Business Plan for the Southeast Coastal Ocean Observing System Regional Association – v1.1

1.0 Executive Summary

The Southeast Coastal Ocean Observing System Regional Association (SECOORA) is envisioned as a regional System of Systems that will effectively link ocean observing system elements operated by separate entities and funded by a variety of sources within the southeastern US. To realize maximum benefit, the whole must operate as one; it must be planned, coordinated, and managed as a system. The following Business Plan is intended to provide a framework to guide the development of the Regional Association (RA) and establish how priorities and goals are set. The governance plan for the RA is listed in **Appendix A.**

SECOORA will produce data and products in response to user requirements identified by its members. These requirements fall within the seven broad objectives of the U.S. Integrated Ocean Observing System (IOOS):

- Detecting and forecasting oceanic components of climate variability
- Facilitating safe and efficient marine operations
- Ensuring national security
- Managing resources for sustainable use
- Preserving and restoring healthy marine ecosystems
- Predicting and mitigating against coastal hazards; and
- Ensuring public health.

The role of Regional Associations (RA) in IOOS is to provide oversight in development and operation of the Regional Coastal Ocean Observing System (RCOOS) in accordance with the philosophy and guidelines developed by Ocean.US (**Appendix B** for preliminary RCOOS design document). A regional approach was chosen by the IOOS community to encompass coastal areas linked by common circulation systems and corresponding ecosystems, and to be responsive to regional concerns. The RAs are being established to design, implement, operate and improve their RCOOS. The regional efforts are intended to determine the appropriate resolution at which variables are measured, supplement the variables measured by the national backbone, provide data and information tailored to the requirements of stakeholders in the region, and implement programs to improve public awareness and education. The value for IOOS is predicated on the intention to build an infrastructure that will enable SECOORA to leverage its investment in environmental observations, systems, and services so that these assets can be applied to other initiatives that generate value to citizens and economies. Within a regional enterprise such as SECOORA, we need to make decisions on what applications and services we intend to embrace (based upon the needs and requirements of our local user groups). However, this growth needs to be done in such a way as to preserve our agility so that transitions in emphasis or application can be made as users' needs shift or evolve. For example, we may make the case that improved spatial/temporal assessments of water quality/beach health is essential to maintaining growth in our tourism industry, but Federal and State budgets may end up being more aligned with Homeland Security issues. Thus, improving Marine Situational Awareness through the exploitation of civil assets may become a more sensible focus area that would enable SECOORA to build the infrastructure needed to move towards self-sufficiency.

SECOORA must have an infrastructure capable of evolving with changing expectations. As such, SECOORA will develop products and services and fill infrastructure gaps within the context of regional priorities. By addressing discovery, access, and interoperability within the federal and regional guidelines, we also enable others beyond our boundaries to exploit our data, information, products, and services in ways that benefit other regions as well as SECOORA. This improves the value proposition for our investment and also enables us to remain agile so that SECOORA can evolve in response to shifting federal and state budgets and shifting priorities among our user base.

SECOORA consists of three interconnected subsystems:

- Observations and Transmission Subsystem
- Data Management and Communications Subsystem
- Modeling and Analysis Subsystem

These subsystems support two primary activities:

- Data/Information/Product Development
- Marketing Plan/Outreach Activities

Development of a complete system will likely take decades. This document describes the design to meet 5-year goals. Designing an RCOOS for the SE US that can effectively address the IOOS societal goals requires consideration of a number of factors, including the SE environmental/oceanic setting, existing capabilities, and anticipated resources. Complete implementation of the SECOORA RCOOS will be an incremental process. The range of temporal and spatial scales over which coastal ocean processes operate requires that both observations and models provide a robust and multi-purpose estimation and prediction system. The range of applications implied by the broad societal goals for the IOOS also dictates that a "nested" strategy will be required for the allocation of resources. Some degree of sub-regional to local focus will also be required for the RCOOS to serve in a Research & Development role for the RA, e.g., providing technology testbeds.

Since resources for the RA are presently limited and future funding is uncertain, SECOORA will direct its efforts towards focused data collection, aggregation and assimilation, and the rapid delivery of products that advance regional priorities. To achieve these goals, SECOORA will concentrate on three of the seven broad IOOS objectives in the Business Plan and RCOOS Design during the initial one to five year time frame. The three targeted objectives are:

1. Facilitating safe and efficient marine operations (Marine Commerce), such as, Search and Rescue;
2. Preserving and restoring healthy Marine Ecosystems, such as, fisheries and monitoring water quality; and,
3. Predicting and mitigating against coastal hazards, such as, short term coastal inundation resiliency & long term sea level rise.

Each of the priorities relies on accurate representation of the physical state of the coastal ocean. While physical variables will be the initial focus for observations in the developing RCOOS, this does not imply the system will serve only as a physical oceanographic estimation system. Rather, this reflects the present state of sensor development and maintenance for the existing biological and chemical sensors, and recognition of physical processes as driving biogeochemical and ecological processes. As more robust, cost-effective technologies become available for measuring chemical and biological properties, these will be incorporated into the RCOOS in a coordinated, multidisciplinary manner. Given the close coupling of physical processes with chemical and biological processes in the coastal ocean, an initial physics-based RCOOS observational design will also serve interdisciplinary needs, including implementing ecosystem-based management practices in the SE coastal ocean.

During the 5-year period, SECOORA will execute regional pilot programs to develop and test physical state estimations for the SE coastal ocean in support of specific applications, including forecasting models for coastal ocean circulation, coastal inundation, surface gravity waves and regional marine meteorology. These pilot programs will be coordinated with similar efforts by neighboring RA's to maximize impact, ensure efficient use of available resources and establish consistent data management. The observations will validate the models, and will be used for assimilation, from which forecasts and products of known accuracy will be produced.

A dynamic SECOORA Sensor Inventory will be established to provide up-to-date databases and maps of regional observing capabilities (locations, sensors deployed, variables measured) and their operational status. Requirements for this include functional links between metadata and observations, and providing the capability to assess the quality of measurements made by specific sensors over time. Input procedures for data providers must be defined to insure that consistent data quality criteria are applied.

Data Management within the first year will focus on establishing the Southeast Ocean Data Partnership to build upon and codify data management procedures and processes established by sub-regional efforts within the SECOORA domain. For planning out to five years, SECOORA will be a proactive leader in the development and maintenance of an effective information management framework for the region. This framework will enable ready access to information from the observing and modeling subsystems. A distributed set of data providers will coordinate information exchange through a virtual regional information hub. Critical elements of the data management development include:

- Defining a Data Dictionary;
- Creating and maintaining ontologies for different data types (an ontology is a form of a data model that represents a domain and defines the relationship among the objects in that domain. Ontologies are made up of objects (classes or categories), characteristics (roles or properties) and relations (functions). Ontologies conform to a strict hierarchical structure of relationships between classes and subclasses as well as among classes);
- Maintaining a SECOORA registry of regional assets, connected to the IOOS Enterprise, and, at a minimum, including data products/information products (directory), models, data centers, platforms and sensors; and,
- Develop inventory profiles for datasets common across the enterprise.

With respect to data analysis and data products, the observation network must be used for validation of model output. The complementary development of regional observing and modeling capabilities is essential to continued improvement of our understanding of processes in the SE coastal ocean and for providing coastal ocean state estimates. Ocean observations will never be dense enough to cover all scales of interest; therefore, in addition to providing end users with real-time observations, the deployment of observing assets must consider what is required to support a range of modeling systems.

Currently, SECOORA members have nowcast/forecast systems for coastal ocean circulation, running quasi-operationally for sub-regions of the SECOORA domain. Within the next five years, SECOORA should test nowcast/forecast systems for sub-regions that can support the priority applications. Modeling products can make an important contribution to an annual SECOORA document, which provides an assessment of state of the southeast coastal ocean, with an emphasis on quantitative descriptions of major events and detection of environmental and ecological change in the region.

For the SECOORA RCOOS to make effective use of technological advances, Marketing and Research & Development must be included in the Business Plan. Products and services must reflect requirements of regional users; therefore, market research is critical for planning and the creation of valued products. Regional user group workshops will be convened to refine and prioritize requirements in the three focus areas. The results of this effort will form the basis for prioritizing and coordinating further expansion of the observation network in support of product and service delivery.

To provide products beneficial to end users, a robust and ongoing program of market research combined with R&D is required to advance capabilities and transition specific information generating activities through the developmental stages of research, pilot projects, and pre-operational to operational status. The growth and changing needs of coastal populations will require the constant development of new information products, which will need to be coordinated with the private sector. Furthermore, as observing and modeling capabilities advance, there will be opportunities to provide new types of information and delivery systems to members. In most cases, significant R&D input will be required for the successful development of the desired products.

A closely related responsibility is to provide regional stewardship for the National Backbone, comprised of observing subsystem, modeling subsystem, and information management subsystem elements provided or supported by federal agencies. This stewardship includes assessment and utilization the National Backbone, and advocating for its enhancement. Coordinated planning for the joint evolution of the combined National Backbone and RCOOS assets and services will be required.

In summary, the SECOORA Business Plan is intended to address near term and longer term (out to five years) regional priorities, initially focusing on three of the seven IOOS societal goals. This regional approach will be carefully engineered to ensure that limited resources are effectively used and user benefits are maximized through smart data collection, aggregation and analysis, and product delivery. Discovery, access, and interoperability in an IOOS compliant manner will enable other RAs to exploit our data, information, products, and services. This approach also enables us to remain agile so that we can evolve our foci in response to shifting federal and state budgets and shifting priorities among our stakeholders. As resources remain uncertain, the near term should be based on current funding and the five year program built on enabling SECOORA to have a functional RCOOS.

2.0 BUSINESS CONCEPT/MISSION

2.1 SECOORA Identification

The name of this organization is the Southeast Coastal Ocean Observing Regional Association (and referred to as SECOORA). This organization is in the process of establishing itself as a nonprofit entity incorporated under the laws of the State of South Carolina.

2.2 Mission Statement

SECOORA is to be designed, implemented and operated as a not-for-profit entity to provide data, information and products on marine and estuarine systems deemed necessary to the users in a common manner and according to sound scientific practice. SECOORA will serve the needs of users with measurements and data transmission, data management and communications, and data analysis and modeling. SECOORA will include the infrastructure and expertise required for this system.

The purpose of SECOORA is to:

- Represent the interests of those that use, depend on, study and manage coastal environments and their resources in the southeast region;
- Provide a forum and mechanism through which coastal ocean stakeholders and information users can assess needs and work towards defining priorities;
- Be a legal entity that provides a fiscal agent with financial responsibility for acceptance and expenditure of funds according to the rules of grantors of the funds, insurability, and the ability to enter into enforceable contracts;
- Represent a partnership or consortium of data providers and users from state and federal agencies, private industry, non-governmental institutions and academia;
- Provide a means by which the Regional Association and the public at large benefit from and contribute to the development and sustained operation of an integrated ocean observing system for the coastal ocean (to the EEZ boundary) and the region's estuaries and lagoons; and,
- Ensure continued and routine flow of data and information and the evolution of SECOORA to adapt to the needs of the user groups and the timely incorporation of new technologies and understanding based on these needs.

2.3 Location

The geographic extent of SECOORA is the coastal zone and the Exclusive Economic Zone (EEZ) in the southeastern United States which includes North Carolina, South Carolina, Georgia, and Florida. Florida is part of SECOORA and the Gulf of Mexico Coastal Ocean Observing System Regional Association. This joint designation reflects the overlapping and interrelated nature of regions. The coastal zone extends inland to the head of tidal affects in rivers. There are other regional coastal ocean observing systems along the Mid-Atlantic and Gulf coasts with which SECOORA will also coordinate: To the North, the Mid-Atlantic Coastal Ocean Observing Regional Association (MACOORA) and, to the southeast, Caribbean Regional Association (CARA).

2.4 Role of SECOORA in IOOS

SECOORA will coordinate and support the development, implementation, and operation of a regional coastal ocean observing system (RCOOS), as part of the Integrated Ocean Observing System (IOOS), and to provide data and data products regarding the ocean to a diversity of users in a timely fashion, on spatial and temporal scales appropriate for their needs. The RCOOS that SECOORA operates is meant to address regional needs and supplement the federal coastal ocean environmental monitoring system (the "national backbone") capabilities provided by various federal agencies in the Southeast (e.g., NDBC buoys and CMAN stations, NOAA PORTS systems, USGS stream gauges, USACE wave stations, etc.). SECOORA will eventually support the seven societal goals defined by IOOS; however, since resources for the RA are presently limited and future funding is uncertain, SECOORA will focus its efforts on data collection, management, aggregation, and assimilation, to support the following three IOOS goals that are of primary interest to the southeast region:

1. Facilitating safe and efficient marine operations: such as, marine commerce and Search and Rescue;
2. Preserving and restoring healthy Marine Ecosystems: such as, fisheries and monitoring water quality; and,
3. Predicting and mitigating against coastal hazards: such as, short term Coastal Inundation Resiliency & long term sea level rise.

As the IOOS is implemented it is vital that essential components of the national backbone and the RCOOSs develop and maintain a high level of interoperability. For data and information flow, sets of standards must be established that enable data sharing among all components and a common set of tools and applications will be needed to enable seamless data discovery, archiving, and transfer. This work has begun with the Ocean.US DMAC plan and will continue within IOOS. SECOORA will actively participate in this national process.

3.0 SECOORA OPERATIONS PLAN

3.1 Observations and Transmission Subsystem

Due to the range of temporal and spatial scales over which coastal ocean processes operate, both observations and models are essential for creation of a robust and multi-purpose estimation and prediction system. The range of applications implied by the broad societal goals dictates that a nested strategy will be required for the allocation of observing and modeling resources. The ability to download and process satellite remotely sensed data on a regional scale from all potential sources is critically needed as well.

To address the range of applications envisioned by SECOORA, a fundamental role for the RCOOS will be the routine operation of forecasting models. SECOORA will also provide observational data because of its stand-alone value. Determining the predictive skill of such models, and providing information that can improve forecasts through data assimilation, will require a robust observation and data transmission network, with appropriately formatted data and model products delivered to users through the RCOOS data management system. Since it is recognized that available resources will set limits to the observational assets that can be deployed and maintained in sustained operation, the implementation plan for the RCOOS in the SE will have to follow the SECOORA defined priorities (see 2.4)

The National Federation of Regional Associations (NFRA) has initiated the development of an up-to-date catalog of observing system assets maintained by the non-federal data providers in each of the Regional Associations (RAs). It is recognized that such asset inventories have been compiled in the past, but without a mechanism for continual update, these rapidly become obsolete. The initial NFRA approach will be to ask each data provider to maintain a list and status of assets and make this accessible via the web.

SECOORA is addressing the regional inventory of observing assets through reorganization and upgrade of a prototype system (developed by the SEACOOS program: http://seacoos.org/Research%20and%20Technology/Folder.Observing/Folder.EquipmentInventory). The initial objectives are to:

1. Provide a dynamic equipment and measured variable inventory function (accessible by individual data providers);
2. Facilitate inter-institution collaboration among field engineers and data managers.
3. Incorporate sensor information as metadata; and,
4. Monitor system-wide performance for data delivery and enable display of regularly updated operational status maps for observing assets in the SECOORA region. The link between observations and sensor metadata will enable SECOORA to monitor system performance down to the sensor level
5. Incorporate supporting resources such as those that are needed to deploy and maintain sensors or collect samples, such as ships, coastal facilities suitable for storage, buoy groups, or calibration facilities.

For implementation of the Observations and Data Transmission System (from inception out to year 5) see **Appendix C**.

3.2 Data Management and Communications Subsystem

Data Management and Communications (DMAC) is one of three broad subsystems identified by Ocean.US for the national Integrated Ocean Observing Systems (IOOS) effort: 1) Observing, which is focused on remotely sensed and in situ measurements and their transmission from platforms; 2) Modeling and Analysis, focused on evaluation and forecasting of the state of the lake/ocean environment based upon measurements; and, 3) DMAC, the integrating component that coordinates the two and renders them available to users. Both IOOS and the RCOOS being developed across the country will have DMAC components and responsibilities. The SECOORA DMAC will coordinate and facilitate the distribution of data and information to and from system components, to and from other observing systems, and to end users at all levels. Access to data from components of the observing system should be facilitated by DMAC protocols and storage services. DMAC should also provide standards and access tools so that outputs from the Modeling and Analysis groups can be made available to scientists, policymakers, educators, the general public and other interested parties.

The Ocean.US DMAC Steering Team recommends the establishment of regionally-based data and information management systems, which address both the national priorities identified by Ocean.US and the needs of regional partners. As there is an enormous volume of near-real-time and historical data available from instruments measuring and monitoring the ocean and coastal waters and air of the southeastern US, the management of these widely distributed data requires a sophisticated system that can organize, retrieve, aggregate, document and disseminate data and derived information for a variety of purposes and applications.

The Information Management (IM) component of the IOOS is fundamental to its entire operation, in that it will provide the network of regional-to-global systems that enables the collection, aggregation, accessing, utilization, archival, and dissemination of data and information products. To advance the IOOS Data Management and Communications (DMAC) Subsystem, it will be necessary to establish a coordinated and cooperative network among the various regional systems and the users of IOOS products. It will also be necessary to establish a range of new capacities to establish this network and ensure its functionality at a range of temporal and spatial scales. The IOOS DMAC is envisioned to be comprised of the following components (First IOOS Development Plan, 2005):

- Metadata. These data describe the various attributes of data sets for the national system, and documentation of these metadata will require development and use of a common vocabulary, identification of required metadata fields, agreement upon sites for publication of metadata, and commitment to publish metadata in a timely fashion.
- Data Discovery. The capacity for searching and locating desired data sets and products and for manipulating accessed data must be established.
- Data Transport. Data and products must be capable of transport over the Internet in a transparent, interoperable manner.
- On-Line Browse. Data must be readily accessed and evaluated through common Web browsers.
- Data Archive. Mechanisms for secure, short-term and long-term data storage must be established.

- Data Communications. The communications infrastructure for accessing and transporting data and data products must be identified and maintained to meet standards.

The Southeast Atlantic Coastal Ocean Observing System (SEACOOS) was originally established to coordinate coastal observing systems in the southeastern US, and create the capacity for meaningful assembly, integration and dissemination of data and information from these systems. With an initial scientific focus on the development of the capability to observe and accurately model the time-varying three-dimensional circulation and state fields in the coastal ocean from the Outer Banks to the Florida Panhandle, an IM component was identified as a priority to enable the integration and interfacing of the observation, modeling, and user application components of SEACOOS. With the transition of SEACOOS towards the implementation of a RA structure, the IM component of SEACOOS is being transitioned to SECOORA.

For implementation of the Data Management and Communications Subsystem (from inception out to year 5) see **Appendix D**.

3.3 Modeling and Analysis Subsystem

The Modeling and Analysis Subsystem is the third component, with a mission to support three primary activities: Product and Services, Research and Development and Marketing/Outreach Planning. A need clearly exists for SECOORA to develop a strategic plan for data analysis, modeling and forecasting implementation that facilitates activities consistent with the three IOOS objectives that SECOORA has prioritized for the next 1-5 year period.

SECOORA will develop a variety of integrated, value-added products based on regional priorities. SECOORA's marketing and public awareness campaigns will bridge the transfer of observed and modeled data to the appropriate user, thereby providing an "end to end" system, through data analyses and value added product development. There is a need to develop ongoing feedback mechanisms to ensure user-satisfaction with products developed under SECOORA guidance.

For this business plan, data analyses and modeling are activities that use observational data to create value-added products in support of an operational RCOOS. Products generated as part of these activities should:

- Conform to national standards and protocols and provide free and open access to non-proprietary data;
- Have the capability to sustain routine, 24/7 operations wherever necessary, including the acquisition and dissemination of data-derived products in real-time or near real-time; and,
- Provide for timely delivery of other services that include the collection and dissemination of data and development of useful products.

3.3.1 Value added product identification (models and other products)

SECOORA will support data collection, modeling, aggregation and assimilation, and product delivery activities. User requirements for product development will have to be identified by the SECOORA Marketing Committee. These assessments should be used to prioritize future resource allocations and to identify continued development of value-added products and support for data analysis tools, visualization tools, cyber infrastructure requirements.

Presently, several nowcast/forecast systems exist in the SECOORA domain. These include quasi-operational ocean circulation forecasting systems. They are based on primitive equation models, treat temperature and salinity stratification, have mesoscale resolution, and use realistic atmospheric, tidal, and open boundary forcing. Synoptic maps of sea surface currents, sea surface temperature, sea surface height, etc. are forecast for three days once a day. For standard release points, Lagrangian particle trajectories are forecast, too. Some provide 24/7 forecasts of wind, water level, wave, and inundation during the hurricane season and include nesting to local levels.

There are numerous other models in use within SECOORA for applications or process studies. A critical first step for SECOORA is to actively engage end users and members so that their needs can be used to help guide the existing or future modeling activities within SECOORA. At the same time, SECOORA is starting an effort to produce an inventory of current modeling activities. Several such inventories exist (e.g. the "Inventory of Hydrodynamic, Water Quality, and Ecosystem Models of Florida Coastal and Ocean Waters" compiled by Florida DEP) which provide a foundation for this effort.

Within the next five years, SECOORA should test and compare nowcast/forecast systems for sub-regions as well as the entire region that can support the priority applications. Modeling products can make an important contribution to an assessment of state of the southeast coastal ocean, permitting quantitative descriptions of major events and detection of environmental and ecological change in the region.

3.3.2 Gap Analysis

There must be a complete inventory of products (available and under-development) within SECOORA. In the beginning, we will only focus on products that address the three SECOORA priority areas. SECOORA should establish a strategy to prioritize resource allocation for development of new data products.

Some value added products require different degrees of spatial and/or temporal coverage and/or additional types of observations (i.e. beyond backbone and core variables). For example, nowcast/forecast systems will need to be validated and verified with independent data sets; e.g., coastal sea level from tide gauges, coastal wave height and period from wave gauges, and coastal inundation from overland water level sensors. Procedures should be developed in coordination with the research and operations groups to ensure that deficiencies in collection networks are regularly re-evaluated with respect to data analyses and value-added product development. Changes in measurements may include: sampling frequency, sampling location, variables measured, rate at which data and information are delivered. Many of these observational changes will have to be made on a case by case basis; however, SECOORA should establish strategies for prioritizing these activities.

A mechanism for identifying those analyses needed to develop scientifically-sound QA/QC criteria and “on-the-fly” flags for real-time data should be developed in conjunction with the DMAC and operations working groups. Furthermore, generalized “error bars” are needed for all model output and other developed products. A plan must be developed to ensure that these analyses and results are periodically reviewed.

3.3.3 Operational Continuity

Development of products (or simply data --- when data is the product) that rely on a continuous stream of observational data (e.g.. near realtime models) must be reliable, quality controlled, and have known error bars. For nowcast/forecast models, in particular, appropriate *in situ* data are needed for data assimilation (e.g. vertical profiles of temperature and salinity are particularly valuable). Additional data will be needed for nowcast/forecast verification and other process models. The availability of observational data must be coordinated with DMAC and observations groups to ensure that delivery of a product is not hindered by breaks in data flow. Procedures should be implemented that will monitor the flow of data and information among observing, DMAC, data analysis and modeling components. These procedures should also address appropriate calibration and servicing approaches for all mission-critical sensors not considered part of the national IOOS backbone.

Because data are a product, policies and error-checking protocols need to be in place so that data and value-added products are of known quality at all times (i.e. the level of accuracy for any data set used in a SECOORA function must be known at all times). The marketing working group should be engaged to ensure that this information (both for data and value-added products) is accessible to users within their particular decision loop, particularly those with mission critical tasks such as navigation and emergency response, which demand appropriate levels of accuracy and consistency at all times.

3.3.4 User Satisfaction

To ensure that SECOORA goals and user-needs are being met, processes need to be in place for regular review of data and value-added product quality, delivery and accessibility by the appropriate user communities. Results of such reviews must be used to guide continued development and/or expansion of data products. The development of these processes will be coordinated with the observations (i.e. data collection/observations & telemetry) and marketing (i.e. cost-benefit of value added products) working groups.

4.0 MARKETING PLAN

A primary function of SECOORA is to ensure that its operations are designed to fulfill the needs of the broader community. Although the SECOORA membership will include representatives of the broad user community, it will be important to assess the needs and priorities of stakeholders beyond the immediate membership so that the products and services developed have optimum utility. An assessment of these needs is essentially a "marketing plan," so the SECOORA strategy can be largely based on existing methodologies. Market research is critical to a successful marketing plan. An initial plan is outlined below with more details given in **Appendix E.**

Establishing, satisfying and growing a user community will be critical to the survival of SECOORA but can not and should not be done in isolation. A number of institutions, both public (e.g. state and federal agencies) and private (e.g. the value-added industry) already provide products to potential SECOORA markets. The market plan is described generically in this document and does not specifically address the roles and responsibilities of participants in the marketing plan but a concept of operations is an obvious topic for further discussion.

4.1 Identifying our Market

To fully understand our diverse market segments, Needs Assessments tailored to each target market must be completed. SECOORA will need to interview potential customers to understand their wants and needs and determine what motivates their buying decisions. This Needs Assessment will help SECOORA understand the target market size and how the market is segmented (the needs assessment is described in Appendix E, section 4.3.3). This process will help SECOORA understand the products and services that are of interest to our market segments. It also will allow SECOORA to gather customer information that is useful in product/service research and development and in developing a marketing plan for those identified products and services.

Output from this process should guide implementation planning. It should also be used in the pursuit of funding for SECOORA, providing justification for data development programs and new collaborative initiatives identified as relevant or needed. The following outline should guide the development of the user needs assessment.

1. Current Information (needed from SECOORA members and potential members)
    a. Agencies/organizations active in the region
    b. Monitoring and observing programs by agency
    c. Data available from monitoring and observing programs
2. User Needs (needed from potential SECOORA customers)
    a. Products/services desired
    b. Data inputs required to provide those products or services
    c. Value of information if available (would they pay and how much)
3. Delivery Channels (how do customers want to obtain the products or services)

4.2 Preliminary Target Market Summary

During years one to five, SECOORA will concentrate on markets affected by the three goals listed in section 2.4. Their information and product needs should to be validated through a preliminary needs assessment to gain a better understanding of their market segment. Information, products and services needs may overlap between target markets. Also, since SECOORA strongly supports outreach and education, the K-16 education market is also listed in this section. Targeted user groups include, but are not limited to:

- Boating (commercial, recreational)
- Cruise Lines (FL only w/ overlap to Caribbean & Mexico Observing Systems)
- Shipping (Pilots Associations, Ports, Shipping Industry, Ferry Operations)
- Public Safety(Hazard planning for disasters, HAZMAT, NWS forecasts, Search and Rescue, HABs)
- Coastal Management
- Fisheries & Fishing (commercial & recreational)
- Recreation and Tourism
- Research
- Education
- Media

4.3 Marketing Strategy

The SECOORA business model is not a simple model with customer's paying for SECOORA's products or services. Figure 4.3 illustrates some of the business relationships that we expect to develop as SECOORA's products and services become readily available. It is envisioned that the Federal Government will be the predominant revenue source for SECOORA and its members. The block "customers" represents all those organizations, institutions and individuals who want information from SECOORA except the Federal Government. While it is recognized that the Federal Government will continue to be a SECOORA customer, for clarification purposes, the Federal Government has been identified separately.

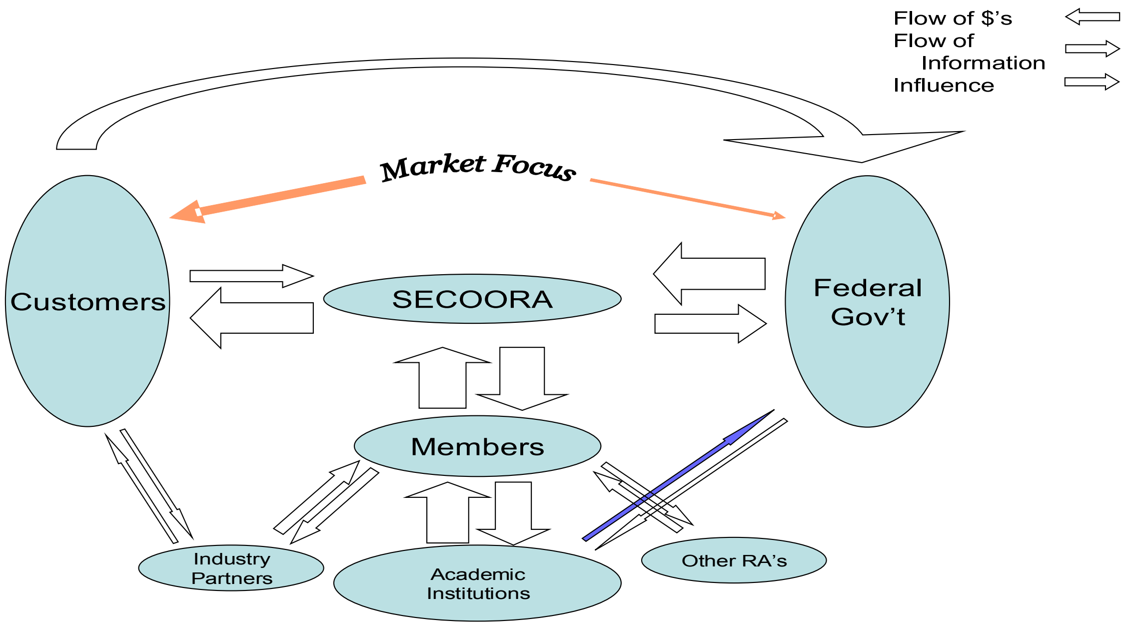

Figure 4.3 SECOORA Business Model

The principle marketing strategy will be to understand the customer's wants and needs and their potential for political influence and/or their ability to pay for the information they receive. In order to optimize and infuse SECOORA with the necessary resources for the organization to succeed, it is imperative that SECOORA be able to provide its members with the dollars necessary to continue development. While the Federal Government will be the major source of funding, it is recognized that obtaining Federal dollars will become increasingly competitive. Having customers who recognize the value of SECOORA's product and services and have the ability and willingness to support SECOORA's pursuit of Federal and State dollars will be critical to the success of the program.

As part of the Needs Assessment, an assessment of the potential value of each customer will be conducted (where value = ability/willingness to pay $ + ability/willingness to support SECOORA politically). This information will be used to prioritize both our marketing effort and product/services research and development initiatives. The long term goals of the marketing plan and SECOORA's business model should be to increase non-federal resources and to diversify the customer set to lessen the impact of local/regional economic trends.

A secondary marketing effort should be initiated in conjunction with the market selection process. Advertising SECOORA's fundamental mission, serving the public good, is needed for long term success. Public services available from SECOORA should be identified and public branding and recognition of SECOORA established early in the marketing effort.

5.0 Research and Product/Service Development

To provide data and information products and services beneficial to users, research and development is required to transition specific information generating activities through the developmental stages of research, pilot projects, and pre-operational to operational status. As coastal populations grow and coastal environments change, there will be a continuing need for new information products. Furthermore, as observing and modeling capabilities advance, there will be opportunities for providing new information to society. In most cases, R&D efforts will be required for the delivery OF products TO specific customers, as identified by the Marketing group. Example focus areas may include the development of: new, more stable, or more reliable in situ measurements or sensor platform technologies; new strategies for synthesizing or interpreting limited data streams; advanced understanding of physical and ecological functioning with the SECOORA domain to detect regional changes, assess RCOOS performance and improve prediction systems; and new strategies for distributing information to end users.

Although R&D efforts will most likely be supported and justified with specific information products and anticipated outcomes in mind, research for improving data products in one area will likely yield improvements in products in other areas. For example, improvements in models of surface currents that are designed to improve management of fisheries by permitting more accurate prediction of larval transport and recruitment will also improve applications related to navigation and shipping by improving search and rescue and mitigation of oil spills. Thus it is important that fundamental research and development offers improvements across the spectrum of societal needs that is the foundation of the coastal IOOS effort.

R&D efforts will also play an important role in the development and internal operations of the RA. It is important for the RA to catalog its observing capabilities, project desired future capabilities, conduct a gap analysis, and establish performance measures. Pilot projects are envisioned to be an important strategy for providing a focus for these activities, thereby facilitating quantitative evaluation of these criteria. In addition, pilot projects may provide an effective strategy for educating the next-generation observatory operators and users.

To ensure that the information distributed through the RA continues to meet the evolving needs of the user community, R&D efforts are assumed to be a continuing effort within the operations of the RA. This will require a sustained funding source within the RA organization to maintain continuity and balance between sustained information delivery and the evolution necessary to meet new challenges and needs.

5.1 R&D Implementation Issues

Support: R&D is envisioned as an ongoing activity representing a strategic investment in the development of future capabilities. To provide continuity of specific efforts and activities and to promote new opportunities, a portion of the RA budget must be available for R&D. Procedures should be established to assess R&D needs within the context of the total RA activities and thereby develop an appropriate budget allocation of the total budget to R&D efforts.

Evaluation/Review Procedures and Criteria: Procedures must be established to evaluate R&D needs and progress and to make recommendations for future support. Reviews of on-going activities and applications for new R&D efforts should occur annually, in conjunction with the Marketing needs assessments. Criteria must be developed to guide the review and evaluation process. Criteria for different stages (Research, Pilot Project, and Pre-operational) may differ. Possible criteria include:

> *Clients and user groups.* How many constituents (including individuals, industries, agencies and/or municipalities) within the RA region will benefit from advancing the delivery of a proposed product?
>
> *Importance of supporting information product.* What is the relative ranking of the proposed new or improved product within the spectrum of societal benefits anticipated by RA activities?
>
> *Feasibility and anticipated development timeframe.* Are significant improvements achievable within the observing, computational and communications capabilities of the RA or proposed improvements of those capabilities?
>
> *Cost of implementation.* Can significant improvements be made within the realities of RA budget projections?
>
> *Likelihood of success.* How likely is the activity to succeed in yielding the proposed improvements of new capabilities?

5.2 R&D Priorities

Pilot projects permit the testing, evaluation, development and improvement of all aspects of the IOOS end-to-end concept. As an on-going activity, it is anticipated that R&D efforts will evolve with time, project maturity and user needs. Over time and as the RA develops, R&D activities are anticipated within all of the major IOOS societal benefit areas; however, during SECOORA's first five (5) years of operation, R&D efforts will support the three highlighted IOOS objectives.

5.3 Possible Pilot Study Ideas

HAB Forecast Tool: This project is aimed at advancing the capability of identifying and predicting the occurrence of Harmful Algal Blooms (HAB) in the SECOORA region. The basic strategy is to more effectively couple remote and *in situ* sensor systems to regional transport models.

There are numerous users groups who would benefit from improved HAB detection and prediction. These include NOAA, NCEP, NASA, individual states, local governments and municipalities who issue public health warnings and control fisheries closures. The societal benefits include improvement in identifying and predicting public health risks, monitoring coastal ecosystem health, managing the sustained use of coastal ecosystems and mitigating the effects of natural hazards.

While significant effort may focus on the west Florida shelf, through the use of regional transport models and other observing technologies, this project may also advance regional integration of information and products. Furthermore, this issue is of importance in many other RA areas and may focus to improve connectivity with other RCOOSs and RAs.

Coastal Inundation Models: This project goal is to advance understanding and ultimately the prediction of coastal inundation during storms. This builds upon ongoing pilot projects such as SCOOP, the Tsunami Inundation Model (for entire east coast), regional efforts (ADCIRC - coastal inundation model) and local efforts such as SEACOOS - FVCOM (Tampa Bay/Charlotte Harbor).

There are many potential users of improved inundation information including county, state and national government officials (FEMA, DOD, NOAA, USACE, DOE) and a variety of private sector industries and constituencies such as insurance companies, port authorities, emergency contingency planners, power companies, and the tourist industry. As such this project has applicability throughout the entire SECOORA domain and can focus aspects of RCOOS operations from sensor networking, modeling and community communication. Improved information delivery will assist in the mitigation of coastal disasters, improve marine operations, enhance national security, mitigate public health risks and improve the management of coastal ecosystems.

Fishery Management Models: This project focuses on biological impacts and provides advanced management tools for the coastal fisheries by improving the accuracy and utility of larval transport and resource recruitment models. The strategy is to improve model nowcasts and forecasts of coastal circulation and integrate that information with appropriate biological data and models. Potential user groups include the Southeast Atlantic Fisheries Management Council, local and state governments, NOAA-NMFS, commercial and recreational fishers, water management districts and the general public.

This project also has the potential to integrate observing and modeling activities beyond the SECOORA domain. The anticipated societal benefits will be mostly within the areas of improved management of coastal resources, reduction of public health risk and improved understanding of coastal ecosystem health. As noted previously, however, many projects may yield synergistic benefits.

Other possible projects: Addition possible projects that have been identified include: 1) Water quality monitoring and change prediction and 2) Maritime Industries, including ocean safety and navigation.

Appendix A: Governance Plan Framework

A. Governance Premises

1. SECOORA is a membership organization and the active participation of its members is core to its effectiveness. The governance structure should therefore place in the membership the ultimate authority to elect the board of directors, amend the by-laws, increase dues, and change the dues structure. The governance structure should also strengthen the membership's role in setting SECOORA's substantive and strategic directions and priorities by giving members a clear role in the organization's planning process. The structure should also provide ample vehicles, such as program committees and working groups, through which members can coalesce, coordinate, work with and support one another.

2. The Board is responsible for developing the *Ends Policies* related to the strategic goals, directions, and priorities of the organization. It is important that the Board prescribe Ends Policies from an appropriately long-term perspective. Boards can make invaluable contributions to implementation planning; however, the Board should not do the actual long-range planning. By casting Ends Policies out toward the planning horizon, the Board lays out those values on which the staff makes and implements operational plans.

3. The Board is responsible for developing *Executive Policies* that define the Board's expectations with regard to executive leadership and communications, and identify Board values with respect to minimum levels of staff prudence and ethics. The Executive Director is designated the Chief Executive Officer (CEO) of the association and is accountable to the Board for the management of the organization. The CEO reports directly to the Board of Directors and appoints staff to assist in carrying out the responsibilities of the organization. The Board of Directors should grant the CEO the necessary responsibility and authority for managing every aspect of the organization's day-to-day affairs. The Board's challenge is to exercise oversight with respect to staff operations, without obscuring role differences and without impeding the CEO's ability to make operations and management decisions. The appropriate expression of the Board's legitimate interest is not to make staff issues into a board issues, but to define Board expectations of the CEO as clearly and concisely as possible in advance.

4. The Board is responsible for developing the *Governance Policies* for the organization. The governance policies should ensure that the Board acts in trusteeship for the organization's members and broader public "ownership." The governance structure should serve as a legitimizing connection between this base and the organization. The Board's status as a subset of the ownership is a built-in mechanism of linkage. Board members do not constitute a random subset however, as they are selected because they can best fulfill the trust of governance. The Board of Directors should be composed to the extent possible of people who reflect the perspectives and views of the various subsets of the ownership. However, in their service on the Board, directors should rise above the interests of their particular organizations, sectors, or political boundaries and focus on what will be best for the community of owners as a whole.

5. SECOORA's Board of Directors should have the option of including some people from outside of SECOORA who are known for their strong commitment to ocean sciences, technology, and public policy, and who bring a broader outside perspective or expertise that can help SECOORA better achieve its mission. There are two major ways in which the Board may be strengthened by including outsiders on the Board.

- Outsider board members bring a range of skills, talents and access that may not be available when it only draws from the membership. This could include people with a background in and access to politics, media, academia, corporate funding, and foundation funding or those who bring a national perspective.

- Membership organizations, such as SECOORA, may sometimes be discounted by the public and elected officials as representing the self-interests of its members. Outside board members, whose only commitment is to the public good, can strengthen credibility.

6. SECOORA's Board should be a size appropriate to be effective, that is small enough to govern effectively and large enough to be inclusive of the different perspectives within SECOORA's membership and broader constituency. There must also be some mechanism for an even smaller body to make urgent decisions when immediate and swift action is needed.

B. Proposed Committee Structure

1. Executive Committee – The Executive Committee shall be made up of the four officers (Chair, Vice-Chair, Secretary and Treasurer) as elected by the full Board of Directors, along with the immediate past Chair. The Executive Director will also serve as an ex-officio, non-voting member of the Executive Committee. The Executive Committee acts on behalf of the Board between meetings of the Board in areas that are defined and restricted by the Board as a whole. General authorities include:

- Performing certain functions on behalf of the Board between meetings (but not supplanting the work of the full board).
- Prepare board meeting agendas
- Plan Board's work and make committee assignments
- Handle emergency or interim situations
- Evaluate the performance of the Executive Director (when applicable).
- Support, review, and monitor the planning process

2. Board Policy Committees - Board policy committees are established by the Board of Directors and regularly report on their activities to the Board. They are established to deal with ongoing responsibilities of the Board. Policy committees are always chaired by a Board member and can be comprised of both board members and non-members. Board policy committees are ongoing and provide written reports at each Board of Directors' meeting. These committees include:

a. Board Development Committee

- Establish criteria for Board selection, identifies and screens prospective nominees, and recommends slate of candidates to the membership.
- Recommend slate of officers for the full Board's approval.
- Reviews with each Board member their participation, attendance, and continuing interest in serving on the Board before re-nominating them.
- Develop the annual Board ballot and coordinate circulation to the membership, allowing ample time for consideration of all candidates and resolution of any technical problems.
- Establish procedures for determining winners of Board elections and handling any disputed election results.
- Establish procedures governing candidate conduct regarding election campaigns.
- Design and implements a Board evaluation process.

b. Governance Committee

- Conduct an annual review of the By-Laws so as to evaluate and update them if necessary to ensure that they stay current, adapt with the times, and remain effective.
- Circulate proposed By-Laws amendments to the full Board for review and approval.
- Circulate Board-approved By-Laws amendments to the full membership for review and consideration prior to the Annual Meeting.
- Coordinate motions related to the By-Laws and Constitution at the Annual Meeting.
- Recommend to the Board standards and guidelines for SECOORA's members as well as sets other criteria for membership in SECOORA above and beyond the standards and criteria already set for full members in the By-Laws.
- Oversee processes for member organizations compliance with the standards and recommends any needed action to the full Board.
- Recruit and review all new applications for membership and makes recommendations to the full Board. The full Board approves all new members.

c. Finance and Audit Committee – Chaired by Board Treasurer

- Oversee financial management and health of organization; reviews budget, regular financial reports, annual audit, financial policies, and major financial decisions
- Coordinate Board assistance, when needed, in fundraising activities, such as identifying and opening doors to new donors and helping to solicit contributions from them.
- Ensure the adequacy of SECOORA's financial disclosure and internal controls.
- Hire or terminate outside auditors and establish the terms of the outside auditor's engagement.
- Engage independent outside legal and accounting advisors when deemed necessary and advisable.

d. Public Policy Committee – (At Board's Direction)

- Suggest comments on proposed legislation whenever it is appropriate.
- Develop testimony to legislative bodies when invited.
- Write letters expressing SECOORA positions on issues.

- Work with national and local agencies on their programs that relate to SECOORA interests.
- Report to the Board on issues of interest to SECOORA within the federal, state, and local governments.
- Recommend appropriate positions on issues for the SECOORA Board and membership.

e. Stakeholder Advisory Council. Once potential users and stakeholders for SECOORA have been identified, a Stakeholder Council will be established to ensure that SECOORA is developed with user benefits in mind. Stakeholder Council members will be appointed by the SECOORA Board of Directors and will reflect the broad spectrum of users and stakeholders interested in the products of ocean observing systems. The Stakeholder Council will provide advice on policies, identify potential new audiences for data and products, provide input to improve data and products, assist or advise on ways to support the activities and enhance the national resources of the National Federation of Regional Associations, and suggest improvements in disseminating data and products to users and decision makers. They will advise on other matters as may be requested by the SEACOORA Board and Committees. The chairperson and other officers, as may be determined to be necessary by the Council members or the Board of Directors, will be elected by the Stakeholder Council members through an election organized by the Membership Committee. At least one member of the Board of Directors shall serve on the Stakeholder Council.

3. Policy Task Forces - Policy task forces may be established by the Board of Directors and regularly report on their activities to the Board. They are always chaired by a Board member, are comprised members of the Board, and are mandated to examine and develop recommendations on Board policy matters. These task forces have a limited time horizon, a defined sunset clause in their mandate, and are required to provide reports at each Board of Directors' meeting until their task is completed.

4. Program Committees - Program committees are authorized by the Board and established by the Executive Director. Program committees report to the Executive Director. The committees may handle operational or management issues and serve in either advisory or functional roles for the Executive Director. The Chair of a program committee is appointed by the Executive Director and must be a SECOORA member or affiliate. Reports on the activities of program committees are provided to the Board of Directors through the Executive Director's CEO Report at each Board meeting. In the absence of a large staff, it is anticipated that a significant portion of SECOORA's mission will be accomplished through the activities of the program committees. Examples of program committees may include:

- Science Advisory Committee
- Data Management & Interoperability Committee
- Education & Workforce Training Committee
- Communications & Public Relations Committee
- Operational Management Committee

C. Proposed Membership Categories

To facilitate broad membership among all sectors, several different categories of membership are available. The primary membership in SECOORA is organizational. Only organizations will be afforded full membership rights and privileges either as Sustaining Members or Institutional Members. There are also individual memberships and affiliate memberships, with limited privileges, available to accommodate and encourage direct participation from ocean observations users and other stakeholders.

Membership Categories

1. Sustaining Member - Any organization substantially engaged in the collection, delivery, or use of ocean observing data or information may join as a Sustaining Member, if they wish to participate at this level. Dues $10,000/ Year

Membership Rights and Privileges for Sustaining Members:

- Full membership voting rights (one vote per organization*)

  (Organization defined as paying dues and a decision maker/speaks on behalf of their organization)*

- Eligibility for nomination and election to the Sustaining Member Board Seats (up to 4).
- Eligibility for nomination and election to the Institutional Member Board Seats (minimum 9).
- Eligibility for nomination and election to the At-Large Board Seats (6)
- Eligibility to attend all SECOORA sponsored meetings with registration fee pre-paid (three per organization).
- Eligibility to lead, participate, and vote on program committees (one vote per organization)
- Access to SECOORA products, services, and training at no cost.
- Access to members-only resources.
- Right to SECOORA logo on organization literature and web site.

2. Institutional Member – Any organization (public, private, non-profit) engaged in the collection, delivery, or use of ocean observing data or information may join as an Institutional Member. Sole proprietorships and individuals are not eligible for membership within this category. Dues $1,000/Year

Membership Rights and Privileges for Institutional Members:

- Full membership voting rights (one vote per organization).
- Eligibility for nomination and election to the Institutional Member Board Seats (minimum 9).
- Eligibility for nomination and election to the At-Large Board Seats (6).
- Eligibility to attend all SECOORA sponsored meetings with registration fee pre-paid (one per organization).

- Eligibility to lead, participate and vote on program committees (one vote per organization).
- Discounts on SECOORA products, services, and training.
- Access to members-only resources.

3. Individual Member - individuals who engage in the collection, delivery, or use of ocean observing data or information may join as individual members. Individual memberships allow for SECOORA participation by individuals operating sole proprietorships and individuals who are unable to act on behalf of their full organization. It also permits participation from multiple individuals within large organizations and encourages broader membership among users. Individual membership, however, does not include full voting membership privileges.

The only voting rights of individual members are for the election of at-large board members. If individuals are elected to serve on the Board through those elections, the member is then entitled to full Board voting privileges for the duration of the term. Dues $500/Year

Membership Rights and Privileges for Individual Members:

- Eligibility for voting, nomination and election for the At-Large Board Seats (6).
- Eligibility to attend all SECOORA sponsored meetings.
- Eligibility to serve on program committees.
- Discounts on SECOORA products, services, and training.
- Access to members-only resources.

4. Affiliate Member – any organization that would otherwise qualify as an Institutional Member but whose ability to officially join SECOORA is constrained in some way. Affiliate membership is determined on a case by case basis by the Board. Affiliate members do not have voting rights. Affiliate members may be eligible for nomination and election by the Board to serve as non-voting, ex-officio Board members.

Definitions

1. Organization: For purposes of membership eligibility, "organization" is defined below. Questions concerning eligibility of organizations will be referred to the Board for decision and clarification.

- Business entity, firm, or corporation (other than sole proprietorship) which has been in business for a minimum of one (1) year
- Academic institution
- Federal, state, regional, or local government entity
- Non-profit corporation which has been in existence for a minimum of one (1) year
- Legally sanctioned association, council, or consortium which has been in existence for a minimum of one (1) year

2. Member in Good Standing: A member in good standing is defined as a member of SECOORA who meets all eligibility requirements and dues are current.

D. Structure and Composition of SECOORA Board

1. Composition of the Board
The Board will be composed of no fewer than 15 members and no more than 25 members in good standing. The number of Board seats filled should at all times be an odd number. The composition will be allocated as follows:

- Sustaining Member Seats – up to 4 seats available to Sustaining Members. Candidates for vacancies to be recommended by the Board Development Committee and elected by a majority vote of the Sustaining and Institutional Members.

- Institutional Member Seats – Minimum of 9 seats available to Sustaining Members and Organizational Members. Candidates for vacancies to be recommended by the Board Development Committee and elected by a majority vote of the Sustaining and Institutional Members. 9 seats will be allocated according to the list below: Additional seats in this category can be filled by any sector.
    - Industry/Private Sector – 3 seats
    - Academic/Research/Education Sector – 3 seats
    - Public Agencies/Non-profit/Other Sectors – 3 seats

- At-Large Seats – Up to 6 seats available to any SECOORA member, including Individual Members. Candidates for vacancies to be recommended by the Board Development Committee and elected by a majority vote of all members. The seats will be allocated according to the list below. To meet the criteria for state association, a nominated member or their member organization must reside in or have an active business address in the state.
    - North Carolina – 1 seat
    - South Carolina – 1 seat
    - Georgia – 1 seat
    - Florida – 3 seats

- Public Seats – Up to 6 seats may be available for individuals of stature from outside of SECOORA membership who would be selected based on their ability to effectively represent broader interests and perspectives. The number of Public Board Members should not exceed 25% of the total Board membership at any given time. Candidates are to be recommended by the Board Development Committee and elected by a majority vote of the Board.

2. Board Terms of Service
Board terms will be three years, with the Board members divided into three classes that would stand for election on a rotating basis. Board members could serve for two consecutive terms. Then they would rotate off that Board for at least one year before they could be reelected. Board

terms of service requirements apply to the individuals elected rather than to the institutions they represent.

3. Board Meetings

Board meetings would be held at a minimum, 2 times a year.

4. Role of Membership in Governance

Each year SECOORA will hold one annual membership assembly, where one officially appointed delegate from each member organization would gather. Organizational members (Sustaining and Institutional) have the ultimate authority to elect the Board, approve any changes to the By-Laws, and approve increases in dues and changes in the dues structure.

Individual Members have an opportunity to participate in the annual membership assembly and vote in the at-large Board elections. Individual Members also have ample opportunity to participate in committees and voice their views on what SECOORA's agenda and priorities should be. All members have opportunities to provide input, shape programs, tactics and strategies, and contribute through program committees and working groups.

Appendix B: Towards a Regional Coastal Ocean Observing System (RCOOS) Design for SECOORA

Summary

A conceptual design for the SE RCOOS is offered. It envisions support of a broad range of applications through the routine operation of a series of predictive models that rely on observations to ensure their validity. A distributed information management system enables information flow, and a centralized information hub serves to aggregate information regionally and distribute it as needed. A variety of observing assets are needed to satisfy the model requirements, and an initial distribution is proposed that recognizes the physical structure and forcing in the region. It includes *in-situ* data collection to provide 3D sampling, HF radar for synoptic sampling of surface currents, and satellite remote sensing of other ocean surface properties. Nested model systems are required to properly represent ocean conditions from the outer edge of the EEZ to the watersheds. The reliance on a vital National Backbone of observations, model products, and data management is obvious and highlights the needs for a clear definition of its components and Concept of Operations (CONOPS). Estimates of costs and personnel to sustain existing programs viewed as initial components of the RCOOS are included.

Background

The U.S. coastal ocean component (COOS) of the Integrated Ocean Observing System (IOOS) is envisioned to consist of a federal network (the "National Backbone") of *in situ* and satellite remote sensing observational, predictive modeling, and data management elements that will be focused broadly on the national scale, as augmented by Regional Coastal Ocean Observing Systems (RCOOSs) that will be focused narrowly on the regional scale. The RCOOSs will be an integral component of their respective regional associations (RAs) of stakeholders (*viz*., data providers and users), which in turn will be members of the National Federation of Regional Associations (NFRA). As a pioneering activity associated with the regional development of COOS, the Southeast Atlantic Coastal Ocean Observing System (SEACOOS) has considered the scientific and technical design criteria of the operational RCOOS that will be a central element of the Southeast Coastal Ocean Observing Regional Association (SECOORA). SECOORA, and its RCOOS, are required to be fully interactive and interoperable with other regional associations (RAs), especially with the neighboring GCOOS for the Gulf of Mexico, CaRA for the Eastern Caribbean, and MACOORA for the mid-Atlantic, as well as with the National Backbone provided by the federal agencies. Discussed here are preliminary thoughts on planning the design of an RCOOS for SECOORA, some aspects of how this RCOOS may interact with the National Backbone, and how elements of the RCOOS will transition to certified, fully operational components of IOOS.

Assumptions about Critical Design Issues

- Federal agency (or community) plans for melding and evolving the National Backbone architecture, which is comprised initially of 153 component federal programs, will emerge soon so that fully credible plans for the RCOOS architecture can be developed.

- Standards and protocols for operational observational sub-systems, and the role of delayed-mode versus real-time observational system elements will be clarified; for example, the definition of real-time may be made application specific.

- A national level Concept of Operations (CONOPS) will be established soon, which will clarify how the National Backbone, national numerical ocean models, and national information management systems will interface with the RCOOS; e.g., will there be collocation, co-mingling of personnel; who will perform the forecaster functions; how much redundancy will be required to meet robustness and resilience standards; will there be national security issues; etc.?

- With a CONOPS, the balance to be achieved between centralized and distributed approaches (at both the national and regional levels) in observing, modeling/prediction, and information management sub-systems will become resolvable.

- Relief may be on the way: Thanks to the NOAA-sponosored IOOS system analyses presently underway, it is not unreasonable to anticipate that by 1 JAN 07, IOOS federal agencies will have resolved these critical issues sufficiently for RCOOS planning to move ahead to a higher level than is possible in this document at this time.

Anticipated Functions and Approaches

The RCOOS of SECOORA will be responsible for providing operational coastal oceanography information services for the states of NC, SC, GA, and FL. These services are broad, complex, and sophisticated, and the RCOOS will need to comprise a partnership among the academic, federal, state, and private sectors to fulfill them. A complete end-to-end system is needed that links researchers and system developers to managers of autonomous observing and modeling systems to national level providers of observations and model products to so-called "super-users" (e.g., NWS marine forecasters, value-added environmental information industry, The Weather Channel, and State Climatologists) who interface to a wide range of end-user societal applications.

The RCOOS will:

- Be designed following appropriate systems engineering principles including a holistic and quantified view of the prediction system performance; consideration of evolving user needs for information and information products; and attention to cost-benefit issues. Metrics will be established to quantify the incremental user benefits (e.g., through improved prediction products) for incrementally increased investment in the overall information and prediction system, as is done in operational meteorology.

- Be built upon an interactive, mutually supportive triad of *in situ* observations, satellite remote sensing, and predictive numerical modeling, with these components linked through sophisticated information management systems (IMS), all for the purposes of describing and quantifying coastal ocean conditions and predicting their future evolution.

- Analyze, on a continuing basis, the performance and adequacy of the National Backbone within the SECOORA domain and recommend its augmentation with additional, or upgraded components (e.g., platforms and sensors). Similarly, the performance and adequacy of national level model products and IMSs to serve SECOORA needs will be analyzed on a continuing basis, and recommendations for improvements will be provided to NFRA and Ocean.US.

- Conduct an R&D program, closely connected to the operational activity, to ensure an evolving and progressive RCOOS technological capability, an ongoing technical assessment of the RCOOS performance, and a periodic scientific assessment of the state of the SECOORA coastal ocean environment.

Many user communities will benefit from enhanced RCOOS information services. They are too numerous to enumerate in detail here (see Website for Ocean.US and SECOORA). However, for the foreseeable future, they can be categorized into three broad thematic application areas: Marine Operations and Emergency Management, Coastal Hazards, and Environmental and Ecological Management. Marine Operations and Emergency Management includes topics of safe and efficient ship routing, offshore oil and gas operations, fishing, and sand and gravel mining; effective search-and-rescue and hazardous material (oil and toxic chemical spills) mitigation operations; efficient offshore aquaculture, waste disposal, and energy operations, etc. Coastal Hazards includes topics of storm winds, precipitation, and waves; storm surge and coastal inundation; rip currents; and beach erosion. Environmental and Ecological Management includes topics of ecosystem-based fisheries management; design and monitoring of Marine Protected Areas; detection of global change; monitoring and prediction of water quality, hypoxia, and harmful algal blooms. Further, researchers and educators are not to be overlooked as recognized and legitimate users of IOOS who, respectively, provide useful feedback on the COOS system performance and the regional environmental and ecological systems on one hand, and build understanding of the natural system and societal issues and options, as well as awareness of SECOORA, etc. on the other hand.

Information on the physical environment (wind, waves, current, temperature, salinity, sea level, turbulence, etc.) constitutes the common denominator for all of these thematic application areas. However, the space-time resolution, spatial-temporal coverage, and timeliness required varies between applications. This information is essential even for ecosystem-based fisheries management because the functioning of marine ecosystems depends upon physical habitat attributes (e.g., temperature, salinity, current, and turbulence) and the horizontal and vertical advective and turbulent transports of nutrients and organisms. This type of information is by design the first to be incorporated into the RCOOS but must be accompanied by a growing list of chemical, biological and geological observations if the RCOOS is to satisfy its full mandate.

Predicted (simulated, hindcast, nowcast, and/or forecast) Lagrangian trajectories are also needed for most applications; e.g., search-and-rescue, oil spill mitigation, and fisheries management (e.g., design of Marine Protected Areas and estimation of larval dispersal) To be accepted as operational products, the predicted trajectories need to be accompanied by "error bars" (i.e., various estimates of uncertainty).

In addition to a continually operating (i.e., routine, strategic mode) predictive information system, the RCOOS will need a complementary contingency-based (i.e., event-driven, tactical mode) predictive information system with rapidly deployable, high-resolution sensing and modeling systems.

While real-time *in situ* and satellite and coastal HF radar remote sensing are essential ingredients for coastal ocean forecasting, numerical models are also necessary to provide assured spatial and temporal coverage, and for prediction capability (simulations, hindcasts, nowcasts, and forecasts). Mesoscale oceanic and atmospheric circulation, tidal, wind wave, ecosystem, sediment transport, and hydrological coupled models are required components.

In summary, the main goal of the RCOOS is to ensure the availability of environmental and ecological observed and predicted data adequate (timeliness, space-time resolution and coverage, accuracy, error metrics, variables, etc.) to meet the needs of the broad user community.

To achieve this goal, the principal objectives for the RCOOS are to ensure the existence and full interactions of (1) a progressive regional *in situ* observational sub-system network that delivers quality real-time, 3D data; (2) a progressive sub-system infrastructure for satellite and coast-based remote sensing data utilization that delivers synoptic surface 2D fields; (3) a progressive numerical ocean prediction sub-system that delivers 3D simulations, hindcasts, nowcasts and forecasts; and (4) a progressive information management sub-system that provides rapid access and/or delivery of information to a variety of users.

Given the main goal and principal objectives outlined above, the major functions for the RCOOS are:

- constitute the infrastructure required for the timely acquisition, access, and dissemination of observational and model/predicted data and information products describing the coastal ocean and surface marine weather conditions

- provide technical oversight to the implementation and ongoing operations of the distributed *in situ* observational sub-system, satellite remote sensing analysis sub-system, numerical modeling and prediction sub-system, and information management sub-system

- conduct the systems engineering analyses required for the evolution of the "system of systems"; e.g., perform coastal ocean Observing System Simulation Experiments

(OSSEs) to guide *in situ* observing system network refinements and designs; e.g., by weighing the merits of alternative observing systems.

- coordinate with the operators and managers of the National Backbone in the operation and evolution of the observational, modeling, and information management sub-ystems

- manage a R&D program to assess performance of prediction system components, detect changes in the natural systems, upgrade the prediction systems, and utilize the prediction systems, and to maximize the synergy between R&D and operations

- organize and conduct regional scale scientific observational and numerical experiments to advance understanding of natural systems, and to facilitate enhancements of the observing and modeling subsystems

- from time-to time, perform re-analyses with upgraded models, data assimilation schemes, and observational data bases to provide best estimates of ocean fields for diagnostic studies of climate variability, coastal ocean change, and regional system dynamics

- facilitate the development and growth of the regional value-added environmental industry

- implement guidance received from advisory groups or committees stood up by SECOORA.

Within an initial buildout plan, the majority of applications envisioned to be served by the RCOOS can be provided predictive capabilities through the development of a set of models:

Physical state models – includes circulation (3D time-varying representations of coastal ocean currents, sea level, temperature and salinity); waves (2D representation of the surface gravity wave field and sediment transport); marine atmosphere (3D time-varying representation of the coastal atmosphere). Enhanced spatial resolution can be provided and/or improved through nesting of models. The model set includes inundation models capable of wetting and drying that can accurately represent the flooding of lowlands during high-water events (hurricanes, extratropical cyclones, etc) which may or may not be the same as the circulation models.

Biogeochemical and ecosystem models – coupled to circulation models to provide prediction of nutrients and various trophic levels. Some exist but these models are complicated, have many free parameters and require a broad spectrum of observations to validate. Theses models will require years of work to develop true operational capabilities.

Socio-economic models – used to represent the role of humans in the ecosystem and to interface with management agencies. The models should include land-use, population distribution, infrastructure mapping, etc.

The aggregate need for the RCOOS is to support the model systems through adequate observations to validate and maintain model accuracy and by providing an information system that enables timely access to all information available from the region. Described below is a vision of what an initial system should look like.

The RCOOS must follow IOOS design principles; e.g., free exchange of data, adherence to community standards, and certification for operational status. The following first describes each of the RCOOS subsystems (*viz*., observational (*in situ* and satellite remote sensing), modeling/prediction, and information management), covering both the National Backbone and regional components, with an introduction and discussion of present assets and future directions. Next, some recommendations are provided to further the development of the RCOOS

An Initial Design

Development of a complete system will likely take decades; we herein describe an initial design, implemented over a 5-year timeline. Designing an RCOOS for the SE US that can effectively address the IOOS societal goals requires consideration of a number of factors, including the SE environmental/oceanographic setting, existing capabilities, and anticipated resources. Implementation of the SECOORA RCOOS will be an incremental process. Due to the range of temporal and spatial scales over which coastal ocean processes operate, use of both observations and models is essential for creation of a robust and multi-purpose estimation (or prediction) system. The range of applications implied by the broad societal goals for the IOOS also dictates that a "nested" strategy will be required for the allocation of resources. Some degree of subregional to local focus will also be required for the RCOOS to serve in an R&D role for the RA (e.g., conducting CODAE's, and providing technology testbeds).

While the initial focus for observations in the developing RCOOS will be physical variables, this does not imply this will serve only as a physical oceanographic estimation system. Rather, this reflects the present state of sensor development and maintenance issues for the existing biological and chemical sensors, and recognition of the importance of physical processes for driving biogeochemical and ecological processes. As more robust, cost-effective technologies become available for measuring chemical and biological properties, these will be incorporated into the RCOOS in a coordinated, multidisciplinary manner. Given the close coupling of physical processes with chemical and biological processes in the coastal ocean, an initial physics-based RCOOS observational design will also serve interdisciplinary needs, including implementing ecosystem-based management practices in the SE coastal ocean.

The intent of this section is to outline major design criteria for the SE RCOOS. This represents a starting point, recognizing that development of the RCOOS will occur in concert with the evolution of the National Backbone, and with input from the broad constituent base that will make up SECOORA. A preliminary RCOOS design is presented below that first considers key oceanic characteristics of the region, and the core variables required for a basic description of the physical system. This provides the rationale for an initial design scheme for the distribution of fixed shoreline and offshore *in situ* observational assets in the SE. How the basic design scheme complements existing elements of the National Backbone is noted. This is followed by a discussion of the important role that will be played by additional observational methods in the SE RCOOS, including coastal HF radar, satellite remote sensing, profiling floats and gliders, surface drifters, and vessels.

The observing subsystem

Design rationale. The basic design of an RCOOS for the SE US coastal ocean has to take into account a number of key geographic and physical characteristics of the region that control coastal ocean processes. These include:

- The presence of a western boundary current system (the Loop Current-Florida Current-Gulf Stream) along the shelf margin throughout most of the FL-GA-SC-NC coastal ocean, including the influence of its meandering jet and front and the mesoscale eddies it sheds;
- A wide range of shelf widths, from <10 km to >100 km;
- Several major estuaries and coastal lagoons that exchange physical and biogeochemical properties and biota with the open shelf;
- Variable input of freshwater to the coastal zone from distributed SE river (and groundwater) sources, with the additional influence of the Mississippi River on the region;
- Seasonal patterns of heating and cooling;
- The influence of synoptic weather systems, and especially major episodic storm events, including easterly waves and tropical cyclones in summertime and extratropical cyclones and frontal systems in wintertime, in producing coastal upwelling and downwelling and other transient flows;

- A highly variable diurnal and semidiurnal tide regime that is dominant in certain shallow water regimes.

The coastal ocean is inherently variable in time and space, thus a central objective of the RCOOS must be estimation of the fundamental properties (state variables) that characterize the condition of the coastal ocean, and are required for forecasting its future state. Oceanic variables include temperature, salinity, density, sea level height, pressure and velocity. Atmospheric variables include surface winds, surface heat and moisture fluxes, and sea level barometric pressure. Necessary boundary conditions for characterizing and forecasting the physical state of the coastal ocean also require estimates of net surface heat flux (measurements of short- and long-wave surface radiation, air and surface sea temperature, and relative humidity) and freshwater fluxes (evaporation, precipitation, river discharge, and groundwater discharge in some areas).

Since ocean processes are three-dimensional, time-dependent, and occur on many space-time scales, no single measurement system (*in situ* or remote) will be sufficient for describing any of the ocean state variables. A "multi-platform, multi-variable" observational approach will be required, integrated with models (including data assimilation approaches). Furthermore, the fundamental value of continuous time series data should be recognized in the design process, such that real-time telemetry systems are backed up with internal recording of data, and so that delayed-mode and historical data are also integrated into the regional data management structure.

Coastal Stations. Existing coastal stations, largely established by NOAA (NOS/CO-OPS NWLON and NWS/NDBC C-MAN), USGS. NPS, ACOE, etc. are geared primarily to sea level and coastal meteorology. These stations provide a solid foundation for further development of shore stations by the RCOOS, which should be approached in coordination/partnership with the NOAA and USGS entities and state and local coastal management and emergency response agencies. Augmentation of water level stations at commercial ports is warranted, since even small changes in water depth can impact the efficiency and safety of deep-draft vessel operations. Further regional partnering with the NOAA CO-OPS PORTS program could be an effective approach in this area. In terms of spatial coverage, there is a need for sufficient coastal water level stations to assess the predictive skill of both (1) high-resolution coastal inundation models, and (2) lower resolution coastal ocean circulation models. For coastal inundation/storm surge applications, there is a practical need to "over-sample" sea level, since many stations are subject to failure of instruments or communications during major storm events.

EEZ Assets. As noted above, the SECOORA domain includes regions with very narrow shelves (near DeSoto Canyon, Cape Hatteras and the SE Florida shelf from Key West to West Palm Beach) as well as broad, gently sloping shelves (off West Florida and in the central South Atlantic Bight). Obviously the deployment of observational assets will have to take this variability in shelf width and coastal ocean properties into account. For the broader shelf sub-regions, three basic sub-domains can be defined:

- A baroclinic outer shelf/slope zone where the physical state is directly influenced by the boundary current (Loop Current/Florida Current/Gulf Stream);
- An intermediate/mid-shelf zone, where circulation is largely forced by winds and tides;
- An inner shelf/coastal zone where the water column is shallow enough that there is interaction between surface and bottom Ekman layers and wind, wave, and tide forcing are significant; in many locations, there is also a zone in which the influence of relatively fresh estuarine outflows leads to buoyancy-driven alongshore flows

Based on the above considerations, a "strawman" array of moored or fixed platform offshore observing elements distributed over the SECOORA domain is advanced (Fig. B1). This consists of a series of cross-shelf deployments, at roughly 100 km spacing in the along-shelf direction, and linked, to the extent possible, to seaports, major topographic anomalies, and other special features. The along-shelf spacing of 100 km is needed to resolve variability in the circulation; many features of coastal circulation in the southeast occur at this scale or smaller (e.g. Florida Current and Gulf Stream meanders). For all but the narrowest shelves, each cross-shelf section would have three measurement sites, supplemented in the near-shore with additional deployments at major locations of estuarine outflow or population centers. The core set of instrumented buoys or platforms should all be equipped for measurements of temperature, salinity, current, wind, and some should be equipped to determine directional waves and net surface heat flux. Coordination with the National Backbone will be critical to deploying and maintaining an adequate array of slope and deep-water moorings, and a leading role for NDBC and associated federal agencies in establishing this portion of the regional network will be strongly encouraged by SECOORA.

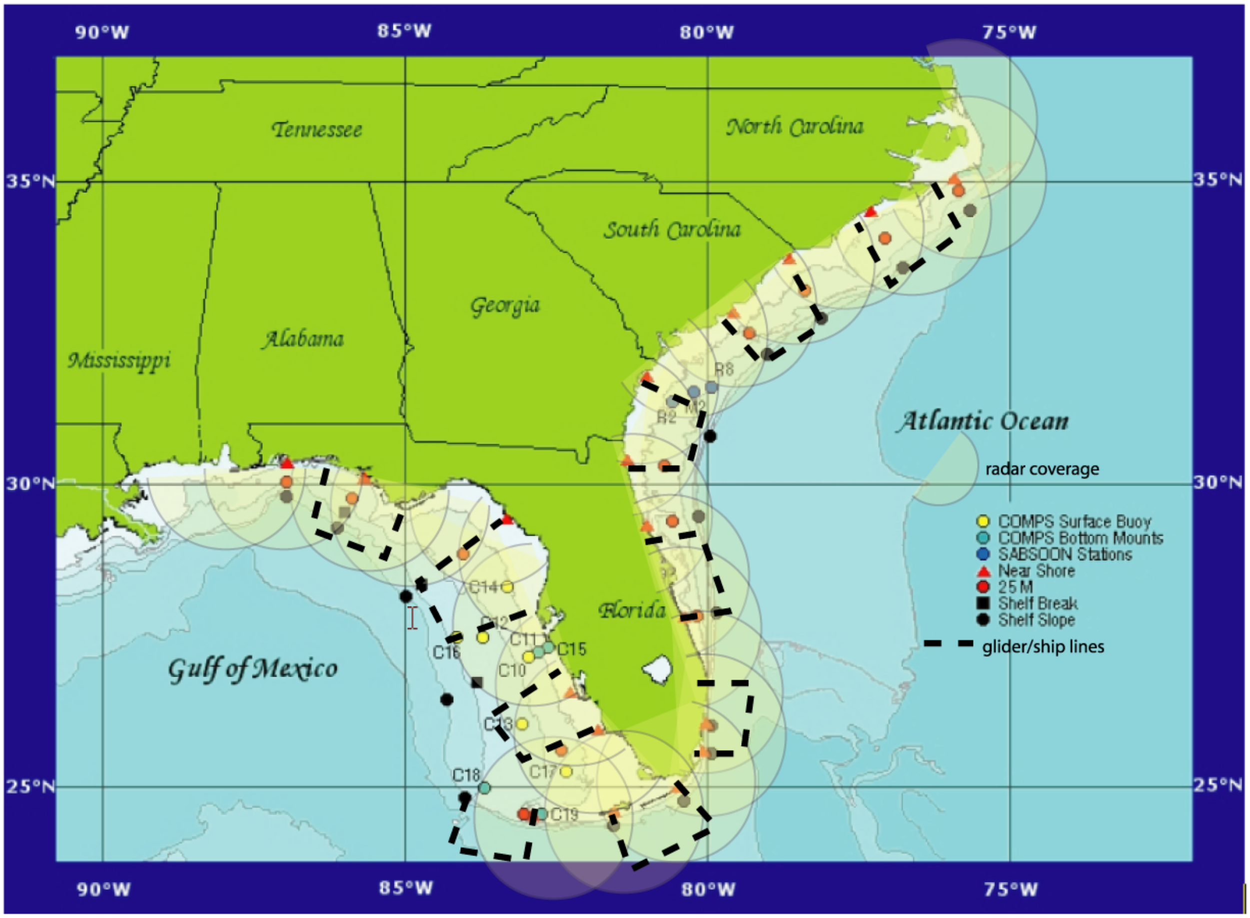

Figure B1 - schematic representation of the observing subsystem asset distribution of fixed platforms/moorings, coastal radar and glider/ship survey lines.

Additional moored and fixed platform *in situ* assets (not represented here) will be positioned in areas of regional and local interest (e.g., major ports and shipping lanes, inshore areas subject to shoreline erosion and rip currents, and Marine Protected Areas). Measured variables at these sites will necessarily be tailored to the local applications (e.g., directional waves, wind, and nearshore currents). There will also be a need for strategic (or "targeted") observational arrays in critical locales to support the requirements of data assimilation. It is recognized that the RCOOS should provide some discretion in the organization of observational resources to serve local needs, and to best exploit available resources and infrastructure, including that supported by the National Backbone and state and local agencies.

Full water column measurements of current, temperature and salinity in each of the three coastal ocean regimes defined above are necessary to specify the flow and density fields. The surface and bottom Ekman layers warrant particular attention given their roles in cross-isobath exchange. Full water column measurements are also required to assess key processes, including boundary current interactions on the shelf-slope, exchange at the shelf break between the coastal ocean and the deep ocean, coastal responses to local wind forcing, and direct estuarine interactions with the coastal ocean.

Another essential observation throughout the coastal ocean domain is surface winds. Due to the complication of land-sea interactions, the quality of numerical weather predictions over the coastal ocean can often be compromised. Most *in situ* moorings or platforms should therefore be equipped with surface wind and barometric pressure sensors. The complete suite of sensors required for heat flux estimates (incoming short- and long-wave radiation, air and sea temperatures, relative humidity) should be supported at a distributed subset of the offshore sites.

Other ancillary measurements are recommended (although not required at all sites), the foremost among these being surface waves. Directional wave spectrum measurements at the shelf slope can provide the boundary conditions needed for coastal ocean wave models, and wave measurements nearshore can be used both to gauge the performance of these models and provide real-time data of immediate societal importance. Provisions for incorporation of additional chemical, geological and biological sensors, as these evolve, should also be included in the design of instrument, power, and communications packages.

Coastal HF Radar. Coastal HF radar mapping of surface currents provides one of the more important of the potential RCOOS measurement systems, offering a field of surface velocity vectors as opposed to the point measurements of fixed offshore assets. Two commercially available systems are operating in the SECOORA domain, CODAR and WERA, each offering varying range and resolution based on frequency and bandwidth. HF radar remains a topic area where the RCOOS can play an important role in technology assessment. Given the widely varying shelf width off the SE, and thus distance from shore to the boundary current front, it would be prudent to assess performance of the four HF radar testbeds now within the SECOORA domain before investing to provide coverage over the entire region. In addition to surface currents, continued evaluation of other potential products from HF radar (such as directional waves from WERA) should be pursued. The region should explore the use of a nested approach with a shorter-range, higher-resolution radar system embedded in a longer-range, lower-resolution radar system to support nearshore and offshore needs together. The region should also explore deploying radar systems on islands or offshore platforms and directing them shoreward to provide nearshore coverage that is otherwise difficult to obtain.

Satellite Remote Sensing. While not an asset class to be deployed, operated or controlled by the RCOOS, satellite remote sensing (SRS) represents an enormous resource for coastal ocean applications. Sea surface temperature (SST), surface ocean color products (including upper layer chlorophyll and suspended materials), sea surface height (SSH), surface winds and other products from passive and active satellite sensor systems are routinely available. Such SRS information is being used for assimilation into models and for descriptive purposes. While the satellite programs themselves are not an RCOOS function, RCOOS support for utilization of SRS data and production of enhanced products, tuned to regional applications, will provide strong justification for continued federal agency support of satellite missions targeting the coastal ocean. An RCOOS role in the support of regional capabilities for downloading, processing, and distributing satellite data, as well as for analysis products and presentation tools, will be critical for effective integration of the satellite information with *in situ* observations and application in regional modeling programs.

Profilers and Gliders. The conventional method for observing 3D fields of temperature, salinity, and other properties (such as chlorophyll and nutrients) is by ship survey. This method is, however, slow, costly, and typically in violation of the rudiments of sampling theory. Needed are techniques for synoptic mapping at intervals sufficient for assimilation into models, particularly for the internal density (T/S) field. (And there may be a role here for airborne surveys, particularly in a tactical mode.) Through a combination of profiling floats, moored profilers, and gliders it is possible to obtain regular mapping of the vertical and horizontal T/S structure, as well as that of other variables with the addition of appropriate sensors. Several systems are presently being assessed in field trials in the SE. As with HF radar, an important role for the RCOOS will be to conduct pilot, testbed projects to evaluate promising new observational technologies, such as various profiling systems.

Ship Transects. As the emergence of long-awaited, robust, accurate, automated biogeochemical sensors continues to be substantially delayed, it will be necessary to include some repeated, quasi-synoptic shipboard surveys. However, they should be designed, conducted, and analyzed in an optimal fashion together with the deployed observational elements, real-time prediction systems, and knowledge of sampling theory and natural variability. The university-based TRANSECTS program is a useful model of how a program may be implemented to serve a variety of purposes. As noted above, there may also be a role here for airborne surveys equipped with remote sensors, expendable profilers, and other air-deployable systems.

Volunteer Observing Ships. With the large volume of commercial shipping and recreational boating activity in the SE, it may be possible to obtain valuable, random coverage by installing automated instrumentation packages, as has been done in the International Sea Keepers program on a global scale.

Surface Drifters. Satellite-tracked surface drifters provide a quasi-Lagrangian view of surface circulation and, with caveats regarding their performance relative to Lagrangian trajectories (not necessarily surface-confined), provide excellent tools for surface trajectory analyses. And they are essential for establishing the error attributes of the predicted trajectories; conversely, they are invaluable for estimating the dispersive properties of varying coastal ocean circulation regimes. Nearshore deployments can be useful for filling data gaps in coastal HF radar coverage, and for examining connectivity between adjacent estuaries and sources of fresh water along many sections of the SECOORA domain.

The modeling subsystem

Because there do not presently exist mature regional-scale modeling systems we propose that the initial focus be on creating, testing and operationalizing model systems to predict the physical state of the coastal ocean and marine atmosphere. The three components to be emphasized are circulation modeling, mesoscale atmospheric modeling, and surface gravity wave modeling. In all cases, adequate resolution to address specific application is to be achieved through nesting of regional or subregional scale model within national model systems.

How best to achieve adequate resolution will need to be determined through thorough testing but at a minimum there should be some redundancy in effort. It is proposed that three modeling groups in each of the modeling components be supported initially.

The information management subsystem

Experience has shown that an information system which engages distributed information providers through standards to promote interoperability can provide a viable regional information management system. The common terminology for this type of construct is a services oriented architecture. Each of the observation and model data providers will be required to adhere to a set of standards and practices that enable information exchange among and between all the of partners. There is also a need to have a central aggregation site, or hub, that is the clearing house for standards and which maintains a database of the aggregated information. This central hub need not be physically located in a signal location but does require a single presence on the internet. Because of the volume of information involved and because of the dangers posed by hazards, it is strongly recommended that there be at least two physical locations that can support the central site activities. The two sites enable a minimum level of redundancy and fail-over capability in case of interruptions in services. The SECOORA Ocean Data Partnership adheres to these concepts and should be encouraged to enhance these recommendations.

The Existing System Elements

The observing subsystem

Introduction. To date, the development of the programs supporting the design, deployment, operation, and maintenance of the observational sub- systems has proceeded in an *ad hoc* fashion. While significant gaps still exist for spatial coverage and variables monitored, there has been an expansion of observational assets in the SE coastal ocean in recent years. The existing elements of the regional observational sub-systems are briefly reviewed below, focusing on sites that provide real-time observations of the coastal ocean and/or coastal atmosphere.

National Backbone Observing Subsystem. As outlined in the Second IOOS Development Plan (hoping for approval in FY06), a dozen or so federal agencies will contribute important *in situ* and satellite remote sensing observational components to the National Backbone. The National Oceanic and Atmospheric Administration (NOAA) and US Geological Survey (USGS) are the major sources of physical observational data for the U.S. coastal zone and coastal ocean. NOAA's operational platforms in the SE are the responsibility of the National Data Buoy Center (NDBC, *http://www.ndbc.noaa.gov/*) under the National Weather Service (NWS) and the Center for Operational Ocean Products and Services (CO-OPS, *http://co-ops.nos.noaa.gov/*) under the National Ocean Service (NOS) (Figure B2). The NOAA NDBC now also imports appropriately formatted observations from non-NOAA entities, with data checked for quality and passed on to the Global Telecommunications System (GTS) of the World Weather Watch. Important satellite remote sensing information for regional applications is also obtained from various NOAA and NASA programs.

Figure B2 - distribution of real-time NOAA assets in the southeast US.

Major components of existing federal observational networks that will contribute to the National Backbone in the SE region include:

- NOAA NDBC meteorological buoys.
  There are presently eight shelf or slope buoys and five deep-water buoys in the SE coastal ocean. These are primarily marine weather stations, reporting surface meteorological variables, sea surface temperature, and significant wave height. Several buoys also make directional wave measurements and NDBC has added salinity measurement and current profiling capabilities at two buoys in the South Atlantic Bight.
- NOAA NDBC Coastal-Marine Automated Network (C-MAN) stations.
  These are fixed platform or shore stations, at eighteen sites in the SE. These are primarily weather stations, with some sites also reporting surface ocean conditions (including sea temperature, salinity, water level, and significant wave height). Six stations in the Florida Keys have been enhanced with additional sensors (e.g., dissolved oxygen) through the SEAKEYS program (Florida Institute of Oceanography in cooperation with NDBC).
- NOAA CO-OPS water level stations.
  Part of the National Water Level Observation Network (NWLON), water level is reported from thirty-eight sites in the SE. Many also provide meteorological observations.
- NOAA National Estuarine Research Reserve (NERR) monitoring sites.

The NERR program, with seven reserves in the SE region, is actively expanding ongoing monitoring efforts to include real-time observations.

- USGS river gauges.

  As part of an extensive national network, some fifty-six USGS stations provide on-line, real-time information for estuarine and coastal sites in the SE. In addition to stream flow and/or water level, many sites also report meteorological and water quality variables.

Several subregional observational programs are also operated by federal entities in the SE, including:

- The NOAA Atlantic Oceanographic and Meteorological Laboratory (AOML) South Florida Ecosystem Research and Monitoring Program.

  Part of a coordinated effort with federal and state programs associated with the Florida Bay and Everglades restoration programs. It has now evolved into the South Florida Real-Time Observing System (SF-ROS).
- The NOAA AOML Western Boundary Current time series.

  Submarine cable measurements, supported through the NOAA Office of Global Programs, provide daily mean transport estimates for the Florida Current at 27N.
- The U.S. Army Corps of Engineers Field Research Facility (FRF).

  Located at Duck, NC, the FRF specializes in nearshore measurements, including directional waves.

Regional Observational Subsystem. A number of real-time observational sub-systems in the SE US are operated by academic institutions, several through inter-institutional partnerships. The addition of these regional systems has contributed considerably to the national observing assets, both in terms of spatial coverage and in the range of variables measured. Programs presently providing real-time *in situ* and remote sensing observations (coastal HF radar, as well as up-to-date satellite data retrieval/processing) are listed below:

- The Southeast Atlantic Coastal Ocean Observing System (SEACOOS) is a partnership that has linked several pre-existing subregional programs operated by academic institutions:
  - The Coastal Ocean Monitoring and Prediction System (COMPS) operated by the University of South Florida (USF) maintains a network of buoys, shore stations and coastal HF radar sites, using CODAR. USF also operates the Physical Oceanographic Real-Time System (PORTS, a NOAA/NOS CO-OPS program) in Tampa Bay, and through its satellite download and processing facilities, the USF Institute for Marine Remote Sensing (IMARS) contributes up-to-date satellite imagery and analysis products to the SEACOOS data portal. Through its Center for Ocean Technology (COT), USF has also developed a Bottom Stationed Ocean Profiler (BSOP) for automomous profiling of temperature, salinity, and other coastal ocean variables. Imagery from both IMARS and other satellite data providers is also used for a variety of circulation-related products.
  - The University of Miami operates a coastal HF radar testbed using WERA in SE Florida, providing real-time surface current coverage over the width of the Straits of Florida, as well as evaluation of HF radar performance and potential new products (including directional waves). As part of the testbed, UM has been

developing an autonomous, telemetric profiling CTD/ADCP system (called SWAMP).

  - The South Atlantic Bight Synoptic Offshore Observational Network (SABSOON), maintained by the Skidaway Institute of Oceanography (SkIO), utilizes the infrastructure of a set of offshore Navy towers (part of a flight training range) to make real-time meteorological and oceanographic measurements. SkIO has also partnered with the Georgia Institute of Technology (Savannah campus) for the deployment of a near-shore directional wave buoy near the Savannah River entrance.
  - The University of South Carolina (USC) maintains two stations in SC for near-shore directional wave and current measurements. USC is also partnering with SkIO in the deployment of a coastal HF radar system using WERA for the central SAB off SC and GA.
  - The University of North Carolina operates the North Carolina Coastal Ocean Observing System (NCCOOS) which includes a coastal HF radar system using CODAR on the Outer Banks and a buoy near Cape Lookout, and has deployed an autonomous meteorological package on one of the Navy towers off GA.

- The Carolinas Coastal Ocean Observing and Prediction System (Caro-COOPS).
  Caro-COOPS is a partnership between the USC, North Carolina State University (NCSU), and the University of North Carolina, Wilmington (UNCW). Five offshore moorings reporting real-time meteorological and oceanographic data and three shorebased meteorological stations are presently maintained. The latter include water level gauges installed in coordination with NOAA CO-OPS.
- The Coastal Ocean Research and Monitoring Program (CORMP) is a partnership between UNCW and NCSU.
  CORMP is expanding an existing monitoring program to include real-time observations. Presently three real-time buoys and one pier station report in the Cape Fear/Onslow Bay area of NC, and an additional buoy is scheduled for deployment in early 2006 (?????). One of the buoys has been deployed in partnership with NDBC and the Marine Corps base at Camp Lejune, NC.

Several other institutions and organizations are presently providing real-time observations in the SE, including the Florida Department of Environmental Protection (directional wave and wind measurements at Melbourne Beach, FL), and Florida Institute of Technology (meteorological and directional wave information at Sebastian Inlet, FL). A number of coastal weather stations operated by WeatherFlow Inc. in the region make real-time, but proprietary, observations.

There will be a growing demand for environmental and ecological information from the estuaries, coastal lagoons, etc. There is much activity and many actors in such domains already, so there will be complexity in adding a regional perspective to the approaches now in play. However, this will be an area of long-term growth in demand, and, thus, an unavoidable opportunity for SECOORA and its RCOOS.

The modeling/prediction subsystem

Introduction. As with observational systems, the federal agencies, primarily Navy and NOAA, will provide operational model products on a national scale with regional resolution as part of the National Backbone. The various RCOOSs will downscale those model products (by nesting) to the much higher resolution necessary to address processes and phenomena of importance within the regions. When SEACOOS commenced in 2002, there was only one National Backbone operational model product available, the Regional Ocean Forecasting System (ROFS) from NCEP. Its domain extends from north of the Straits of Florida to the Canadian Maritime Provinces. Due to its uncertain quality, and lack of outside community involvement, it has not been often used except for preparing Gulf Stream frontal analyses downstream of Cape Hatteras. There were no operational regional prediction systems in the Southeast at that time, although there had been a first-generation system at UM for the Straits of Florida a decade earlier.

National Backbone Modeling/Prediction Subsystem. A coherent effort has yet to be made to define the National Backbone for COOS modeling/prediction systems. However, in an *ad hoc* fashion, an initial, partial capability has emerged recently. For example, the Global Navy Coastal Ocean Model (Global NCOM or G-NCOM) has been running as a quasi-operational prediction system for a few years at NAVO, and, since 1 OCT 04, its output has been available to the civilian community through NCDDC; it was officially declared operational in FEB 06.. Similarly, in late DEC 05, NCEP declared its Atlantic-HYCOM (Hybrid Coordinate Ocean Model) prediction system operational, complete with disclaimers related to uncertainties in the quality of its initial implementation. In parallel, the Coast Survey Development Laboratory (CSDL), together with the Center for Operational Ocean Products and Services (CO-OPS), both of NOS, has been implementing operational estuarine models and prediction systems, and now shelf models and prediction systems. Within the SECOORA footprint, they have partially functional systems in Tampa Bay and St. Johns River.

Regional Modeling/Prediction Subsystem. In view of the relatively large size of the SECOORA domain, its complexity, and the distributed modeling expertise in the region, the SEACOOS modeling activity has been organized around three natural subregions: the West Florida Shelf (WFS at USF), East Florida Shelf (EFS at RSMAS), and the Georgia-Carolina Bight (GCB at UNC-CH). The WFS, EFS, and GCB models have been implemented in overlapping domains for several numerical and dynamical reasons, not the least of which is that it facilitates cross-validation activities. The modeling focus has been on circulation modeling for the stratified, open coastal ocean (continental shelf and slope), though there is some effort in tidal and storm surge modeling and estuarine modeling. The emphasis has been on implementing, evaluating, and evolving quasi-operational (i.e., automated, continually operating) baroclinic nowcast/forecast systems with mesoscale-admitting resolution of several km or less. Because the shelf regions are so strongly forced by "weather cycle" winds and atmospheric pressure, as well as tides, the forecasts are made for a few days, coinciding with the extent of high mesoscale atmospheric numerical predictability.

The circulation models are forced by (1) the eight principal tides (four diurnal and four semi-diurnal) with tidal amplitudes and phases on open boundaries determined from community global tidal models; (2) synoptic surface atmospheric pressure, surface winds, and surface heat flux determined from operational numerical weather predictions by the NCEP NAM-eta model (12 km, 1 hr) with 84-hr forecasts updated 3-hourly; and (3) open boundary conditions from either climatology initially and now synoptic basin-scale or global relatively coarse-resolution models. {River runoff forcing, based on climatology, is also used by some groups. With the availability of real-time runoff data anticipated in the foreseeable future, all groups are expected to use such synoptic freshwater discharge data.} The three subregional groups are making Lagrangian surface trajectory estimates and are also making some exploratory efforts with ecosystem and sediment transport modeling. A priority is to continue refining the computational grids to more fully encompass and resolve the nearshore waters, coastal lagoons, and estuaries.

The USF group has utilized the Princeton Ocean Model (POM), Rutgers Ocean Modeling System (ROMS), Finite-Volume Coastal Ocean Model (FVCOM), and the Hybrid Coordinate Ocean Model (HYCOM). The RSMAS group has utilized POM exclusively. The UNC-CH group has utilized the Dartmouth barotropic unstructured, finite element grid model (QUODDY) and HYCOM, plus an unstratified, finite element grid model (ADCIRC) for tidal and storm surge modeling.

Though starting from different historical and technical backgrounds, the three modeling groups have attempted to move ahead in a parallel fashion as much as possible. For example, all groups implemented 3D unstratified (barotropic) wind-driven and tidal-driven models in a quasi-operational fashion. Though this exercise was not fully realistic without stratification and the baroclinic Gulf Stream System, it was useful for bringing each group into alignment with tidal constituents utilized, time synchronization, graphics, etc. It also led to a melded, real-time product on display at the SEACOOS Website, though its practical value is limited to well-mixed zones where the circulation dynamics are dominated by tidal currents and wind-forcing. However, this experience paves the way for the collective display of baroclinic model output with comprehensive dynamics and ocean phenomena. Additionally, model output is available by ftp in NetCDF format for “super users” from the DODS servers in the individual modeling institutions.

Presently, USF is running a baroclinic WFS-ROMS nested into the NRL 1/12th degree North Atlantic-HYCOM (known as COMPS) quasi-operationally with 84-hr forecasts using weekly updates of open boundary conditions from HYCOM and daily updates of local atmospheric forcing and posting results daily on the Web. UM is running baroclinic EFS-POM (known as EFSIS) quasi-operationally with daily updates of 84-hr forecasts of open boundary conditions from NAVOCEANO’S Global-NCOM and posting results daily on the Web. UNC is preparing to run a baroclinic QUODDY implementation nested within a HYCOM sub-domain which supplies initial hydrographic fields and boundary conditions; daily Web-postings of 3-day forecasts for the region from northeastern Florida to the North Carolina-Virginia border are planned.

Much model verification and validation activity, using *in situ* and remote sensing observations, is presently in progress. However, the need in some areas to add more vertical resolution (especially in the surface and bottom boundary layers to support applications models) and horizontal resolution (especially over the inner shelf to address smaller mesoscale eddies and fronts) is apparent. The circulation models need to be extended to cover more of the estuaries and coastal lagoons, and there are ongoing diagnostic studies in some regions that need to be continued. More elaborate ecosystem and sediment transport models will be needed, as well as wind wave, mesoscale atmospheric, and hydrological models. Methods of 4D data assimilation will need to be introduced in the near future for many purposes, including participation in CODAE (Coastal Ocean Data Assimilation Experiment) and the conduct of OSSEs (Observing System Simulation Experiments). However, there is still a shortage of appropriate observations for data assimilation in the SEACOOS domain. Data assimilation at the present time consists of nudging modeled SSTs to observed values in order to correct for incomplete surface heat flux data.

SEACOOS also has other diagnostic modeling programs ongoing for hurricane storm surge inundations (e.g., a Hurricane Charley hindcast for the Charlotte Harbor estuary and hypothetical hurricane simulations for Tampa Bay) and for estuarine and inner shelf interactions (e.g., Tampa Bay and Biscayne Bay).

There are several other coastal ocean modeling efforts in the SE, but not all of them have an operational orientation or even expectation. However, NCSU has an extensive modeling effort focused on storm surge, coastal inundation, wind, and wave prediction. Some elements of this modeling effort are moving towards operational capability in the Albemarle-Pamlico Sound, Charleston Harbor, and the Cape Fear sub-subregion. The NCSU COOS efforts are linked primarily with Caro-COOPS and CORMP. SURA/SCOOP's program for storm surge modeling is another academic quasi-operational modeling activity.

The information management subsystem

Introduction. The Information Management component of the IOOS is fundamental to its entire operation, in that it will provide the network of regional-to-global systems that enables the collection, aggregation, accessing, utilization, archival, and dissemination of data and information products. To advance the IOOS Data Management and Communications (DMAC) Subsystem, it will be necessary to establish a coordinated and cooperative network among the various regional systems and the users of IOOS products. It will also be necessary to establish a range of new capacities to establish this network and ensure its functionality at a range of temporal and spatial scales. The IOOS DMAC is envisioned to comprise the following components (First IOOS Development Plan, 2005):

- Metadata. These data describe data sets for the national system, including development and use of a common vocabulary, identification of required metadata fields, agreement upon sites for publication of metadata, and commitment to publish metadata in a timely fashion.
- Data Discovery. The capacity for searching and locating desired data sets and products and for manipulating accessed data must be established.
- Data Transport. Data and products must be capable of transport over the Internet in a transparent, interoperable manner.
- On-Line Browse. Data must be readily accessed and evaluated through common Web browsers.

- Data Archive. Mechanisms for secure, short-term and long-term data storage must be established.
- Data Communications. The communications infrastructure for accessing and transporting data and data products must be identified and maintained to meet standards..

National Backbone Information Management Subsystem. The various existing federal programs that will help constitute the establishment of the National Backbone; e.g. NDBC, NWLON, NERRS, NCEP, NCDDC, NODC, NCDC, etc. have their own systems for managing data. Substantial work is required to ensure interoperability among these systems and the various emerging RAs. DMAC has provided guidance to facilitate interoperability, but development of coherent protocols, processes, and infrastructure is also required.

Various federal (and state) agencies have important bathymetric/topographic, geological, benthic habitat, socio-economic, satellite imagery, etc. digital databases in the coastal zone suitable for GIS renditions, etc. A need to aggregate them regionally is anticipated, and this may become a National Backbone activity.

Regional Information Management Subsystem. Regional and subregional observing systems in the SECOORA region have established a number of the necessary components described by IOOS DMAC. Where the capability for addressing specific requirements does not yet exist, progress has been made in identifying and characterizing those needs, with a view towards "filling the gaps." In general, efforts focused primarily in SEACOOS, with support from Caro-COOPS, have established a system that enables the aggregation, access, and dissemination of real-time and delayed-mode data from in situ observations, model output, and remotely sensed imagery. This aggregation and subsequent visualization of distributed data requires development of a process that can be utilized by other regional and subregional systems, and can help the community push towards interoperability. The steps being taken to establish this system of aggregated data include:

- Inventory of existing and potential data types.
- Identification of standard data ontologies, file formats, and transport protocols.
- Software for data applications and for interfacing different applications; e.g., Web mapping.
- Database schemas for the variety of data types.

Also essential is the appropriate hardware for the system, at both centralized hubs and distributed data providers. A basic hardware infrastructure is in place within SEACOOS, but this does not include provisions for redundancy and back-up. The prevalence of severe tropical cyclones in the SE, and their frequent disruption of communication and power systems for several days, is a hazard that needs to be taken into account in designing the SECOORA-RCOOS. An offsetting factor is that it would be very rare for a hurricane to disrupt power and communication systems throughout the entire region, especially simultaneously. Hence, there is a possibility of designing a resilient regional system.

The following briefly describes the current status of the required DMAC elements identified by IOOS:

Metadata - The generation of metadata, or "data about data", is essential, but is one of the major bottlenecks in developing a community data management effort. There is a historical reluctance for data providers to document metadata consistently, and the IOOS community has not yet adopted a set of standards and requirements for metadata documentation. A starting point for identification of standards is the Federal Geographic Data Committee approved Content Standard for Digital Geospatial Metadata (FGDC-STD-001-1998) (CSDGM) that is the primary standard for the description of spatial data and is mandated for use by federal granting agencies. However, it is limited in the types of data that it addresses, and its implementation is not "user friendly." Thus, steps are being taken within SEACOOS and Caro-COOPS to enlarge metadata documentation capabilities through consideration of additional standards and markup languages (e.g. Marine XML, SensorML). SEACOOS and Caro-COOPS have also been developing a tool – Meta-Door -- that facilitates the creation of metadata documentation by non-technical (and technical) data providers. The development of the initial phase of Meta-Door (http://nautilus.baruch.sc.edu/twiki_carocoops/bin/view/Metadoor/WebHome) is complete, allowing users to manage their FGDC-oriented record data. The data management community in the SE also needs to interface with other groups addressing metadata standards issues to ensure nation-wide continuity. These include (1) the Cooperative Ocean/Atmosphere Research Data Service (COARDS; http://www.cdc.noaa.gov/people/julia.collins/coop/, a NOAA/university cooperative for the sharing and distribution of global atmospheric and oceanic research data sets; (2) the Open Geospatial Consortium (OGC; http://www.opengeospatial.org/), non-profit, international, voluntary consensus standards organization working on development of geospatial and location-based services standards, and (3) the Marine Metadata Interoperability Initiative (MMI; http://marinemetadata.org/), a relatively new NSF-funded community-based initiative focusing on metadata standards.

Data Discovery -To search and access RCOOS data and information products, it is essential that the metadata are accessible, as in a central clearing house, and that both data and metadata adhere to standards that enable searching and location of desired information. For SEACOOS, some essential standards and protocols have been identified for dealing with the SEACOOS, Caro-COOPS, and CORMP ocean observations data. First, a "draft data dictionary" has been created to provide a standard vocabulary for SEACOOS data. Second, a SEACOOS "NetCDF (network Common Data Form) Standard" has been developed, which describes a set of conventions and standards, including netCDF format categories, required variables, and required and recommended attributes for all data. Adoption of SEACOOS CDL provides sufficient conformity to enable automated search and aggregation tools, and yet is flexible enough to deal with many different data sources and enable data aggregation in near real-time. These "tools" are readily available for use by the broader community.

Data Transport - Data formatting and transfer processes have been assessed and adopted by the SEACOOS and Caro-COOPS data management teams. Advanced protocols that have been assessed, incorporated, or adapted, as appropriate, include the following: assessment of DODS/OPeNDAP; utilization of MapServer Internet mapping techniques for integrated data discovery and display; establishment of both netCDF and Relational Data Base (RDB) DODS servers; and establishment of data transfer processes through GIS or OpenGIS Consortium (OGC) Web Mapping Service (WMS)/Web Feature Service (WFS) protocols.

On-Line Browse - Virtually all observing and modeling subsystems in the SECOORA area have established Web portals for dissemination of data and metadata. These exhibit various levels of functionality and complexity, and available features include the aggregation of (near) real time data and access to a variety of data visualization products such as graphs, maps, and relevant images. Data can be retrieved through specification of parameters and spatial and temporal requirements, and choices are often provided for raw data or a variety of data products. Web sites also often provide information on user applications or links to related sites.

Data Archive - Another major need is the establishment of archival protocols and repositories. Currently data and information products are largely stored at the data providers' institutions. However, the aggregated data and recent model products for SEACOOS are stored on the SEACOOS servers at USC. Data protocols will need to include transfer and storage in national (and perhaps regional and local/institutional) archives, such as the NODC and NCDC. The national strategy for archival of IOOS information remains to be determined.

Data Communications - Communication systems for transport of real-time data and access of data bases are in place via satellite telemetry and the Internet, but these also will need to be enhanced. Multiple satellite technologies are currently in use; GOES and Iridium are currently the primary providers, and improvements can be achieved in two-way communication, reliability, and communication costs. For onshore or nearshore observing sites, cell phone communications may be utilized, which is usually more reliable and cost-efficient. The data transport capacities are uneven among the states in the SECOORA region, and transport of high volume information; e.g., model output, satellite imagery, and coastal HF radar data, may be limited by broadband limitations beyond the control of SECOORA. The IOOS community should encourage enhancement of communication capabilities within the region and nation.

The new SECOORA Ocean Data Partnership (ODP) seeks to establish a region-wide effort in data sharing that leverages the advances made by SEACOOS and Caro-COOPs and which engages are greater set of data providers in the southeast. It proposes to establish a board drawn from the institutions that are a party to the agreement, hire a data management coordinator, and create a technical group that represents the expertise of the partners. The organizational structure follows a successful SEACOOS model and should be readily transitioned to an operational component of SECOORA at the appropriate time.

Recommendations

The several general recommendations immediately below for the overall RCOOS are followed by several specific recommendations for each sub-system. The phased development process for the RCOOS of SECOORA should consider these recommendations. The present document should provide the basis for SECOORA to seek broader input, through an open process, for the design of its RCOOS.

- SECOORA should be attentive to present efforts by Ocean.US to develop community standards and protocols for observational, modeling/prediction, and information management sub-systems, and levels of performance and certification procedures for them, but SECOORA will continue supporting on such efforts in the region while Ocean.US completes its work.

- A Concept of Operations (CONOPS) is urgently needed to complete the initial design of the RCOOS, but it may need to wait until the two NOAA contractor reports are completed by 31 AUG 06, and NOAA announces its response, presumably by 1 JAN 07.. {NOTE: A CONOPS addresses management issues of command and control, responsibility and authority, budgeting and expenditures, program management, degree of centralized versus distributed approaches, etc. It is difficult (or impossible) to define and size the RCOOS without a CONOPS for the National Backbone; for example, the RCOOS could range from a few SECOORA staff members managing a R&D program with $10M p.a. budget for grants and contracts, to an organization of 250 persons running a $50M p.a. in-house regional program. In the latter case, the staff could be a mix of public and private sector employees.}

- SECOORA should become more proactive in advancing the National Backbone because it is the part of COOS the federal agencies are sure to support on a long-term basis, but not necessarily perform in-house.

- The importance of satellite remote sensing to the RCOOS needs broader recognition and its special requirements need to be met via SECOORA.

- SECOORA should advocate for the importance of CODAEs (Coastal Ocean Data Assimilation Experiments) and OSSEs (Observing System Simulation Experiments) to aid it with the evolving design of the RCOOS and the overall systems engineering approach that is likely to come.

- A number of promising application areas have been identified, perhaps especially in the arena of ecosystem-based approaches to fisheries management.. They offer SECOORA the opportunity to taking an experimental ("demonstration") approach, together with users and other providers, to developing its RCOOS using best contemporary scientific practices, and the proven scientific and engineering method of successive iterations.

- In particular, the stage has been set by SEACOOS for SECOORA to initiate, as a pilot project, a set of subregional COOS experimental forecast centers, involving the analysis of *in situ* and satellite remote sensing data and model output in making synoptic maps in order to be ready to address subregional scale events (e.g., red tides). The WFOs, value-added industry, media, and academia should be partners in these experimental forecast centers where, through intereactions with various user communities, valuable experience can be gained for the iterative design of the RCOOS.

- More generally, enough experience has been gained with SEACOOS that a science agenda for SECOORA RCOOS could begin to be developed. Such an agenda will help to guide the development of the RCOOS R&D program.

<u>Observing Subsystem</u>. SECOORA should:

- Coordinate with elements of the National Backbone on the location of additional federal observing assets, in particular for shelf break/slope and deep-water sites offshore, and in the areas of major ports inshore.

- Continue the dialog with NDBC, and develop a dialog with other contributors (e.g., CO-OPS) to the National Backbone, on regional priorities for enhancements of sensor suites on existing *in situ* fixed and moving platforms.

- Coordinate with the National Backbone to secure the core support required to sustain the *in situ* observing component of the RCOOS; critical elements include ship time for deploying and servicing offshore systems and regional calibration centers for at least the basic suite of meteorological and oceanographic sensors.

- Promote robust regional capabilities in satellite remote sensing, including capabilities for near real-time data acquisition, processing and distribution, and help coordinate development and validation of regionally "tuned" satellite remote sensing products.

- With guidance from Ocean.US, ensure that the contributors to the RCOOS meet national standards for data quality and performance.

- To enhance the efficiency of SE observational activities, support technology fora for exchange of information (within the RA and nationally/internationally) on sensors, supporting infrastructure (e.g., power, telecommunications, deployment hardware), and operational procedures.

- Promote new observing system technology; e.g., autonomous vertical profilers, nutrient sensors or shallow water acoustic tomography.

- As part of the RCOOS R&D effort, support regional testbeds to critically evaluate observational technologies, and pilot studies that target specific applications for RCOOS information.

<u>Modeling/Prediction Subsystem.</u> SECOORA should:

- Recognize the importance of, and advocate support for, CODAEs and OSSEs to aid with the evolving design of the RCOOS and the overall systems engineering approach that is likely to come.

- Embrace model/prediction subsystem diversity and appreciate the potential for ensemble forecasting.

- Take a hierarchical, distributed approach to operational modeling/prediction sub-systems. For example, it can sub-sample Global-NCOM (NAVO) and Atlantic-HYCOM (NCEP or

NRL) for regional-scale circulation estimation products. Similarly, even higher-resolution sub-subregional models can use output from subregional models for open boundary conditions.

- Foster the further evolution of modeling/prediction sub-systems; for example, the nesting of very high-resolution inner shelf and estuarine/lagoonal models, the coupling of dynamical models (coastal mesoscale meteorological, coastal hydrological, and coastal wave models), the coupling of (one-way, embedded) applications models (e.g., ecosystem, sediment transport, and wave models), and the utilization of advanced numerical modeling methods (e.g., data assimilation schemes, non-hydrostatic models, and unstructured and adaptive grids).

- Encompass both comprehensive baroclinic operational circulation models (essential for advective and turbulent transport estimates, water quality and ecosystem models, etc.) and integrated barotropic operational tide, storm surge, and wave models (essential for coastal inundation estimates, sediment transport models, etc.).

- Provide output from subregional model/prediction sub-systems (together with in situ and satellite remote sensing observations) to subregional marine forecast centers which should be operated in a partnership fashion with the WFOs, value-added industry, media, and academia.

Information Management Sub-System. SECOORA should:

- Establish an IMS regional "hub" that provides coordination, guidance, and centralized data aggregation, distribution, and storage functions.

- Maintain and strengthen distributed foci of IM expertise at the major observational and modeling sub-system locations. This step will provide in-house management of data, assurance of implementation of standards, and technical support, with assistance from the central "hub."

- Establish at one or two of the distributed foci a back-up site that provides redundancy and insures continuous operations in case of infrastructure failures at the central hub.

- Establish an agreement with a NOAA archive(s); e.g., NODC or NCDC, for long-term security and archival of observational and model data. Separate regional archives are needed for more "specialized" or region-specific data products; e.g., data aggregations, high-resolution model outputs.

- Identify the optimal satellite telemetry system(s) for transmission of real-time data, and establish or secure the necessary land-based connectivity and bandwidth for information dissemination.

- Identify appropriate standards with respect to common vocabulary, metadata format and content, metadata publishing protocol, data formats, and transport protocols.

- Establish a portal that serves as a single site for accessing regional IOOS observational data and model/prediction products, as well as links to other user-targeted portals that utilize/provide specialized treatments of regional data.

Criteria for Participation

A number of institutions/organizations are currently engaged in activities relevant to RCOOS. SECOORA should encourage participation in data exchange but must also ensure that the entities are capable of providing a reliable stream of information. A challenge to be faced is defining which entities should be supported to create the initial RCOOS. Criteria for participation to be considered should include some record of performance; organizations should have at least 1 year to demonstrable experience. For entities that collect observations or run model simulations, there must exist a capacity to manage their data in a manner consistent with RCOOS practices and standards, and the capacity to maintain the resources at least in a pre-operational mode. There should also be a requirement that providers adhere to free and open exchange of data, and that they have a demonstrated commitment to IOOS.

Research and Development

A critical component of the initial system will be assessment and quantification of information quality. SECOORA should support a strong R&D program to utilize the full system – observing, modeling and IM – to characterize the environment in the SE, and any secular changes that may have occurred, through diagnostic studies and to quantify the accuracy of the model products using the available observations. This program should include historical characterizations and data mining activities as a way to identify and include existing information in a regional database. Specific funding to support IM development in this area may be important.

SECOORA should also allocate R&D funding to pursue growth of the system in priority areas identified by its Board. For example, if beach erosion is deemed a high priority for SECOORA and it is found that the existing system is not able to provide the type of information required, a R&D program in this area should be funded to explore the best way to augment the observing system to provide the needed information.

It is recommended that R&D funding be at a level of 20-40% of the operational budget for the RCOOS.

Appendix C: Implementation of the Observations and Data Transmission System

Current State of the Observation and Data Transmission System.

The National Federation of Regional Associations (NFRA) began development of an up-to-date catalog of observing system assets maintained by the non-federal data providers in each of the Regional Associations (RAs). It is recognized that such asset inventories have been compiled in the past, but without a mechanism for continual update, these rapidly become obsolete. The initial NFRA approach will be to ask each data provider to maintain a list and status of assets and make this accessible via the web.

SECOORA is addressing the regional inventory of observing assets through reorganization and upgrade of a prototype system (developed by the SEACOOS program: http://seacoos.org/Research%20and%20Technology/Folder.Observing/Folder.EquipmentInventory). The initial objectives are to:

6. Provide a dynamic equipment and measured variable inventory function (accessible by individual data providers);
7. Facilitate inter-institution collaboration among field engineers and data managers.
8. Incorporate sensor information as metadata; and,
9. Monitor system-wide performance for data delivery and enable display of regularly updated operational status maps for observing assets in the SECOORA region. The link between observations and sensor metadata will enable SECOORA to monitor system performance down to the sensor level
10. Incorporate supporting resources such as those that are needed to deploy and maintain sensors or collect samples, such as ships, coastal facilities suitable for storage, buoy groups, or calibration facilities.

<u>One Year goals</u>.

Core Year 1 goals will focus on development of a dynamic inventory of observations collected within the region, defining the requirements for regional pilot programs to support physical state estimation for the SE coastal ocean (including regional forecasting models for coastal ocean circulation, coastal inundation, surface gravity waves and regional marine meteorology), and initiating a research and development effort in biogeochemical sampling.

- A dynamic SECOORA Sensor Inventory will be established to provide up-to-date maps of regional observing capabilities (locations, sensors deployed, variables measured) and their operational status. This will require development of a new relational database schema to enable the link between metadata and observations and provide the capability to assess the quality of measurements made by specific sensors over time. Input procedures for data providers will be defined that allow for an inclusive regional network, while ensuring that consistent metadata and data quality criteria are applied.
- With the initial goal of supporting physical state estimation, the observational program will establish procedures to specify the fields to be measured, the time and space scales over which the observations must be acquired, specify accuracy criteria for measured variables,

and define the maximum latency of data delivery. An initial definition for core variables to be measured in support of physical state estimation is presented in Table C.1, recognizing that requirements will vary between specific applications.

- Operating requirements for existing observing and data transmission elements will be compiled (e.g., maintenance costs, personnel requirements, equipment inventories). This information will help define what can be achieved near-term and guide allocation of resources for further system development.
- A working definition of operating requirements will be developed. Serious consideration will be given to adopting a form of service level agreement in which data providers and the RCOOS agree to a level of reliability for data delivery. This will need to consider the requirements for frequency of data delivery (e.g., hourly for operational meteorology), which are the key assets, and what proportion of these need to be online at any given time. This definition (or set of definitions) will be critical to decisions regarding allocation of resources (e.g., priority observations, where redundancy is critical), setting longer term goals, and defining expectations for users.
- In coordination with other SECOORA working groups, multi-year R&D pilot programs for establishing the accuracy of physical state estimation, and enhancing observing capabilities for biogeochemical and ecological applications will be initiated, following a similar process of evaluating present capabilities, defining key variables, and what is required for achieving sustained observations of these fields.

Table C1. An initial list of "core" *in situ* variables and specifications for physical state estimation 1

Variable	Spatial Resolution		Temporal Resolution	Accuracy General	Accuracy Applic^{n} specific	Latency General	Latency Applic^{n} specific
Tier 1 Priorities	Horizontal	Vertical (*In-water variables*)					
Current Speed and Direction	For point measurements ≤100 km at shelf break; inlet-scale inshore	At minimum surface and near-bottom. Mid-water for mid-shelf and deeper. At 1 m intervals for shelf where possible	1 hour	1.5 cm/s			
Water Temperature	≤100 km at shelf break; inlet-scale inshore	Near-surface at all locations; near-bottom and mid-depth where possible; vertical profiles in zones of frequent stratification as possible	1 hour	0.1 ˚C			

Salinity	≤100 km at shelf break; inlet-scale inshore	As for water temperature; coincident measurements to the extent possible	1 hour	0.1 PSU			
Water Level	Approx. 50 km intervals along coast; higher resolution at key locations (e.g., ports)	-----------	1 hour routine; 6 min for EM planning	1 mm			15 min for EM applications
Directional Waves	≤100 km at shelfbreak; finer resolution inshore according to local issues (erosion, alongshore transport, beach nourishment)	-----------	1 – 6 hour	1 cm			
Winds	≤100 km along shelfbreak; ~ 30-50 km across broader shelves; ~ 50 km along coast	------------	1 hour;	0.3 m/s; 3 degrees			

Tier 2 Priorities							
Air Temperature	Distribution as set for standard met pkgs	------------	1 hour				
Barometric Pressure	Distribution as set for standard met pkgs	------------	1 hour	0.1 mbar			
Relative humidity	Distribution as set for standard met pkgs	------------	1 hour	1%			
Precipitation	Distribution as set for standard met pkgs	------------	1 hour	1 mm / hr			10 min accumulation rates for EM
Short- and long-wave solar radiation	< 100 km alongshelf; cross-shelf coverage at ~30-50 km; co-located with air and surface water temperature	------------	6 min collection; hourly transm.	3% / 10%			

Photosynthetically available radiation	< 100 km alongshelf; cross-shelf coverage at ~30-50 km	------------	6 min collection; hourly transm	5 μmole photons / m2 / s			
Dissolved oxygen							
Nutrient concentrations							
Water quality parameters							
Species-specific distribution and abundance							

Five Year vision.

The pilot program has established definitions for operational requirements and a framework and process for further systematic development of regional observing capabilities.

- Transition of the more robust elements of the observation and data transmission network to an operational basis proceeds, and improvements in overall capabilities are pursued through ongoing, systematic analysis of data gaps (locations, variables, space and time scales), the performance and servicing requirements for sensors and the supporting infrastructure, and maintenance/servicing procedures.
- Core logistic and infrastructure support has been developed in coordination with elements of the National Backbone. This includes regionally available and flexibly scheduled vessel support for maintenance operations and calibration facilities for key sensors.
- A regional pool of experienced engineering and technical support personnel has been established.
- Targeted applications of information from the physical forecasting models are developed in coordination with elements of the National Backbone and regional users.
- Initial R&D efforts targeting improved observational capabilities to support ecological and biogeochemical models will provide the basis for moving these technologies to a more operational basis, again with primary emphasis on data that is critical to validation and calibration of these models.
- A virtual operations center will provide automated monitoring of system components and measure system performance through time. This information will provide the basis for on-going evaluation of system components and identification of priority targets for system upgrades.

Gap analysis

An initial gap analysis of observational components shall be performed for physical state estimation based on a comparison of perceived needs in Year 1 of the program with the inventory of existing assets, and operational requirements defined for delivery of key variables (Appendix B provides an estimate of initial needs). The subsequent pilot program(s) will better define the requirements through testing and application of information to specific applications, allowing a re-evaluation in Year 5. A similar gap analysis for non-physical observed variables can proceed as initial models are developed and inventories of regional assets are completed.

Controls

The observations and data transmission sub-system is intended to provide robust and flexible data collection and delivery system tailored to regional and local needs. Requirements for routine maintenance, along with the need for timely response to adaptive or tactical sampling collection and non-routine trouble-shooting and repairs suggests that a distributed network of support teams along the coast with the necessary infrastructure should be funded. A distributed system for operational support would ensure some redundancy in services that will be needed to ensure a robust response to extreme events, but should be weighed against the cost savings associated with a more centralized support team. Considerations should include to location and availability of vessel support, onshore infrastructure to house and maintain sensors, engineering and technical personnel, and demonstrated capabilities in maintaining ocean observing platforms and sensors. There is an expectation that data providers will also ensure consistent metadata and QA/QC procedures are followed.

Performance Measures

Basic system performance metrics will be provided by the updated regional equipment inventory/data delivery tracking system (see Table C2 for a short list of possible metrics). Within this framework, a virtual operations center should be established that monitors the observing and data transmission system in real time and provides feedback to data providers and institutional data managers. Data gaps can be flagged and providers notified that data is not flowing from their system. Weak links in sensors, supporting infrastructure (e.g., power, data acquisition systems, mechanical systems) and in the communications stream may thus be identified, allowing targeted evaluation and upgrade of specific system components. With data failure information stored and linked to sensor metadata and the observations, queries can be constructed to assess performance on a more detailed basis. With additional code development, problems could be tracked and automatically logged to the levels of individual sensor function, instrument package performance, data transmission, database population and data re-distribution.

Table C2 - short list of possible metrics

Metric
number of reporting observing platforms/number of sensors per platform
number of observations reported per unit time (e.g. month) per sensor per platform
transmission delay
accuracy level by measured variable
number of data streams including QA/QC flags

3.2.1.6 Issues

Cost- and time-effective development of a robust observation and data transmission capabilities for the SE will require close coordination with elements of the National Backbone and effective information exchange among the technical and engineering personnel within the region.

Mechanisms for ensuring such communication and coordination must be established. Key issues for coordination with the National Backbone and among regional partners include:

- location of observing assets, particularly for shelf break/slope and deep-water sites offshore, and in the areas of major ports inshore;
- continued dialog on regional priorities for enhancements of existing fixed and mobile platforms;
- ensuring that there will be adequate core logistical and infrastructure support for the RCOOS *in situ* components, including ship time and small vessel support (deployment, routine maintenance and available for unscheduled repairs), engineering support for power, communications and mechanical systems, and regional calibration centers for at least the basic suite of meteorological and oceanographic sensors;
- promoting robust regional capabilities in satellite remote sensing, including near real-time data acquisition, processing and distribution of satellite products; and coordinated development and validation of regionally tuned algorithms for satellite products;
- promoting development and field tests for new observing system technologies;
- support of regional test-beds for critical evaluation of observational technologies in sustained operation and to support pilot studies targeting specific applications of RCOOS information;
- ensuring that a sufficient pool of trained technical and engineering personnel is available and can be reliably supported.

Appendix D: Data Management and Communication

In support of the Integrated Ocean Observing System (IOOS), the OceanUS Data Management and Communications (DMAC) Steering Team recommends the establishment of regionally-based data and information management systems, which address both the national priorities identified by OceanUS and the needs of regional partners. As there is an enormous volume of near-real-time and historical data available from instruments measuring and monitoring the ocean and coastal waters and air of the southeastern US, the management of these widely distributed data requires a sophisticated system that can organize, retrieve, aggregate, document and disseminate data and derived information for a variety of purposes and applications.

The Information Management (IM) component of the IOOS is fundamental to its entire operation, in that it will provide the network of regional-to-global systems that enables the collection, aggregation, accessing, utilization, archival, and dissemination of data and information products. To advance the IOOS Data Management and Communications (DMAC) Subsystem, it will be necessary to establish a coordinated and cooperative network among the various regional systems and the users of IOOS products. It will also be necessary to establish a range of new capacities to establish this network and ensure its functionality at a range of temporal and spatial scales. The IOOS DMAC is envisioned to comprise the following components (First IOOS Development Plan, 2005):

- Metadata. These data describe data sets for the national system, including development and use of a common vocabulary, identification of required metadata fields, agreement upon sites for publication of metadata, and commitment to publish metadata in a timely fashion.
- Data Discovery. The capacity for searching and locating desired data sets and products and for manipulating accessed data must be established.
- Data Transport. Data and products must be capable of transport over the Internet in a transparent, interoperable manner.
- On-Line Browse. Data must be readily accessed and evaluated through common Web browsers.
- Data Archive. Mechanisms for secure, short-term and long-term data storage must be established.
- Data Communications. The communications infrastructure for accessing and transporting data and data products must be identified and maintained to meet standards.

The Southeast Atlantic Coastal Ocean Observing System (SEACOOS) was originally established to coordinate coastal observing systems in the southeastern US, and create the capacity for meaningful assembly, integration and dissemination of data and information from these systems. With an initial scientific focus on the development of the capability to observe and accurately model the time-varying three-dimensional circulation and state fields in the coastal ocean from the Outer Banks to the west Florida shelf, an IM component was identified as a priority to enable the integration and interfacing of the observation, modeling, and user application components of SEACOOS. With the transition of SEACOOS towards the implementation of a RA structure, the IM component of SEACOOS has transitioned to SECOORA.

The primary components of the IM infrastructure are the data inputs (in situ observations, remotely sensed data, and model output), the stepwise processes applied to the data (aggregation, analysis, visualization and delivery of data and model output), and the various user-defined products and tools derived from the data. Essential to this IM effort are the development of standards, processes, and protocols to ensure consistency and quality of information and the development of appropriate interfaces, such as web platforms, for delivery of a variety of applications to an equally diverse variety of users.

Metadata –

The generation of metadata, or "data about data", is essential, but is one of the major bottlenecks in developing a community data management effort. There is a historical reluctance for data providers to document metadata consistently, and the IOOS community has not yet adopted a set of standards and requirements for metadata documentation.

Metadata support several activities across the IOOS Enterprise, most notably:

- Asset Discovery
- Asset Management
- Asset Exploitation

The term "asset" is used instead of "data", since within the IOOS Enterprise, there are many assets that can leverage metadata in addition to data/information products. Such assets include but are not limited to:

- Observations
- Data products
- Information products
- Services
- Tools
- Models
- Programs/Projects
- Algorithms
- Instruments/Sensors
- Data Centers/Archive Centers

A robust metadata philosophy will encompass all such assets.

The content requirements for each of the three activities are not completely orthogonal, and, as a result, once the metadata are generated for one activity they can be exploited for any one of the others.

Asset Discovery

Discovery of IOOS Assets is typically mediated though the interaction with some sort of registry.

Asset Type	Registry Description	Metadata Characteristics
Observations, Data Products, and Information Products	Typically, the search for data or information products takes one of two forms. 1) A user may first query a registry that contains high-level descriptions of datasets, products, or systems to find out what is available (This type of registry is often called a **Directory** or **Clearinghouse**) . Once datasets of interest are identified, that user then queries an **Inventory**, which contains the spatial and temporal characteristics of each member (granule) in the dataset. Sometimes the distinction between Directory and Inventory is blurred and a single query at the high level registry returns information on specific granules. 2) In the second case, when a user knows the dataset or system that he/she wants to query, the user interacts directly with the inventory registry first.	The DMAC Expert Team on Metadata and Data Discovery examined several metadata catalog services available for use as initial systems for publishing of high-level IOOS metadata. The four systems are identified for initial use include: the Federal Geographic Data Committee (FGDC) **National Spatial Data Infrastructure (NSDI) Clearinghouse**; the **geodata.gov portal** operated in support of the Geospatial One-Stop (GOS) Initiative; the **Global Change Master Directory (GCMD)**; and the **Ocean Biogeographic Information System (OBIS)**. Discovery Metadata include but are not limited to: • Title • Originator • Keywords • Spatial extent • Temporal extent • Online resource URL (http, ftp, telnet, etc.) • Access constraints • Data set format
Services	Service registries can be accessed in a number of ways. Most can be accessed via a Web interface, so if one is looking for a service or type of service, one can use a service registry like a typical search engine, entering keywords and reading	The first major standard to appear was **UDDI (Universal Description, Discovery and Integration),** which was designed mostly with

	textual descriptions of each service. However, many registries are designed to permit a second mode of use, where services are described in a machine-readable way. This means that, should one service become unavailable, the systems that were using that service can search the service registry for a second, compatible service that could be used in its place. We expect that over time, many existing applications and tools will be recast within a Services Oriented Architecture paradigm making the Services Registry even more robust	SOAP-based Web services in mind. UDDI metadata include • Name of service • Description of functionality • Where it can be found • Protocol used to communicate with it Also includes formal service taxonomy
Models	Although the GCMD provides a link to models, very little has been done to develop a model registry within a oceanic or environmental context.	Model discovery metadata may include but is not limited to the following: • Inputs • Resolution • Grid • Outputs • Constraints
Data Centers	GCMD provides a link to data center metadata. Not sure if other data centers registries exist.	Data Center discovery metadata may include but is not limited to the following • Contact information, • Hours of operation • URLs, links • Access policies • Pricing structure
Other	Other assets are typical not as relevant to asset discovery	

Note at the GEOSS level, assets are grouped into either a Component Registry or a Services Registry.

Asset Management

The DMAC Archive Expert Team has the responsibility to define metadata attributes that will enable systematic access (both human and machine) and ensure that responsible data management practices are in place across the IOOS Enterprise. Examples of asset management metadata attributes include but are not limited to:

- Unique identifier
- Textual summary or abstract, purpose
- Progress/status
- Observation parameters (attribute name, units, valid values, etc.)
- Data source information (instrument type, manufacturer, calibration, etc.)
- Originator
- Quality assurance / quality control methods
- Data set type (raster, vector, point)
- Data set format
- Data set location (server, file system, database name, etc.)
- Use constraints
- Physical location within data center/archive;
- Usage information (number of accesses, date of last access, etc.)
- Expiration date;
- Data set lineage and version history
- Points of access and available access methods
- Data set citation and references
- Data set latency specification

Asset Exploitation

Although the distinction between discovery and exploitation (use) metadata can overlap, there are a number of metadata attributes that are more relevant to the use of an asset rather that the discovery of the asset. Use metadata attributes include but are not limited to:

- Textual summary or abstract, purpose
- Observation parameters (attribute names, units, valid values, etc.)
- Data source information (instrument type, manufacturer, calibration, etc.)
- Originator
- Quality assurance / quality control methods
- Sample collection methods in field (when applicable)
- Sample analysis methods (when applicable)
- Data processing methods
- Spatial extent (horizontal and vertical geographic location)
- Accuracy of location
- Temporal extent
- Use constraints
- Liability

3.2.2.1.1 Current State

SECOORA is not unlike many other regional associations in terms of its metadata philosophy. Wirth limited guidance from the National DMA (11 recommendation from the Metadata and

Data Discovery Expert Team (see Table 1)), most entities within SECOORA have addressed metadata within their own domain.

Metadata & Data Discovery Recommendations				
MET 1.0	Metadata Catalog Services	05/10-12/2006	Std/BP	1.0
MET 2.0	Required & Recommended Vocabularies for IOOS Metadata	05/10-12/2006	Std/BP	1.0
MET 3.0	IOOS Vocabulary Version 1.0	05/10-12/2006	Std/BP	1.0
MET 4.0	Metadata standards review & supporting tools	05/10-12/2006	Dev. Work	1.0
MET 5.0	IOOS Metadata Content Requirements Version 1.0	05/10-12/2006	Std/BP	1.0
MET 6.0	Guidance applies to current data sources, and whenever possible, to legacy data holdings & inventories	05/02/2005	Std/BP	1.0
MET 7.0	All metadata should follow an XML-schema with an XML style sheet	05/02/2005	Std/BP	1.0
MET 8.0	Metadata should be compliant with the Federal Geographic Data Committee (FGDC). If FGDC extensions are not available for specific type of data in question, use an alternative, community-accepted standards & document standard used	05/02/2005	Std/BP	1.0
MET 9.0	Data providers be alert to their metadata needs, and identify gaps so that their needs can be addressed through the ST	05/02/2005	Std/BP	1.0
MET 10.0	Submit metadata to one of the National Spatial Data Infrastructure nodes where they will be widely available to the community	05/02/2005	Std/BP	1.0
MET 11.0	Metadata providers should document any data dictionaries or vocabularies used	05/02/2005	Std/BP	1.0

Table 1. DMAC Metadata Recommendations

Most SECOORA institutions have embraced the Federal Geographic Data Committee approved Content Standard for Digital Geospatial Metadata (FGDC-STD-001-1998) (CSDGM) as the primary standard for the description of spatial data and is mandated for use by federal granting agencies. Although the CSDGM includes elements needed for asset discovery, asset management and asset exploitation, it does not include everything. In addition, it is limited in the types of data that it addresses (via profiles), and its implementation is not "user friendly." Thus, steps are being taken within SEACOOS and Caro-COOPS to enlarge metadata documentation capabilities through consideration of additional standards and markup languages (e.g. Marine XML, SensorML).

In addition, SEACOOS and Caro-COOPS have also been developing a tool – Meta-Door -- that facilitates the creation of metadata documentation by non-technical (and technical) data providers. The development of the initial phase of Meta-Door (http://nautilus.baruch.sc.edu/twiki_carocoops/bin/view/Metadoor/WebHome) is complete, allowing users to manage their FGDC-oriented record data.

3.2.2.1.2 Desired Future State

In the near future (3-5 years), SECOORA is viewed as a proactive leader in terms of developing and maintaining an effective metadata framework for the region. Elements of the framework include the following activities/actions:

- SECOORA has contributed to the national effort to define an IOOS Vocabulary and/or recognize existing, useful controlled vocabularies. If need be, SECOORA has defined and registered a SECOORA-defined extension to the IOOS Vocabulary.
- SECOORA has contributed to the national effort to define an IOOS Data Dictionary. If need be, SECOORA has defined and registered a SECOORA-defined extension to the IOOS Data Dictionary.
- SECOORA has created and maintains ontologies for its primary products and services. In addition, communities of interest have the ability to create, update and register their own ontologies with SECOORA.
- SECOORA has contributed to the national effort to define appropriate oceanographic-relevant profiles for the FGDC CSDGM. If need be, SECOORA will elevate SECOORA-defined extension(s) to the FGDC for review.
- SECOORA routinely transmits and maintains metadata entries in one of the four top level directories.
- SECOORA maintains its own Registry of assets. The registry is one of several that are logically connected to the IOOS Enterprise. This registry includes data products/information products (directory), models, data centers, platforms and sensors, at a minimum.
- SECOORA maintain an up-to-date XML schema of every product that is generated through the RA.
- Links are provided from directory records to underlying data access systems whenever possible.
- Develop inventory profiles for datasets common across the enterprise
- SECOORA has contributed to the national effort to define minimum standard content for asset discovery, asset management, and asset exploitation metadata. If need be, SECOORA has defined and registered SECOORA-defined content best practices.
- The process of generating metadata is automated to the highest degree practical

- SECOORA has contribute to the national effort to create and maintain a set of SOA-compliant metadata services
  - Metadata generation/update services
  - Ontology creation/update services
  - Ontology equivalence services
  - Dataset access/parsing services (based on XML-schemas)

3.2.2.1.3 Gap Analysis

SECOORA does not have the coordinated metadata framework as defined above. Experience has shown that the primary constraint to the timely generation and quality control of metadata is that fact that it is tedious, time consuming, and requires resources that would probably be rather doing anything else. However, it is more cost effective to capture metadata during the lifecycle of an asset as it is generated, rather than to go back and try to generate it after the fact.

3.2.2.1.4 Activity Required to Close Gap

The activities required to close the gaps identified above are listed in the following table

Item	Activity Description	Responsible Party	Suspense Date	Estimated Cost ($K)
1	Get update on DMAC Metadata/Data Discovery Expert Team activities			
2	Coordinate with NFRA on RA input to IOOS Vocabulary, Data Dictionary, ontologies, services etc. Strategy should be to “divide and conquer”			
3	Evaluate the lifecycle of selected “key” representative SECOORA assets (data sets, models, etc) and determine the points in the life cycle where/when metadata ought to be generated. Develop strategies for automating these processes.			
4	Use SECOORA Testbed to prototype /evaluate automated processes			
5				
6				

Table 3.2.1.1 Proposed Metadata Gap Closure Activities

The following definition were developed by the DMAC Metadata and Data Discovery Expert Team

Federal Geographic Data Committee

The FGDC coordinates the sharing of geographic data, maps, and online services through an online portal, geodata.gov, that searches metadata held within the NSDI Clearinghouse Network and other forms of online metadata collections including ArcIMS Metadata Services, Web Accessible Folders (WAF), and Open Archives Initiative (OAI) Metadata Services. U.S. Federal agencies and organizations that develop data using federal funds are required to provide FGDC compliant geospatial metadata to an online metadata collection that is discoverable via geodata.gov.

National Spatial Data Infrastructure Clearinghouse

The NSDI Clearinghouse Network is a community of distributed data providers who publish collections of metadata that describe their data and map resources, documenting data quality, characteristics, and accessibility. Each metadata collection, known as a Clearinghouse Node, is hosted by an organization to publicize the availability of data within the NSDI. The metadata in these nodes is searched by the Geospatial One-Stop portal, geodata.gov, to provide quick assessment of the extent and properties of available geospatial data resources.

Geospatial One-Stop

The geodata.gov portal is operated in support of the e-government Geospatial One-Stop Initiative to provide "one-stop" access to all registered geographic information and related online access services within the United States. Geographic data, imagery, applications, documents, web sites, data acquisition plans, and other resources are being catalogued and the metadata made available for discovery in this portal. Registered map services allow casual users to build online maps using data from many sources. Registered data access and download services also exist for use by those interested in downloading and analyzing the data using GIS or viewer software.

Global Change Master Directory

NASA's Global Change Master Directory was established to promote and facilitate the exchange of scientific data sets in support of global change research. The GCMD database holds descriptions of Earth science data sets and services covering all aspects of Earth and environmental sciences. Its portal provides the capability to search for data and services, offers authoring tools to assist contributors and an Interoperability Forum to discuss content and database issues. The GCMD content is harvested by GOS.

Ocean Biogeographic Information System

The Ocean Biogeographic Information System (OBIS) is a web-based provider of global geo-referenced information on marine species (any record that a particular species or other taxonomic group was observed or collected at a particular location). It also provides several spatial query tools for visualizing relationships among species and their environment. The data within OBIS come from an international federation of providers. Ocean Biogeographic Information System (OBIS) was established by the Census of Marine Life (CoML) program, though it is not limited to CoML-related projects.

Vocabularies

A vocabulary is a list or a collection of words or of words and phrases (terminology) of a particular group or field. Typically a vocabulary includes definitions or explanations of each term to ensure a common understanding of its use among the group.

> Example:
>
> Sea Surface Temperature = The temperature of the ocean surface. The term sea surface temperature is generally meant to be representative of the upper few meters of the ocean as opposed to the skin temperature, which is the temperature of the upper few centimeters.

Data Dictionaries

Data dictionaries can take a vocabulary a step further by providing additional attributes for each of the terms. These attributes can include elements such as long names, short names or labels, definitions, data classes or categories, data types (measured or derived), units of measure, valid ranges of values, code sets, and related terms. An example of the content of a data dictionary entry is as follows:

> standard name: sea_surface_temperature
> long name: sea surface temperature
> label: sst
> definition: The temperature of the ocean surface. The term sea surface temperature is generally meant to be representative of the upper few meters of the ocean as opposed to the skin temperature, which is the temperature of the upper few centimeters.
> category: oceanographic
> data type: measurement
> unit of measure: Celsius, decimal degrees
> valid ranges of values: 10.0 , 35.0
> related terms: water temperature, water surface temperature

In its simplest form, a data dictionary is commonly tabular (as in a database management system). Data dictionaries also can provide a representation of how the data are structured or categorized, but the dictionaries usually do not reach the extent of defining complex relationships between the elements. If such discrete logic is added to the elements in a data dictionary, the dictionary can evolve into an ontology.

Ontologies

An ontology is a form of a data model that represents a domain and defines the relationship among the objects in that domain. Ontologies are made up of objects (classes or categories), characteristics (roles or properties) and relations (functions). Ontologies conform to a strict hierarchical structure of relationships between classes and subclasses as well as among classes.

With respect to vocabularies, an ontology can provide the structure of a vocabulary similar to that of a thesaurus. Ontologies also can be used to define relationships among the content of independent vocabularies. For example, given three vocabularies: (1) the IOOS Vocabulary Version 1, (2) the Global Change Master Directory Science Keywords, and (3) Climate and Forecast (CF) Standard Names, related terms may be represented in three different ways.

IOOS	**GCMD**	**CF**
Temperature	Water_Temperature	sea_water_temperature
Bathymetry	Bathymetry	sea_floor_depth_below_geoid sea_floor_depth_below_sea_level sea_surface_height_above_geoid

Within an ontology, the relationship among the terms can be defined to reflect that the IOOS term Temperature is broader than the GCMD term Water_Temperature which is in turn broader than the CF term sea_water_temperature. With regards to metadata, data discovery systems which use forms of ontological mapping among vocabularies expand discovery capabilities and enhance search result sets.

3.2.2.2 Data Discovery

Data discovery allows a user to find through ad-hoc queries the location of data (or assets) within the RCOOS universe. After identifying the data, the user should have easy access through downloads in structures (files) that conform to appropriate national and/or international standards. Data discovery should be built upon Metadata, Data Archive and Data Transport standards, and a useable design will require these to be largely in place. However, the design and development of these three elements should be undertaken with Data Discovery as a higher-level goal. User-friendly data discovery will enhance the use of non real-time environmental data for more in-depth and specialized analyses that could be undertaken by users from many different disciplines.

To search and access RCOOS data and information products, it is essential that the metadata are accessible, as in a central clearing house, and that both data and metadata adhere to standards that enable searching and location of desired information. At present, it seems reasonable to restrict data discovery to databases of metadata rather than include searches of the data variables. Thus, searches on location, time-span, data types, platform, etc., will use metadata, however, if searches were to include observed values (e.g. temperature) then the datasets of these variables would need to be accessible by the search engines and this could be a vastly more complicated system.

3.2.2.2.1 Current State

At present, search capabilities for ocean data are severely limited, generally restricted to dataset catalogues, which tend to be voluminous and not easily searchable. The user usually has to know which observing systems are taking data in a given region and go directly to those sites to query their databases. Once found, the datasets are often not in a standard format and may have differing metadata conventions.

For SEACOOS, some essential standards and protocols have been identified for dealing with the SEACOOS, Caro-COOPS, and CORMP ocean observations data. First, a "draft data dictionary" has been created to provide a standard vocabulary for SEACOOS data. Second, a SEACOOS "NetCDF (network Common Data Form) Standard" has been developed, which describes a set of conventions and standards, including NetCDF format categories, required variables, and required and recommended attributes for all data. Adoption of SEACOOS CDL provides sufficient conformity to enable automated search and aggregation tools, and yet is flexible enough to deal with many different data sources and enable data aggregation in near real-time. These "tools" are readily available for use by the broader community.

3.2.2.2.2 Desired Future State

The first requirement is that the metadata associated with observational and model output assets have a standard vocabulary and use the same conventions (for units, variable names, etc.). This is being addressed by the metadata unit (Section 3.2.2.1). This will allow participating institutions to submit metadata to a central clearing house. Existing metadata schemas may require translation to common adopted vocabularies. Also required are the locations (logical and physical) of the datasets referred to by each metadata record along with their access methods. It is noted that a specific dataset (say a sea surface temperature time series from a buoy) may have more than one location or instance (i.e. it may be available as near real-time at one location and also as an archived dataset at several archive centers). The central clearing house will need this information and some method of prioritizing based on the level QA/QC performed. Therefore, location information overlaps with the Data Archive unit (Section 3.2.2.5) and standardized access methods (OpeNDAP, OGC, etc.) involve the Data Transport unit (Section 3.2.2.3).

The above information (Metadata, location and access methods) should be assembled into a searchable database. This is likely based on Relational Database (RDB) technology and may possibly be a distributed database. Thus, database schemas (tables) will need to be constructed for each generic observational type and model outputs. This will need to be done very carefully so as to be comprehensive and also to define the links between tables, because the database structure will be the basis of constructing search engines (presumably web based). Powerful search engines (i.e. capable of high precision in finding datasets) are necessary for efficient use of observed and model data. Dataset catalogues are usually not much use because entries are not precise and they quickly become voluminous (c.f. NVODS/OpeNDAP experience).

When datasets have been located through searches, then these datasets will need to be assembled and accessed by the user. This will probably require the development of aggregation servers (OpeNDAP is currently undertaking some development of aggregation servers). There will be various levels of access of aggregated data ranging from display of location (say) to download of the data to the user's system for further specialized analysis.

3.2.2.2.3 Gap Analysis

- Adopt standardized vocabularies for metadata, location and access information.
  - Develop translations if needed.
- Develop RDB schemas for each (generic) type of dataset or asset along with their location(s) and access methods.
  - Generate automatic methods of populating the central clearinghouse RDB with information from the dataset generating institutions or entities.
- Develop search engines and their user interfaces to query the RDB tables.
- Develop methods and protocols to assemble and access data identified by search procedures.
  - May require the development of aggregation servers capable of assembly of datasets from dispersed systems that store datasets in differing formats.
  - Development of user-friendly interfaces to search engines and display of aggregated results.

In the above "develop" does not necessarily mean start from scratch, but could mean the adoption of software, standards and protocols developed by other IOOS groups (such as NVODS/OpeNDAP). Thus, one important task/activity is to identify useful technologies that could be adopted or modified to accomplish the main tasks given above.

3.2.2.2.4 Activity Required to Close Gap

The activities required to close the gaps identified above are listed in the following table

Item	Activity Description	Responsible Party	Suspense Date	Estimated Cost ($K)
1				
2				
3				
4				
5				
6				

Table 3.2.1.2 Proposed Data Discovery Gap Closure Activities

3.2.2.3 Data Transport –

Data Transport is one of the key elements in the Data Management component of a Regional Coastal Ocean Observing System (RCOOS). Data Transport refers to transparent, interoperable access and delivery of data and data products over the internet. The Integrated Ocean Observing System (IOOS) Data Management and Communications (DMAC) Data Transport Expert team in its most recent guidance (http://dmac.ocean.us/dacsc/imp_plan.jsp) has identified network data access protocol (OPeNDAP), formerly known as DODS, open GIS consortium web services and the use of Service Oriented Architectures (SOA).

3.2.2.3.1 Current State

SEACOOS data providers in the SECOORA region in conjunction with the SEACOOS Data Management Coordinating Committee (DMCC) decided to implement OPeNDAP NetCDF transport protocol, consistent with the recommendation of IOOS DMAC Data Transport Steering Team. Data providers established a DODS/OPeNDAP server at each participating institution to serve their observation data using the NetCDF file format. NetCDF format convention (http://seacoos.org/documents/metadata) and data dictionary (http://nautilus.baruch.sc.edu/twiki_dmcc/bin/view/Main/DataDictionary) that extends the NetCDF Climate and Forecast (CF) metadata convention (http://www.cgd.ucar.edu/cms/eaton/cf-metadata/index.html) were established by SEACOOS to implement this transport protocol. The development of this transport method, format standard, and the data dictionary enabled smooth transport and aggregation of these files to a centralized server and relational database. This allowed creation of data products such as aggregation driven maps (GIS), time series graphics, and access to aggregated data and products. Expansion of the data sharing commons to a larger audience in the SECOORA region may necessitate the revisiting and extension of these standards although they have proven robust to date.

The aggregated database of observations from data providers within the SECOORA region has been XML (eXtensible Markup Language) and web service enabled, again consistent with the recommendation of IOOS DMAC Data Transport Team. Community accepted World Wide Web Consortium (W3C: www.w3.org) and Open GIS Consortium (OGC: www.opengeospatial.org) standards were used. The data providers data within the SECOORA region are presented in OGC specifications such as the Web Mapping Service (WMS) for allowing online access to maps and the Web Feature Service (WFS) for online access to geospatial data. The services can be accessed, controlled and presented by web browsers as well as other GIS software platforms (ESRI and GAIA applications). SEACOOS OGC compliant services rely on the Map Server CGI engine (http://mapserver.gis.umn.edu/). The coastal ocean observing projects that uses these services are: the OpenIOOS Interoperability Test-Bed Demonstration Project (http://www.openioos.org/), GoMOOS (http://www.gomoos.org), Carolinas Coast (http://www.carocoops.org/carolinas) and (http://gisdata.usgs.net/website/NC_OneMap) NCOneMap.

3.2.2.3.2 Desired Future State

Regional and sub-regional coastal ocean observing systems within SECOORA region have tested/established/implemented the data transport technologies (OPenDAP and OpenGIS Consortium (OGC) Web Mapping Service (WMS)/Web Feature Service (WFS) recommended by IOOS DMAC. The possible data transports that will be used by SECOORA is a reflection of the anticipated community needs and uses of SECOORA data and the issues related to the complexity or volume of the transported data itself. One distinction in the choice of data representation and transport is in the sharing of data internal to SECOORA technical infrastructure or other similar partner infrastructures used towards system/data replication or redundancy. Data passed between similar SECOORA type structures and services while not intended to be a general data or data transport protocol may develop into this as a secondary application. Data transport which is not used internally for system purposes, which *is* developed for public or community sharing of data will likely fall into one of two categories - data transport of report based file oriented data or data transport using query based web services.

Data Transport - Report/File Based

There are many advantages to report/file based data sharing. A periodically generated file can provide just the necessary data in the needed format for further analysis using client/desktop tools. A file can be generated once and downloaded multiple times, reducing the possible server workload involved in generating the same information.

Files can be shared via the web using common HTTP and FTP methods or encoded as part of other message protocols such as SOAP.

Possible file formats used by SECOORA would include (but not be limited to) the following (Table: Possible File Formats).

Table: Possible File Formats

Data File Formats	Brief Description
ASCII and CSV (Comma) Separated Value)	
XML (eXtensible Markup Language)	XML is an improvement over ASCII only based formats in that XML provides a stronger more extensible syntax for document validation (XML Schemas), parsing(XPath) and existing toolsets for processing. XML is also more 'readable' as a text/tag oriented format and can be compressed to help address storage/bandwidth related issues.
GML (Geography Markup Language)	GML is an XML standard which includes elements specific to geospatial processing.
KML (Keyhole Markup Language)	KML is a XML format used by Google to support display of data within the 3D Globe application 'Google Earth' http://earth.google.com and possibly other developing 3D

	Globes similarly such as NASA's Worldwind or ESRI's ArcExplorer.
RSS (Really Simple Syndication)	RSS is a 'push/publish' mechanism for supplying the latest information in an agreed community standard xml schema or using certain xml markup tags. GeoRSS http://www.georss.org is a variation on this which includes xml elements for geospatial location. For SECOORA community ObsRSS (http://nautilus.baruch.sc.edu/twiki_dmcc/bin/view/Main/ObsRSS) which could be used for supplying platform-specific xml feeds of the latest data.
ESRI shapefile	Shape File is a popular file format for traditional GIS based analysis using ESRI or other GIS tools capable of reading the shapefile format.
Image Files (.png,.gif,.jpg)	PNG files represent the highest lossless compression format for images and can be used for sharing remote sensing or other images for further image display, overlay or analysis needs.
NetCDF -	NetCDF (Network Common Data Format) is a file format supported by Unidata which has several useful tools developed to allow further subsetting and analysis of the NetCDF file such as ncBrowse (http://www.epic.noaa.gov/java/ncBrowse). SEACOOS has also developed a NetCDF convention (http://seacoos.org/documents/metadata) for data aggregation and sharing.

The creation of these file based output products from raw data sources will be facilitated by two methods. The first method for more high volume data flows (millions of records per hour in the case of model or gridded datasets) is the use of existing tools or techniques for file based conversions from raw data to more useful or standardized formats. The second method for lower dataflows(<100,000 records per hour for in-situ observations) is the use of a common relational database schema infrastructure labeled 'Xenia' (http://nautilus.baruch.sc.edu/twiki_dmcc/bin/view/Main/XeniaPackage) which will aim to provide a common relational database around which many popular file outputs and services can be automatically generated.

Query/Web-Service Based

A query/web-service based data transport will also rely on file formats and controlled vocabularies in its implementation similar to a report/file based system, but also applies standards to the request/response protocol so that queries and responses involving time, location, platform or observation are better defined and facilitated.

SECOORA has leveraged and will continue to follow and be involved in test-beds or usage which involve the OGC protocols such as WMS (Web Mapping Service) for sharing map images, WFS (Web Feature Service) for sharing data and more recently SOS (Sensor Observing System) for sharing platform and observation data.

SECOORA will also continue to provide OPeNDAP access to netCDF and relational database data via the corresponding supplied software.

Transport of SECOORA data and products will be available by HTTP request returning an XML document (referred to as REST) and other more complex protocols such as SOAP as needed.

The critical concern in the use of web service based request/response based protocols are the formats and controlled vocabularies of the services used. The encoding of the message between systems is a secondary concern to whether the document terms (time, location, observation types and measurement values) can be mapped between systems. In regards to metadata and data mapping, the SECOORA group will continue to follow and participate in metadata and data standards being developed within the community.

Also essential is the appropriate hardware for the system, at both centralized hubs and distributed data providers. A basic hardware infrastructure is in place within SEACOOS, but this does not include provisions for redundancy and back-up. The prevalence of severe tropical cyclones in the SE, and their frequent disruption of communication and power systems for several days, is a hazard that needs to be taken into account in designing the SECOORA-RCOOS. An offsetting factor is that it would be very rare for a hurricane to disrupt power and communication systems throughout the entire region, especially simultaneously. Hence, there is a possibility of designing a resilient regional system.

Various federal (and state) agencies within the SECOORA region have important bathymetric/topographic, geological, benthic habitat, socio-economic, satellite imagery, etc. digital databases in the coastal zone suitable for GIS renditions, etc. All these agencies will have a present data transport protocols to transport their data holdings or will be involved in evaluating/implementing other IOOS recommended data transport protocols; e.g. NOAA-CSC (Data Transport Laboratory: http://www.csc.noaa.gov/DTL/) NDBC, NOAA-NOS (http://opendap.co-ops.nos.noaa.gov/content/index.php), NERRS, NCEP, NCDDC (http://www.ncddc.noaa.gov), NODC, NCDC, Exchange Network (http://www.exchangenetwork.net), Ocean Biological Information System (OBIS: http://www.iobis.org), USGS etc. It is critical for SECOORA DMAC team to be engaged in communication/dialogue with these agencies to facilitate implementation of needed transport technologies to make SECOORA data interoperable. Substantial work is required to ensure interoperability among these systems and the various emerging RAs. IOOS DMAC has provided guidance to facilitate interoperability, but development of coherent protocols, processes, and infrastructure is also required.

It is essential to make sure funding is available for the existing IM personnel in the regional and sub-regional observing systems within the SECOORA region. For example, SECOORA should have strong DMAC team and each participating institution should have minimum 2 staff members to help with supplying quality controlled data, maintaining technical infrastructure and communications and supplying some level of redundancy in communications and functionality between institutions(back-up sites). The redundancy parts require that things be in a more complete, packaged and documented state (any development should be finished first) so finishing up some minimal efforts in quality-control and SEACOOS database/product redundancy is a prerequisite to that. There is also a need to incorporate mechanisms for updating aggregated or redundant date if the data provider further qc's the data at a later date.

3.2.2.3.3 Gap Analysis

(1) Evaluation of community needs, e.g. What are the data file formats that are preferred by the other arms of SECOORA – Extension & Education, Observations, Modeling as well as public or Emergency Managers or other state and Federal agencies.
(2) Participating in National activities such as NOAA-CSC Data Transport Laboratory (DTL), IOOS interoperability, Marine Metadata Interoperability (MMI) projects and dialogue with other neighboring Regional Associations and continuing communication with IOOS DMAC Data Transport Expert Team.
(3) Establishment of Quality Control and development of QA/QC web services.
(4) Continued identification of new data formats and Data transport technologies.

3.2.2.3.4 Activity Required to Close Gap

The activities required to close the gaps identified above are listed in the following table

Item	Activity Description	Responsible Party	Suspense Date	Estimated Cost ($K)
1				
2				
3				
4				
5				
6				

Table 3.2.1.3 Proposed Data Transport Gap Closure Activities

3.2.2.4 On-Line Browse –

Within a distributed regional data partnership, datasets must be easily browsed and accessed through common Web browsers. This functionality should serve external users seeking to explore and access regional data and internal users seeking to verify that data flow processes are working. On-Line Browse covers the individual components used to populate existing user or regional specific websites such as files (CSV, XML, shapefiles, etc) and products (maps, plots, animations, etc) as well as the various websites themselves. This component is crucial as the link between Data Discovery and the gateway to Data Transport. Consistency in format and ease of use are important to connect the various internal pieces required for On-Line Browse and ensure seamless connection to other RA functions.

3.2.2.4.1 Current State

Virtually all observing and modeling subsystems in the SECOORA region have established Web portals for dissemination of data and metadata. These exhibit various levels of functionality, complexity and available features. These existing portals and the content therein provide users the ability to browse regional data and then access datasets of interest. Data can be retrieved through specification of parameters and spatial and temporal requirements, and choices are often provided for raw data or a variety of data products.

The existing online browse functionality of these portals covers a range of features and products including a variety of map and graphic displays:

Interactive Maps (user controls spatial, temporal, content, and query parameters)
Map animations (user controls spatial, temporal, content, and query parameters)
Static Map images (pre-generated regions, variables, times)
Web Mapping Services (default representations with user control if needed)
Time Series graphs and plots
Observation value graphics (digital representations of analog dials and gauges)

These features can be divided into two thematic groups based on the level of expected user involvement. Query based products allow user control over the temporal, spatial and content parameters of the On-Line Browse product(s). These are geared toward more experienced users and are intended to be flexible enough to address many potential user queries. Report based products are based on assumptions made by data providers through a suite of products intended to meet a certain set of identified user needs. These do not require much user input and are tailored for quick answers to common questions at the local/platform or regional/observation scale. Many of the products mentioned above default to a report mode with additional query based functionality as an option. A crucial piece to wrap each of these products is the container web site that provides information on user applications and connections between data discovery tools and data access and transport.

While data transport is not the focus here, it is recognized that browse tools need to be closely coupled with transport formats and methods. Seamless connections to these access methods are built into some existing regional data browse applications but not all. Currently the regional methods of data transport in use are:

File based access: HTTP access to CSV, XML, shapefiles or image files, GeoRSS
Data subset methods: DODS/OPeNDAP access to NetCDF, database, or HDF backends
Web Map Services: OGC WMS
Data Web Services: OGC WFS, OGC SOS

3.2.2.4.2 Desired Future State

The overarching goal of regional On-Line Browse is an interwoven set of applications connecting discovery of data, through a variety of browse tools that refine data requests, to access and transport of identified data. Ideally many of these components could interoperate from a small set of institutions as is likely in the distributed nature of the RA enterprise. Many of the pieces required for this integration currently exist in the region, but the glue to bind them into a larger architecture is not fully developed. Care should be taken to leverage existing applications where possible to minimize the amount of new development required.

Once appropriate plugs are constructed to data discovery tools, two main types of browse products should be available, tools for creating regional map products of discovered data and tools for local/platform specific data streams such as time series graphs or latest platform data displays. Both sets of products should provide users the ability to define their own query based on time, space, variable, and application as well as a predefined set of report products providing quick answers to common questions, societal application, or internal data verification. Both reports and user defined queries should allow users to slice or aggregate data along the various dimensions of the dataset(s) of interest. A loop mechanism back to data discovery should also be provided after query or report products are created for discovery of additional datasets (identify more data like this). Focus should be maintained on the latest data for both queries and reports while still providing a limited set of archival data options.

Once iteration between data discovery and map/graphic representation of user query or preset report is completed, an easy transition should be available to access the dataset(s) of interest. Ancillary or external data not available for distribution by the RA should have external links to the source institutions for each layer. Ideally the transition to access and transport should be aware of the users' settled upon dataset and query/report options and link to a dynamically populated access page. This might include a CSV, XML, or shapefile of the data requested, or a completed DODS access form, or a dynamically built OGC WMS or WFS URL. Help should also be provided for the various transport and file types available. Access should also be provided to the Data Transport pages directly from Data Discovery if On-Line Browse is not required.

The interoperability and integration required to enable a powerful and flexible On-Line Browse capability will prove a difficult but crucial component to regional data sharing efforts.

3.2.2.4.3 Gap Analysis

(1) Evaluation of Community needs, e.g. How do the other arms of SECOORA – Education and Extension, Instrumentation, Modeling as well as the public or Emergency Managers use online browse resources. If not using browse functionalities, what specific products do they need?
(2) Participating in national activities such as IOOS interoperability and MMI (search and usage vocabularies) and dialogue with other neighboring Regional Associations and continuing communication with the IOOS DMAC.
(3) Establishment of Quality Control and development/documentation of QA/QC flags used within products.
(4) Continued identification of products and their website context, the packaging and documentation of those products/websites and the staff support necessary to maintain the reliability and quality of those products/websites.

3.2.2.4.4 Activity Required to Close Gap

The activities required to close the gaps identified above are listed in the following table

Item	Activity Description	Responsible Party	Suspense Date	Estimated Cost ($K)
1				
2				
3				
4				
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Table 3.2.1.4 Proposed On-line Browse Gap Closure Activities

3.2.2.5 Data Archive

Another major need is the establishment of archival protocols and repositories to maintain and provide access to desired IOOS data in perpetuity. Details of the national strategy for archival of IOOS information remain to be determined, but the IOOS DMAC Plan lists a number of high-level requirements that shape the outline of the desired end state. SECOORA institutions have made a good start towards meeting IOOS archival requirements.

3.2.2.5.1 Current State

Currently, the archival of SECOORA data takes place under a patchwork combination of local (institutional)-level, regional (RCOOS)-level, and national-level activities. At the local level, each SECOORA institution presumably maintains a copy of all data it collects, though there is at present no centralized catalog of these distributed data stores, nor any agreed-to archival maintenance procedures or schedule. For example, CORMP collects near-real-time, telemetered buoy data, non-real-time buoy data, and shipboard data. The near-real-time data are transmitted to the NDBC DAC, and ultimately are archived at NCDC and/or NODC. The non-real-time buoy data and shipboard data are currently stored only at CORMP and accessible only through the CORMP website.

At the regional level, some buoy and other data are aggregated in a centralized database maintained under the auspices of Caro-COOPS at the University of South Carolina (USC). These data, including sst, winds, water level, air temperature, air pressure, salinity, wave height/period, surface current speed/direction, are made available via a public OPeNDAP server. In addition, a small subset of model output and remote-sensing-based products are aggregated at USC. Presently, this regional data does not submit any of the aggregated data to NODC for long-term archival, but relies on the contributing institutions to do so.

Finally, much of the SECOORA buoy data are submitted for long-term archival at NOAA data centers (NCDC and NODC). These data are routed from the data providers to the Data

Assembly Center at NOAA NDBC. NDBC then performs routine QA/QC and passes the validated data to the NOAA data centers for maintenance in perpetuity. The NOAA data centers implement regulations for data stewardship from the National Archival and Records Authority (NARA). These include:

- Maintaining adequate and up-to-date technical documentation for each electronic information system that produces, uses, or stores data files
- Providing for backup and recovery of records to protect against information loss
- Ensuring that information is not lost because of changing technology or deterioration by converting storage media to provide compatibility with the agency's current hardware and software
- Maintaining magnetic computer tapes in accordance with specific NARA guidelines
- Periodically reviewing the contents of archives for disposition in conjunction with data center NARA guidelines.

Currently, these buoy data include weather observations, sea surface temperature, wave observations, and ADCP currents data. It should be noted that the datastreams telemetered to shore and sent to NDBC typically do not include the entire raw datasets collected by the buoys, due to bandwidth limitations. These raw datasets are at the present time handled at the institutional level. For example, CORMP buoys are downloaded during servicing, and the complete raw datasets are held at CORMP.

3.2.2.5.2 Desired Future State

The fundamental goal for RCOOS data archival is an established pathway to archive for all desired datasets in accordance with the IOOS DMAC Plan. The architecture envisioned in the DMAC Plan to accomplish this includes four complementary components: archive centers, regional data centers, modeling centers, and data assembly centers. *Archive centers* (such as the NOAA data centers) acquire, preserve, and provide access to data in perpetuity. Their mission includes constant monitoring of data streams, accurate accounting of all records, frequent accuracy checks, and migration to newer media as required. *Regional data centers* (such as at USC) acquire and provide access to data within their specified geographic domain. It is envisioned that these centers will provide data to support a variety of scientific, public, and commercial activities within their area. These centers may support long-term archival if they meet IOOS standards for data stewardship, or they may simply transfer data systematically to an archive center. *Modeling centers* combine data with models to produce analyses, forecasts, and hindcasts. They may provide direct access to model products, but will forward desired products to appropriate archive centers for long-term stewardship. Lastly, *data assembly centers*, such as NDBC, obtain IOOS data within there sphere of expertise and provide QA/QC as well as data access. Typically, data assembly centers, like modeling centers, do not archive data, but serve as a conduit between data providers and archive centers. At least one copy of all desired data will reside in a designated national archive center, but the DMAC Plan stipulates that duplicate copies of some datasets be maintained, e.g. “observational and research quality data that can not be reproduced or easily regenerated”.

Building upon the SEACOOS data management framework, SECOORA is well positioned both to satisfy and to flesh out the rudimentary data archival requirements described in the DMAC

Plan. A mature data-archival architecture for SECOORA will take advantage of the existing regional data center at USC, the existing archival pathways for real-time buoy observations, and will have a set of accepted best practices for data stewardship to be followed by each data provider at each member institution. Established archival pathways will exist for all SECOORA data, including not only buoy obs but also temporary or fixed mooring data, moving-platform and station data, coastal HF radar, model output, and analysis products. Each data-management activity (archive center, regional data center, modeling center, and data assembly center) must maintain accurate dataset-level metadata as well as an accurate inventory of its holdings, and these must be searchable via the Web. Ideally, not only will there be an accurate inventory of data stores at each activity, there will be an accounting trail that records each transaction as data is passed from one center to another, quality-assured, transformed, etc. Integration of these various components of the archival system will depend upon a robust metadata management system that will include either a centralized, searchable metadata repository or a means of cascading a metadata search across distributed repositories.

3.2.2.5.3 Gap Analysis

A rigorous gap analysis of the SECOORA data archival subsystem depends upon a complete and detailed documentation of the status quo, which unfortunately does not exist at this time. This is especially true with respect to archival procedures followed at each member institution. Because such an analysis is beyond the scope of this plan, we consider this a fundamental gap and recommend an immediate effort to inventory each datastream from each institution and track its ultimate fate, as well as its path and any modifications it undergoes along the way.

Lacking a detailed analysis, some more general statements can be made about gaps relating to specific data types. These include:

<u>Gaps in archival infrastructure</u>
The greatest immediate need is the establishment of standards for data handling, data inventory, and metadata creation procedures at the institutional level. At the regional level, software for tracking of datastreams from sensor to archive is needed; SEACOOS has the beginnings of such a system with the SEACOOS Data Flow Monitor.

<u>Near-real-time observations from permanent buoys</u>
For the most part, the handling of near-real-time observations from permanent buoys, including meteorological, sea-surface temperatures, and wave observations, appears to satisfy the basic archival requirements, though perhaps plans should be made to archive raw buoy data in addition to what is processed by NDBC. In addition, plans should be made for the next generation of buoy-mounted sensors, e.g. acoustic sensors for estimating fish abundance.

<u>Non-real-time buoy observations</u>
Some members (e.g. CORMP) collect buoy data that are not telemetered. These are not being archived, beyond storage at the institutional level.

<u>Shipboard observations, including station data (e.g. hydrocasts) and underway data (e.g. ADCP, geophysical data)</u>

No archival plan established, other than the University of Miami Explorer of the Seas data and archival of shipboard observations by CORMP, University of North Carolina Wilmington at the institutional level.

HF radar
No archival plan established.

Remotely sensed data
Both the USF and USC maintain in-house receiving systems and archives for satellite (AVHRR, ocean color) data. In addition, USF maintains a distribution system and talks are underway with NOAA on transferring some of these data for long-term archival at NODC.

Model output and products
Each institutional modeling center maintains some modeling output for internal use; in addition a subset of model output from each institution is being sent to the Caro-COOPS aggregated database where it is exposed to web-GIS applications. Plans for a national archive and distribution system for ocean model output are in development at NOAA NODC.

Derived data (e.g. chemical analyses of water, sediment)
No archival plan established, except the CORMP (University of North Carolina Wilmington) program archives analyzed data (nutrient analyses and Chlorophyll a etc.) derived from water samples collected during cruises at the institutional level.

Complex merged data analyses (e.g. SST OI)
No archival plan established.

3.2.2.5.4 Activity Required to Close Gap

The activities required to close the gaps identified above are listed in the following table

Item	**Activity Description**	**Responsible Party**	**Suspense Date**	**Estimated Cost ($K)**
1	Institutional and regional-center inventories of: • Datastreams -incoming /outgoing • archival practices- (metadata, QA/QC, file formats, maintenance)			
2	Archival infrastructure plan:			

	• what needs to be archived at each level • Hardware and software needs to achieve these • QA/QC protocol			
3	Continue implementation and documentation of archival procedures for remote sensing and models			

Table 3.2.1.5 Proposed Archive Gap Closure Activities

3.2.2.5.4 Activity Required to Close Gap

The activities required to close the gaps identified above are listed in the following table

Item	Activity Description	Responsible Party	Suspense Date	Estimated Cost ($K)
1				
2				
3				
4				
5				
6				

Table 3.2.1.5 Proposed Archive Gap Closure Activities

3.2.2.6 Data Communications –

Data communications in this context consists of two components; communication systems for transport of real-time data from collection platforms and sensors, primarily via satellite telemetry; and access to the stored data via data bases and web interfaces through the Internet. Data Transport is covered in detail in Section 3.2.2.3. Enhancement in these two component areas is needed and will produce significant improvement in overall system throughput.

3.2.2.6.1 Current State

Multiple satellite technologies are currently in use for communication with remote platforms with GOES and Iridium currently being the primary providers. Orbcomm can also be an option in cases where data volume is not the limiting factor. Service Argos is the data communications of last resort, when other methods fail, due to unusably low bandwidth. GOES has the advantage of having no cost associated with the data transmission, but at this time the volume of data that can be returned in a given transmission is limited and there is currently no mechanism for two-way communications. Iridium has the advantage of two-way communications and the capability of transferring large volumes of data, but the costs associated with this method make it a difficult option to implement on a wide basis. Improvements in satellite technologies must be made in the areas of two-way communication, reliability, increased bandwidth, and lowered communication costs.

For onshore or nearshore observing sites (including HF radar), a number of options are available including residential phone lines and cell phone communications, RF modems (e.g., Freewave, UHF and VHF band transceivers operating in both public and FCC licensed frequencies), cable modems, DSL lines, satellite television providers, and government satellite providers such as the NOAA GOES. Most of these are more reliable and cost-efficient than their counterparts for remote platforms and, in addition, provide higher data rates and two way communications. DSL lines and cable modems are the preferred communication method for these sites, but availability of these services is limited in some areas. RF modems are used in locations that are remote, but within the line of sight of a base station. These RF modems are very reliable but public frequencies have encountered in areas that have a large amount of radio traffic, which then requires the shifting to operation at a specific FCC licensed frequency (selection based on bandwidth, availability, and propagation distance/terrain). GOES can be used in all US locations (onshore and nearshore as well as remote), has an existing and operational infrastructure in place, and whose transmissions are relatively independent of weather effects. Iridium can also be used in all US locations and an operational Iridium infrastructure dedicated to ocean observing, similar to Service Argos, has been proposed by the OceanUS DMAC.

Arrangements with Naval range managers have allowed the use of microwave links from offshore Navy tactical towers. Microwave links provide T1-level bandwidth over a range of up to 30 miles between nodes, but can be affected by atmospheric conditions. Future use of microwave links will likely be limited to existing Naval towers due to the high maintenance and operational costs, although the throughput of these connections is the highest possible for offshore use. Microwave links are, in essence, wireless LANs in 10/100-Base-T Ethernet topologies running a TPC/IP protocol. All of the offshore computers appear as nodes on a subnet. Data is transferred using FTP protocols. The wireless segment of the data transport is totally transparent.

The data transport capacities (i.e. access to the data stored on remote servers) are uneven among the states in the SECOORA region, and transport of high volume information such as model output, satellite imagery, and coastal HF radar data may be limited by broadband limitations beyond the control of SECOORA. Some institutions in the SECOORA region participate in Internet 2 experiments, but not widespread due to costs and manpower requirements.

The IOOS community should encourage enhancement of the capabilities of each of these components of communication within the region and nation.

3.2.2.6.2 Desired Future State

As the volume of data that is collected continues to increase, we have to find ways to transmit more data, at higher throughput, and for a lower cost per byte. There are a number of ways to try to accomplish this: we could look for better and faster telemetry methods; we could try to improve our current telemetry systems by working with the agencies that provide our current telemetry; and we could reduce the amount of data that is necessary to send by doing more of the data processing and QA/QC evaluation on our measurement platforms.

For GOES to continue to be a viable solution for the transmission of real time data, the available throughput needs to increase as the volume of data that needs to be transmitted continues to increase. A major step in this direction was achieved with the ability to transmit binary files using the new high data rate transmitters. This does not help those who are still using the older 100 baud transmitters. Another major improvement would be the ability to have access to larger transmit windows, or the ability to be assigned adjacent windows and use them as though they were a single larger window. Currently, as you migrate to the faster speed transmitters, the size of the transmission window you are given is reduced proportionally. This gives GOES the ability to schedule more transmissions, but the user is not given the ability to transmit larger volumes of data. The next logical upgrade to GOES would be the addition of two-way communications to allow users to change sampling parameters based on environmental conditions or to attempt to correct any problems that might occur with sensors or platforms that are not performing correctly.

Iridium currently has the desired two-way communications with compressed data rates around 100Kbs, but a reduction in the associated costs. Iridium is the only existing data communications method suitable for offshore ADCPs. The best way to make Iridium affordable for ocean observations would be for IOOS or individual regional associations to establish their own Iridium service provider for bulk rates and services as proposed by Ocean.US. An international users group for geophysical Iridium communications is operated by SEACOOS and should be continued.

Orbcomm is a low cost alternative to Iridium, but is not truly real time. It is a “store and forward” system. Data is transmitted in “packets” attached to e-mail messages. These packets are a fixed size, so a larger data transmission would have to be broken into multiple packets on the measurement platform, and each packet transmitted in a separate e-mail and reassembled at the shore station. As the volume of data that is collected and transmitted increases, these packet sizes would have to increase to make this method a viable solution.

The largest hurdle we are facing with onshore or nearshore observing sites is that the coverage for cable modem or DSL networks varies greatly throughout the region. In many cases we are finding that even if residential telephone service is available, the communication lines have not been upgraded to handle DSL traffic. The first logical upgrade that should be made here is for all of the necessary phone lines to be upgraded to allow support for DSL network communication. In areas where cable television is available, whatever upgrades that are necessary for cable modem network service should also be made. In areas where neither DSL nor cable modems networks are available, network service from satellite television companies can be used. This service is more expensive than either DSL or cable modem, therefore either IOOS or the regional association should look at negotiating a contract with one of these satellite television companies. Satellite television service is also only suitable for stably fixed shore platforms.

The most promising data communications method is not currently in user in the Southeast. The Royal Netherlands Institute for Sea Research in cooperation with the University of Utrecht has built a Wifi cloud encompassing the entire coast line of the Netherlands with a range from shore to 100 km offshore. Using the BATMAN protocol (https://snr.freifunk.net/svn/b.a.t.m.a.n/), this cloud has nodes which build ad-hoc self-organizing networks, where routes are calculated dynamically so the network can cope with nodes appearing, disappearing or changing geographic position. Meshcube (http://www.meshcube.org/meshwiki/) nodes consuming low power and equipped with long range ominidirectional antennae are mounted in marine enclosures to provide continuous medium bandwidth connectivity across large areas of ocean. Bandwidth diminishes with the distance between nodes. The Southeast requires pilot projects and eventually the construction of a Wifi cloud covering the coastal region of study.

Some estuarine stations employ cell phone modem technology to momentarily establish either TCP/IP or Zmodem connections for the relatively low bandwidth transfer of data. While slightly more expensive than DSL or cable modem technology, such connections are also prime candidates for replacement with long-range Wifi clouds. Replacement of cell phone links with Wifi would enable continuous real time operation instead of batched near real time operation.

While the data that are collected from some sensors and measurement platforms is relatively small in size and easily transported via the internet at any speed, model output, remotely sensed data, and HR radar data can quickly grow to a volume that could easily bog down even the fastest internet provider. For this reason SECOORA should look at partnerships with agencies that are working on next generation internet solutions like Internet2, the Abilene Project, the national Lambda rail, and SURA.

3.2.2.6.3 Gap Analysis

GOES provides a very reliable and cost effective (free) method of transmitting data from remote platforms and/or sensors. In conjunction with improvements in on-board data processing, upgrades must be made in the amount of data that can be sent during a transmission. One way this can be accomplished is to allow users a larger transmission window or to give users consecutive windows and allow the broadcast to span the multiple windows. Another method would be to continue the development of the system and transmitters to handle faster transmission speeds. The addition of two-way communications will likely be a very difficult and costly upgrade as it will require not only an upgrade to the GOES system itself, but the development of a GOES DCP that is capable of receiving data as well as transmitting data.

Orbcomm will be a better solution for platforms that operate in near real time mode that will not be affected by the "store and forward" method of operation. An increase in data packet size will help reduce the number of data packets that need to be sent, and the biggest benefit here would be that by sending fewer data packets, the probability of loosing a data packet would be reduced.

The time required to reassemble the data packets on the shore based server is negligible compared to latency inherent in the "store and forward" method of telemetry.

Ocean observations in the Southeast have benefited from a Naval program drawing to a close: the "Iridium Pioneers" program granted very low cost Iridium SIMs with unlimited airtime to a limited number of partners. As this program comes to a close, existing Iridium based platforms will need to convert to commercial SIMs.

Use of microwave links may increase if more Naval tower ranges are opened to ocean observations in the Carolinas and Florida. Some startup and operational expenses will be incurred.

Most institutions have access to the internet as part of their infrastructure. The connection to these next generation internet providers is currently very costly and requires a yearly commitment. Once connected you still only have very high speed connection to other subscribers of this system. For this to be useful, SECOORA as a whole would have to have the ability to connect to this next generation internet.

3.2.2.6.4 Activity Required to Close Gap

The activities required to close the gaps identified above are listed in the following table

The activities required to close the gaps identified above are listed in the following table

Item	Activity Description	Responsible Party	Suspense Date	Estimated Cost ($K)
1	Contribution to two way and higher bandwidth GOES capability			
2	Contribution to IOOS Iridium service			
3	Replacement of Iridium SIMs with commercial SIMs			$100k/yr
4	Microwave maintenance and startups			$50K/yr
5	Conversion of Orbcomm systems			$50K
6	Conversion of shore cell systems to broadband			
7	Wifi pilot			$200K

Table 3.2.1.6 Proposed Communications Gap Closure Activities

3.2.2.7 Ocean Data Partnership

The Southeast Coastal Ocean Observing Regional Association (SECOORA) is working to establish an Ocean Data Partnership (ODP), a region-wide effort in data sharing with its data providers. This partnership will be represented by governmental agencies, private sector, intergovernmental organizations, and non-governmental organizations, including academic, research, or other non-profit entities, each of which engaged in the collection of physical, biological, chemical, or geologic data within the SECOORA region. This includes the coasts of North Carolina, South Carolina, Georgia and Florida, from the head of the tide to the Economic Exclusive one (EEZ). This collaboration will provide a unity of effort to share and benefit from the vast and growing quantities of data in their respective databases. Through the coordinated access to the respective databases, the signers wish to advance a truly integrated ocean observing system in the SECOORA area of responsibility, promote an understanding of the diversity and distribution of life and contribute to integrated oceans management.

3.2.2.7.1 Current State

Towards establishing the SECOORA Ocean Data Partnership, first an ODP committee was formed that consists of members of data providers within the SECOORA region. The committee was charged and tasked with writing a Memorandum of Understanding (MOU) for the ODP and develop strategies to implement the same to present it to the data providers in the SECOORA region. The details of the MOU are available at SECOORA web site (http://www.secoora.org). The goal is to build off the processes and procedures learned with the Southeast Atlantic Coastal Ocean Observing System (SEACOOS) and create a mutually beneficial data flow in the entire SECOORA region. This is a non-binding MOU and the signers agree that a coordinated effort is needed to enable users to share data throughout the SECOORA region. The MOU provides for the signatories to run the governance so the signatories will all have a leadership and voting role of the agreement. There is no cost involved other than a willingness to share the data. The ODP came into existence on September 1, 2006.

The ODP MOU was circulated to all the data providers within the SECOORA region as well as the effort was presented at the SECOORA workshop held at Jacksonville during September 2006 workshop. There are currently about ten signatories and they presented in the following table.

Data Provider Program Name	Organization
Coastal Ocean Research Monitoring Project (CORMP)	University of North Carolina Wilmington (UNCW)
Coastal Ocean Monitoring and Prediction System (COMPS)	University of South Florida (USF)
Carolina Coastal Ocean Observing and Prediction System (Caro-COOPS)	University of South Carolina (USC)
Tampa Bay Physical Oceanographic Real-Time Oceanographic System (TB-PORTS)	University of South Florida (USF)
Seakeepers Observations	Seakeepers
NOAA NERRS Monitoring Network	NERRS Centralized Data Management Office at USC

North Carolina Coastal Ocean Observing System (NCCOOS)	University of North Carolina (UNC), Chapel Hill
South Atlantic Bight Synoptic Offshore Observational Network (SABSOON)	Skidaway Institute of Oceanography
Florida Fish and Wildlife Conservation Commission real-time monitoring and other oceanographic data	Florida Fish and Wildlife Conservation Commission
Everglades Marine Monitoring Network	National Park Service and Florida Institute of Oceanography

Work is in progress in expanding the partnership. A governing board for information management has been established drawing members from the participating organizations. Dr. Madilyn Fletcher of University of South Carolina was elected Chair for the Governing Board of Information Management. The details of the responsibilities of the Governing Board and the Chair are outlined in Section 5 of the MOU. The Chair will be serving on the SECOORA Steering Committee. An Information Management Coordinator (IMC) will be hired to provide liaison between the data providers and the ODP Governing Board and SECOORA steering committee. Position description for the IMC has been drafted, and is ready to be advertised. Section 6 of the MOU outlines the responsibilities of the Information Management Coordinator and SECOOR staff. The ODP host selection is in progress and this will be selected by Partnership's Governing Board. The host will initially will consider the framework and data standards established by the SEACOOS, including White Papers on Data Sharing Practices and Quality Assurance/Quality Control and other sub-regional efforts, as the starting point for managing data.

3.2.2.7.2 Desired Future State

The purpose of the ODP is to promote and coordinate the sharing and linking, dissemination, application, and archiving of data all physical, biological, chemical, or geological data within the SECOORA region. Strategies have to be developed to expand the existing partners list. The Information Management Coordinator hiring has to be completed. The IMC has to create a Technical Guidance document to be circulated among the data providers. The technical guidance document should outline the "nuts and bolts" guidance and specific recommendations in key areas needed for successful data sharing and interoperability. The IMC will also have to prepare a annual work program and proposed budget to implement the work program. The host selection has to be completed and the ODP effort cost for SECOORA to establish and maintain the ODP is to be estimated.

3.2.2.7.3 Gap Analysis

- Selection of Host
- Hiring of Information Management Coordinator
- Creation of ODP Technical Guidance Document
- Creation of Annual work program and schedule
- Establishing a SECOORA ODP Portal
- Cost Estimates for the establishing and maintaining the ODP
- Strategies to expand partnership

- Links to other RA's and National backbone

3.2.2.7.4 Activity Required to Close Gap

The activities required to close the gaps identified above are listed in the following table

Item	Activity Description	Responsible Party	Suspense Date	Estimated Cost ($K)
1				
2				
3				
4				
5				
6				

Table 3.2.1.7 Proposed ODP Gap Closure Activities

3.2.2.8 Controls/Constraints

3.2.2.9 Performance Measures

3.2.2.10 Outstanding Issues

3.2.2.11 Summary

The Southeast Atlantic Coastal Ocean Observing System (SEACOOS) was originally established to coordinate coastal observing systems in the southeastern US, and create the capacity for meaningful assembly, integration and dissemination of data and information from these systems. With an initial scientific focus on the development of the capability to observe and accurately model the time-varying three-dimensional circulation and state fields in the coastal ocean from the Outer Banks to the west Florida shelf, an Information Management (IM) component was identified as a priority to enable the integration and interfacing of the observation, modeling, and user application components of SEACOOS. With the transition of SEACOOS towards the implementation of a RA structure, the IM component of SEACOOS has transitioned to SECOORA.

The primary components of the IM infrastructure are the data inputs (in situ observations, remotely sensed data, and model output), the stepwise processes applied to the data (aggregation, analysis, visualization and delivery of data and model output), and the various user-defined products and tools derived from the data. Essential to this IM effort are the development of standards, processes, and protocols to ensure consistency and quality of information and the development of appropriate interfaces, such as web platforms, for delivery of a variety of applications to an equally diverse variety of users.

Building upon existing IM strengths of the principal SEACOORA institutions and an understanding of national (OceanUS DMAC) and international guidelines and recommendations for data management, the specific objectives of the SEACOORA IM component are to:

- Maintain a distributed system of observations and applications;
- Maintain, use, and adapt existing infrastructures to promote flexibility, efficiency, and rapid progress – that is, avoid imposing a comprehensive yet expensive and disruptive restructuring exercise;
- Promote accessibility of both information and applications, such as through open access to all data and utilization of open source software whenever appropriate.

Appendix E: Marketing Plan

A primary function of SECOORA is to ensure that its operations are designed to fulfill the needs of the broader community. Although the SECOORA membership will include representatives of the broad user community, it will be important to assess the needs and priorities of stakeholders beyond the immediate membership so that the products and services developed have optimum utility. An assessment of these needs is essentially a "marketing plan," so the SECOORA strategy can be largely based on existing methodologies. Market research is critical to a successful marketing plan; therefore, what follows are only the basics of how to get started until the necessary market research is complete.

4.1 Identifying our Market

To fully understand our diverse market segments, Needs Assessments tailored to each target market must be completed. SECOORA will need to interview potential customers to understand their wants and needs and determine what motivates their buying decisions. This Needs Assessment will help SECOORA understand the target market size and how the market is segmented (the needs assessment is described in section 4.3.3). This process will help SECOORA understand the products and services that are of interest to our market segments. It also will allow SECOORA to gather customer information that is useful in product/service research and development and in developing a marketing plan for those identified products and services.

Output from this process should guide implementation planning. It should also be used in the pursuit of funding for SECOORA, providing justification for data development programs and new collaborative initiatives identified as relevant or needed. The following outline should guide the development of the user needs assessment.

4. Current Information (needed from SECOORA members and potential members)
    a. Agencies/organizations active in the region
    b. Monitoring and observing programs by agency
    c. Data available from monitoring and observing programs
5. User Needs (needed from potential SECOORA customers)
    a. Products/services desired
    b. Data inputs required to provide those products or services
    c. Value of information if available (would they pay and how much)
6. Delivery Channels (how do customers want to obtain the products or services)

4.1.1 Understanding our Market

How will SECOORA's products and services be positioned? From preliminary discussions most customers want information from "operational systems." Achieving "operational" status will require SECOORA to: 1) provide 24/7 operations with assessments on the data quality; and 2) create robust systems and applications that meet our customer's diverse needs.

- Some want raw observation data (~5%),
- Some want observation data that have been normalized and sanitized (~20%),
- Most want conclusions drawn from observations and data (~60%)
- Some want information that increases knowledge (~15%)

To be successful, SECOORA must be able to select and prioritize key products and services that satisfy customer "needs" and be able to provide those core products and services to members in a way that will minimize SECOORA investment costs and maximize return.

Feedback from current and prospective buyers is required to fully understand the decision making process of current and potential SECOORA customers. Examples of questions that should be asked and updated annually include:

- How do you feel about SECOORA products/services?
- What do you like/dislike about products and services and why?
- When will you buy?
- At what price will you buy?

4.1.2 Marketing Plan Focus

When complete, the Marketing Plan should address the following:

1. How are we positioning SECOORA's products and services?
2. What are SECOORA's principle target customers?
3. What are the key messages?
4. What marketing media will be used?
5. How can we leverage public relations to promote SECOORA?
6. Are there any strategic alliances?

4.2 Target Market Summary (preliminary)

4.2.1 Vertical Markets

During years one to five, SECOORA will concentrate on markets affected by the three goals listed above. Their information and product needs should to be validated through a preliminary needs assessment to gain a better understanding of their market segment. Information, products and services needs may overlap between target markets. Also, since SECOORA strongly supports outreach and education, the K-16 education market is also listed in this section. Targeted user groups include, but are not limited to:

Boating (commercial, recreational): Near real-time meteorological and oceanographic information is needed for nearshore and offshore waters, inlets and rivers so that boaters and sailors can make safe boating and sailing decisions. Water levels, tides, currents, directional waves, weather conditions and visibility are of primary concern. To provide these services SECOORA must serve meteorological and physical oceanographic data in near real-time at strategic locations particularly in nearshore navigation routes and inlets/channels prone to chronic sedimentation.

Cruise Lines (FL only w/ overlap to Caribbean & Mexico Observing Systems): The cruise industry is primarily located in Florida where cruise ship departures to the Caribbean and Mexico are frequent. This target industry provides the opportunity for SECOORA to work with CARA and observing systems in Mexico. Of primary concern for this industry are available draft in transit routes to ports, water levels and tides, sedimentation and shoaling in or near transit routes, weather conditions nearshore and off-shore, wind and wave data, and visibility. Providing real-time water level trends and projections allows for safer and more efficient transit planning into and out of harbors.

Shipping (Pilots Associations, Ports, Shipping Industry, Ferry Operations): Primary concerns for shipping industries are: available draft, water levels, tides, sedimentation and shoaling, weather conditions, wind and wave data, and visibility. To provide these SECOORA must serve water depth in real-time at strategic locations particularly in nearshore navigation routes, connecting channels, harbor approaches, and navigation channels prone to chronic shoaling. Further, there is need for real-time water level trends and projections that promote safer and more efficient transit planning, and optimum cargo loading and conveyance management.

Public Safety: SECOORA has the opportunity to partner with numerous federal, state and local agencies to enhance public safety. Public safety encompasses hazard planning, search & rescue, climate prediction, and weather and hazards forecasting. Examples of information SECOORA can provide to different market segments are listed below:

- Hazard planning for disasters such as hurricanes, extra-tropical storms and nor'easters include activities such as forecasts of inundation; predictions of areas most likely to experience power outages, and providing real-time meteorological data so that ferry transportation can be shut down and bridges and overpasses closed. Post-event activities include modeling activities to determine contamination and debris dispersal, water level monitoring for flood water assessment; and validation of model output.
- Responders to oil and hazardous substance spills and natural disasters may require SECOORA current observations and predictive information on nearshore circulation, currents, weather conditions, wave heights, water temperature, and water quality; and location and information data on potential spill sources, receptors and resources.
- Meteorology and climatology research in the SECOORA domain will augment National Weather Service products and services and improve public safety. For example, real-time data improves the accuracy of forecasts for rip currents and wave heights, and refines numerical models and wave climatologies.
- US Coast Guard and local responders search and rescue operations need observational and predictive information on weather conditions, wave height/direction/period, wind speed and direction, currents speed and direction and inundation. Information augmented by SECOORA data providers can refine the scope of the search area and help minimize loss of life and property.
- Information on harmful aquatic organisms (e.g. harmful algal blooms), natural and synthetic toxins, and pathogens can be coupled with water quality and physical data such as circulation patterns, water depth, and current speed and direction to help managers make beach, waterway and fisheries closure decisions that protect human health.

Coastal Management: In addition to water quality monitoring, coastal managers focus on erosion and sediment transport, hazard management, habitat change, land use patterns, coastal development, aquatic nonindigenous species management and coastal water quality, including Harmful Algal Blooms. Identified data needs include forecasts, sediment transport patterns, geospatial information (updated land use/land cover), landscape characterizations, and biological inventories of nearshore areas. Predictive models are needed to simulate and predict effects of shore protection structures and changes in land uses on nearshore areas, water quality, and coastal habitats.

There is a need for more advanced predictive modeling tools to support beach managers in forecasting the presence of biological pathogens in nearshore waters. Meteorological data, wind/wave forecasts and nearshore circulation modeling are particularly important to assess the frequency and cause of pathogen loadings. Meteorological data collected should include air temperature, hourly rainfall, relative humidity, and hourly wind speed and direction. Other factors commonly monitored include water temperature, conductivity, current speed/direction, solar radiation, pH, dissolved oxygen, chlorophyll, and turbidity. Improved knowledge of local hydrodynamics, regional environmental processes, beach orientation with respect to water circulation patterns and the temporal changes in nearshore currents are needed.

Fisheries & Fishing (commercial & recreational): Fisheries managers include, but are not limited to, fisheries management councils, state and federal marine fisheries departments and fisheries researchers. Identified needs include real-time physical and biological data and modeling products to complete stock assessments, understand larval fish recruitment, and undertake ecosystem management activities.

The fishing industry includes commercial and recreational fishers as well as brokers and processors. Both commercial and recreational fishermen need near real-time meteorological and oceanographic information to make safe boating decisions and help locate target species. These data needs include bottom water temperature, sea surface temperature, precipitation (important for estuary dependent species such as shrimp) and water quality data.

Recreation and Tourism: Recreation and tourism is a broad umbrella category, ranging from restaurants to watersports, where a variety of businesses located in coastal communities are represented. SECOORA will need to determine which recreation and tourism industries are viable markets. Coastal managers are required to make decisions that affect tourism, such as beach closures, and their information needs are somewhat different than those of recreation and tourism providers. Recreation and tourism activities include: Swimming, SCUBA Diving, Surfing, Para-sailing, Kite Boarding, and sunbathing. Most information needs will be near real-time meteorology and beach-specific water temperature, wave and current data.

Research: The Research community is fundamental to each Market Segment and user group. While their specific interests vary, their basic needs are usually focused on the availability and use of "raw" observation data rather than any processed data. Many SECOORA members are part of the Research community. While the Research community is a critical component of the Market Segment and User Groups and the success of future products and services, it is not expected to be a significant source of revenue.

Education: Education materials developed through SECOORA must be designed for a wide variety of age groups and audiences, including both traditional and non-traditional (informal) educational settings. Traditional settings include K-16 classrooms and university and post-graduate programs. Informal settings include public libraries, museums, aquaria, education camps and environmental learning centers. Development of materials requires partnerships between the curriculum development unit and scientists. Organizations such as the Centers of Ocean Sciences Education Excellence (COSEE), USC Science Education Center, NCSU Science House and sub-regional COOS programs will help guide product development. The COSEE programs can be particularly valuable as SECOORA is uniquely poised with three of the ten national organizations in its domain (COSEE-SE, Florida COSEE and the Gulf of Mexico COSEE).

SECOORA education products need to meet national curricula standards to maximize their classroom use. Per the Great Lakes Observing System and COSEE-SE assessments, the most frequently cited education need is readily accessible standards-based lesson plans and activities that revolve around real-time physical ocean conditions. Of primary interest is information related to weather and associated forecasts and advisories, including rip-currents, easy-to-understand analyses of trends in estuaries, and water quality data collected, compiled, and analyzed through SECOORA. The preferred delivery methods identified are teacher training workshops, Internet-based distance learning (i.e., "virtual" learning opportunities), mobile SECOORA learning centers and traveling displays, and nearshore/underwater camera surveillance to promote knowledge and interest in what lies beneath the water.

Media: Weather and water forecasting products can be targeted and made available to specific media outlets. User specified media outlets will also have to be approached as SECOORA products and services are unveiled. An example of a SECOORA product developed for a specific user and target audience is located in **Appendix F**.

Other Uses
Additional user needs assessments for the following areas should be pursued by SECOORA:

- Water Treatment (pollution – coastal management)
- Municipal and Industrial use of water (discharge)
- Shoreline Protection and Use (coastal management)
- National/Homeland Security – port security: Homeland security interests need estimations and predictions of near-surface currents, water quality/clarity and near-surface visibility; real-time video and acoustic monitoring; aerial and satellite imagery; and atmospheric and aquatic monitoring for nuclear, biological and chemical (NBC) contaminants.
- Oceans & Human Health research collaboration (pharmaceuticals)

4.2.2 Customer Base
Who is going to "pay" for the data, products and services provided by SECOORA? The customer base and examples of each are listed below:

- Federal Government – FEMA, NOAA, NSF, USACE;
- State Government –state emergency managers, DOT, water quality managers, natural resource managers;
- Local – county emergency managers, beach officials, municipalities;
- Public – individuals, recreational fishing organizations/clubs;
- Commercial – ports and shipping;
- Private Industry (either use data directly or for value added product development) – Accuweather, charter boat captains, SailFlow; and,
- Foundations – Foundations are a funding source which can be developed through a strategic focus on issues that are vitally important to them. This focus should allow

SECOORA to establish clear connections between a foundation's agenda and SECOORA services and deliverables, and then communicate them effectively in funding proposals.

4.2.3 Unique Geographic Feature

The Intercoastal Waterway (ICW) is a unique feature within the SECOORA domain. Maintenance requires federal and state level support. The ICW is impacted by weather, climatology, water supply, hydrology, estuaries, tidal influence, dredging (ICW & inlets), coastal development and stormwater runoff. It is prone to large of amounts of boater traffic, which has spawned a number of businesses that cater to the boating and tourism industries (fuel, dockage, restaurants, fish houses). Numerous residential communities have also sprung up along the ICW. This geographic feature should be considered by SECOORA for specific study and assessment since ICW-specific projects may present unique funding opportunities. The US Army Corp of Engineers is a potential consumer that could be targeted since they are tasked with maintaining the ICW.

4.2.4 Market Selection Process

The market selection process is the defining of the markets SECOORA chooses to serve. In the near-term this has to be driven by the ability of that market to provide value to SECOORA (where value = ability/willingness to pay + ability/willingness to support SECOORA) AND the ability of SECOORA's members to easily and quickly provide the services or products that serve this market.

The market selection process requires two fundamental assessments be completed before a successful market strategy can be executed.

1. An assessment of SECOORA members products and services
2. A survey and assessment of potential customers needs

Once these activities have been completed, then the limited marketing resources can be targeted on those customers that offer the most near term potential for SECOORA's and its members success.

4.3 Marketing Strategy

The SECOORA business model is not a simple model with customer's paying for SECOORA's products or services. Figure 4.3 illustrates some of the business relationships that we expect to develop as SECOORA's products and services become readily available. It is envisioned that the Federal Government will be the predominant revenue source for SECOORA and its members. The block "customers" represents all those organizations, institutions and individuals who want information from SECOORA except the Federal Government. While it is recognized that the Federal Government will continue to be a SECOORA customer, for clarification purposes, the Federal Government has been identified separately.

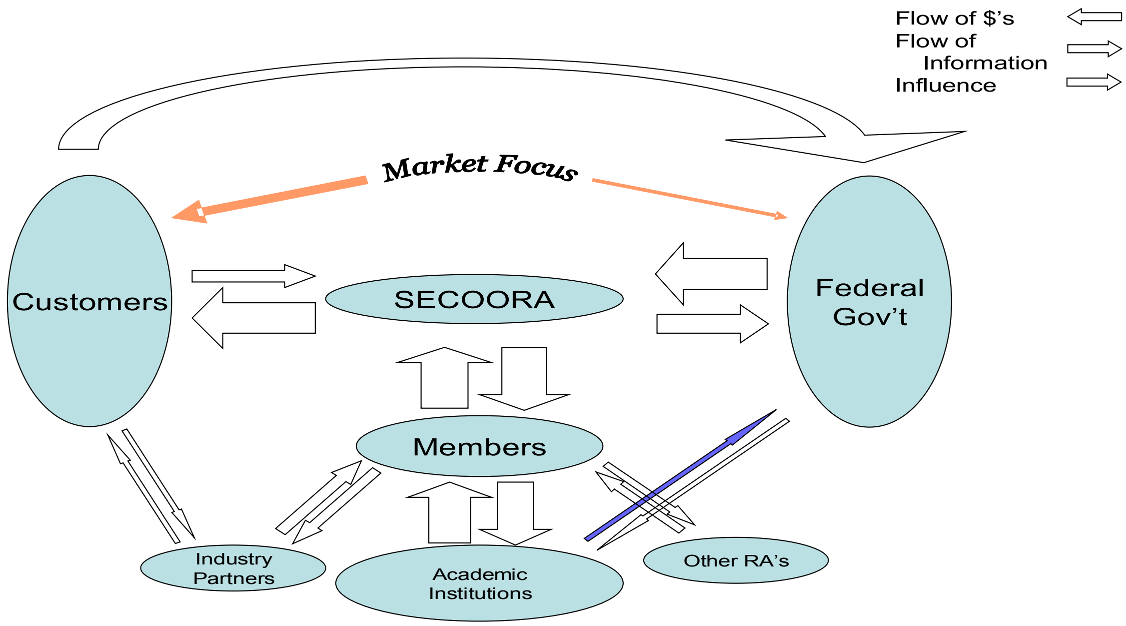

Figure 4.3 SECOORA Business Model

The principle marketing strategy will be to understand the customer's wants and needs and their potential for political influence and/or their ability to pay for the information they receive. In order to optimize and infuse SECOORA with the necessary resources for the organization to succeed, it is imperative that SECOORA be able to provide its members with the dollars necessary to continue development. While the Federal Government will be the major source of funding, it is recognized that obtaining Federal dollars will become increasingly competitive. Having customers who recognize the value of SECOORA's product and services and have the ability and willingness to support SECOORA's pursuit of Federal and State dollars will be critical to the success of the program.

As part of the Needs Assessment, an assessment of the potential value of each customer will be conducted (where value = ability/willingness to pay $ + ability/willingness to support SECOORA politically). This information will be used to prioritize both our marketing effort and product/services research and development initiatives. The long term goals of the marketing plan and SECOORA's business model should be to increase non-federal resources and to diversify the customer set to lessen the impact of local/regional economic trends.

A secondary marketing effort should be initiated in conjunction with the market selection process. Advertising SECOORA's fundamental mission, serving the public good, is needed for long term success. Public services available from SECOORA should be identified and public branding and recognition of SECOORA established early in the marketing effort.

4.3.1 SECOORA Members
Currently SECOORA members include state agencies, academia & research institutions, companies with data management interests, private industry, and regulatory organizations.

4.3.2 Product/Services

A recommended process to gather information associated with vertical markets is to partner with local business schools in each state to create needs assessment tools, conduct interviews and compile assessment results. This can be done in conjunction with undergraduate or graduate level courses on an annual basis. The information obtained will provide SECOORA with up-to-date market needs so that existing products and services can be evaluated and new products and services developed in conjunction with the R& D and Data Analysis and Modeling components of SECOORA.

4.3.3 Needs Assessment

Building a comprehensive database of potential users is essential to the success of SECOORA. A good way to identify existing leadership and establish contact points is by attending meetings of trade associations, professional societies and other groups. SECOORA has initiated participation by working with the Southeast Coastal Manager Focus Group on Ocean Observations Needs. Other avenues to identify user needs and make potential users aware of SECOORA include:

- Attending existing user group-specific meetings and conferences and make SECOORA information/education presentations. Participation in this type of activity provides insights into target market needs and enables needs assessments to be completed by a select target market.
- Recruiting representative user group members for inclusion on appropriate SECOORA advisory, administrative and governing entities.
- Conducting surveys, forums and listen-ins to assess specific user needs, gaps and deficiencies in existing services and other input contributing to product research and development.
- Holding thematic workshops and conferences to generate additional user input, and promote dialogue between users and the SECOORA governance/administrative function.
- Publishing SECOORA-related papers and articles in professional journals, trade publications and other specialized media.
- Offering value-added products, tailored to user group needs.
- Working with SECOORA membership to expand participation through symbiotic effort.
- Targeted geographic and political outreach strategies may also be developed, aimed at specific regions, states and local levels of government. Multi-national outreach should be initiated to promote discipline-wide international participation in SECOORA.

Results of the needs assessment will be analyzed to generate the product development strategies for specific observing, modeling and research activities that will fulfill market demand. A prioritized user list will be generated based upon who needs the product/service and their ability to pay or political influence (federal or state dollars).

4.3.4 Marketing Process

Building upon the needs assessment analyses, targeted marketing and promotion of SECOORA should involve custom-designed, narrowly-focused outreach initiatives.

4.3.5 Marketing Campaign

This effort should disseminate general information about SECOORA with the objectives of establishing a basic knowledge and awareness of SECOORA among the general public, promoting the intrinsic value of improved coastal observation and monitoring capabilities at regional, national and global levels, building a grass roots base of support for future legislative initiatives, and recruiting new SECOORA users and members. Potential vehicles include:

- Brochures
- SECOORA website
- News releases
- Press kits
- Fact sheets
- Public service broadcast spots
- Press conferences
- Newsletters
- Logo development, refinement and proliferation
- Demonstrations
- Targeted Public Relations

The marketing campaign will benefit from involvement with the NOAA marketing strategies and with those of other Regional Associations. By working collectively to promote Observing System needs and components shared by all RAs, certain synergies and economies of scale will be realized. To be effective, the campaign will require a significant commitment of SECOORA staff, its board, membership and resources.

4.3.6 Specific/Targeted Strategies: Targeted marketing strategies must occur for the following customer bases after the needs assessments have been completed and products/services identified within each group.

- Federal
- State
- Local
- Public
- Commercial
- Private Industry
- Formal Education

An example of a targeted strategy, using the Federal Government is located in **Appendix G.**

Appendix F: Carolinas Coast NWS Example – process used to develop product

Currently, region-specific information on marine and coastal conditions is collected by, stored in, and disseminated from a wide range of government and academic institutions. One of the most efficient ways for coastal ocean observing systems to disseminate marine information to the public is through a partnership with local NOAA NWS Weather Forecast Offices, since the targeted audiences (general marine community, recreational and commercial mariners, scuba divers, fishermen, marine safety officials and the general public) already rely on these offices for marine observations and forecast needs. The Carolinas Coast marine website, created for the NWS-Wilmington, NC Weather Forecast Office, is an example of how two COOS worked with a federal partner to help meet the target market needs.

To assure that the new Carolinas Coast marine website met user needs, a focus group was created to guide website development. This focus group met throughout the web development process and provided feedback during the website construction. The focus group is comprised of North Carolina and South Carolina members of the Coast Guard Auxiliary and regional Sail and Power Squadrons, local fishermen, NC ports officials and a variety of other marine constituencies, COOS data managers, website developers and outreach staff. Also, meteorologists from the Wilmington and Charleston Weather Forecast Offices attend focus group meetings to provide NWS product specific input.

With the end user in mind during product creation and with their input during site construction, the Carolinas Coast web development team was able to gain community support for the product before it was even deployed. And, since the website was developed as an NWS product, it will be available from an "operational" entity, not an academic institution.

Appendix G: Federal marketing strategy

Targeted and strategic communications should be established with federal legislative stakeholder groups. Since much of the SECOORA funding will come from federal dollars, targeting stakeholder groups that will provide political support will be beneficial. Some of these stakeholder legislative entities include (but are not limited to) those listed below. Comparable state level stakeholder groups, including non-governmental interests, should also be identified.

Senate:
Smart Growth Task Force
Tourism Caucus

House:
Congressional Boating Caucus
Congressional Climate Change Caucus
Congressional Coastal Caucus
Congressional Travel and Tourism Caucus
House Oceans Caucus

A legislative program should be prepared which advocates for federal legislation to authorize and appropriate the IOOS programs, including SECOORA. Where appropriate, the legislative initiatives should also be directed to the states (NC, SC, GA and FL) to ensure programmatic consistency and function across the region. Coordination of the legislative initiatives should involve principally the SECOORA Board of Directors and other key stakeholders. When appropriate, coordination should involve the other 10 RAs to strengthen its effectiveness.

The content of the legislative program should include SECOORA-based success stories to illustrate how coordinated data delivery through SECOORA has benefited various user communities. It should succinctly link SECOORA products and deliverables to states and congressional districts, as well as watersheds, water/land economic resource zones and ports, among others.