

Southeast Coastal Ocean Observing Regional Association (SECOORA)

IMPLEMENTATION OF REGIONAL INTEGRATED OCEAN OBSERVING SYSTEMS:
SUPPORT OF RCOOS DEVELOPMENT IN SECOORA

This grant proposal is submitted to the NOAA Coastal Service Center in response to the Funding Opportunity Title: FY 2008 Implementation of Regional Integrated Ocean Observing Systems Funding Opportunity Number: NOS-CSC-2008-2001072

Principal Investigator:


Capt. Parker Lumpkin (ret.)
Interim Executive Director, SECOORA
S.C. Sea Grant Consortium
113 Calhoun Street
Charleston, SC 29401
P: 843-953-6497
F: 843-953-2080
E: parker.lumpkin@scseagrant.org

Institutional Representative:


M. Richard DeVoe
Chair, SECOORA Board of Directors
Executive Director, S.C. Sea Grant Consortium
287 Meeting Street
Charleston, SC 29401
P: 843-953-2078
F: 843-953-2080
E: rick.devoe@scseagrant.org

Fiscal Representative:


Elaine L. Knight
Assistant Director
S.C. Sea Grant Consortium
287 Meeting Street
Charleston, SC 29401
P: 843-953-2078
F: 843-953-2080
E: elaine.knight@scseagrant.org

Year 1 - August 1, 2008 to July 31, 2009 – Funding Request = \$3,448,412

Year 2 - August 1, 2009 to July 31, 2010 – Funding Request = \$3,459,700

Year 3 - August 1, 2010 to July 31, 2011 – Funding Request = \$3,476,595

Submitted – December 3, 2007

Project Title: Implementation of Regional Integrated Ocean Observing Systems: Support of RCOOS Development in SECOORA

Recipient Institution: South Carolina Sea Grant Consortium, Charleston, SC

**Principal Investigator
and Primary Contact:**

Capt. Parker Lumpkin (ret.)
SECOORA interim Executive Director
South Carolina Sea Grant Consortium
287 Meeting Street
Charleston, SC 29401
email: elaine.knight@scseagrant.org
ph: (843) 953-2078 fax: (843) 953.2080

Co-PIs: See Appendix C for a full list of project partners and co-principal investigators as well as their CVs.

Project Statement

Public safety, maritime commerce, and the health of the coastal marine environment are primary issues facing the coastal United States. The Southeast Coastal Ocean Observing Regional Association (SECOORA) proposes to establish an integrated, end-to-end regional coastal ocean observing system (RCOOS) addressing these overarching themes as they pertain to North Carolina, South Carolina, Georgia, and Florida. The work proposed herein will consolidate COOS assets and products in the Carolinas with COOS efforts in Georgia and Florida to establish a user-driven observing system that spans the entire SECOORA footprint. The foundation of the SECOORA RCOOS will build initially upon six primary elements included in this proposal, but also others underway in the region supported by FY07 awards. Four of the elements are designed to assess in a systematic way the state of the regional coastal marine environment, and two of which are meant to build cohesion and flexibility into the entire system. All six elements address the above motivational themes. The proposed efforts, broadly speaking, include:

1. Maintenance and development of existing observing assets and consolidation of existing sub-regional observing systems,

2. Construction of an integrated and embedded modeling system that capitalizes on the data streams generated by (1),
3. Development of ecosystems models, that exploit the data streams generated by the first two tasks, targeted at predicting the characteristics of regionally important fish stocks,
4. Establishment of a data management system designed to disseminate, rapidly, high quality products to general users of the information from the preceding three efforts as well as those under development by SECOORA FY07 awardees,
5. Establishment of a systems engineering based structure to the observing system architecture that enables the seamless interoperability of the first four tasks, and
6. Integration of an end-user community into the fabric of SECOORA to insure the responsiveness of the above five tasks and future observing system development to regional needs.

Practical means by which SECOORA will initially serve the above themes include planned cooperation and data sharing with the NOAA National Weather Service (NWS), and involvement of the observational and modeling activities with the Search and Rescue Operations of the US Coast Guard (USCG). These efforts are reflected in the PI list of this proposal and address the motivations of public safety and maritime commerce. SECOORA will also address ecosystems-based management through involvement in the Southeast Data Assessment and Review exercise, again an interest reflected in the make-up of the SECOORA PI list. These activities expand upon existing cooperative efforts between SECOORA and the US Army Corps of Engineers (ASACE), NWS, and several State agencies to develop inundation, wave, and water quality products. In recognition of the evolving nature of national and regional ocean observing programs and the needs of end-user communities, the systems engineering-based architecture underpinning SECOORA and the central role of regional stakeholders within SECOORA will generate feedback into present and future RCOOS development, thereby guaranteeing continuing regional relevance of the observing system.

PROJECT DESCRIPTION

1.0 GOALS AND OBJECTIVES

Overview. The Southeast Coastal Ocean Observing Regional Association (SECOORA; <http://secoora.org>) proposes to implement an integrated regional coastal ocean observing system (RCOOS) which encompasses NC, SC, GA, and FL and develop targeted, stakeholder-driven regional applications. SECOORA incorporated as a legal entity in August 2007 and has addressed a major concern voiced in reviews of its FY07 RCOOS submission by selecting, through an open process, all participants in its RCOOS program. This FY08 RCOOS program is formulated to support established but currently unfunded projects and leverage ongoing, previously funded projects in the southeast to the extent consistent with SECOORA goals (as defined in its Business Plan; <http://secoora.org/meetings/spring-2007/business-plan/>) and recognizing the budget and time frame constraints of the funding opportunity. Key objectives of SECOORA's RCOOS development effort includes the establishment of mechanisms that will enable ongoing evaluation of the adequacy of the SE RCOOS design, further development of performance metrics for system components, and assurances that the evolution of the SE RCOOS is coordinated with the national IOOS program and complements RCOOS development in adjacent regions. SECOORA will promote an RCOOS that is responsive to specific users needs, promotes efficient utilization of resources, incorporates new data providers and new technologies, and provides ongoing assessment of the system.

The goals for each of the primary elements for SE RCOOS development are listed below, along with specific objectives for each.

Goal 1: Maintain and enhance the regional observing system in support of existing assets and provide *in situ* real-time data to stakeholders in the areas of Search and Rescue, Fisheries, and Coastal Hazards (Years 1, 2 and 3).

Objectives:

- Sustain and enhance and enhance observing assets in the SECOORA domain, including buoys, offshore towers and coastal stations established through prior sub-regional and regional efforts and not supported through FY07 awards. SECOORA will focus on assets in GA and FL to complement FY07-funded programs in the Carolinas, thereby providing expanded coverage for the entire region.
- Merge data streams from all four states to provide a region-wide data network of supported observing stations for the SE RCOOS.
- Maintain four high frequency radar (HF radar) surface current measurement systems including long-range CODAR (West Florida and North Carolina) and WERA (southeast Florida and at the Georgia/South Carolina border), estimate their accuracy, establish reliable error-bars for stakeholder specific applications, and provide the data in near-real time to identified user groups such as USCG, local fisherman, modelers, and emergency planners.

Goal 2: Advance SECOORA sub-regional to regional scale physical models, including coupled atmosphere, surface wave, and ocean circulation models, to support SECOORA applications in Search and Rescue, Fisheries, and Coastal Hazards (Years 1, 2 and 3).

Objectives:

- Sustain and enhance Nowcast/Forecast systems currently used in the region.
- Establish accuracies of observed and simulated data through appropriate comparisons and intercomparisons.
- Coordinate with USCG and MACOORA to enable surface current field input to the USCG Search and Rescue Operations (SAROPS) application.
- Establish a regional-scale model for the SECOORA domain, including capabilities for ensemble modeling.

- Link the Circulation Modeling and Ecosystem Modeling efforts that are supported in this proposal.

Goal 3: Implement ecosystem models describing the variability of nutrient and lower trophic levels (phytoplankton and zooplankton) and their links to target fish species in the SECOORA region in support of fisheries management decisions (Years 1, 2 and 3).

Objectives

- Develop and enhance ecosystem models that will quantify the role of abiotic (e.g., circulation and hydrography) and biotic (e.g., feeding environment) effects on the growth, survival, and recruitment of target species in the SECOORA region.
- Link Ecosystem Modeling with Circulation Modeling efforts at ecologically relevant space and time scales to characterize the flow field in the SECOORA region relevant to the transport (dispersal and retention) of target species from offshore spawning locations to near-shore nursery areas.
- Develop nowcasting capabilities of oceanographic and ecosystem properties to provide relevant information for use in the South-East Data, Assessment, and Review (SEDAR) recruitment forecast process (<http://www.sefsc.noaa.gov/sedar>).

Goal 4: Provide timely delivery of high-quality data and products, promote regional data integration and ensure that the SECOORA data management practices are consistent with national DMAC guidance (Years 1, 2 and 3):

Objectives

- Optimize and ensure access to near-real-time, delayed mode, and model output data via a web browser that supports the thematic priorities of fisheries/ecosystem management, hazards, and search and rescue.
- Exploit resource-oriented and service-oriented architectures to develop, test, and apply a range of applications, including (1) data and information integration services, (2) discovery services for

producing metadata, (3) visualization/browse services, (4) access and parsing services, and (5) QA/QC services.

- Integrate DMAC advances with other SECOORA data management activities, such as the Ocean Data Partnership and Carolinas RCOOS.

Goal 5: Establish a System Engineering methodology for the SECOORA RCOOS design and implementation to ensure system efficiency, responsiveness to user needs, and inter-regional interoperability (Years 1, 2 and 3).

- Establish a System Engineering process that ensures end-user needs, operational aspects (e.g., cost of maintenance), and sustainability (e.g., technology upgrades) are taken into full consideration at the very outset of architecture definition, design, and development.
- Develop methodologies for the RA design and implementation that maximizes use of existing assets, maximizes interoperability, ensures cost effectiveness, and ensures long term sustainability.

Goal 6: Engage national and regional partners, stakeholders, and end-users in the RCOOS Design (Years 1, 2 and 3).

- Work with the SECOORA Stakeholder Council to determine where real-time data gaps exist within the region and prioritize these needs. Work with SECOORA member programs to identify creative solutions that enable these data gaps to be filled, as best as possible.
- Ensure ecosystem and fisheries modeling efforts are coordinated with the stakeholder groups they are serving.
- Ensure Circulation Modeling efforts are coordinated with USCG, GCOOS and MACOORA.
- Regularly meet with MACOORA and GCOOS representatives to seek opportunities to leverage funds across the regions and share lessons learned and outreach initiatives.

- Work with COSEE-SE and COSEE GoM to develop standards-based curricula based on fisheries/ecosystem management, coastal hazards, and search and rescue activities.

2. Background

The Integrated Ocean Observing System (IOOS), proposed by OceanUS and the National Ocean Research Leadership Council, is envisioned as a coordinated network of observations, data management, and analyses/models that systematically acquires and disseminates information on past, present, and future states of the oceans. The coastal component of IOOS, covering the nation's EEZ, is to be a national backbone of federal assets embedded in nested regional observing systems and designed to assess and predict the effects of weather, climate, and human activities on coastal ocean ecosystems. Observations encompass physical, chemical, and biological aspects of coastal waters; data management includes multiple paths of data delivery via direct links to specific users; and circulation, wave, and ecological forecasting supports national and regional management needs in public safety, national security, energy, fisheries, and commerce.

The SECOORA domain includes Florida, Georgia, South Carolina and North Carolina, and overlaps with GCOOS to the west and MACOORA to the north. The coastal waters within SECOORA are linked by the Loop Current-Florida Current-Gulf Stream System (LC-FC-GS). This provides strong scientific justification for SECOORA's RCOOS boundaries (Fig. 1, Appendix A) and clear linkages to GCOOS since the Loop Current is the outflow condition from the Gulf of Mexico and the inflow condition for the Florida Current that forms the core of the Gulf Stream. SECOORA took a major step forward during summer 2007 by electing a Board of Directors, incorporating, and establishing a committee structure to run the RA and its RCOOS (Fig. 2, Appendix A). SECOORA includes several sub-regional COOS Programs, which differ in history, funding sources, and capabilities. These include SEACOOS, FLCOOS, Caro-COOPS, and CORMP. Leveraging of these regional COOS programs has been significant.

There is substantial on-going engagement of federal and state agencies in the SE. Many of the existing regional observing sites are designated National Data Buoy Center (NDBC) stations, and procedures have been established for data flow into the NDBC network (including web display of the real-time observations). There has been cooperative technology assessments (e.g. Seim and Edwards 2007) and NDBC, NOS, USACE, and state agency representatives have regularly participated in regional COOS workshops. In 2007, CORMP and Caro-COOPS partnered with the USACE and received NOAA funding for the Carolinas RCOOS, a user-driven sub-regional COOS designed with a wave and water quality focus. Many of the NC and SC assets will be funded in 2008 with that support. We propose herein to expand collaborative efforts by incorporating a broader spectrum of SECOORA members and other providers, including the: Carolinas RCOOS, FLCOOS, USACE, NOAA (NWS, NDBC, NMFS, and NERRS), USCG, South Atlantic Fisheries Management Council (SAFMC), SEACOOS partners, and non-federal agencies. The inclusion of programs beyond those previously supported by NOAA COTS and ONR, coupled with resources leveraged through the NOAA FY07 projects, will allow for a cost-effective increase in SECOORA-wide observational capabilities, enhanced spatial and time-intensive monitoring, coupling of physical and environmental data for application development, and additional information for model validation and benchmarking. This proposal will merge regional observing system assets into a single coordinated, interoperable RCOOS for the SE aimed at supporting end-to-end systems and advancing the societal goals of the national IOOS.

The considerable investments in program development over the past five or so years have established essential foundation elements for a successful RCOOS. Within the SECOORA domain, there has been significant augmentation of federal observing assets, not only in terms of the number of sites (the "dots on the map"; Fig. 3, Appendix A), but in the range of variables measured, the availability of sub-surface as well as surface observations, and the broad-field measurements of surface currents provided by HF-radar. A diverse array of *in situ* observing platforms has fostered the development of considerable

expertise in deploying, maintaining and evaluating *in situ* observing system components (instruments and associated data acquisition, mechanical, power, and communications systems), and shore-based HF-radar systems. The satellite data download and processing capabilities of the USF Institute for Marine Remote Sensing (IMaRS), have been utilized in the SEACOOS program to deliver real-time SST and ocean color products to the regional data portal, including optimally interpolated (OI) "cloud-free" products from the USF Ocean Circulation group. Information Management infrastructure for aggregation, normalization, and multi-format display of in situ, HF radar and satellite remote sensing data has been developed. A number of modeling systems have been operated in quasi-operational mode. And the basic elements for a regional outreach and education network have been put into place.

3. Audiences

This proposed effort leverages projects funded through the NOAA FY07 FFO, including development of a new coupled wave and current operational model (Luetlich et al.), regional storm surge and inundation model test bed (Sheng et al.), improved nearshore wave and rip current forecasts (Leonard et al.), and Year 1 funding to the SECOORA RCOOS (Seim et al.) for support of HF radar and information management activities. The audiences who will benefit immediately from the proposed RCOOS include:

NOAA National Weather Service Weather Forecast Offices (WFOs): The nine WFOs within the SECOORA domain will use RCOOS information and products to generate forecasts for coastal waters, the surf zone, and rip currents. These offices rely on the observations provided by the regional and sub-regional COOS within SECOORA that fill gaps in National Backbone coverage. WFO forecasts are used by emergency managers, media, and the general public for planning purposes and to support and promote safe transportation across the coastal waters. The coastal observation platforms supported by the SECOORA RCOOS will be integral to the development of the 2007 NOAA-funded Southeast Marine Weather Portal and directly benefit the NWS constituents (beach-goers, surfers, SCUBA clubs and businesses, commercial and recreation mariners, Port Authorities, and emergency management officials).

Regional Fisheries Management Community (e.g., NOAA National Marine Fisheries Service, Regional Fisheries Management Councils, state fisheries resource managers): Recognizing the dominant role that environmental factors play in stock dynamics, the South Atlantic Fisheries Management Council (SAFMC), as part of the evolution to ecosystem-based management, is encouraging the National Marine Fisheries Service (NMFS) to work towards improving stock assessments with environmentally explicit recruitment indices. Refined stock assessments will provide better information for conservation, management, and improvement of fisheries resources within SECOORA. The proposed ecological modeling effort directly involves SAFMC, NMFS SE, and state resource managers in its development and is linked to RCOOS development through the theme of coastal ocean circulation and hydrography, and, in the case of Fisheries, how these processes impact the structure of marine habitats.

US Coast Guard (USCG) Search and Rescue Operations: (SAROPS): The USCG is working closely with MACOORA to establish the capability to ingest observed and forecast surface currents through the National HF radar server network. Coordinated by Co-PI Art Allen of the USCG, SECOORA will transfer technologies developed in the Mid-Atlantic Bight to the SE for making observed surface currents, Short Term 24-hr Surface Current Predictions (developed by University of Connecticut; Ullman et al. 2006), and dynamical forecasts available for use in the USCG Search and Planning tool, SAROPS. A number of SECOORA assets (the EFSIS and UNC-CH ADCIRC models, and observed velocity fields from COMPS, CORMP, UNC CODAR, and RSMAS East Florida Shelf HF Radar; Turner et al. 2007) have already been identified as viable inputs to SAROPS.

Emergency Management: Emergency management personnel are being engaged in the operational and modeling activities within the RCOOS. For example, some COMPS coastal sites are operated in close collaboration with Florida local and state emergency management officials. Wherever possible, there are direct line-of-sight radio links from the observing site to the local emergency operations

center. COMPS personnel provide training for the emergency managers on how to access and use the data from each site (Appendix D, Letter of Support).

Public Stakeholders and Education: data and information from observations will continue to be used by local newspapers and websites which target coastal fishermen, mariners, surfers and other recreational users in the region, such as www.roffs.com, www.fryingpantower.com, and www.sailflow.com. Local municipalities (e.g. Sebastian Inlet District and Martin County) currently provide funds for data collection systems in the region and desire real-time access to the data. Engagement with formal and informal education programs will build on prior efforts in addition to new national efforts, notably those coordinated by the COSEE programs in the SECOORA region.

Additional users, their needs, and the observational requirements, enhancements, and applications to address these, will be identified and prioritized by the SECOORA Stakeholders Council (SC).

4.0 Approach

SECOORA's RCOOS development program comprises interrelated tasks that are complementary to currently funded activities and move SECOORA towards a coordinated, sustainable regional observing, modeling, and data management enterprise. Our focus is to provide tangible economic and societal value to the Southeast. We intend to:

1. Enhance and sustain real-time observing assets in the SECOORA domain, including buoys, offshore towers and coastal stations (established through prior sub-regional and regional efforts and not supported through FY07 awards). Selected observing stations will be upgraded to real-time status in areas presently lacking real-time coverage.
2. Enhance and calibrate high frequency radar (HF radar) surface current measurement systems and provide the data in near-real time to identified user-groups and the NDBC/National HF radar network for further distribution.

3. Implement coupled ocean-atmosphere models, including surface wave modules, at sub-regional and regional scales encompassing the SECOORA domain. The regional models will be nested within global and/or basin-wide models and will in turn host higher resolution estuarine and coastal lagoon circulation models.
4. Implement ecosystem models linking nutrient and lower trophic levels (phytoplankton and zooplankton) to target fish species in the SECOORA region.
5. Further enhance a Data Management infrastructure that will efficiently integrate and disseminate regional ocean observing data (*in situ* and remotely sensed), information products, and services and support the thematic priorities of fisheries/ecosystem management, hazards, and search and rescue.
6. Ensure the components and services of the SECOORA RCOOS can interface seamlessly within a broader, interoperable structure through a System Engineering approach.
7. Translate RCOOS technology and findings to education stakeholders through web-based resources and workshops and interactions among researchers with educators.

4.1 Task Descriptions

For each task below, a brief description is followed by tables summarizing the technical approach and roles and responsibilities of the parties involved. The “challenges/risks faced” and the “mitigation strategy to be employed” for each task are outlined in Appendix A, Tables 1-6.

4.1.1 *In situ* Regional Observations Infrastructure

The FY07 funded proposal *Integration of Coastal Observations and Assets in the Carolinas in Support of RCOOS Development in SECOORA* (Leonard, et al.) supports observing assets off of the coasts of NC and SC. Task 4.1.1 of this proposal complements that activity by sustaining and enhancing the observing assets off FL and GA, creating an observational infrastructure spanning the SECOORA

region. These assets are critical to our modeling and applications portfolio and are needed to support funded FY07 activities and activities outlined in this proposal.

Off FL, seven Coastal Ocean Monitoring and Prediction System (COMPS) buoys, distributed across the broad west Florida shelf, telemeter real-time meteorological and oceanic information that is posted onto the Internet. This array provides surface meteorology and in-water measurement of temperature, salinity, and currents and is used in a range of applications, including Harmful Algal Bloom dispersal. Through recent NOPP funding, acoustic sensors will be added to the COMPS network, providing a large-scale integrated physical-biological observing array that can address fisheries issues. The COMPS coastal sites provide surface meteorology and water level data along the west Florida coast adding critical information on coastal inundation during storm events. In the Florida Keys, the SEAKEYS coastal stations have collected 17 years of concurrent physical and biological observations. These stations have served as a test bed in which NDBC and sensor manufacturers have developed new, more reliable sensors and techniques for real-time marine environmental monitoring. Off Dania Beach on the SE Florida Shelf, a Nova Southeastern University Oceanographic Center (NSUOC) mooring has observed temperature, salinity, currents and directional waves since June 1999. Farther north, Florida Institute of Technology (FIT) stations off Sebastian Inlet and Jensen Beach, Florida, carry ADCPs with pressure sensors and thermistors to provide temperature, currents, water level, and wave information. Added acoustic and radio telemetry will provide real-time access to these east Florida data, which will begin to address the significant gap in coverage that presently exists off the east coast of Florida.

Since 1999, the SABSOON program, located in GA, has used offshore Navy towers for real-time observations. Data are retrieved hourly by on-tower computers and transmitted to the Skidaway Institute of Oceanography (SkIO) via the Navy microwave communications system. SABSOON instruments include complete surface meteorological packages, including PAR, fixed depth pressure sensors (water level, non-

directional waves), bottom-mounted cabled ADCPs, near-surface and near-bottom CTDs, and an initial set of bio-optical measurements (UW PAR, chlorophyll fluorescence, turbidity). These observations also complement the cross-shelf coverage targeted in the SECOORA business plan. Leveraging an NSF project in 2008 will allow SkIO to conduct much of the servicing of one tower through joint use of ship time.

Task Descriptions – *In situ* Observations. (For Challenges/Risk & Mitigation, see Appendix A)

| Activity name | Technical Approach | Roles and Responsibilities |
|--|--|--|
| Upgrade NSUOC & FIT sensors and stations for real-time access. Upgrade COMPS coastal station hardware and satellite telemetry upgrade and process tidal datum information | NSUOC & FIT: Install acoustic modem on stations and pier or surface mooring; evaluate options and implement the best one. COMPS: Test and install new radio and satellite telemetry equipment at sites. Processing tidal datum information for all tidal/ weather stations. | NSUOC and FIT staff in collaboration with USF field and technical personnel. |
| Maintain and operate COMPS, SEAKEYS, SABSOON, NSUOC, and FIT stations | Conduct preventative maintenance on established systems; troubleshoot & repair as needed; maintain inventory of system components & service, calibration records. | Engineering & field technical personnel; coordination with SECOORA and other partners by all PIs. |
| Data QA/QC | Implement standards adopted by SECOORA; data ported to NDBC subject to NDBC QA/QC; COMPS water level data in accordance with NOS/CO-OPS NWLON standards and protocols. | PIs and SkIO, USF, FIO, NOAA/AOML, NSUOC, FIT personnel will coordinate with SECOORA DMCC on adopted regional QA/QC standards and with NOS/CO-OPS. |
| Data delivery to SECOORA, NDBC, NOS and other users and data archive | Communications & data processing procedures established in SEACOOS deliver common format (netCDF) data to SECOORA; data delivery to NDBC continue as established; data archive continue with upgrades when possible; COMPS coastal station water level published with NOS/CO-OPS. | SkIO, USF, FIO, NOAA/AOML, NSUOC, and FIT DM and IT personnel. |
| Provide support to SECOORA's outreach and education initiatives | Develop and maintain appropriate training and outreach materials. | PIs from the research, web, data management participants with COSEE education |

4.1.2 Support/Enhance HF Radar

Shore-based HF-radar systems for surface current mapping have been deployed at four locations in the SE, including long-range CODAR on the West Florida Shelf and North Carolina and WERA in southeast Florida and at the Georgia/South Carolina border, providing test-bed experience with these two commercial options in both broad and narrow shelf environments. The FY07 funded proposal *Enhancing the Regional Coastal Ocean Observing System in the Southeastern United States* (Seim et al.) provides partial support for these assets for one year. This proposal provides the support and packages the surface current data in a manner that will be valuable to our region and our stakeholders via the National HF radar servers and through the SECOORA website.

Two types of commercial HF Radar systems are presently available and operated in the SECOORA domain: the SeaSonde CODAR, most common in the U.S., and WERA, more commonly used in Europe. The key difference between WERA and CODAR is the approach used to determine the range and direction of the return signal. WERA systems use phased array beam-forming receiver arrays, allowing unambiguous determination of range and azimuth for estimations of currents along radials with spatial resolution depending on bandwidth. Because of the multiple receive antennae, the signal-to-noise ratio in the WERA system is higher, and spatial resolution finer than for the CODAR system operating at the same frequency. Spatial resolution of the deployed WERA systems is 1 to 3 km. In addition to current measurements, the WERA beam-forming receiver arrays allow wave estimation (significant wave height and direction) and surface wind direction, using manufacturer-supplied software. By contrast, CODAR uses a single crossed-loop/monopole and proprietary software for direction-finding (a least-squares method to estimate hourly averaged currents). The spatial resolution of the CODAR long-range system is about 6 km at 100 km and, at present, significant wave height data are only available as a single area-integrated estimate. The advantage of the CODAR system is ease of deployment, with its significantly smaller beachfront footprint. It is critical to develop and support use of both systems in the U.S. Combining radials

from WERA and CODAR systems is possible but requires an in-depth study of interoperability. This type of study is one of the objectives of the GCOOS proposal in which both L. Shay and R. Weisberg are involved.

Accurate measurement of surface currents and waves is relevant to a range of economic, societal, and research applications within the SECOORA footprint. These include USCG and military search and rescue operations, tracking and predicting oil spills and harmful algal bloom trajectories, assessing shoreline erosion, predicting rip currents, providing maritime forecasts of currents and waves to the recreational and commercial marine communities by the National Weather Service Weather Forecast Office, and improving the coastal ocean circulation response to physical forcing (e.g. winter storms and hurricanes). This latter point is central to improving storm surge and inundation models to evaluate not only water levels, but the wind-driven currents that pile the water against the coast.

Task Descriptions – HF Radar. (For Challenges/Risk & Mitigation, see Appendix A)

| Activity name | Technical Approach | Roles and Responsibilities |
|--|--|---|
| Maintaining sites | Routine maintenance of HF radars. | All radar groups |
| Radial accuracies | Accuracy current estimation procedures developed by University of Hamburg. | All radar groups |
| <i>In situ</i> data comparison | Compare radial and vectors at available <i>in situ</i> measurements. | All radar groups |
| Mean radials over hourly intervals for the U.S. National Network | WERA data should be sent to the UM server and CODAR data sent to Rutgers. | All radar groups |
| Provide support to SECOORA's outreach and education initiatives | Develop and maintain appropriate training and outreach materials. | All radar groups working with educators |

4.1.3 Develop Nowcast/Forecast Circulation Models

The objective of this task is to understand, via advanced modeling systems, the fundamental coupling between physical processes and material property transports within the region. Given the interconnected nature of the U.S. southeast coastal ocean waters via the Loop Current-Florida Current-Gulf

Stream system, it is essential to work within the regional context that encompasses the Gulf of Mexico, Straits of Florida, and the South Atlantic Bight. This approach entails various levels of complications (e.g. varied bottom topography, resolution, open boundary condition specifications) and requires the use of regional model ensembles with downscaling/nesting strategies. Thus our starting points are the existing models POM, ROMS, FVCOM, NCOM, and HYCOM deployed in various configurations (e.g. quasi-operational with atmospheric forcing from operational Numerical Weather Prediction centers and eight-tidal constituent forcing from tidal models) and with various means of downscaling from the global ocean to the coastal ocean using operational ocean models (cf. Mooers, et al. 2005). New to this task is a coupled model that incorporates a 6 km horizontal grid Weather Research and Forecasting (WRF¹) model for the regional atmosphere, 4 km grids for the Regional Ocean Modeling System (ROMS²) for the regional ocean, and Wave Watch III ³ for the regional surface waves, over a coastal ocean domain that includes all of the southeast and the Gulf of Mexico.

A strength of the new coupled system is that both WRF and ROMS have existing adjoint models (Moore et al. 2004) that can be used for variational data assimilation to improve model predictions, and for sensitivity analysis that can assist in SECOORA observational array design. Sensitivity of the ocean state to forcing variables can be computed to quantitatively determine which ocean state variables and/or forcing terms should be observed and at what sampling interval. Examples of such data assimilation techniques in coastal modeling applications can be found in He et al. (2005), He and Wilkin (2006), Peng and Xie (2006), and Peng et al. (2007). Other approaches to data assimilation will also be pursued, such as the sequential applications of HF-radar data to improve circulation modeling (Barth et al 2007). Since the concepts of downscaling remain research and development topics, we will continue to pursue our ongoing nowcast/forecast activities, add the new activities as presented above, and progress in a logical manner

¹ WRF website: <http://www.wrf-model.org/index.php>

² ROMS website: <http://www.myroms.org/>

³ WWIII website, <http://polar.ncep.noaa.gov/waves/wavewatch/wavewatch.html>

guided by quantitative comparisons with observations. This progress will also incorporate more river runoff forcing where needed, add higher resolution bottom topography, and entail the use of higher-resolution nested models for estuaries, coastal lagoons (cf. Fiechter et al. 2006), and Marine Protected Areas, such as the Finite Volume Coastal Ocean Model (FVCOM; e.g. Weisberg and Zheng 2006). With evolution of these modeling systems, capabilities for the ensemble modeling of the SECOORA domain will be pursued.

These modeling systems together with the ecosystem modeling component (see details in next section) will be able to directly address three priority program areas: (1) Facilitating safe and efficient marine operations by providing more accurate circulation, wave and particle trajectory predictions, (2) Preserving and restoring healthy marine ecosystems by providing quantitative assessment of coastal ocean nutrient, phytoplankton and zooplankton biomass distributions for relating to coastal fishery variability, and (3) Predicting and mitigating coastal hazards by providing nowcasts/forecasts of tropical and extra-tropical storms, coastal surges and inundation, beach erosion, and harmful algal blooms. By providing space- and time-continuous realization of SE coastal ocean states, these model simulations and forecasts will be valuable for stakeholders such as the NWS, NOS, USCG, and other coastal ocean managers.

Task Descriptions – Circulation Models. (For Challenges/Risk & Mitigation, see Appendix A)

| Activity name | Technical Approach | Roles and Responsibilities |
|---|--|----------------------------|
| Sustain and enhance nowcast /forecast systems | Continue quasi-operational output and improve bottom topography, forcing, data assimilation etc. | Mooers, He, Weisberg |
| Analyze value of downscaling | Compare model runs with GODAE versus climatological open boundary conditions. | Mooers, He, Weisberg |
| Evaluate nowcast/forecast systems | Assess model skill against observations. | Mooers, He, Weisberg |
| Regional wave model development and coupling | Refine wave-atmosphere boundary layer dynamic and parameterizations. | Xie, He |
| Regional WRF model refinement and coupling | Refine ocean-atmosphere boundary layer dynamic and parameterizations. | Lackmann , He |
| Ensemble modeling | Experiment with combining the output from the | Mooers, He, Weisberg |

| | | |
|---|---|---|
| | models thru weighted averages. | |
| Link to ecosystem modeling component | Information exchange and collaborations with ecosystem modeling team. | Werner, He, Weisberg, Mooers |
| Provide support to SECOORA's outreach and education initiatives | Develop and maintain appropriate training and outreach materials. | Werner, He, Weisberg, Mooers and COSEEs |

4.1.4 Develop Ecosystem Model and Relate to Fisheries

This task is designed to support the regional move to Ecosystem-Based Fisheries Management as directed by the President's Ocean Action Plan and embraced by the South Atlantic Fishery Management Council's (SAFMC) Fishery Ecosystem Plan. Initially our target fish species will be Gag Grouper (*Mycteroperca microlepis*), a member of the grouper family in the snapper/grouper complex managed by the SAFMC. We choose gag because of its high commercial and recreational fishery value and its distribution throughout the SECOORA domain ranging from the continental shelf and shelf-edge, into the nearshore and estuarine regions, which will require integration across all SECOORA assets to obtain sufficient information to aid the SAFMC in its assessments. The approach is of broad importance, in that fisheries-oceanographic models will provide insight into transport mechanisms for *Oculina* coral, its associated fauna, and during the early life stages of species in the snapper-grouper complex (e.g., gag grouper, snapper and porgy) that use offshore bank habitats (e.g., *Oculina* Bank) for spawning. The ecosystem modeling system will contribute to SECOORA's goal of providing environmental and ecological information to assist in preserving and restoring healthy Marine Ecosystems including fishery resources. Over time, this approach should be expanded to other cross-shelf species, as well as those associated with deeper shelf-margin habitats (e.g., *Lophelia* reefs and *Polyprion americanus*) that also occur throughout the SECOORA domain, responding to needs identified in the Deepwater Coral Research and Monitoring Plan for the South Atlantic Region (SAFMC 2007).

We will explore both abiotic and biotic effects on gag grouper and we will (1) consider the role of circulation on gag recruitment, including the effect of on- and offshore positions of deep ocean currents (e.g., the Gulf Stream) on the transport of larvae from their spawning locations to the mid-shelf, where a combination of wind- and tidal currents, modulated by larval behaviors, subsequently carries them to their juvenile estuarine habitats, and (2) develop and implement a suite of ecosystem models ranging from point- to 3D formulations, including uncoupled or dynamic linkages between lower and higher trophic levels based on NEMURO (North Pacific Ecosystem Model for Understanding Regional Oceanography) and NEMURO.FISH (Kishi et al. 2007; Megrey et al. 2007; Werner et al. 2007).

Task Descriptions – Ecosystem Modeling. (For Challenges/Risk & Mitigation, see Appendix A)

| Activity name | Technical Approach | Roles and Responsibilities |
|---|--|--|
| Obtain relevant circulation (abiotic) components | Obtain flow fields and characterize Lagrangian properties. Downscale as needed to smaller domains. | Werner, T. Shay and Circulation Team |
| Select hindcast years for validation | Compile biological, fisheries and physical data and conduct simulations. | Sedberry, Pugliese, Werner, T. Shay and Circulation Team |
| Develop lower trophic level (LTL) model | Modify NEMURO to SAB foodweb description. | Eslinger, Werner |
| Couple circulation and LTL models with fisheries model | Time series from LTL input to the higher trophic mass/energy balance models. | Ecosystem and Circulation Teams |
| Link to SEDAR process and forecasting | Participation in SEDAR process and integration into stock assessment models. | Ecosystem Team and SAFMC |
| Provide support to SECOORA's outreach and education initiatives | Develop and maintain appropriate training and outreach materials. | Ecosystem and Circulation Teams and COSEEs |

4.1.5 Enhance Data Management Architecture

Data Management and Communications (DMAC) is a critical component of the RCOOS that enables regional users to access observational data, model output, and other coastal information. Task 4.1.5 is designed to continue the effort to establish an extensible, applications-agnostic data management

architecture begun in FY07 that will be tailored to address our priority issues (e.g., fisheries/ecosystem management, hazards, and search and rescue).

Data management activities are overseen at two levels: (1) the DMAC-ODP level, which comprises the original SECOORA Ocean Data Partnership (ODP; see <http://secoora.org/documents/odp>), and the functional DMAC operations consistent with the national DMAC, and (2) the Data Management Coordinating Committee (DMCC), derived from SEACOOS and extended to engage the SECOORA membership. The SECOORA DMCC will focus on technical aspects of shared problem-solving, beta-testing of new developments, dissemination of new technologies, and interaction with other technical DMAC efforts beyond the region. Team members of the SECOORA DMCC will be technical personnel based at the partner institutions, who will communicate regularly on collaborative development efforts. The continued development of processes, procedures, and tools will exploit resource-oriented and service-oriented architectures to develop, test, and apply a range of applications, including (1) data and information integration services, (2) discovery services to generate and optimally exploit metadata, (3) visualization/browse services (e.g. pre-generated map images and graphs, hourly downloadable data files), (4) access and parsing services, and (5) QA/QC services, including best practices/standards recommended by the IOOS DMAC (Ocean.US 2005) and QARTOD (see Fig. 4, Appendix A). The SECOORA web portal will be optimized for tailored, transparent access to near-real-time, delayed mode, model output, and satellite data, as well application products/services for various communities of interest.

Task Descriptions – Data Management. (For Challenges/Risk & Mitigation, see Appendix A)

| Activity name | Technical Approach | Roles and Responsibilities* |
|--|---|-----------------------------|
| Enhance the extensible architecture | Implement Xenia Database application and relevant schema. | SC, DMAC-ODP, DMCC |
| Exploit resource- and service-oriented designs | Develop data integration, discovery, visualization, access/parsing, and QA/QC services. | SC, DMAC-ODP, DMCC |

| | | |
|---|--|--------------------|
| Demonstrate how the data management architecture supports application development | Enhance data normalization and engage regional stakeholders to support applications (e.g., near-shore forecasts, water quality data products). | SC, DMAC-ODP, DMCC |
| Continue to enhance and optimize web portal | Develop additional web services; data archival; feedback mechanisms; modify for educational implementation | SC, DMCC, COSEE |
| Assess/ establish data archival capability | The ODP and regional stakeholders will establish a data archival strategy. | DMAC-ODP, SC |
| Promote efficiency and progress of information management operations/development | The Information Management Coordinator (IMC) will provide recommendations to the SECOORA BoD via the ODP and DMAC. | DMAC-ODP, BoD, SC |
| Provide support to SECOORA's outreach and education initiatives | Develop and maintain appropriate training and outreach materials. | DMAC-ODP, DMCC |
| * DMAC-ODP (combined Data Management and Communications Committee-Ocean Data Partnership); SC (Stakeholders Council); BoD (Board of Directors); DMCC (Data Management Coordinating Committee); see <i>www.secoora.org</i> for organizational structure. | | |

4.1.6 Systems Engineering

Systems engineering is a cross-cutting theme that will support the execution of all of the tasks defined throughout sections 4.1.1 to 4.1.5. At its core, System Engineering is a process with well-defined check points which ensure that the developed system or system-of-systems ultimately fulfills the needs of all stakeholders, including end-users and operators. Applying systems engineering rigor to the development of SECOORA's regional IOOS components will allow for the timely development of a sustainable operational system, scalable and evolvable to meet future demands and operating as a whole to meet the functional and operational objectives of its stakeholders; to wit:

- 'Timely development' means minimization/elimination of cost and schedule overruns.
- 'Sustainable' means that the system can be operated and maintained over a long period of time taking into consideration life cycle factors (e.g. cost of maintenance, upgrades, and disposal).

- ‘Operating as a whole’ means that the individual sub-systems and systems plug and play in a structured, secure, and controlled environment that enables individual system evolution while maintaining holistic consistency that meets critical overall functional and operational objectives.

Task Descriptions – Systems Engineering. (For Challenges/Risk & Mitigation, see Appendix A)

| Activity name | Technical Approach | Roles and Responsibilities |
|---|--|-----------------------------------|
| Assess current operational processes and methods | Document ‘as-is’ operational view. Validate through stakeholder interactions. | System Engineer |
| Identify desired future state, gaps and cost/schedule drivers | Compile and baseline target functional, operational and derived requirements. Continue stakeholder interaction. | System Engineer |
| Conduct trade analyses | Develop target designs for sensors, buoy, and shore-based platforms that meet the baseline requirements. Validate designs with an architectural analysis taking a holistic regional IOOS view, and modify designs as necessary. Develop upgrade plan | System Architect, System Engineer |
| Determine operational support requirements for upgraded designs | Develop operations plan for target designs. Assess changes to operations processes and methods and ensure viability. Develop implementation and transition plans. | System Engineer |
| Provide support to SECOORA’s outreach and education initiatives | Provide schedule for appropriate integration ROOS concepts into education programs. | System Architect, System Engineer |

4.2 User Involvement

The systems engineering approach described above is intended to ensure that all aspects of the regional enterprise can be traceable to defined user requirements. We will continue to interact with a wide spectrum of end-users and end-user groups identified within the SECOORA Stakeholders Council. Below are examples of interactions already underway.

- Many of the real-time observations supported in this proposal are integral to the Southeast Marine Weather Portal, currently being developed in collaboration with the NOAA National NWS offices in

the region (Dorton et al.). Inclusion of observational data within the marine weather portal provides important maritime safety information to the recreational and commercial marine communities.

- Florida Keys National Marine Sanctuary and Florida state agency resource managers provide feedback to SEAKEYS on needed improvements for the observing array and the SEAKEYS Field Manager serves on the Sanctuary Advisory Board. SEAKEYS staff regularly interact with the Key West Pilots Association, fishermen, and divers to assure they are providing the best possible data to these groups.
- The USCG R&D Center is actively involved in using and evaluating circulation information. The inclusion of Art Allen as a Principal Investigator on the proposal signifies our commitment to providing as much useful information through appropriate channels as possible.
- The SAFMC, as part of its evolution to ecosystem-based management, is encouraging NOAA NMFS to work towards improving stock assessments with environmentally explicit recruitment indices. In addition, establishing a dialogue and bridging the gap between oceanographers and fisheries (and habitat) managers is a critical step to encompassing an ecosystem approach to stock assessments. We will begin to address this need through direct participation by SAFMC and NOAA Coastal Services Center staff in the ecosystem modeling component of this effort.
- COMPS coastal sites are operated in close collaboration with local and state emergency management officials with limited funding provided for Operation and Maintenance needs.
- The SECOORA-ODP will work directly with the DMAC and Stakeholders Council to obtain recommendations and continued feedback from end users, stakeholders, and partners.

4.3 Quality Assurance

SECOORA has developed a comprehensive set of QA/QC requirements that will be implemented through formal procedures related to data collection and data processing. The SECOORA DMCC will

proactively participate in the National DMAC Standards review and approval process to ensure compatibility with national-level QA/QC initiatives. Some task-specific QA/QC activities include:

- Sensors are calibrated regularly and bench-tested prior to deployment. Where possible, sensors are compared to independent sensors to ground-truth data. SkIO and USF personnel have been involved in SEACOOS/SECOORA discussions for implementation of a consistent QC flagging scheme for the netCDF data format, with initial efforts focused on winds and waves.
- Central to building a reliable network of HF radars is assessment of surface current data quality. In addition to assessing daily variations in coverage and uptime, an important measure of success is through comparisons of HF radar surface currents to available *in situ* measurements within the radar domains.
- *In situ* data from existing SECOORA observing networks will be used for model validations, sensitivity analysis, and data assimilation. Standard automated model skill assessment matrices will be used to measure success, including model/data *rms* misfits, space and time correlation coefficients, and vector regressions as skill metrics.
- Model validation for the ecosystem abiotic component will be carried out via retrospective analyses focusing on the role played by hydrography and shelf-wide circulation to the interannual recruitment variability for target fish species (e.g. gag grouper). The retrospective analysis will be based on archives of hindcast studies for the SECOORA-wide ensemble circulation models downscaled to shelf-scale circulation fields. Lagrangian (particle tracking) models will be used to examine the cross-shelf transport of early life stages of out target species during selected periods for which data is available. Similar retrospective hindcasts will test the validity of the NEMURO lower trophic model formulation, using existing datasets to calibrate and validate model results via formal methods of parameter estimation and model sensitivity (e.g., Yoshie et al. 2007).

4.4 Education and Outreach

Each task proposed in Section 4.1 includes an education and outreach component. One of the strengths of SECOORA is the wide diversity of existing sub-regional efforts and outreach capabilities and experience with observing information translation to specified audiences. The project team is strongly committed to fostering working relationships with these groups to ensure that the data and products are useful to and accessible by the largest possible audience. Through outreach, engagement, and formal partnerships, we will effectively identify, evaluate, and promote the benefits of our activities to our targeted user groups. In addition to the outreach efforts being performed through the SECOORA “planning grant,” education and outreach activities will also include:

- With the SECOORA Stakeholder’s Council, determine where real-time data gaps exist within the region and prioritize these data requirements and, together with SECOORA member programs, find creative solutions that enable these data gaps to be filled, as best as possible.
- Ensure ecosystem and circulation modeling efforts are coordinated with the stakeholder groups they are serving. This will be accomplished by including these stakeholders in the SECOORA Stakeholders Council and holding regular meetings between modeling project PIs and stakeholders so that ecosystem/circulation modeling efforts can be tailored to stakeholder needs.
- Meet with MACOORA and GCOOS seek opportunities to leverage funds across the regions and share lessons learned and outreach best practices. SECOORA staff will meet with GCOOS and MACOORA staff annually; representatives will be invited from those RAs to SECOORA regional meetings (e.g., the Stakeholders Council, DMAC, web development committee).
- Work with COSEE-SE and other educational partners (such as Sea Grant) to identify format and resources to support extension of fisheries/ecosystem management, hazards, and search and rescue activities to specified audiences. Project PIs will participate identifying and developing

appropriate examples for inclusion to formal and informal education audiences through web-based resources and professional development workshops in the research themes. There will also be a significant effort to partner with national educational efforts.

4.5 Consistency with IOOS Development Plan

The SECOORA Program Committees (Science Advisory, DMAC, and Operations and Maintenance) will periodically review progress being made by SECOORA RCOOS investigators to ensure that all activities are being executed within the framework defined by the IOOS Development Plan and the IOOS DMAC Plan. Deviations will be reported to the PI who will initiate corrective action, as necessary. In particular, the Data Management plan was developed and will be implemented within the context of the IOOS Development Plan. In addition, a robust HF radar network is one of the key goals for IOOS following the Ocean.US plan on the Surface Current Mapping Initiative.

5.0 Benefits

The SECOORA RCOOS and its supported applications address aspects of products and services listed under three of the IOOS societal goals (Weather & Climate, Maritime Operations, and Ecosystem), as well as both real-time and sustained aspects of IOOS development. This effort will build a solid foundation for the SE RCOOS, one that will serve a broad range of applications, accommodate stakeholder needs, and establish the infrastructure required to test and operate new technologies to address these needs. Further, SECOORA RCOOS development is a step toward a national "integrated" observing system that (1) efficiently links observations, data communications and management, and data analysis and modeling to constitute an "end-to-end" system, (2) provides rapid access to multi-disciplinary data from many sources, (3) serves data and information required to achieve multiple goals that historically have been the domain of separate observing programs, (4) efficiently links advances in modeling to development of operational capabilities, and (5) involves cross-cutting partnerships among federal and state agencies and

academic institutions (see Appendix C for partners list). Further elaborations of the benefits that will be realized from this program include:

Integration of regional assets into the IOOS: The SECOORA RCOOS will directly benefit the national IOOS, utilizing and enhancing established observing system assets (*in situ* systems, HF radar, modeling, information management, and outreach/education programs) to significantly augment the present National Backbone in the Southeast US coastal ocean. The Systems Engineering component will ensure that these assets will be extensible and interoperable with those of both the national IOOS and the RCOOS networks of adjacent regions. Sub-regional programs with experience in all facets of observing systems will be integrated into the SE RCOOS, addressing SECOORA applications and enhancing the functionality of the regional system. Benefits will include improved communications, more efficient coordination of observing operations (reducing costs and building operational capacities), combined data archival, enhanced data integration, increased availability of RCOOS information, improved forecasting, and faster response times for water quality issues.

Improved NWS marine forecasting: The WFOs and the NOAA Ocean Prediction Center incorporate stations that will be maintained by the SECOORA RCOOS as official verification points in the National Marine Verification Program. The statistics from these stations are also used to calculate GPRA metrics reported to Congress each year. Expected intangible benefits include improved safety and saved lives.

An expanded regional coastal ocean information portal: The *Carolinas Coast* (CC) marine portal (www.weather.gov/carolinascoast) was officially launched by the NWS in April 2007. This project has established partnerships between sub-regional COOS, NOAA's NWS, and a private sector partner to benefit the regional marine community. Initially designed for NC and SC coastal areas, the project has been embraced by SECOORA and NWS Headquarters, and received funding to expand coverage to the entire SECOORA footprint. This expanded effort, the Southeast Marine Weather Portal (SMWP), serves as

a test case for “operationalizing” interactions between the ocean observing community and potential users, including emergency managers, search and rescue operators, and weather forecasters. One of the primary functions for the SMWP is to aggregate real-time coastal data for NC, SC, GA, and FL and make these data readily accessible users via a web portal. The SECOORA RCOOS will maintain information flow critical to operation of this site.

Coastal Ocean Circulation Model Applications: Sub-regional to regional circulation models directly address the three SECOORA priority areas: (1) in concert with the ecosystem modeling element, they will advance fisheries and ecosystem management by providing more accurate circulation specifications needed to quantitatively assess advection of nutrients, phytoplankton, and zooplankton distributions (cf. Fiechter and Mooers 2007), (2) they will support search and rescue operations by providing more accurate wave, marine weather, and particle trajectory predictions, and (3) they will provide regional wave field estimates, which contribute towards safe and efficient marine operations and improve coastal inundation predictions.

Ecosystem/Fisheries Applications: Ecosystem modeling activities will support the regional move to Ecosystem-Based Fisheries Management as directed by the President’s Ocean Action Plan and embraced by the South Atlantic Fishery Management Council’s (SAFMC) Fishery Ecosystem Plan. The approach is of broad importance, in that fisheries oceanographic models will provide insight into larval transport mechanisms of coral and fish species that rely on offshore habitats. In addition, a critical step for implementing Ecosystem Based Management is establishing a working dialogue between oceanographers and fisheries and habitat scientists. Roger Pugliese of the SAMFC, a co-PI on this project and member of the SECOORA Stakeholder’s Advisory Council, is positioned to play a key role in establishing this dialogue in the SE.

Public Safety: RCOOS information can be a vital asset for recreational and commercial fishermen, boaters, and sailors. Real-time and time-series data are displayed on COOS and NDBC websites, and

incorporated into NOAA NWS weather radio, hazards alerts, and forecasts. The value of these data is demonstrated by web site and NDBC statistics, as well as by direct e-mail communications from individual users. Real-time observations allow mariners to make boating decisions based on up-to-date weather and sea state reports. The US Coast Guard Auxiliary units and US Sail & Power Squadrons also promote the use of these data sources in boater safety courses. The observations and products generated by this RCOOS relate directly to SECOORA's search and rescue priority. The rip current forecasting tool will be used by lifeguards and the coastal circulation modules will address US Coast Guard needs for current information in nearshore and coastal waters.

Public awareness: The stakeholder nature of many monitoring programs in the SE brings considerable public attention and provides an effective mechanism for increasing public awareness of coastal issues. The RCOOS information network will provide a broader environmental context for public consideration of high-visibility issues such as coastal water quality, harmful algae blooms, and storm impacts.

Education: Regional tasks will build on previous regional and national efforts among COSEE and NOAA educators. This will include a (1) needs assessment with participating formal and informal stakeholders on formats for real-time data products and concepts, (2) identification of science education concepts within the proposal focus themes and development of products aligning with federal and state education standards, and (3) implementation of professional workshops and presentations at conferences to transfer knowledge and skills. The goal is to build a community of educators who can receive and use SECOORA information.

6. Milestone Chart

| Task Name | 2006-2009 | | | | 2009-2010 | | | | 2010-2011 | | | |
|---|-----------|---------|---------|---------|-----------|---------|---------|---------|-----------|---------|---------|---------|
| | Aug-Oct | Nov-Jan | Feb-Apr | May-Jul | Aug-Oct | Nov-Jan | Feb-Apr | May-Jul | Aug-Oct | Nov-Jan | Feb-Apr | May-Jul |
| Maintain in-situ observing system | | | | | | | | | | | | |
| Upgrade NSUOC, FIT, and COMPS stations | XX | XX | XX | XX | XX | XX | | | | | | |
| Upgrade & process tidal datum information | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX |
| Maintain & operate existing stations as proposed | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX |
| Data QA/QC, delivery to clearinghouses & users, local archival | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX |
| HF Radar | | | | | | | | | | | | |
| Operate Radars, Determine radial accuracies, compare w/ in situ data | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX |
| Transfer mean radials to IOOS Servers | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX |
| Provide Short-Term Current Predictions | | | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX |
| IT Links to Deliver Products | | | | | XX | XX | XX | XX | XX | XX | XX | XX |
| Circulation Modeling | | | | | | | | | | | | |
| Sustain & enhance nowcast/forecast systems | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX |
| Analyze value of downscaling | XX | XX | XX | XX | XX | XX | XX | XX | | | | |
| Evaluate nowcast/forecast systems | | | | | XX | XX | XX | XX | XX | XX | XX | XX |
| Regional wave & WRF model development & coupling | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX |
| Ensemble modeling & Link to ecosystem modeling | | | | | XX | XX | XX | XX | XX | XX | XX | XX |
| Ecosystem Modeling | | | | | | | | | | | | |
| Obtain circulation components/select hindcast yrs for validation | XX | XX | XX | XX | | | | | | | | |
| Develop NEMURO model, couple circulation & NEMURO w/ fisheries model | XX | XX | XX | XX | XX | XX | XX | XX | XX | | | |
| Establish sustained ecosystem component simulations protocols | | | | | XX | XX | XX | XX | XX | XX | XX | XX |
| Link to SEDAR process & forecasting | | | | | XX | XX | XX | XX | XX | XX | XX | XX |
| Data Management (DM) | | | | | | | | | | | | |
| Enhance extensible architecture | XX | XX | XX | XX | | XX | | XX | | XX | | XX |
| Exploit resource- & service-oriented designs | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX |
| Demonstrate DM architecture support for appl. devel. | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX |
| Continue to enhance & optimize web portal | | XX | | XX | | XX | | XX | | XX | | XX |
| Assess/ establish data archival capability | XX | XX | XX | | | | | | | | | |
| Promote efficiency & progress of Info. Manag. ops/development | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX |
| Systems Engineering (SE) | | | | | | | | | | | | |
| Inventory existing in-situ sensors & Assess operational processes & methods | XX | XX | | | | | | | | | | |
| Identify key drivers of upgrade & Determine upgrade path & plan | | | XX | XX | | | | | | | | |
| Develop & apply SE to modeling systems | | | | | XX | | | XX | | | | XX |
| Develop target architecture & design for modeling apps. | | | | XX | XX | | XX | | XX | | XX | |
| Determine modeling operational support req's | | | | | | XX | XX | XX | XX | XX | XX | XX |
| Assess existing data management architecture | XX | | | | XX | | XX | | XX | | XX | |
| Identify key drivers of DM system | | XX | XX | | XX | | XX | | XX | | XX | |
| Determine DM enhancement path & upgrade plan | | | XX | XX | | | | | | | | |
| Identify oper. support req's for enhanced architecture & upgraded designs | | | | XX | | XX | | XX | | XX | | XX |
| Education Activities | | | | | | | | | | | | |
| Internal educ. mtg's w/ PIs to establish education plan w/ researcher involvement | | XX | XX | XX | XX | | XX | | XX | | XX | |
| Regional formal and informal educators survey | | | | | XX | XX | | | | | | |
| Develop education products based on surveys | | | | | | | XX | XX | | XX | XX | |
| Educators workshops based on year 2 activities | | | | | | | | | | | | XX |
| All tasks provide support to SECOORA outreach & education initiatives | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX |
| Program Management Activities | | | | | | | | | | | | |
| Project PI meetings | XX | | XX | | XX | | XX | | XX | | XX | XX |
| Semi-annual reports | | XX | | XX | | XX | | XX | | XX | | XX |

SOUTHEAST COASTAL OCEAN OBSERVING REGIONAL ASSOCIATION
(SECOORA):
Implementation of Regional Integrated Ocean Observing Systems: Support of RCOOS Development
in SECOORA
1 Aug 08 to 31 Jul 11
PROJECT BUDGET DESCRIPTION AND JUSTIFICATION

| Program Element | Year 1 | Year 2 | Year 3 | Total |
|----------------------|---------------------|---------------------|---------------------|---------------------|
| Program Mgmt | \$ 251,000 | \$ 247,000 | \$ 251,000 | |
| Observing Systems | 719,998 | 722,546 | 725,041 | |
| Circulation Modeling | 529,544 | 541,457 | 548,032 | |
| Ecosystem Modeling | 494,827 | 497,415 | 499,746 | |
| HF Radar | 700,868 | 701,361 | 703,240 | |
| DMAC | 502,484 | 499,969 | 499,882 | |
| System Engineering | 249,591 | 249,952 | 249,655 | |
| Totals | \$ 3,448,412 | \$ 3,459,700 | \$ 3,476,595 | \$10,384,707 |

This budget summary is provided to give an overview only; for detailed budget descriptions, please see Appendix B. There are seven broad program elements (PE) in the proposal. Each of the Program Elements is linked to produce and expand a functional end-to-end RCOOS.

1. The **Program Management** PE is to support a RCOOS Manager, for Education and Outreach, and for Comptroller Services (SC Sea Grant).
2. The **Observing Systems** PE is to support maintenance and development of existing observing assets, building and expanding the NOAA investment in the FY07 Carolina RCOOS by expanding support into GA and FL. This effort will support National Weather Service Forecasts, Port Authorities, emergency managers, regional fisheries management community etc.
3. The **Circulation Modeling** PE is to establish a region-wide circulation model building on existing models in the region to support Search and Rescue, Emergency Management and other regional stakeholders.
4. The **Ecosystem Modeling** PE is to develop ecosystem models that exploit data streams produced from the Observing and Circulation Modeling. This effort will be used for management of regionally important fish stocks such as the Gag Grouper and support the regional fisheries management communities.
5. The **HF Radar** PE is to maintain 4 existing HF Radar sites and integrate with HF efforts of GCOOS and MACOORA. These radar sites support Search and Rescue, Emergency Managers, and provide model validation.
6. The **DMAC** PE is designed to rapidly disseminate high quality data and products to regional and national stakeholders, in keeping with national IOOS Standards and Procedures.
7. The **System Engineering** PE is to establish an RCOOS structure that provides seamless interoperability, cost effectiveness, and long-term viability.