastructure (Goals 3 and 6) needed to fill long-standing gaps in our regional network. Objectives and tasks are also included in Table 3, Milestones. For each goal, the objectives, technical approach, data management, and product development are described.

#### **Goal 1: Continue SECOORA's region-wide governance and communication structure to engage users and stakeholders in coastal observing science.**

**Objective 1.1: Maintain governance and management for the RA and RCOOS.**

SECOORA's existing membership, governance, management, and communications enterprise uniquely positions SECOORA to coordinate the SE's coastal and ocean observing activities. SECOORA is a nonprofit membership organization with five full-time and one part-time staff who provide program development, data and information management, communications, accounting and other program coordination and management services. Hernandez leads the team and oversees SECOORA staff and operations. Dorton is the Deputy Director and DMAC coordinator. Wakely is the Communications Director,



leading outreach efforts including web and social media content development. Lee is the Chief Financial Officer. Bischof is the Director for the Southeast and Caribbean Disaster Resilience Partnership (not funded through the IOOS Year 5 proposal). Tracy Buchman is the part-time accountant. Additionally, contractors Trembl, Patroliia, and Galverino provide additional support.

SECOORA is governed by a Board of Directors and by-laws that stipulate both geographic and sector (i.e. academic, private, public/nonprofit) representation. Members represent a broad range of stakeholders and expertise with interests in the coast and ocean. SECOORA Board of Directors serve three-year terms, with approximately 1/3 of the Board elected annually by the membership. Board responsibilities include oversight of fiscal matters, and development of proposals. As of May 2017, SECOORA is a certified Regional Information Coordination Entity.

#### Objective 1.2: Engage users and other stakeholders to prioritize investments.

All SECOORA members and PIs represent their institutions, peers, and/or interest groups in SECOORA decision-making and serve as ambassadors for SECOORA and IOOS. RA staff, PIs, and partners actively engage in local, regional, and national stakeholder groups (e.g. NOAA SECART, Florida Atlantic Coast Telemetry (FACT) network, Integrated Tracking of Aquatic Animals in the GOM (iTAG), American Meteorological Society, Marine Technology Society, etc.), which help SECOORA establish priorities, identify leveraging opportunities, and reduce redundant efforts in our region.

SECOORA uses formal and informal communications to engage members and stakeholders. Communication activities and products include an annual report, informational one-pagers, and other print material, presentations at meetings, press releases, e-newsletters, a webinar series, and content for website and various social media outlets. Finally, SECOORA regularly surveys users and stakeholders regarding priorities and requirements. These efforts increase stakeholders' awareness of observing activities and their relevance.

#### Objective 1.3: Provide DMAC infrastructure to enable collaboration and decision-making.

SECOORA continues to enhance its DMAC subsystem to improve efficiency, coordination, and sustainability of the system as a whole, while maintaining all existing data partnerships. Axiom Data Science, LLC (Axiom) provides the DMAC infrastructure and management support for SECOORA. Dorton coordinates the DMAC activities with the Axiom project team (Wilcox, team lead). Axiom provides comprehensive technical solutions to meet data management needs, while using open source software resources, high performance computing clusters, and interoperability services. This framework leverages systems, capabilities and lessons learned from ongoing DMAC efforts for the Alaska Ocean Observing System, the Central and Northern California Ocean Observing System, and US IOOS. The resulting DMAC system increases data access and allows SECOORA to develop new capabilities and tools to meet a variety of user needs.

SECOORA is committed to implementing the standards and guidelines set forth by the US IOOS DMAC subsystem. SECOORA is a certified Regional Integration Information Coordination Entity (RICE) and our data management system meets federal standards. Programmatic and data management information required for RICE certification can be found on the following website:

<https://secoora.org/certification/>. The [SECOORA data management plan](#) outlines the DMAC goals and objectives, the DMAC system architecture and structure, data ingestion methods, and quality control procedures. Through Axiom, SECOORA has access to large computational and storage resources. This allows processing and integration of larger and more complex datasets into the DMAC system and better positions SECOORA to respond to user requests for high performance computing, such as oil spill trajectory modeling

Direct data access for all SECOORA funded and other regional data are provided through the SECOORA data portal and catalog and a variety of services including OPeNDAP, WCS, WFS, WMS and in common formats including CSV, MATLAB, and JSON. These services are provided by a combination of THREDDS, ERDDAP, and GeoServer. The SECOORA data catalog allows users to search and query the entire DMAC infrastructure and allows users to find all SECOORA data resources (e.g., buoy, HFR, glider, ship, satellite or model), and immediately be presented with metadata and the ability to extract and visualize the data. Axiom will continue working with stakeholders, through web portal feedback and virtual and in-person workshops, to refine the SECOORA data portal and catalog based on user requirements.

**Simplified Coordination and Integration:** Currently, the SECOORA funded *in situ* data providers submit their data to NDBC independently. In Year 5, NDBC will test an ERDDAP service to pull SECOORA provider data into the NDBC system. This will allow for a streamlined submission process for SECOORA data providers as they will only have to provide data to SECOORA.

## **Goal 2: Continue existing core observation investments in the region.**

**Objective 2.1: Maintain HFRs distributed throughout the region.**

**HFR arrays** currently maintained and operated in the region (Appendix 1, Figures 2 and 3) map surface currents at high spatial and temporal resolution across the coastal ocean, outer shelf, and slope. These arrays include Coastal Ocean Dynamics Applications Radar (CODAR) and Wellen Radars (WERA). Five SECOORA members (UNCCH, USC, UGA SkIO, UM, USF) operate priority HFRs distributed through the region. An additional priority radar will be deployed in North Key Largo (NKL) by UM in fall 2020 (the original deployment in 2019 was delayed by permitting and then COVID). The permitting and NEPA requirements for this HFR are complete. Expansion of the HFR network, made possible with Year 3 Fill the Gaps funding, is covered in section 6.4.

All of the HFR provide surface current data in near real time to SECOORA and to the HFR National Network at Scripps Institute of Oceanography (Scripps) and Rutgers through the US IOOS-sponsored HFR Surface Current Mapping Initiative. WERA installations also provide surface wave measurements as a function of position and time over a subset of the domain. Operational and quality metrics are routinely checked. This includes assessment of daily variations in coverage and uptime using metrics such as database latency, range of coverage, and number of solutions as implemented by the National HFR Network.

**Objective 2.2: Maintain 21 *in situ* stations along the Carolina and WFS coasts.**

Strategically placed *in situ* arrays address marine user observational needs and provide critical data for SECOORA and partner modeling efforts. Two institutions (UNCW and USF) will continue to operate and maintain 21 *in situ* stations along the coasts of the Carolinas and WFS (Appendix 1, Figure 2), several of which have been operational for almost 20 years. USF will sustain four offshore real-time meteorological/oceanographic stations (three buoys, one tower); two non-real-time subsurface stations; and five real-time meteorological and water level stations, some equipped with water temperature and salinity sensors. The Clam Bayou coastal station, maintained in partnership with YSI/Xylem, measures water quality variables<sup>1</sup> and is used as a USF teaching site. UNCW will sustain nine real-time meteorological/oceanographic stations located offshore of NC and SC and one non real-time station located in Onslow Bay, NC. Two of the real-time stations include WaveRider buoys co-located with a meteorological buoy and these are operated and maintained in partnership with USACE and CDIP at Scripps. One station includes a small co-located SeaView Systems SVS-603 inertial wave sensor. All of these *in situ* stations augment a number of existing real-time observing sites operated by federal and state agencies. Table 1 provides the list of variables measured by the *in-situ* assets.



The buoy and coastal station designs are robust, with both the Carolinas and WFS arrays surviving prior hurricanes. Moorings and coastal stations are generally deployed for one year with intermediate servicing as needed. This annual schedule requires instrument calibration and repairs, expendables replacement, ship-time, engineering support, and data management support. USF WFS network data telemetry is via the NOAA Geostationary Operational Environmental Satellite (GOES) network and UNCW uses Iridium and cell phone services. UNCW and USF address data management and US IOOS data certification requirements such as QARTOD implementation, data delivery, operational system alerts and system performance monitoring. All data feeds into the SECOORA DMAC system.

Table 1. Moored and Coastal Stations

	Wind Spd, Gust, Dir.	Air Temp	Barometric Pressure	Rel. Humidity	SW/LW Radiation	Water Temp	Currents	Waves	Cond/ Salinity	Water Level	Fish Acoustic Sensors
<b>UNCW Moorings</b>											
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			
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
<b>USF Moorings</b>											
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			
<b>USF Coastal Stations</b>											
Shell Point	X	X	X							X	
Aripeka	X	X	X							X	
Fred Howard State Park	X	X	X							X	
Clam Bayou	X	X	X			X			X	X	
Big Carlos Pass	X	X	X							X	X

\*Non real-time station

### Objective 2.3: Maintain the sensors on NOAA GRNMS buoy (NDBC 41008).

SECOORA continues to support ocean acidification and water quality monitoring at the Gray's Reef National Marine Sanctuary (GRNMS) as part of NOAA's international effort to quantify the effects of ocean acidification. The sensors deployed include pCO<sub>2</sub>, pH, dissolved oxygen (DO), turbidity, chlorophyll, salinity and water temperature. UGA is responsible for the maintenance of the sensors on the buoy. Partners for this project include NOAA PMEL, NDBC and the USCG. During Year 5, the project team will continue development of a through hull sensor mounting system that began in Year 4. The goal is to access the sensors from the topside of the buoy instead of SCUBA divers accessing the sensors from beneath the buoy. NDBC and PMEL engineers are collaborating on the redesign effort. The primary Year 5 outcome is to complete the deployment design, test the system, and if all are in agreement, install the deployment tubes on the GRNMS buoy.

### **Goal 3: Begin to address geographic gaps in observations.**

Although the SE region benefits from a number of legacy subregional observing programs, major gaps remain in the spatial extent of the observatory. SECOORA will continue investment in the glider observatory to continue to build-out the RCOOS in order to meet priority stakeholder needs.

#### **Objective 3.1: Maintain a regional glider observatory in the SAB.**

Glider data provides regional 4-D information on temperature, salinity and density structure, and oxygen/turbidity/CDOM/chl-a concentrations. Four gliders from the pool of instruments owed/operated by SECOORA, SkIO, and USF will be deployed from locations in Florida and Georgia on shelf- and shelf-edge sampling missions with northward trajectories. These mapping missions serve as a baseline of operations, providing spatial coverage for data assimilation and fisheries applications along the southeast Atlantic coast. Glider data are used by GRNMS, NOAA OAR, U.S. Navy, NASA, and state agencies.

The SECOORA glider Franklin, purchased in Year 3, is based at SkIO and has improved operational capacity for the region. During Year 5, USF and SkIO will conduct 3 “baseline” glider missions in the SAB. Gliders are deployed off Cape Canaveral and coastal Georgia to conduct shelf survey missions, with operations approximately between the 20m and 50m isobaths. The USF glider will use Gulf Stream currents to survey the shelf edge and Gulf Stream along the entire SAB before recovery off NC. At least one of these missions will be timed with hurricane season to maximize the impact of near-surface heat content information for tropical weather prediction.

Glider operations integrate *in situ* and HFR observations, satellite imagery, and regional model predictions to optimize glider tracks. The Ocean Tracking Network (OTN) has made several Vemco Mobile Transceivers (VMTs) available for mounting on observatory gliders. Acoustic data will be shared with the fisheries research community (Ocean Tracking Network, FACT, GRNMS).

#### **Objective 3.2: Install a new coastal water quality station in Charleston Harbor.**

SC DNR worked with USACE and USCG to install a piling-based water quality station in 2017; however, the station was destroyed due to a ship collision in 2018. In Year 4, SECOORA worked with SC DNR to move the station to Fort Johnson, on the opposite side of Charleston Harbor (in relation to the piling deployment site). The Fort Johnson location is outside of the shipping channel and should be safer than the originally deployment location. The instrumentation deployed on the station includes a YSI EXO2, data logger, and communications equipment. The YSI EXO2 measures water temperature, conductivity/salinity, dissolved oxygen, pH, turbidity, chlorophyll fluorescence, and water depth.

### **Goal 4: Continue delivery of operational model forecasts and products to serve priority users.**

A central goal of SECOORA is to develop, in partnership with end users, operational products that will support decision-making. Along with ongoing delivery of the regional model forecasts that fill temporal and spatial gaps in observations, SECOORA will develop and enhance products in collaboration with our partners to support their operational needs. Product delivery plans are included in Table 2 and geographic scope is shown in Appendix 1, Figure 2.

#### **Objective 4.1: Enhance and operate a Coupled Marine Environmental Assessment and Prediction System.**

SECOORA supports an advanced regional marine environment assessment and prediction capabilities through a suite of fully coupled ocean-atmosphere-wave-marine ecosystem prediction models informed and updated continuously through data assimilation. This system is used to predict coastal ocean conditions over the entire SECOORA footprint with a high degree of accuracy and provides detailed sub-regional information through relocatable grid refinement and nesting technology. SECOORA project team members

at NCSU will build off of previous year advances to: 1) sustain NCSU's ocean circulation nowcast/forecast modeling system to generate regional nowcasts and forecasts of ocean circulation, waves, marine weather on a routine basis and use google analytics to track their usage; 2) refine advanced ocean data assimilation (DA) schemes into the prediction system; 3) start running DA nowcast/forecast system in pseudo-operational mode; 4) continue model skill assessment for marine environmental variables through appropriate comparisons with independent (non-assimilated) observations (e.g., mooring observations); 5) continue refining low trophic level marine ecosystem predictions, perform a suite of hindcast experiments for detailed performance evaluation; 6) conduct outreach activities by giving a series of SECOORA public webinars describing different aspects of modeling system (e.g., hindcast and data assimilation) and modeling functionality (e.g., trajectory prediction); and, 7) finalize the 2007-2017 long-term hindcast results and make this data archive available for SECOORA. When doing so, we will work with Axiom closely to make sure the model output is searchable in the SECOORA data catalog with "user friendly" Interface and language.

#### Objective 4.2: Operate the West Florida Shelf (WFS) ocean model.

The WFS model focuses on the GOM and provides daily, automated ocean circulation N/F by nesting Finite Volume Coastal Ocean Model (FVCOM) into HYbrid Coordinate Ocean Model (HYCOM). The model simulations are quantitatively gauged against *in situ* observations<sup>2</sup> from west of the Mississippi River Delta to south of the Florida Keys with real time river inflows versus climatology. This West Florida Coastal Ocean Model (WFCOM), with resolution beginning at 4km along the open boundary, includes the various estuaries, telescoping down to 150m in both Tampa Bay and Charlotte Harbor. WFCOM provides the tracking capability for WFS HABs (in collaboration with FWC). The Tampa Bay Coastal Ocean Model (TBCOM) is nested in WFCOM. TBCOM provides resolution as fine as 20 m and includes Tampa Bay, Sarasota Bay, the Intra-Coastal Waterway and all of the inlets connecting these water bodies with the adjacent GOM. Both WFCOM and TBCOM continue to provide critical HAB trajectory forecasts to local and state agencies as part of a collaboration with the Florida Wildlife Research Institute. Model simulations are accessed from NOAA GNOME through the NOAA GOODS using THREDDS data server capabilities developed with the assistance of SECOORA DMAC. These multidisciplinary applications will continue to develop new products via stakeholder outreach.

#### Objective 4.3: Provide an early warning system for swimming beach and shellfish harvesting waters.

Bacterial pollution in the coastal areas is an issue for swimming beaches and shellfish harvest areas. The [How's the Beach](#) project team will maintain and enhance existing decision support tools available for Long Bay, SC Charleston Harbor, SC and Folly Beach, SC, Sarasota and Manatee county beaches of FL, Chesapeake Bay, MD, and Kill Devil Hills, NC. The project team will: 1) Expand and enhance the existing decision support tool that couples rainfall, water temperature, wind, tide, and salinity data (provided by the NWS, ocean observing systems, and state programs) with direct measures of Enterococcus concentrations to provide daily nowcasts of bacteria concentration for locations in Florida, expanding on the Florida-wide network of coastal locations operated by Mote Marine Laboratory; 2) Investigate the expansion of a shellfish management decision support tool previously created to predict fecal coliform levels for shellfish harvest areas in Folly Beach and Murrells Inlet, SC for potential use in NC, 3) Continue working with the City of Folly Beach, SC to provide site-specific water quality data and nowcasts for swimming beaches and shellfish harvesting waters of the Folly River; and, 4) Re-design the How's the Beach website and app; and, 5) Continue to develop and distribute community and stakeholder outreach and education materials.

#### Objective 4.4: Optimize and enhance the SECOORA Marine Weather Portal (MWP).

The MWP (<http://mwp.secoora.org>) provides real-time data, hurricane watch/warning information and

hurricane tracks, and NWS forecasts.

#### Objective 4.5: Develop Python data analysis tools for oceanographic services

Data analysis tools for oceanographic services are being developed by Filipe Fernandes. The primary Year 5 objectives are: 1) Demonstrate value of IOOS data and services; 2) Monitor operation of the DMAC enterprise; 3) Ensure DMAC standards and best practices are up-to-date and DMAC data and services are relevant to potential user communities; 4) Improve the operation of the IOOS GitHub organization and software libraries therein.

#### Objective 4.6: Implement special projects.

Hollings Scholarship: SECOORA works with the IOOS office and our members to host Hollings Scholars. The scholars work with a SECOORA member and learn all facets of an ocean observing program; from the science to the at-sea operations. Scholarship funding will be provided to the institution that hosts the Hollings scholar and support activities above and beyond the Hollings funding to assure that the scholar has a well-rounded experience.

Radiowave Operators Working Group (ROWG) meeting support: SECOORA partner, ECU's Coastal Studies Institute (CSI), is planning the next ROWG meeting. CSI will host a virtual meeting in October/November 2020 as a kick-off event and to identify the planning team for in-person meeting, to be held in Manteo, NC, in late Spring 2021.

2020 Hurricane Glider Deployments: SECOORA partner UGA/SkIO will lead the 2020 Hurricane Glider deployments. Two missions are planned for the SAB portion of SECOORA's domain during hurricane season, June 1 through October 31, 2020. Each mission will be 4-6 weeks in duration and the gliders will be operated on the shelf out to the shoreward edge of the Gulf Stream. All data will be submitted to the IOOS Glider Data Assembly Center where it can be shared through the Global Telecommunications Gateway where data can then be assimilated by ocean models, including those operated by NOAA, the U.S. Navy, SECOORA, and other regional association partners.

Support for Navy Gliders (deployments/recoveries): SECOORA will coordinate with glider team members for Navy glider deployments and recoveries. The NC Outer Banks, and SECOORA partner ECU CSI, will be the northern extent for the glider recoveries. Other recoveries will be coordinated between SECOORA, UGA/SkIO, and UNC-Chapel Hill. Additionally, SkIO will provide glider piloting support for Navy gliders during the 2020 Hurricane season.

Biology/Estuarine Soundscape Observatory Network in the Southeast: The SC Estuarine Soundscape Observatory Network is a scalable, long-term soundscape characterization (i.e. passive acoustics) coastal marine observatory. The project team, based at USC – Beaufort, will use a cloud-based platform for collaboration and develop data syntheses, visualizations, and products to ensure the data are relevant for management applications. Soundscape data are used to monitor animal behavior at multiple levels of biological complexity (i.e., from snapping shrimp to fish to marine mammals) and at time scales ranging from minutes to years. The soundscape approach provides the ability to 'eavesdrop' on key behaviors of marine animals that can change rapidly or gradually in response to environmental changes and human impacts. This project will advance our understanding of the use of passive acoustic technologies in combination with environmental data and traditional biodiversity surveys as well as processes for analyzing and handling these 'big data' using cloud-based collaborative tools.

### FACT Acoustic Telemetry Network and Georgia DNR Coastal Receiver Array

SECOORA provides support for the FACT Animal Telemetry Network (ATN) by hosting their website and sponsorship of the FACT semiannual meetings. SECOORA will continue ongoing efforts to increase observations in our region and incorporate more biological data into our data management system by working with: 1) Fisheries Data Solutions (Joy Young, FACT data wrangler) which leads communications, data acquisition efforts, and training for the FACT network; and, 2) the Georgia Department of Natural Resources which maintain an existing acoustic receiver array along the Georgia coastline.

Regional Ocean Data: SECOORA will host a competitive opportunity to increase data sharing in the southeast that focuses on ocean and coastal geospatial data required by states and regional organizations to address management issues. The scope of this opportunity is broad, enabling project teams to focus on data collection, data formatting, or data sharing systems. Projects will be regional in scope or contribute to a regional-scale enterprise and include measurable engagement with stakeholders. Details on this opportunity are available: <https://secoora.org/request-for-proposals-to-enhance-regional-ocean-data-sharing/>

CETACEAN Project: The goal of this project is to develop a Gulf of Mexico platform (Compilation of Environmental, Threats, and Animal Data for Cetacean Population Health Analyses: CETACEAN) that provides user-friendly access to datasets that would assist the Trustees, restoration planners, responders, and conservation managers to assess the health of cetacean stocks and the stressors that threaten them over time and space. SECOORA and Axiom will work with partners to develop this platform based on recommendations from the CETACEAN Steering and Executive Committees. The objective for this year is to work with stakeholders to define requirements and build a functional prototype system.

Increasing awareness of ocean acidification in the Southeast: The Southeast Ocean and Coastal Acidification Network (SOCAN) was established in 2014 through a partnership between NOAA's Ocean Acidification Program (OAP) and SECOORA. SOCAN will: 1) Convene an Executive Team to identify new ideas to revitalize the working groups; 2) Facilitate stakeholder and scientific working group meetings; 3) Host virtual town halls for stakeholders across the SE; 4) Develop long-term goals and objectives to evaluate accomplishments over the last 5 years; 5) Lead proposals to fund SOCAN capacity building and coordinate scientific proposal efforts; 6) Publish newsletters and continue website updates, as needed.

Additional Observations Initiative: Via a competitive mini-proposal process, SECOORA will solicit proposals for:

- Biological data management (Matt Howard biology funds)
- Product development to fill gaps identified in SECOORA's RCOOS Strategic Operational plan.
- Observing projects to fill gaps identified in SECOORA's RCOOS Strategic Operational plan.

## **Goal 5: Initiate new operational products to meet additional user needs**

### **Objective 5.1 Implement a HAB forecasting system for the WFS.**

The scope and scale of recent Harmful Algal Bloom (HAB) events have highlighted significant gaps in the ability to detect, respond to, and mitigate *Karenia brevis* blooms and their impacts. Efforts to improve HAB observations and forecasting are ever evolving to integrate more comprehensive, interdisciplinary data streams and models. In the Gulf of Mexico, a suite of observational and modeling approaches are necessary to advance our knowledge of *K. brevis* bloom dynamics. This toxic dinoflagellate forms high biomass blooms nearly annually on the WFS. Currently, 4-day predictions of HAB transport (USF/FWRI)



and respiratory irritation (NOAA/FWRI) are issued; however, an overarching goal is to generate longer term forecasts (1-2 weeks to seasonal) to improve management and mitigation of the impacts of these blooms. The following tasks will be undertaken: 1) Two, 2-4-week glider missions will be conducted annually. The gliders will be outfitted with a Solid Phase Absorption Toxin Tracking (SPATT) sampler to provide a cumulative assessment of brevetoxins over the duration of the deployment; 2) Ship-based field surveys will be expanded spatially along the WFS; 3) Satellite remote sensing image processing will refine algorithms used for tracking red tide using ocean color; and, 4) In situ physical data from moorings, HFR, and gliders will be coupled with ecological modeling to evaluate *K. brevis* bloom dynamics.

Objectives 5.2 - 5.3: Funds are not available for these objectives

### **Goal 6: Continue building critical elements of the observing system by adding biogeochemical and marine sound sensors, and HFRs**

Objectives 6.1-6.2: Funds are not available for these objectives.

#### **Objective 6.3: Implement a regional ocean sound observing initiative to characterize and measure sources of sound production and establish acoustic baseline levels.**

Acoustic data previously collected from known or suspected spawning sites of important commercial reef fishes (black grouper and red grouper) are being used by the research team from Mote Marine Laboratory to create a library of labeled sounds from known and unknown sources. Hundreds of acoustic files from different habitat types are being classified for this project. Because fish make species-specific sounds, machine learning algorithms are being developed and trained to identify sounds produced by known species from these acoustic files. Sounds of unknown biological sources and anthropogenic sources (boats, ships, drilling, hydroacoustic surveys for oil/gas) can also be classified for automatic detection. Advances in machine learning for processing acoustic wav files are being shared with SECOORA/Axiom and will be made available to the IOOS Data Management and Communications community. Additionally, a new interactive exhibit on fish acoustics is being installed in the Mote Aquarium, which has 350,000 visitors a year. This exhibit makes significant use of this SECOORA funded work.

#### **Objective 6.4: Install and operate new HFRs**

With Year 3 Fill the Gaps funding, SECOORA PIs are expanding HFR coverage along the U.S. East Coast. HFRs are being deployed and maintained as follows (see Appendix 1, Figure 3):

- CSI is redeploying an HFR on Ocracoke, NC after the installed WERA was destroyed by Hurricane Dorian in 2019.
- SkIO has approvals for WERA HFR installation at Cape Canaveral National Seashore and Kennedy Space Center. NEPA compliance paperwork has been submitted to the IOOS office for both locations. Anticipated installation is Fall/Winter 2020. USC has identified Myrtle Beach State Park as the location for the final “Fill the Gaps” HFR to be installed.
- FIT is in the process of siting two HFR on the east coast of Florida. One at Treasure Shores Park (Indian River County) and the other at Patrick Air Force Base. These two WERA were purchased by SECOORA and will be operated by FIT. NEPA environmental compliance paperwork has been submitted to the IOOS office for Treasure Shores Park and Patrick Air Force Base. The IOOS office and SECOORA are working with Patrick Air Force Base on NEPA process concerns. Installation is anticipated for Fall/Winter 2020 for both locations.
- USC has identified Myrtle Beach State Park as the location for the final “Fill the Gaps” HFR to be installed. This WERA was purchased by SECOORA and will be operated by USC.
- Florida Atlantic University will maintain the HAUL CODAR located near Miami, FL.



## User Benefits and Product Delivery

SECOORA’s approach to developing end-user applications begins with identification and engagement of local, regional, and national partners who have articulated a need that can be addressed through coastal ocean observations or applications. Partners are engaged to develop specifications that guide the product and service development effort. End-users participate in the design, development, and validation of such products. All observational data, maps, models and other coastal and ocean observing information and products are easily accessed via the SECOORA website and data portal, and announced via social media outlets, and e-newsletters.

Our product delivery plans are tailored to meet user needs and provide important benefits. All SECOORA generated data is delivered through a variety of web services and webpages, and benefits include support for NOAA NWS marine weather forecasts and marine hazards advisories, USCG SAR operations, and USACE modeling and sediment management applications. Data and data products also support ecosystem management and fisheries stakeholders. Resource managers, recreational anglers and commercial fishers will benefit from improved efficiency in catching target species and less fuel usage. SECOORA’s rich data repository allows stakeholders to access historic data. Examples of uses of this archived data include: 1) informing managers and the public of the paths and intensities of past tropical storm systems and coastal water levels associated with these events; 2) visualizing when and where polluted water could move into coastal areas; and 3) providing data to inform climate vulnerability assessments. Table 2 outlines additional delivery plans for products funded by this award and Figures 2 and 3 in Appendix 1 show observing locations and areal extent of products included in this proposal.

Table 2. Product Delivery Plans and Users

Goal and Objectives		Delivery Plans and Users:
<b>4 Continue delivery of operational model forecasts and products to serve priority users</b>		
4.1	Coupled Marine Environmental Assessment and Prediction System	N/F model results served via web services. Stakeholder groups include USCG, NOAA NMFS, NOAA OR&R, Bureau of Ocean Energy Management, NC DENR, SC DNR, GA DNR, FL FWC, NWS and SAFMC.
4.2	West Florida Coastal Ocean Model	N/F model results served via web services. Stakeholder groups include USCG, FL FWC/FWRI, recreational mariners, NOAA Office of Response and Recovery.
4.3	Advisory System for Beach and Shellfish Waters	Smartphone apps and web services. Products include forecasting products for beach and shellfish water quality. User groups include resource managers, public health officials, local government officials and representatives of potentially vulnerable populations.

## Summary

The proposed \$4,151,154.67 in funding will support the core RCOOS framework which provides:

- Regional coverage over a geographically large and diverse section of the US coastal ocean;
- Stakeholder engagement relative to RCOOS components, including moorings and coastal stations, HFR, and model data on which citizens, decision-makers, and scientists have come to depend;
- Cross-state and intra-regional cooperation;
- Maintenance of critical in-water infrastructure, data flow from offshore to the web, and proven technical capabilities and experience in operational coastal ocean observing; and,
- Expansion of SECOORA’s biological data holdings, products, and ocean observatory through competitive mini-proposal opportunities.

As a mature RA, SECOORA must balance maintenance, filling important gaps in observations, and creating new connections to users through thoughtful expansion of products and services to build-out the

RCOOS. The proposed activities will deliver stakeholders the ongoing observations and modeling products they rely on, and new integrative project components that leverage existing SECOORA efforts (observations, models and DMAC) to create new and exciting opportunities.

## Milestones and Cost Proposal

Table 3. Goals, Objectives/Milestones and Schedule

Goals and Objectives	2020-2021 (Quarter)			
	1	2	3	4
<b>Goal 1: Continue SECOORA's region-wide governance and communication to manage RA and engage users and stakeholders in coastal observing science</b>				
Maintain governance and management for the RA and RCOOS	x	x	x	x
Engage users and other stakeholders to prioritize investments	x	x	x	x
Maintain and operate DMAC	x	x	x	x
<b>Goal 2: Maintain existing core observation investments in the region</b>				
Maintain 15 HFR distributed throughout the region	x	x	x	x
Maintain 21 <i>in situ</i> stations along the Carolina and WFS coasts	x	x	x	x
Maintain the Sensors on NOAA GRNMS Buoy	x	x	x	x
<b>Goal 3: Begin to address geographic gaps in observations</b>				
Establish and maintain a regional glider observatory in the SAB	x	x	x	x
Operate a new coastal water quality and metrological station in Charleston Harbor, SC	x	x	x	x
<b>Goal 4: Continue delivery of operational model forecasts and products to serve priority users</b>				
Enhance and operate a Coupled Marine Environmental Assessment and Prediction System for the SE	x	x	x	x
Operate the West Florida Shelf Ocean Model	x	x	x	x
Provide an Early Warning System for Swimming Beach and Shellfish Harvesting Waters	x	x	x	x
Python Data Analysis Tools for Oceanographic Services	x	x	x	x
Special Projects	x	x	x	x
<b>Goal 5: Initiate new operational products to meet additional user needs</b>				
Implement a HAB Forecasting system for the WFS	x	x	x	x
<b>Goal 6: Continue building critical elements of the observing system by adding biogeochemical and marine sound sensors, and HFRs</b>				
Acoustic sensor data analysis, machine learning processing techniques	x	x	x	x
Work with SECOORA PIs to expand HFR footprint within the region	x	x	x	x

**Cost Proposal.** Summarized costs of this 2020-2021 effort are in Table 4. \$4,151,154.67 support Goals 1 through 6. All components of this effort are leveraged; however, it is difficult to provide exact dollar values on contributions. Most of the observing assets were purchased with non-IOOS funds, and ongoing maintenance is subsidized by other grants. The same is true of most of the modeling work, i.e. models were initially developed with other funds. Five percent of the SECOORA Executive Director's salary is supported from member dues, as is a portion of her travel. Finally, a number of PIs are working at very subsidized rates or at no cost.

Table 4. Costs by Objective, PI and Institution

Obj.	PI/Contractor	Inst.	YR 5
<b>Goal 1</b>	<b>Governance, Outreach &amp; DMAC</b>		
1.1-2	Hernandez (Governance & Outreach)	SECOORA	507,028
1.3	Wilcox (DMAC base, HABS, and Soundscape)	Axiom	219,716

	<b>Goal 1 Sub-total</b>		<b>726,744</b>
<b>Goal 2</b>	<b>Maintain existing core observations</b>		
2.1	<b>High Frequency Radars</b>		
	Shay	UM	123,800
	Voulgaris	USC	91,000
	Edwards	UGA/SkIO	110,000
	Seim	UNCCH	56,021
	Muglia	CSI	67,779
	Weisberg	USF	156,000
	Hernandez (Operating funds for FIT & additional HFR)		75,400
	<b>Sub-total HFR</b>		<b>680,000</b>
2.2	<b>Moored &amp; Coastal</b>		
	Leonard (Carolinas)	UNCW	372,300
	Weisberg (WFS Moor.)	USF	255,000
	Luther (WFS Coastal)	USF	51,000
2.3	<b>GRNMS Buoy</b>		
	Noakes (Gray's Reef)	UGA	25,697
	<b>Sub-total Moored &amp; Coastal &amp; GRNMS</b>		<b>703,997</b>
	<b>Goal 2 Sub-total</b>		<b>1,383,997</b>
<b>Goal 3</b>	<b>Address geographic gaps in observations</b>		
3.1	<b>Gliders</b>		
	Edwards	UGA/SkIO	20,000
	Zhang	GA Tech	38,000
	Seim	UNCCH	29,000
	Lembke	USC	50,000
	Hernandez (Holdback for expenses)		16,000
	<b>Sub-total Gliders</b>		<b>153,000</b>
	<b>Goal 3 Sub-total</b>		<b>153,000</b>
<b>Goal 4</b>	<b>Continue delivery of operational models and products</b>		
4.1	He (Regional Model)	NCSU	132,600
4.2	Weisberg (WFCOM)	USF (Funding included in Objective 2.2)	
4.3	Porter (Beach/Shellfish)	USC	102,000
4.5	Fernandes (Python Tools)	Brazil	77,880
4.6	Special Projects (Hollings, Reg. Ocean Data, Mini-proposal, Navy glider, Hurricane glider, Soundscape, ROWG, ATN, SOCAN)	Various	1,175,715.67
	<b>Goal 4 Sub-total</b>		<b>1,488,195.67</b>
<b>Goal 5</b>	<b>Initiate new operational products to meet additional user needs</b>		
5.1	Hubbard (HABS)	FWRI	200,000
	<b>Goal 5 Sub-total</b>		<b>200,000</b>
<b>Goal 6</b>	<b>Continue building critical elements of the observing system by adding biogeochemical and marine sound sensors, and HFRs</b>		
6.3	Locascio (Acoustics)	Mote Marine Lab	190,000
6.4	Baxley (HFR)	FAU	9,218
	<b>Goal 6 Sub-total</b>		<b>199,218</b>
	<b>GRAND TOTAL</b>		<b>\$4,151,154.67</b>

## Appendices

### Appendix 1: Maps and Figures

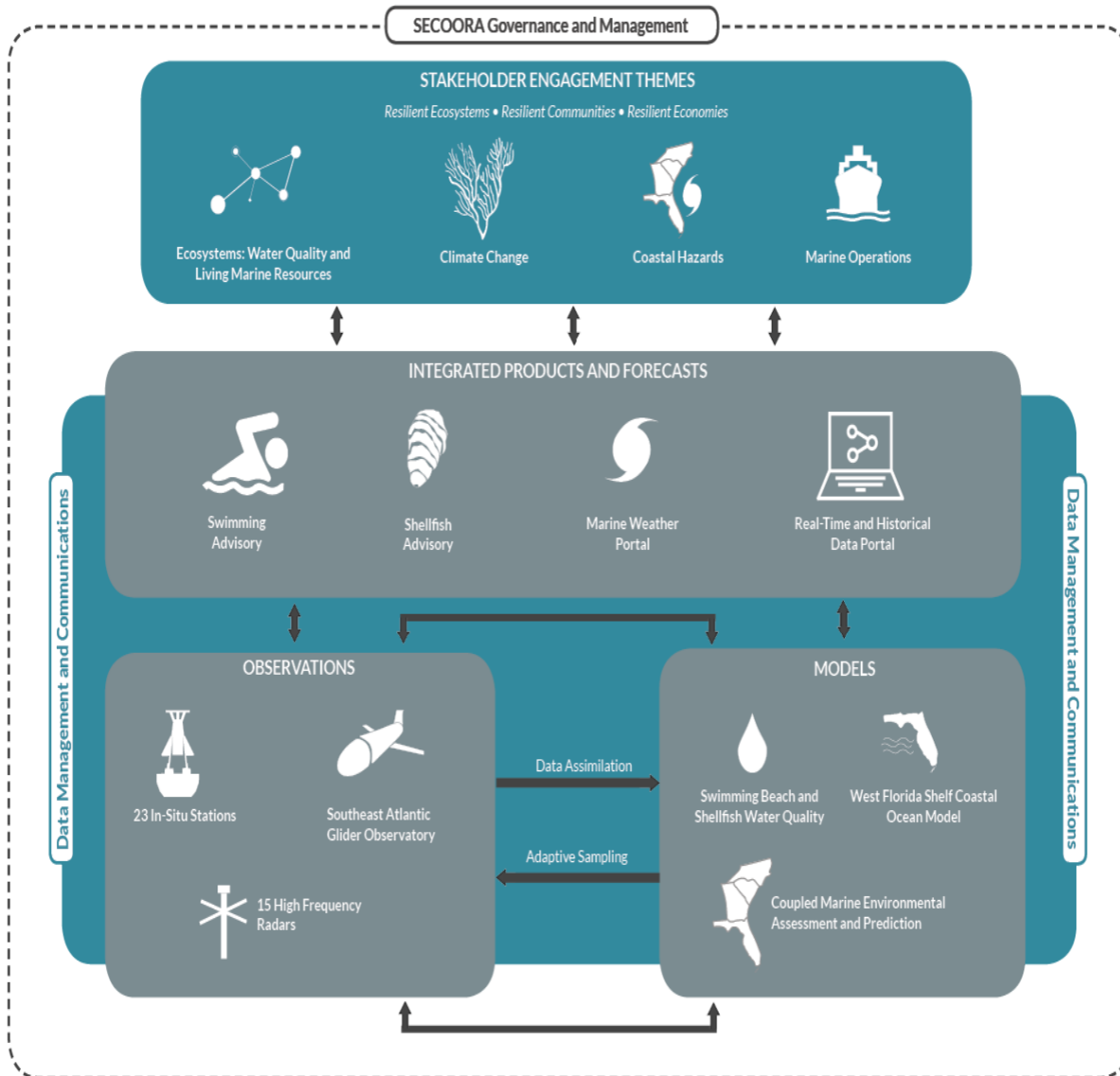


Figure 1: This schematic is a visual representation of the overall proposal. With oversight from Governance and Management, and in collaboration with PIs, Data Management and Communications successfully manages and integrates data for a suite of tools and applications. Each component is linked to priority stakeholder needs under four theme areas.

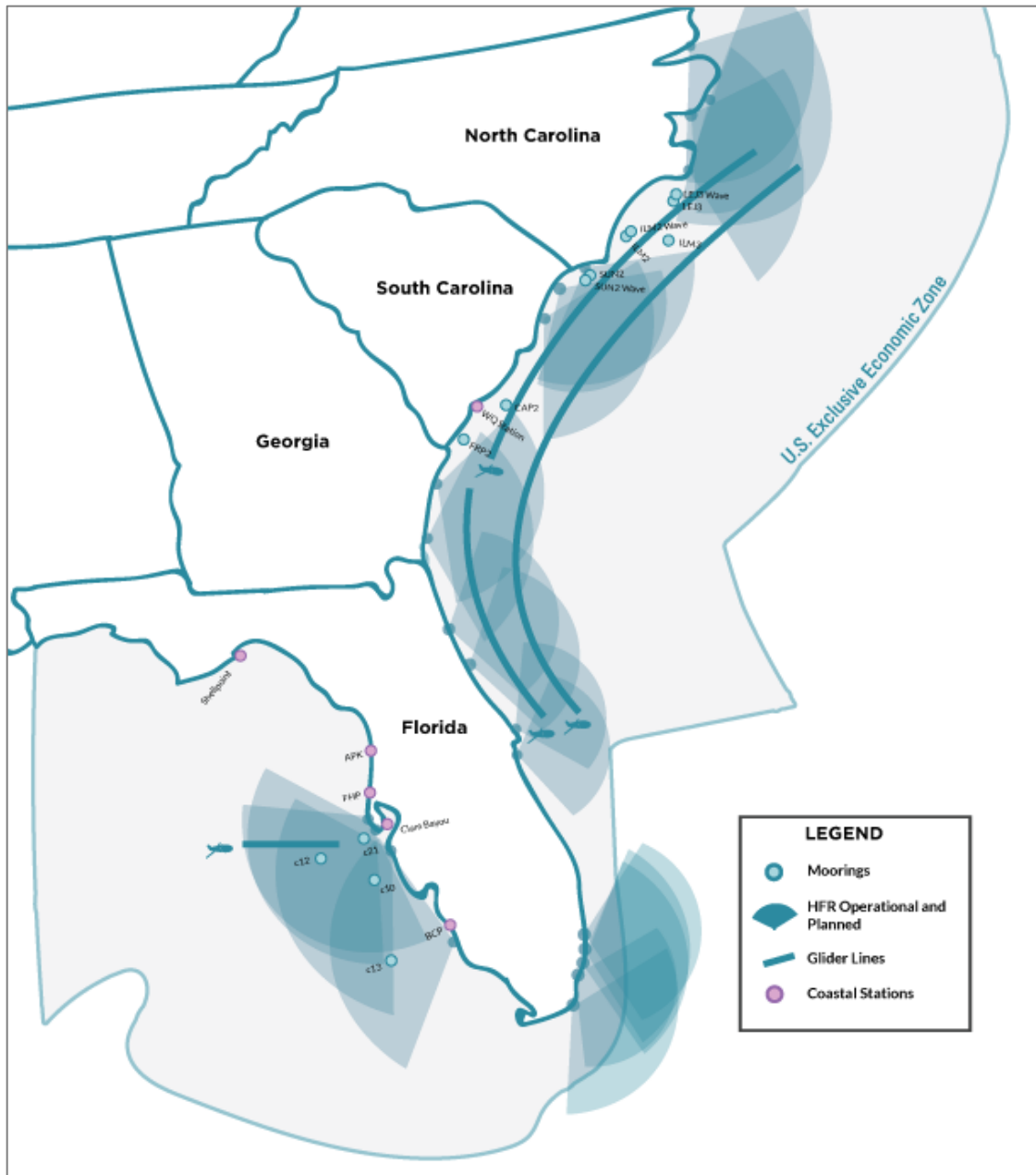


Figure 2: Map of existing SECOORA observations (buoys, coastal and HFR station locations) and glider sampling locations.

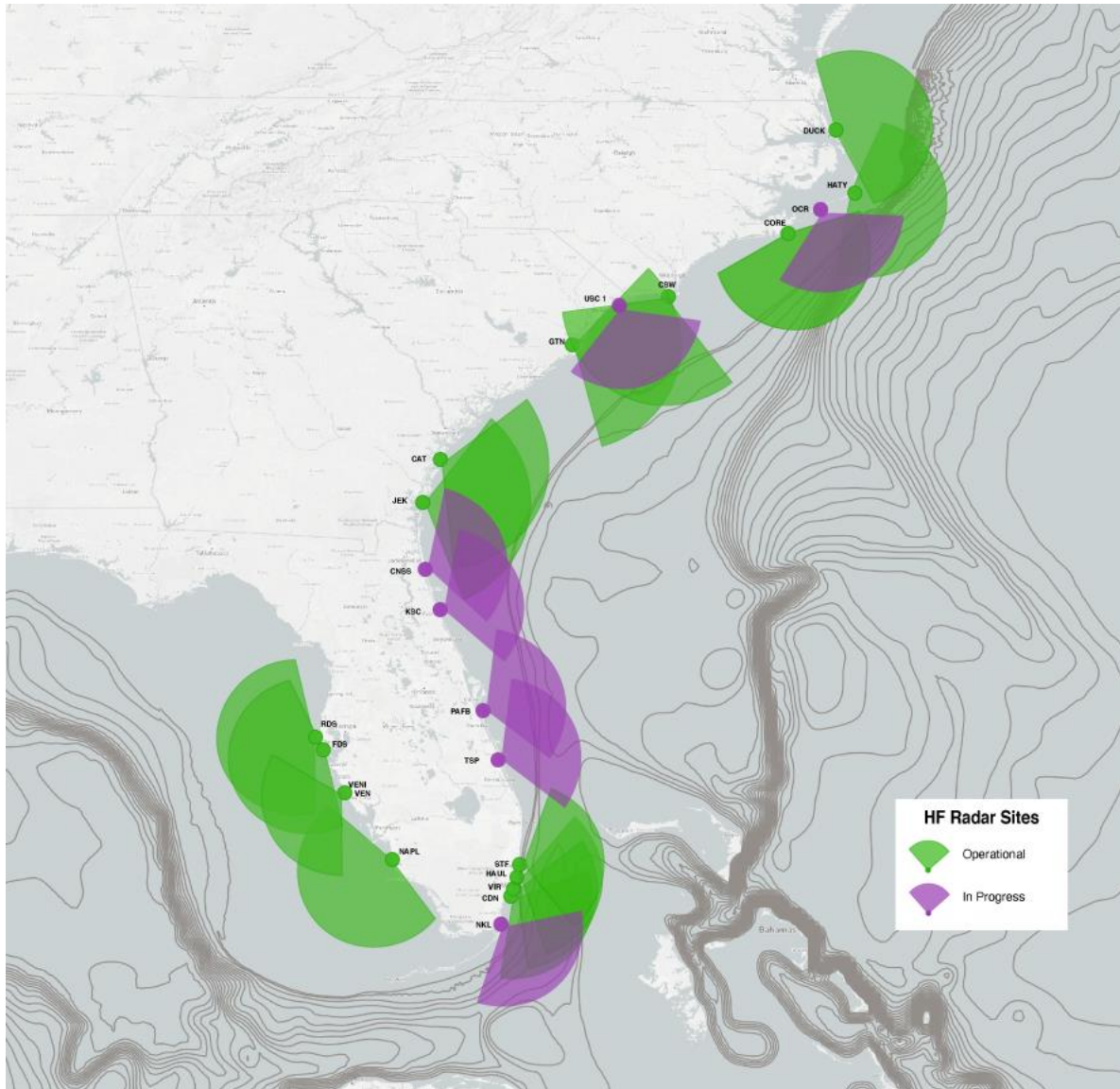


Figure 3. Currently deployed SECOORA and FAU HFR are highlighted in Green. The HFR (in purple) are in the permitting process of permitting with two exceptions. OCR in NC is a previously established site that was destroyed during Hurricane Dorian. This site should be redeployed winter 2020. NKL, in south FL has already undergone the permitting and NEPA requirements and is being deployed.



## Appendix 2: References

- <sup>1</sup> Clam Bayou Station, <http://comps.marine.usf.edu/index?view=station&id=CLB>
- <sup>2</sup> Zheng, L. & Weisberg, R.H. (2012). Modeling the West Florida Coastal Ocean by Downscaling from the Deep Ocean, Across the Continental Shelf and into the Estuaries, *Ocean Modeling*, 48 (2012), 10-29.