Southeast Atlantic Marine Monitoring and Prediction Center:

2001 Coastal Ocean Research and Monitoring Program (CORMP)

University of North Carolina at Wilmington
NOAA Award # NA16RP1460
Semi-Annual Progress Report, 1 August 2001 to 31 January 2002

Submitted by:

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INTRODUCTION

Funded by NOAA, the University of North Carolina at Wilmington began a Coastal Ocean Monitoring Project (COMP) in September 1999-- a multi-disciplinary research and monitoring effort focused on the coastal ocean off southeastern North Carolina. In 2001, the university received new funding from NOAA to support the Coastal Ocean Research and Monitoring Program (CORMP). Research was added to the program title because, in addition to sustained sampling and measurement of basic oceanographic parameters, CORMP conducts process-oreinted research on issues such as ecological responses to storm events, chemical and biological effects of the Cape Fear River's plume on the coastal ocean, and larval fish recruitment. During the first COMP grant, for example, investigators assessed the impacts of Hurricane Floyd on coastal ocean water quality, but were hindered by a lack of pre-storm baseline information. Permanent monitoring stations subsequently established in the Cape Fear River plume and Onslow Bay now provide baseline data and research opportunities from the shoreface to the outer shelf. The final report for NOAA award # NA96RP0259, which funded COMP from September 1999 through May 2001 and previous semi-annual progress reports are posted on the program web site at http://www.uncwil.edu/cmsr/comp/results.htm.

In August 2001, UNCW's CORMP was awarded NOAA grant # NA16RP1460. Program objectives for the period of August 1, 2001 to July 31, 2002 include:

- *Research and Observations:* 1) understand coastal ocean processes responsible for cross-shelf transport; 2) understand the means by which coastal ocean processes control primary and secondary productivity, including fisheries; and 3) understand interactions between riverine and coastal ocean systems including impacts of anthropogenic and stochastic events (e.g., hurricanes)
- *Data Management:* ensure timely delivery of data, adequate quality control, adaptability to changing user requirements, wide dissemination and easy access to program products
- *Modeling Products:* develop predictive models of effects of natural and anthropogenic impacts on coastal ocean ecosystems and socio-economics of the region
- *Program Management:* establish stronger external ties to user groups, and other research and monitoring programs to help leverage and integrate CORMP into a broader regional context.

This progress report describes accomplishments for the first six months of grant # NA16RP1460 covering the period from August 1, 2001 to January 31, 2002.

MILESTONES AND ACCOMPLISHMENTS

Research and Observations

Primary efforts and accomplishments of the program relate to continued data gathering and research work in Onslow Bay and the Cape Fear River plume. Appendix A contains progress reports that summarize the objectives, tasks accomplished, collaborations, products and future plans for each of the major CORMP projects (Table 1). The program Web site (www.uncwil.edu/cmsr/comp) provides access to program descriptions (including major operations and monthly cruise logs) and results.

Table 1. CORMP research and monitoring projects supported by NOAA award # NA16RP1460.

PI	Title	Issue(s)
Cooper	*Characterization of the Colored Dissolved Organic Matter (CDOM) in the Waters of Onslow Bay, the Cape Fear River Plume and Coastal Southeastern North Carolina*	Water Quality, Productivity
Durako	*Optical Characterization of the Waters of Onslow Bay, the Cape Fear River Plume and Coastal Southeastern North Carolina*	Water Quality, Productivity
Lankford	*Fisheries Recruitment Oceanography: Abundance and Diversity of Ichthyoplankton in Onslow Bay, North Carolina, in Shelf and Gulf Stream Water Masses*	Fisheries Oceanography
Leonard	*Storm Impact on Sediment Mobility and Biotic Response in Onslow Bay, NC*	Sediment Movement & Shoreline Stability
Mallin	*Ecological Impacts of The Cape Fear River Plume*	Water Quality
Pietrafesa/ Bingham	*Coastal and Estuarine Physical Oceanographic and Meteorological Observational Network and Coupled Model System*	Cross-Cut: Ocean Circulation
Posey	*Connections between Coastal Ocean Processes and Estuarine-Dependent Fisheries*	Fisheries Oceanography, Productivity
Spivack	*Determination of Cross-Shelf Dispersion in Onslow Bay Using Radium Isotope Distributions*	Cross-cut: Ocean Circulation
Cahoon*	*The distribution of phytoplankton in Onslow Bay*	Productivity

* -- funded by development funds

Milestones, as defined in the original proposal to NOAA, and actions taken during this report period related to research and observations include (in the same order as presented in the proposal):

- Report, present, publish on: mid-shelf sediment transport processes in Onslow Bay, NC, physical oceanographic processes on the mid and outer shelf of Onslow Bay, reef fish recruitment to mid-shelf live bottom reef, bio-optical comparison of CFRP and Onslow Bay waters

As reported in Appendix A, products addressing each of the above topics have been accomplished. We expect many more refereed publications will evolve in the coming year, as the program matures and dissertations are completed. Most of the graduate students who began with the program in 2000 will finish their thesis work in Spring 2002.

- Expand physical oceanographic monitoring network in partnership between UNCW and NCSU

NCSU has repaired and purchased necessary equipment to establish the NC offshore network (see Pietrafesa project report in Appendix A). We anticipate that this equipment will be deployed by March 2002, depending on weather.

- Establish partnership with US Army Corps of Engineers to enhance network in Cape Fear River Plume (CFRP) and Long Bay; technical report on expanded Onslow Bay and Long Bay networks

We spent many hours discussing partnership efforts with the Corps of Engineers in conjunction with the Wilmington Harbor project (http://frf.usace.army.mil/capefear/). Although no direct partnership (e.g., involving funding exchange, joint operations) will likely occur, data will be shared between the programs. In addition, some CORMP investigators are involved in the Harbor project on separate grants/contracts. A report on the offshore network will be part of the next progress report.

- Partnership with Sea Grant to study finfish and shellfish (blue crab) recruitment in CFRP and establish new faster identification techniques for identification of finfish and shellfish larvae

As reported by Lankford et al. in their project report (Appendix A), they are receiving substantial co-funding for this project from NC Sea Grant and will likely have the new crab larval identification technique operational in 2002.

- Conduct workshop on assessment of primary productivity in the coastal ocean

This workshop is scheduled for Spring 2002.

- Partnership with NOAA/NOS to establish calibration station for SeaWiFS ocean color data

We initiated conversations with Dr. R. Stumpf, NOAA/NOS. He has an established ocean color satellite calibration program in the Albermarle-Pamlico Sound, which he is using to develop new algorithms for interpreting the SeaWiFS satellite data. He expressed interest in sharing data and joining a similar effort in the coastal ocean off Cape Fear.

Data Management

Proposed milestones and actions taken during this report period related to data management include:

- Report on historical data from the NC/SC coasts and existing or planned coastal ocean monitoring programs in the SAB

In 2001, CORMP participated in a regional effort to inventory ocean observing programs around the nation, spear-headed by NOAA's Coastal Services Center. Results for the southeast region are reported on at http://www.csc.noaa.gov/cts/coos/southeast.html. A regional planning meeting of current observing programs off the Carolinas is planned for February 2002.

- Develop CORMP data template (metadata and observation log)

The first step in maximizing integration, accuracy and accessibility to CORMP data sets is to establish metadata for the program. Metadata is essentially "data about data."-- information as to the characteristics of a data set, lineage of a data set, and contacts for accessing or acquiring a data set. Standardized metadata procedures provide a means to document datasets within organizations, to contribute to and facilitate multi-participant data exchange programs, and facilitate locating, understanding and utilizing existing data sets. NOAA's Coastal Services Center will provide metadata training for CORMP data custodians in February 2002.

The CORMP Data Management Plan (Appendix B) is a strategic and action oriented-plan designed to meet the research objectives, integrate the varied projects and datasets, and make the results accessible for various users. The plan takes advantage of an opportunity that has arisen for 2002 -- a partnership with a data management team at the Belle W. Baruch Institute for Marine Biology and Coastal Research at the University of South Carolina.

The Information Technology (IT) specialists of the Baruch Institute have extensive experience in experimental design, analytical methods, statistical analysis, database management, and the implementation and application of quality assurance/quality control (QA/QC) procedures. Moreover, the Baruch Institute has been a leader in environmental data management for over 20 years and currently administers the Centralized Data Management Office (CDMO) of NOAA's National Estuarine Research Reserve System. Recognizing that data are one of the most valuable products of CORMP and South Carolinas' Coastal Ocean Observing and Prediction System (Caro-COOPS), the Baruch Institute will establish a joint CORMP/Caro-COOPS Data Management Office (CCDMO) in support of providing fast, effective, and open access to quality-controlled coastal ocean data and associated metadata through a Virtual Network Information System (VNIS). Tasks in the plan that we will work with the CCDMO on include: 1) development of a relational database for data entry and reporting and 2) a QA/QC and operations manual with guidelines and procedures for CORMP data collection and archival. This partnership will be established in May 2002, after the SC program receives it's funding.

- Establish partnership with NOAA Coastal Services Center, Charleston, SC, to promote liaison with coastal managers

We met with the CSC staff in December 2001. As a result, they will provide training in February 2002 to CORMP data custodians on how to prepare and maintain metadata for the CORMP data sets. We are incorporated into their listing of regional observing programs. Our Scientific Advisory board, scheduled to meet in March 2002, includes a former (left after we established the board) CSC staff member who specializes in stakeholder issues.

- Conduct pilot study (requirements analysis and feasibility report) for implementation of clearinghouse node, ftp site and Web GIS for CORMP data in 2002

The CCDMO will host the metadata and dataset server and develop a GIS interface for the NC/SC data (see above and Appendix B for more). In addition, we have initiated a partnership with Dr. R. Huber, UNCW Dept. of Education and NC Sea Grant , to develop innovative data visualization tools for displaying CORMP results (see www.uncwil.edu/oceanview). These tools convey data to the public, especially educators and students, in user-friendly ways that provoke inquiry-based learning.

- Identify dedicated webmaster assigned to upgrade the existing CORMP web site

The CORMP web site (www.uncwil.eud/cmsr/comp) was completely redone and launched in December 2001 by a part-time Webmaster, Mr. Justin Arnette. We will continue to work with the Webmaster to develop new products.

Modeling Products

Proposed milestones and actions taken during this report period related to modeling products include:

- Establish MOU with EPA and NOS to exchange data and validate bio-optical model

The EPA MOU has been signed by UNCW and is now at EPA for signature. The NOS MOU is in draft form and under review by UNCW.

- Conduct workshop to identify and report on existing ecosystem models in the CFRP and Onslow Bay.

In May 2001, after submission of the proposal, we held a working group meeting with the following objectives:

  - discuss models that may apply to CORMP's observation system
  - describe plans for the new CORMP physical processes observing system
  - identify next steps for CORMP modeling efforts.

Len Pietrafesa, NCSU, summarized justifications for establishing a shelf-wide observing system in Onslow and Long Bays. He used a Coastal-Global Ocean Observing System (CGOOS) workshop report to lead this discussion, e.g., provided lists of core variables that should be measured for various applications. He highlighted specific needs for the SAB coastal ocean, including increased coverage (time and space), real-time or near-real-time coverage, continuous coverage. Only through enhanced coverage will we be able to do forecasts versus hindcasts or nowcasts.

Lian Xie, NCSU, described plans for an integrated modeling program that starts with physical processes (atmospheric and oceanic) and subsequently couples with models for chemistry, biology and geology. NCSU's Coastal Marine Environment Prediction System (CMEPS) uses several physical models, e.g., the Princeton Ocean Model (POM, http://www.aos.princeton.edu/WWWPUBLIC/htdocs.pom/), Wave Model (WAM), and the FOAMv program (http://www2.ncsu.edu/eos/service/pams/meas/www/foamv/foamv.html). CMEPS will apply a suite of coupled air-sea-wave models (http://www.confex.com/ams/cpp3/abstracts/228.htm) to the areas of the CORMP observing system (e.g., Cape Fear River).

CORMP investigators suggested potential products including models related to bio-optical characteristics of river plume and shelf waters, physical/biological interactions on shelf reefs, fate and transport of CDOM in the coastal ocean, response of coastal ocean primary production to river discharge events, coastal ocean circulation, and recruitment dynamics in the Cape Fear River Plume. Dr. Xie reviewed this list and proposed the following action plan:

1. configure POM for the Cape Fear River (CFR-POM)
2. use initial model runs to improve CORMP mooring strategy
3. use CORMP observations to validate CFR-POM
4. couple new CFR-POM with bio-optical model
5. couple new CFR-POM with fish recruitment model
6. couple with other models (sediment transport, reef/sediment interactions)

- Develop models for shelf circulation and storm surge in Onslow Bay based on the offshore mooring network data

We plan to deploy the moorings in March 2002. NCSU is now preparing new physical model for the Cape Fear region. Initial and subsequent steps that couple this model with other models will require working groups to help Dr. Xie parameterize the new model (e.g., what spatial/temporal resolutions required? what vertical elements?).

Program Management

Proposed milestones and actions taken during this report period related to program management include:

- Enhance partnerships and communications with other coastal ocean programs in the region

Several external partnerships have been described above. In addition, we met with directors of North and South Carolina Sea Grant programs to discuss other partnership ideas, for example, we plan to collaborate with SCSG on a regional planning workshop in October 2002. Also in 2002, a new ocean observing system was funded for monitoring the coastal ocean off South Carolina. The Carolinas Coastal Ocean Observing and Prediction System (Caro-COOPS) will be closely integrated with CORMP, as evidenced by our joint data management office described above.

- Establish a CORMP scientific advisory board

In December 2001, invitations were sent to initiate the CORMP Scientific Advisory Board. The board consists of representatives of user groups and experienced experts in ocean science (Table 2). Their role will be to advise the program on a number of issues, for example, identification of regional research priorities and opportunities for strengthening, leveraging, and promoting program activities. The board will provide connections with users to help ensure that the program is addressing both regional and national ocean priorities. The first meeting is planned for Spring 2002, after which the board will meet at least annually.

Table 2. CORMP Scientific Advisory Board members who have accepted as of January 2002.

Name	Job Title	Affiliation
Donna Moffitt	Director	NC Division of Coastal Management
Paul Moersdorf	Director	NOAA Natl. Data Buoy Ctr.
Earle Buckley	Prog. Development	NOAA Coastal Services Center
Ron Baird	Director	National Sea Grant College Program
Bud Cross	former Dir.	NMFS Beaufort Lab
Ron Hodson	Director	NC Sea Grant
Madilyn Fletcher	Director	Belle W. Baruch Institute
Fred Saalfeld	Exec. Director	Office of Naval Research

APPENDIX B

CORMP DATA MANAGEMENT PLAN, 1/25/01 DRAFT

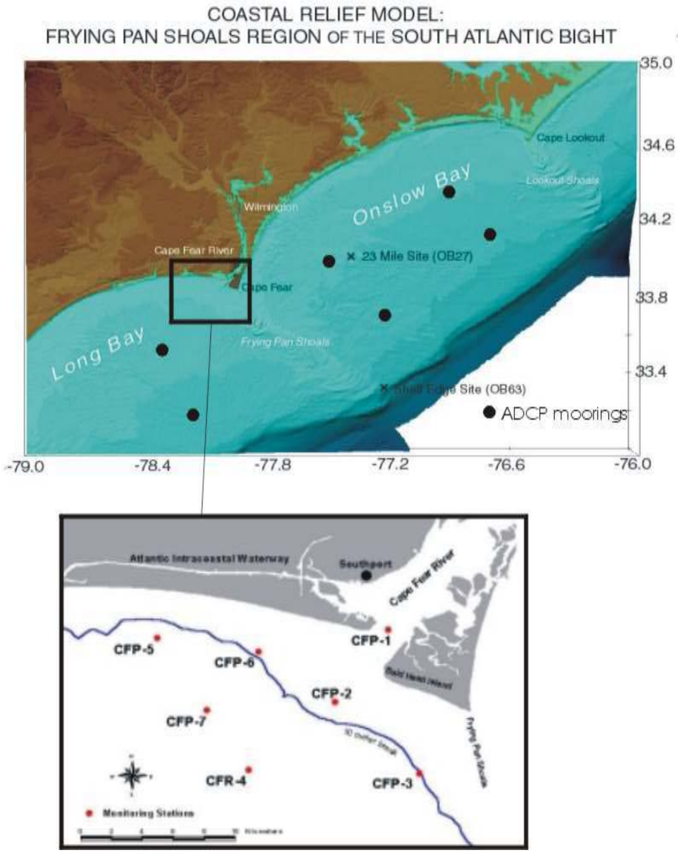
Coastal Ocean Research and Monitoring Program (CORMP)

Data Management System

1-25-02 DRAFT

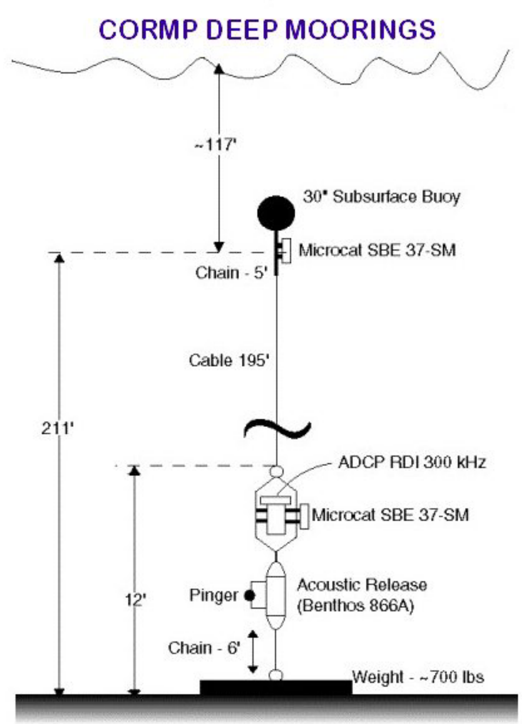
COASTAL OCEAN RESEARCH AND MONITORING PROGRAM (CORMP)

Need for Coastal Ocean Research and Monitoring off the Southeast United States



Human population and associated development are growing along America's coasts and threaten marine resources and ecosystem health. Better-informed management, more accurate predictive models, inter-disciplinary scientific studies and long-term monitoring are required.

The South Atlantic Bight (SAB)-- coastal ocean between Cape Hatteras, North Carolina, and West Palm Beach, Florida— is experiencing the largest coastal population growth of any region in the nation. It is plagued by frequent major storm events and flooding. Fishery harvests are declining. Industrial and agricultural pollution is rising. Toxic microbial outbreaks and harmful algal blooms are increasing. Development and paving of coastal lands is hastening the introduction of pollutants to watersheds and the coastal ocean.



Ocean Observing Systems-- Knowledge, Prediction and Solutions

The strategic plan for the Congressionally-mandated Integrated Ocean Observations System (IOOS) calls for a "sustained, integrated system" to improve weather forecasting, predictions of climate change and related impacts on coastal populations, safety and efficiency of marine operations, and coastal ecosystem health. The *Coastal Ocean Research and Monitoring Program (CORMP)* at the University of North Carolina at Wilmington (UNCW) is a research and monitoring program that addresses these goals in the coastal ocean. The program mission is to provide an inter-disciplinary science-based framework that supports sound public policy leading to wise coastal use, sustainable fisheries and improved coastal ocean ecosystem health.

The National Oceanic and Atmospheric Administration (NOAA), the nation's steward of coastal ocean habitats and resources, funds the program.

CORMP Observing System

The basic elements of an ocean observing system include: 1) measurement of core variables and transmission of data, 2) data management and 3) mathematical modeling. CORMP data (including physical processes, ocean color, water quality, radiation, sediment types and seafloor community characteristics) are collected during monthly sampling transects and from long-term moorings off North and South Carolina. Data products will be disseminated via a national clearinghouse node for metadata, ftp site for data sets, and interactive web-based Geographic Information System for products. Models in development include a storm surge model for the Cape Fear River basin and a general shelf circulation model.

CORMP Research Initiatives

CORMP undersea tripod

Fisheries Oceanography: The most valuable commercial fisheries in the Southeast U.S. are estuarine-dependent-- adults spawn offshore and larvae journey inland to nursery grounds. CORMP describes recruitment processes on offshore reefs, spawning grounds, and areas being considered for protected status. The Cape Fear River, like most SAB rivers, opens directly into the coastal ocean. Salt and larvae exchange freely through the mouth. CORMP scientists evaluate the role of the Cape Fear River plume in attracting, concentrating and successfully transporting offshore larvae into the river's estuaries.

Water Quality: UNCW's Lower Cape Fear River Program maintains an estuarine monitoring program in the river, tidal creeks, marshes, embayments, and Intracoastal Waterway. These areas exhibit increasing signs of environmental stress and pollution. CORMP provides similar water quality data for the coastal ocean (e.g., dissolved oxygen, nutrient levels), including conditions during and after major perturbations, such as hurricanes, floods and pollution events. Observations and analyses are used to monitor and predict the impacts of human activities and land-use change in the watershed on the coastal ocean.

Productivity: Primary productivity is a source of life and threat to human and ecosystem health. Nutrient pollution may lead to increasing incidents of harmful algal blooms, fish kills and low oxygen events. CORMP assesses primary production in a variety of ways. Light spectrum measurements in the coastal ocean are correlated with phytoplankton pigments and colored dissolved organic matter (CDOM)-- data used for validation of ocean color data from satellites (SeaWiFS) and development of new bio-optical modeling algorithms.

Sediment Transport and Shoreline Stability: SAB coastal areas are battered annually by tropical cyclones and extra-tropical storms that attack shoreline stability, sand resources, properties and human lives. CORMP monitors and assesses the impacts of high-energy storm events on sediment transport and the ecology of seafloor ecosystems, particularly "live bottom" reefs. CORMP models will aid effective, sustainable utilization of offshore sand resources and commercial fisheries.

Ocean Circulation and Weather: Physical observations are the backbone of CORMP's field observational and numerical modeling program. A network of oceanographic moorings, from the shore to outer shelf off North and South Carolina, provide input to a hydrodynamic model for estimates of currents, tides, internal and gravity waves, temperature, salinity and sea level fields. Real-time data will be added in 2002-03.

CORMP Partners

Partnerships now exist with NC Sea Grant, the National Undersea Research Center at UNCW, ocean color and SeaWiFS experts at NOAA and the Environmental Protection Agency, University of Rhode Island, and physical oceanographers at North Carolina State University. These and future partnerships leverage resources and enable scientists involved in similar programs to work together.

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CORMP- Operations Program

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Operations Lead:
Sharon A. Kissling, Kisslings@uncwil.edu 910-962-2327

Other Personnel (list name, affiliation and role e.g., investigator, technician, student):

Mr. Jason Souza, CMS/UNCW, Research Technician (nutrient and water chemistry sample processing)
Mr. Chris Angelow, CMS/UNCW, Electronics Technician
Mr. Drew Hodge, CMS/UNCW, Research Technician (vessel operator)

Operations Summary:
- Dayboat (<10 m) days **42**
- Ship days (> 10 m) days **44**
- Special field operations (check): **X** Scuba Diving, **X** Seismic/Side scan, **X** CTD rosette

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PROJECT DESCRIPTION

CORMP operations staff provide safe, effective support for the numerous research projects. CORMP operations staff carry out scheduling and reservation of ship and boat time. Operations staff design, assemble and deploy the moorings from UNCW's research vessel *Cape Fear,* with support from UNCW-NURC diving teams. CORMP operations staff maintain the offshore moorings at both the CFRP and Onslow Bay stations (Figure 1), including recovery, data retrieval, cleaning and refurbishment, recalibration, and re-deployment.

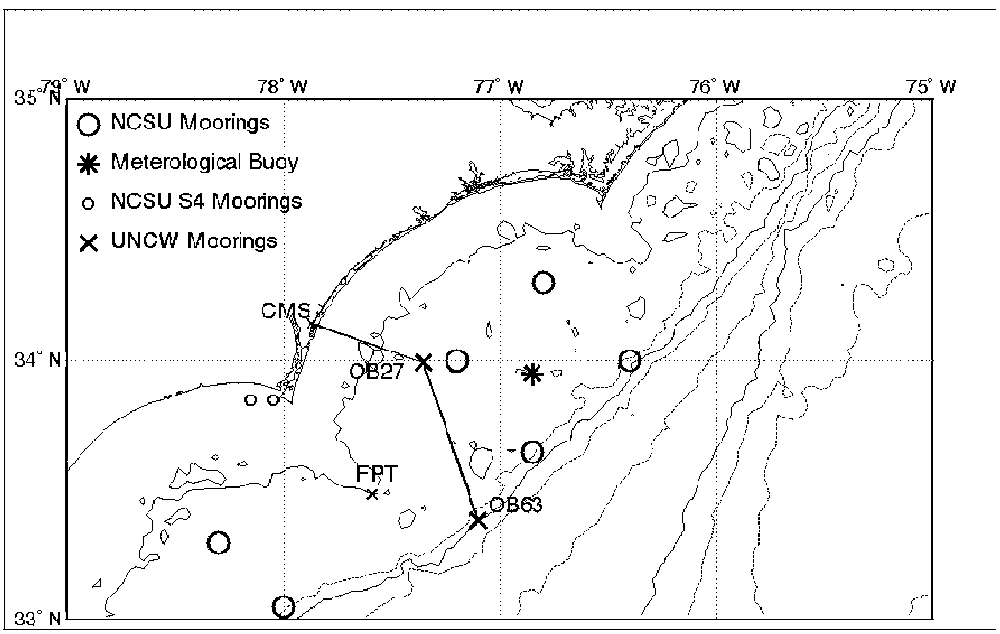


Figure 1. CORMP study area and offshore moorings.

Permanent seafloor installations at seven stations in Onslow and Long Bays (Figure 1) provide long-term, continuous data on currents, temperature, conductivity, and other parameters. The moorings consist of taut wire moorings (Figure 2) and Acoustic Doppler Current Profilers in trawl-proof housings.

Monthly cruises on the R/V *Cape Fear* cross the Onslow Bay shelf out to the 100-meter isobath (Figure 1) and collect samples that support several of the CORMP research objectives, including water quality and chemistry, fisheries oceanography, optical data, and data pertaining to ocean physical parameters and circulation patterns. Field collections are made using numerous instruments owned by UNCW-CMS (e.g., CTD and Water Bottle Rosette, side-scan sonar), NCSU (e.g., ADCPs and in situ CTDs), other CORMP investigators, and equipment purchased by CORMP. Operations technicians assist with the processing and storage of samples both aboard ship and back in the lab.

Monthly cruises also take place using small boats in the Cape Fear River plume. At seven stations throughout the plume (Figure 3), water and sediment samples are collected. Lowered instruments assess water quality. Towed gear collect particle and plankton samples.

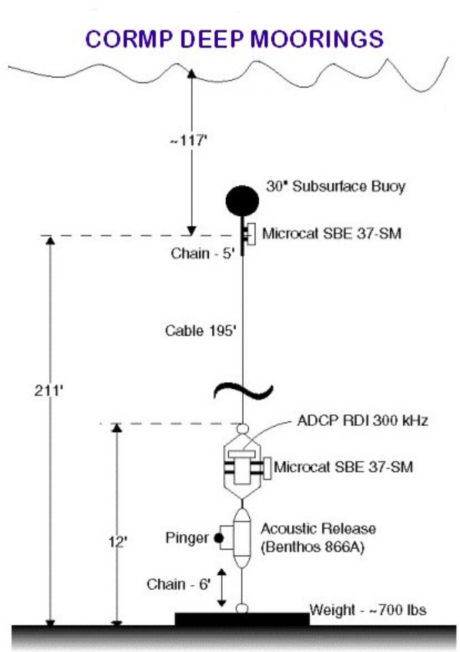


Figure 2. CORMP offshore taut wire mooring.

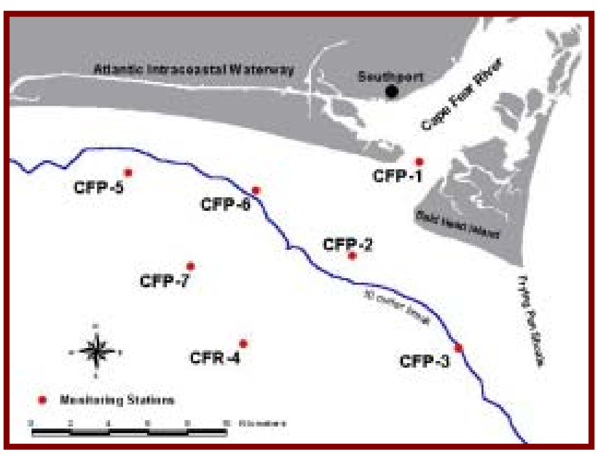


Figure 3. CORMP sampling stations in the Cape Fear River Plume.

CORMP DATA MANAGEMENT

OVERVIEW-- CORMP/CARO-COOPS DATA MANAGEMENT OFFICE (CCDMO)

As described in the program proposal for 2001-2002, CORMP is a data intensive program involving gigabytes of varied data types each year. The varied science and operational components offer opportunities to promote research, new and interesting educational products, and public outreach opportunities. Data streams and graphical depictions are useful tools for on-line education modules at many levels. An opportunity has arisen for 2002 for a partnership with a data management team at the Belle W. Baruch Institute for Marine Biology and Coastal Research at the University of South Carolina.

The Information Technology (IT) specialists of the Baruch Institute have extensive experience in experimental design, analytical methods, statistical analysis, database management, and the implementation and application of quality assurance/quality control (QA/QC) procedures. Moreover, the Baruch Institute has been a leader in environmental data management for over 20 years and currently administers the Centralized Data Management Office (CDMO) of NOAA's National Estuarine Research Reserve System. Recognizing that data are one of the most valuable products of CORMP and South Carolinas' Coastal Ocean Observing and Prediction System (Caro-COOPS), the Baruch Institute will establish a joint CORMP/Caro-COOPS Data Management Office (CCDMO) in support of providing fast, effective, and open access to quality-controlled coastal ocean data and associated metadata through a Virtual Network Information System (VNIS).

CCDMO RATIONALE

A multi-participant/project/program data management program is a scientific and management challenge and imperative for effective coastal ocean research and monitoring efforts. The management of short-term and long-term coastal ocean data sets provide for baseline studies, trend analyses and impact assessment of both natural and human-induced impacts and changes. Advances in IT are rapidly changing the way research and resource management agencies can assimilate, manage, disseminate and share the data and information pertinent to effective resource management.

Acknowledging that it is difficult enough to develop and maintain a single participant (e.g., intra-agency, intra-site) database management program, potential participants of a multi-participant program must first come to grips with why they should participate. Two compelling reasons include: First, federal directives require federally funded organizations and projects to make their data and information available to the public, and to coordinate database development. Second, it makes sound financial and resource management sense to optimize the costs of collecting, maintaining and assessing environmental data.

By implementing a program fostering the exchange of good data and information among groups, spatial overlap in data collection efforts can be eliminated potentially lowering data collection costs. By providing scientists and managers with the best available data regardless of jurisdictional boundaries or agency affiliation, more informed coastal ocean management decisions can be made and appropriate plans implemented. This is especially true when dealing with coastal ocean management issues which do not adhere to jurisdictional boundaries, therefore management plans that may have both environmental and economic impacts within and across jurisdictions should be based on the most comprehensive data available.

Data management and information dissemination must be identified as an integral part of the CORMP and Caro-COOPS research and monitoring programs. In-house expertise in the IT's of data management, system administration, telecommunications, computer engineering, Web services, and technical support must be developed and combined with scientific knowledge of coastal ocean sciences for the selection, implementation, development and maintenance of techniques and services for data acquisition and transfer, data and metadata management, information dissemination. The proposed VNIS will employ state-of-the-art computing and communications technology and software to perform research, to design and implement the information infrastructure necessary for database management, and to disseminate data and information. Developing wired and wireless links between offshore observing systems and host field stations, and wired networked facilities and teleconferencing capabilities, interaction between researchers on campuses and at the field laboratory as well as with those working at other locations is facilitated. Data, metadata, and information dissemination will be a large part of the data management program. The VNIS will supply researchers, research technicians, and students with data management expertise and resources, including such things as how to design the experimental database before the research begins, manage research data, error-check and document data, and archive data.

CCDMO OBJECTIVES

The CCDMO will develop a Web-enhanced, database management and information dissemination program to support the database management and information dissemination infrastructure for CORMP and Caro-COOPS. Specific tasks include:

- Establish a Data Management Committee to provide comment and guidance on data management issues and policies.
- Perform a user needs assessment (UNA) of all funded project participants to determine existing data management and overall IT capabilities, as well as identify pending data collection activities and anticipated IT support.
- Work with all project participants to ensure compliance with these data management and information dissemination guidelines
- Develop a Web-enhanced, data management and information management infrastructure-- the focal point for the assimilation of data and metadata, or links to existing data and metadata, required to support the CORMP and Caro-COOPS, as well as support common data analyses.

These efforts will not be undertaken in a vacuum but will be developed to ensure compatibility, to the greatest extent possible, with the overall needs of participating field stations and in conjunction with ongoing or planned regional and nationwide data management initiatives including LABNet, CastNet, the NERRS System-wide Monitoring Program, and LTER to name a few.

CCDMO DATABASE MANAGEMENT PROGRAM

A properly implemented database management program consists of several items including hardware and software, personnel, data and documentation. More important to the overall success of maintaining a usable database is the implementation of a database management strategy. In addition to obtaining inter-administrative support, the CCDMO will establish and support five key components of a successful multi-participant database management program:

- user needs assessment (UNA);
- data collection protocol;
- quality assurance/quality control (QA/QC) procedures;
- program documentation and metadata; and
- data and information dissemination hub.

User Needs Assessment (UNA)

Within any multi-participant database management program, there will exist a variety of hardware platforms, software preferences, data management practices and expectations. The identification of existing and proposed database management programs, technology facilities and support personnel, and system requirements and expectations comprise the first step in the development and implementation of a multi-participant database management program. This is accomplished through the administration of a UNA to all potential participants in the program.

A current UNA will be administered involving all funded CORMP and Caro-COOPS participants to identify: 1) existing information technology expertise, and 2) existing and proposed coastal ocean data collection efforts. By analyzing the results of the UNA, the development of the database management program begins by identifying what is being done by whom, who has what, and what is expected.

Data Collection Protocol

The UNA will lead to identification of what data are to be collected and for what purposes. This forms the basis of the development of the data collection protocol, the documented identification of what, when and how parameters are measured. These constitute the data standards. The data collection protocol combined with proper documentation provides for consistency and ensures data collection procedures can be assessed at a later date (e.g., years later after data collection personnel and data collection techniques may have changed).

An expectation that every CORMP and Caro-COOPS participating group will or can conform to consistent data collection techniques is most likely unrealistic. If the results of the UNA indicate that one or more environmental parameters are consistently identified as important, it may be possible to implement a data protocol that ensures consistency for key data variables. If through the UNA we identify key environmental variables that are to be measured by different projects at differing locations within the programs' anchor sites, CCDMO will work with researchers to standardize, to the greatest extent possible, data collection protocols. By using consistent protocol for data acquisition and QA/QC, these data will provide for an inter-site comparison of parameters.

Quality Assurance/Quality Control Procedures

Data required for coastal ocean research and management may be collected using a variety of techniques including remote sensing, *in situ* sampling, and the use of automated data loggers. It is anticipated that data entry may involve manual entry of data from handwritten field sheets, downloading data directly from a data logger to a computer, wired and wireless data transfer from anchor sites, or from digital image processing and GIS techniques. Collected data are of no use to researchers and resource managers if the data do not accurately reflect measured conditions. The development, implementation and consistent application of QA/QC procedures facilitate the detection of data corrupted by errors caused by automated or human data collection and data entry techniques.

Data archival and protection will be an important component of VNIS QA/QC procedures. The CORMP and Caro-COOPS participants must implement and adhere to a data backup plan. This includes maintaining multiple copies of all data sets, off-site storage or a secure, fireproof. In addition, a database management strategy must provide for data integrity and security to ensure that data sets are not altered or accessed improperly. Implemented QA/QC must be fully implemented and adhered to. As with all components of a multi-participant database management program, documentation of the QA/QC process is a requirement.

Program Documentation and Metadata

Proper program documentation takes time and often the importance of documentation is not recognized. As personnel changes occur, data collection procedures are altered, and data are exchanged among groups. Data documentation, currently referred to as *metadata*, are "data about data". Metadata provide information as to the characteristics of a data set, lineage of a data set, and contacts for accessing or acquiring a data set. Standardized metadata procedures provide a means to document datasets within organizations, to contribute to and facilitate multi-participant data exchange programs, and facilitate locating, understanding and utilizing existing data sets. The choice of a database structure should not matter as long as the content and structure of the metadata standard are adhered to by those responsible for data collection and management.

In 1994, the President signed Executive Order 12906 titled *Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure* requiring federal agencies and federally-funded projects to use the Federal Geographic Data Committee (FGDC) standard to document data they produce beginning in 1995. The FGDC metadata standard was developed from the perspective of "what a user needs to know about a data set." The standard provides a common set of terminology and definitions, and supports common uses of metadata. A good description of metadata and links to metadata development tools is available at the NOAA Coastal Services Center's Web presentation at http://www.csc.noaa.gov/metadata/#fgdc.

As with data QA/QC, it is the ultimate responsibility of the CORMP and Caro-COOPS investigators to develop appropriate metadata in support of data collection activities. While the CCDMO will propose to identify and support the use of a single metadata generator for all CORMP and Caro-COOPS datasets, how researchers generate FGDC-compliant metadata is ultimately their decision.

Data and Information Dissemination Hub-- VNIS

In addition to the development of data protocol and procedures for QA/QC, the database management program can only be successful if participants and potential users have access to the data being collected and information being generated. This is the issue of connectivity and communication. Connectivity is the ability to access data and information regardless of where the data are stored and on what type of machine. Advances in hardware, software and telecommunications have eliminated the past bottleneck of communicating across different hardware platforms. Communication is the process of utilizing the connectivity to identify, provide, obtain and exchange data, ideas and information pertinent to effective resource management.

The CCDMO will implement a Virtual Network Information System (VNIS), a "virtual" Web-based data and information dissemination hub, as one technique used for connectivity and communication. The concept of an information hub should not be confused with the concept of centralized computing. Centralized computing implies a single computer acting as a server to one or more terminals, each of which is dependent upon the server. The role of an information hub is to facilitate coordination and communication within a site and across any number of sites. Although the information hub will be at one location, within the Geographic Information Processing Lab of the Baruch Institute for Marine Biology and Coastal Research, interacting with numerous other groups, the information hub will not take the place of or supersede the existing database management programs of organizations involved in the multi-participant program. At a minimum, our proposed information center will coordinate the exchange of data and metadata, develop and disseminate standard products and provide documentation.

The VNIS information hub will be cognizant of FOI laws and issues of data disclaimers covering custodial liability and their potential impact on a multi-participant database management program. The information hub will be set up as a central repository for collected data and include links to individual CORMP and Caro-COOPS collaborating institutions so that when a data request is made to the information hub, the transfer of requested data (and associated metadata) is transparent.

The VNIS information hub can facilitate the exchange of ideas and foster interaction by developing a series of standard products providing for some level of inter-site comparison. Standard products, regardless of complexity, should provide information important to the overall goal of effective coastal resource management.

One effective tool for the development of an information hub is the World Wide Web (WWW or Web). Using hypermedia browsers, the WWW provides a hypermedia interface to the various protocols, data formats and information archives used on the Internet. It provides powerful new methods for visualizing, exchanging, and using data and information that can be accessed from a variety of platforms including Macintoshes, Windows and Unix-based systems. In the development of a Web-based data and information dissemination hub, several issues must be addressed including access to the Internet and the WWW. While Internet access is becoming more and more common, it is still possible that participating anchor site field stations may have no or limited access to the Internet. The user needs assessment will help to identify the level of access available to the Internet and the WWW.

IMPLEMENTATION

CORMP initiated data collection and archival in 2000. Data sets are now archived and handled by individual data custodians—students or faculty working in the investigators' laboratories. Caro-Coops will not initiate operations and data collection until Summer 2002 at the earliest. The following action plan will be followed to initiate incorporation of existing CORMP data into the new CCDMO data management program.

CORMP Data Management Team

The first step for CORMP is to pull together a team of the data custodians to work with the CCDMO manager (Dr. D. Porter). The team will include at least five individuals who are: 1) here for more than the next 12 months, 2) responsible for a significant amount of the CORMP data, and 3) have expertise and interest in developing CORMP DM capabilities. Team members may include:

- Jim Epps, NCSU, oceanographic and meteorological data
- Troy Alphin, Benthic Lab, infauna and sediment data
- Piotr Kowalczuk, Water Chemistry Lab, optical data
- Matt McKiver, Lower Cape Fear River Program, nutrient data
- Ansley Wren, Coastal Sounds and Ocean program, sediment transport data
- Fred Bingham, Physics Department, oceanographic data

In addition, the team will work on an ad hoc basis (depending on the issue) with the university's Computer Science department who can add advice and resources to DM endeavors. Dr. Ron Vetter, CS Chair, is very supportive of this service.

The first DM team meeting will be in January 2002.

DM Tasks

The CORMP DM team will address the following near-term tasks:

- review and redraft this program DM plan, to be included in next CORMP proposal to be submitted to NOAA by Feb. 28, 2002—target date Jan. 15
- visit Baruch Inst. to discuss DM plans and new CCDMO as clearinghouse for CORMP metadata and data sets—target Feb. 1

- participate in metadata training provided by NOAA's Coastal Services Center—target date Feb. 15
- prepare metadata for CORMP data sets—target Mar. 30.

The DM team will pursue other DM tasks in 2002, including:

- Relational database: CSC has also offered to have a database expert work with us on creating a Information Management System (relational database) for CORMP. This IMS will integrate project information and data sets. The system will facilitate data entry and access to all CORMP information. Reports can be easily generated and cover all projects in the system.

- CORMP QA/QC and Operations manual: Several issues mandate development of protocol for program operations and data management; equipment calibration by CMS has been undocumented and not routine. QA/QC procedures exist in some labs, but should be documented in one location for reference and legacy (what happens when the custodian leaves, as students and techs often do).

Although specific target dates are not defined, progress should be made on the IMS and manual in time for the first CORMP advisory board meeting. The advisory board meeting should be held in February-March in time to review the program's draft proposal and make recommendations before submission to NOAA.

CORMP DATA SETS

In 1999, an NOPP task team drafted a national plan for a U.S. Integrated Ocean Observations System (IOOS)[1]. The report recommends objectives for the coastal ocean component of IOOS, including:

- Obtain more accurate estimates of inputs of freshwater, sediments, nutrients, and contaminants to coastal waters on local to regional and national scales
- Improve marine meteorological forecasts and coastal circulation models
- Document the effects of human activities on coastal ecosystems
- Improve scientific information in support of fisheries management and assess the efficacy of management actions through the development of an integrated in situ and remote sensing observing system for monitoring and predicting change in selected species of living resources and the quantity and quality of coastal habitats (e.g., intertidal, seagrasses, kelp beds, water column, and sediments)
- Develop an expanded and enhanced network of moored instruments in inland seas (estuaries, bays, sounds, the Great Lakes) and open waters of the EEZ for sustained, synoptic measurements of meteorological (including atmospheric deposition) and oceanographic (physical, chemical, and biological) properties at more locations
- Develop a network of coastal index sites (pilot projects) that quantify the causes and consequences of environmental variability in coastal waters and improve predictions of environmental change and human impact in key locations
- Implement a comprehensive and integrated program of in situ and remote measurements of water levels, surface waves and currents and timely dissemination of nowcasts and forecasts in all major ports and other coastal waters used for marine operations.

The NOPP report also presents an internationally-recognized set of core variables needed to address these objectives, which are now routinely used by national programs, the Navy, industry, state, federal, and academic institutions. CORMP's multi-disciplinary mission and approach addresses these recommended objectives (Figure 2) and its data sets match the NOPP core variables (Table 1).

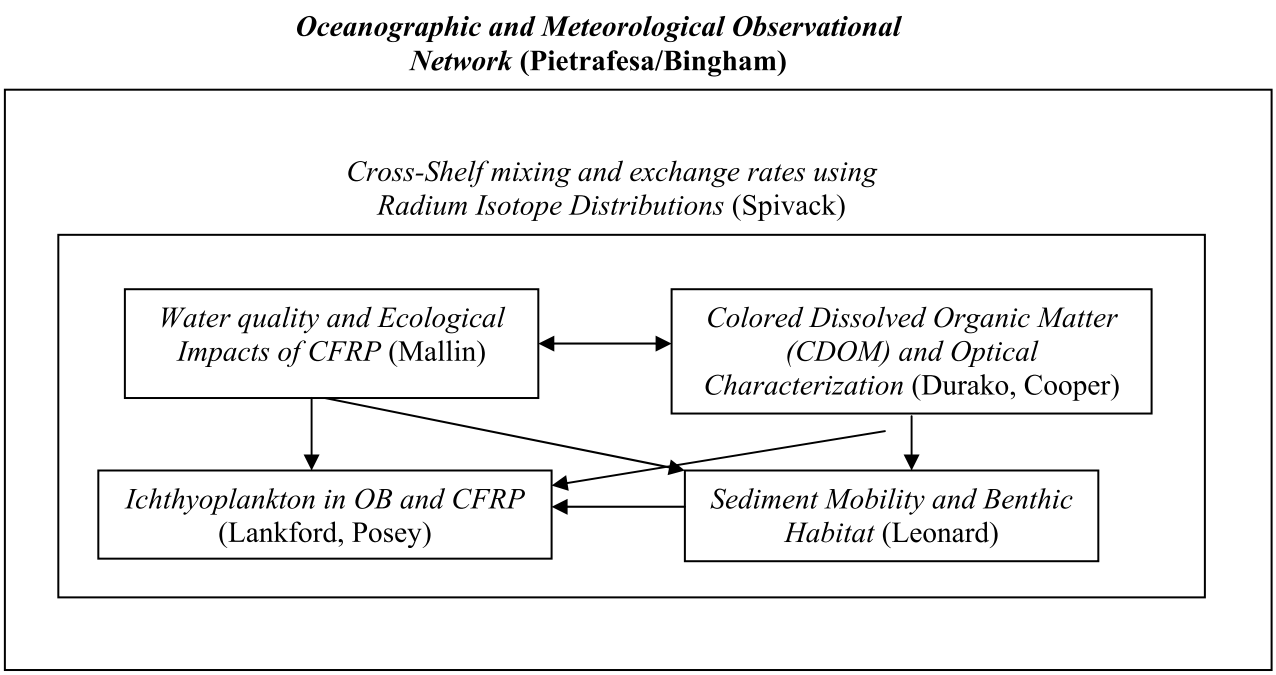


Figure 2. Schematic of inter-relationship between CORMP projects and data as of December 2001.

[1] NOPP (National Oceanographic Partnership Program). 1999. An Integrated Ocean Observing System: A Strategy for Implementing the First Steps of a U.S. Plan. Task Team Report for CORE available at http://www.coreocean.org/Dev2Go.web?id=220672&rnd=27938.

Table 1. Inventory of data elements collected during CORMP projects: see Figure 2, Oce = Pietrafesa, Rad = Spivack, Wq = Mallin, CDOM = Durako, Fish = Lankford, Sed = Leonard

Parameter	Unit	Location		Project					
		CFRP	OB	Oce	Rad	Wq	CDOM	Fish	Sed
Physical:									
air pressure	in/Hg								
currents	cm/s		x	x	x	x	x	x	x
radiance/irradiance	μW/cm^2/nm	x	x			x	x	x	
salinity	ppt	x	x	x	x	x	x	x	
sea state/wave ht.	ft								
temperature	^{o}C	x	x	x	x	x	x	x	
wind	kts		x	x					
Geological:									
turbidity	NTU	x	x			x	x	x	x
Chemical:									
ammonium	ug/l	x				x		x	
dissolved oxygen	mg/l	x	x			x		x	
DOC	ug/l								
nitrate	ug/l	x				x		x	
orthophosphate	ug/l	x				x		x	
pH	--	x	x			x		x	
radium	dpm/100l		x	x	x				
silicate	ug/l	x				x	x	x	
total nitrogen	ug/l	x				x		x	
total phosphorus	ug/l	x				x		x	
Biological:									
chlorophyll a	ug/l	x	x			x	x	x	
infauna	n/m^2	x	x			x		x	x
zoo/meroplankton	n/m^3	x	x			x	x	x	

More detailed descriptions of these variables follow, including why and how they are collected, arranged by the major program issues as identified in the program overview, including:

- Fisheries Oceanography
- Water Quality
- Productivity
- Sediment Transport
- Ocean Circulation and Weather

FISHERIES OCEANOGRAPHY:

CORMP fish studies have two major thrusts: 1) to determine the influence of the Cape Fear River plume on the recruitment of the larvae of estuarine –dependent fisheries from the coastal ocean to estuaries, and 2) examine the role that Gulf Stream (GS) intrusions may have in transporting larval fish across the shelf in Onslow Bay, NC.

Plume Studies:

- Compare larval density of selected finfish and decapods within the estuarine plume of the Cape Fear River to that in adjacent coastal ocean areas: bongo net tows (Figure 1) 1 m beneath surface and epibenthic net on bottom; larvae identified to lowest possible taxonomic level (at least families) and sorted by station
- Compare variability in physiological condition of selected larvae within the plume to that in adjacent coastal ocean water; data consists of:
  - *Biochemical assays*: enzyme activities spectrophotometrically for citrate synthase (citric acid cycle), hydroxyacyl-CoA dehydrogenase (fatty acid metabolism), hexokinase (glycolysis) and lactate dehydrogenase (anaerobic glycolysis); protein concentration using Bradford assay.
  - *Phosphorus NMR*: to assess relative levels of ATP, ADP and NADP, in conjunction with standard biochemical assays; ^{31}P-NMR spectra collected on frozen homogenates on a Bruker 400 DMX spectrometer
  - *RNA/DNA ratios*: higher ratios indicate better larval condition; utilize standard spectrophotometric techniques
- Develop rapid assessment technique for identification of larvae: Identify suitable genetic markers in the mitochondrial genome that distinguish *C. sapidus* and *C. similis*

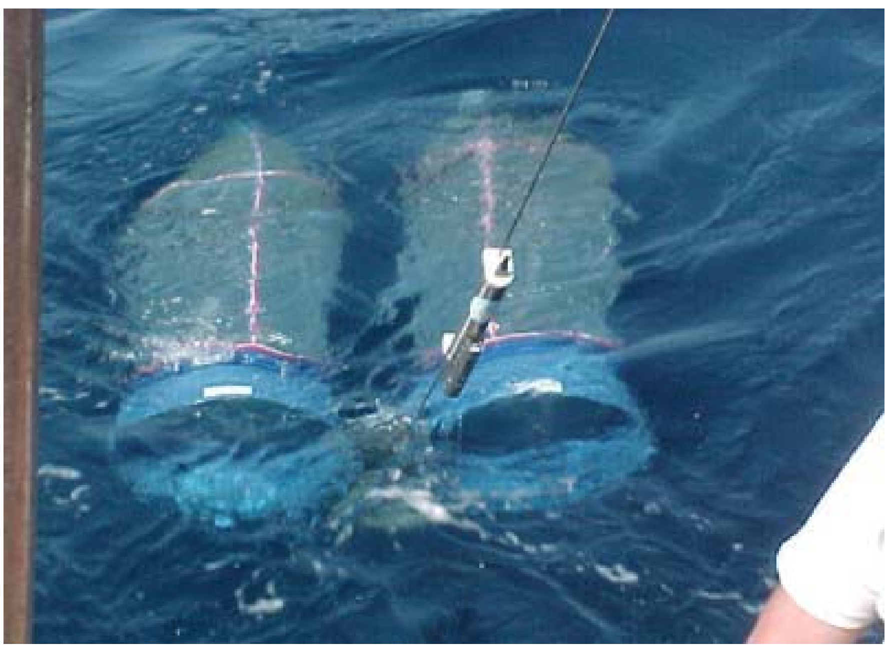


Figure 1. Bongo nets used to sample larval fish in plume and on shelf; Microcat CTD on wire records T, Salinity and depth of tows.

Shelf Studies:

- Compare concentrations, diversities and percentages of preflexion larval fish between shelf water, GS front, GS Intrusion, and GS axis: neuston net (surface) and bongo net (stepped oblique subsurface) tows (Figure 1) during monthly OB shelf cruises (Figure 2); larvae identified to lowest possible taxonomic level (at least families) and sorted by station and water mass (Figure 3)
- Correlate samples to position of GS: AVHRR imagery and permanent moorings; water mass intrusions at shelf station identified by T/S signature (Figure 4).

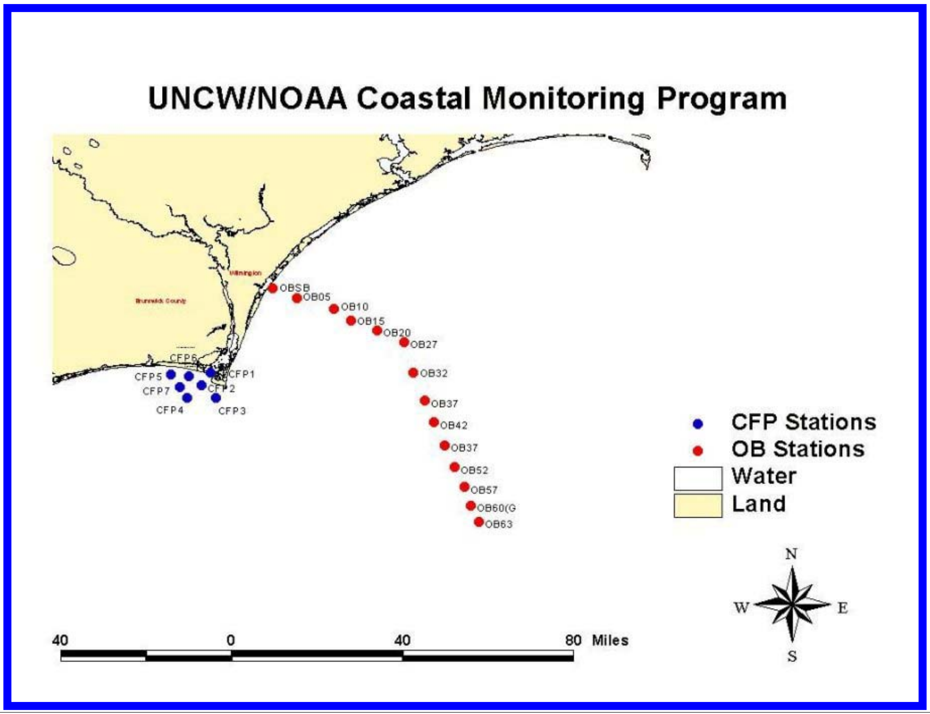


Figure 2. Chart showing location of Cape Fear River plume and Onslow Bay sampling stations.

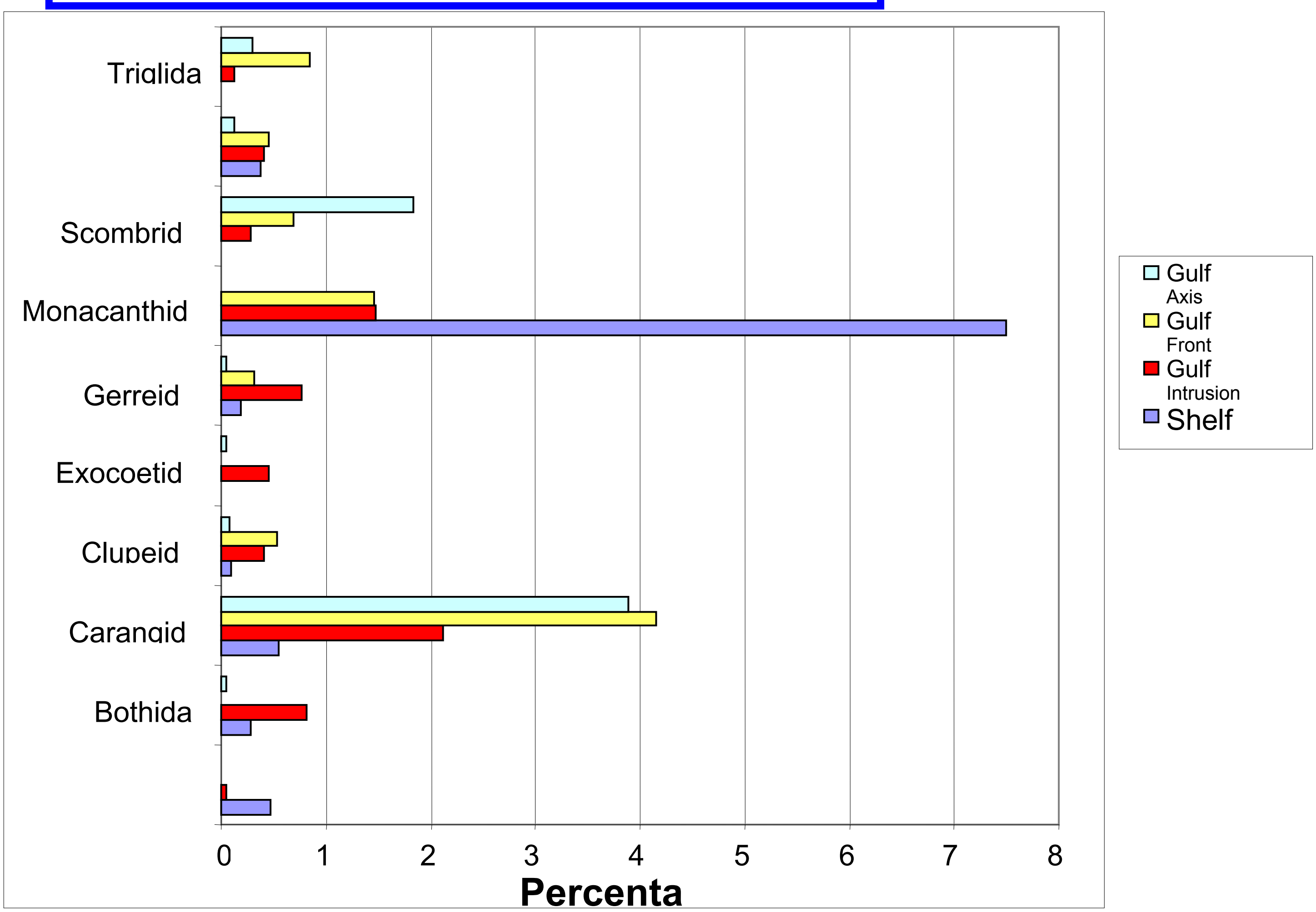


Figure 3. Data on fish larvae from OB shelf transect.

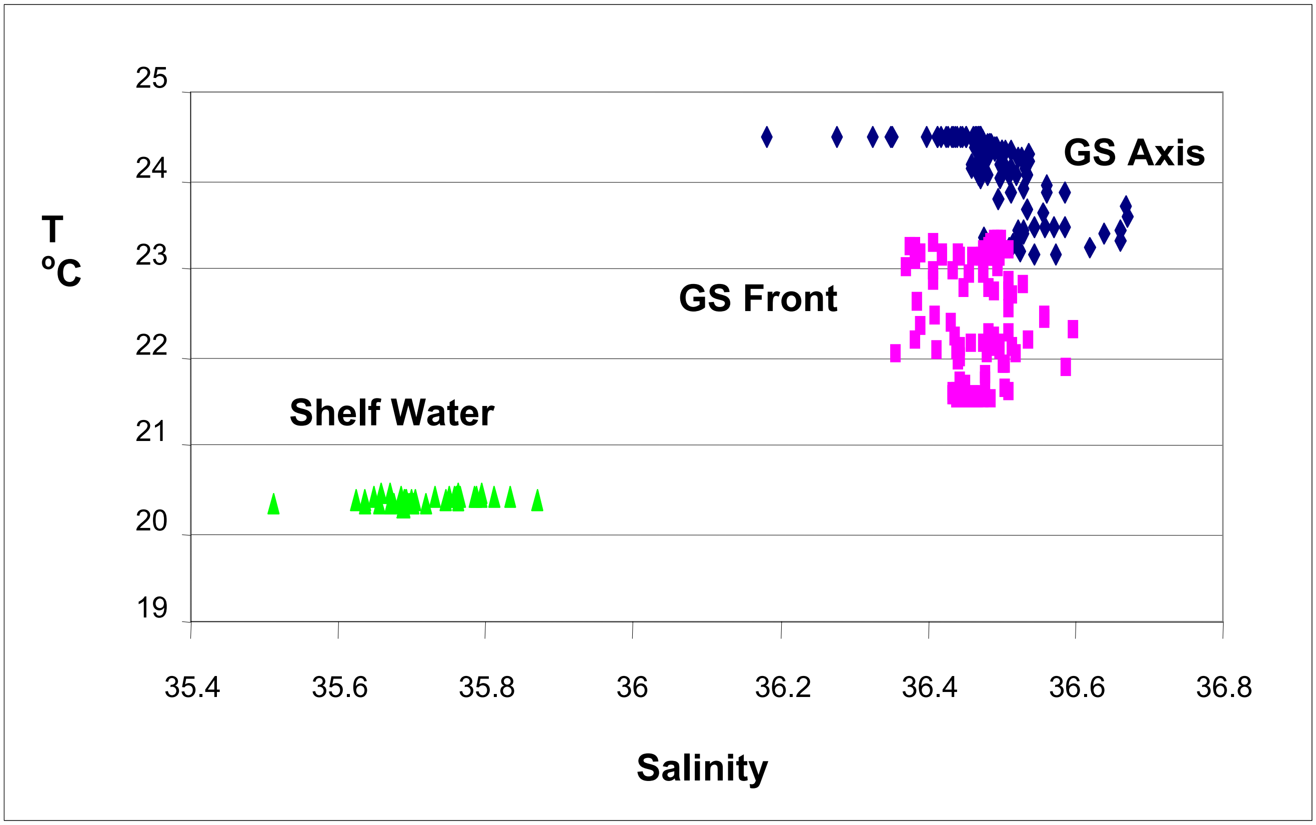


Figure 4. Temperature and salinity signature of shelf and GS waters.

WATER QUALITY—NUTRIENTS

The overall goal of the CORMP water quality studies is to assess the effect that the Cape Fear River plume has on the physical, chemical, and biological characteristics of the coastal ocean. This is a multidisciplinary effort involving the collaboration of a nutrient/plankton researcher (Michael Mallin), a benthic ecologist (Martin Posey), a marine botanist (Michael Durako) and a marine chemist (Stephen Skrabal). CORMP is an extension into the coastal ocean of estuarine monitoring that is part of the Lower Cape Fear River Monitoring Program (http://www.uncwil.edu/cmsr/aquaticecology/lcfrp). Monthly cruises are conducted to sample seven stations located within and outside of the river plume area, within 15 km of the estuary mouth. The following parameters are measured: *temperature, salinity, turbidity, pH, dissolved oxygen, nitrate, ammonium, total nitrogen, orthophosphate, total phosphorus, silicate, chlorophyll a, zooplankton, meroplankton and solar irradiance characteristics of the water column.* On-site physical parameters are obtained using YSI multiparameter instruments and light field characteristics collected by Li-Cor instrumentation (see Productivity-in situ data set). Nutrients are analyzed at the UNCW Center for Marine Science Nutrient Laboratory using an Auto Analyzer, and trace metals are collected quarterly using clean techniques and analyzed at the UNCW Chemistry Department. A QA/QC Manual developed for the LCFRP guides CORMP sample processing and analysis (http://www.uncwil.edu/cmsr/aquaticecology/lcfrp/pdf%20page.htm).

The LCFRP has also developed useful tools for data display (see http://www.uncwil.edu/riverrun/idd.html). These tools include a GIS interface and Data Visualization Tool is a graphing utility for displaying multiple water quality parameters simultaneously. The DVT shows the units and data tables for river stations sampled up through May 2000.

Five plume stations (CFP1, CFP2, CFP3, CFP4, and CFP6) are also sampled quarterly for benthic organisms (Figure 1). The quarterly sampling coincided with the seasonal distributions of benthic and epibenthic organisms that use the Cape Fear estuary. A Petite Ponar grab sampler (15cm X 15cm X 15cm) is used to collect five grab samples for infaunal analysis and one for sediment grain size analysis at each station. As part of standard protocol, two of the five samples from each station are archived. Macrofauna (>0.5mm) are identified to species whenever possible. This work is carried out by the UNCW Benthic Ecology Lab (http://www.uncwil.edu/cmsr/benthic/).

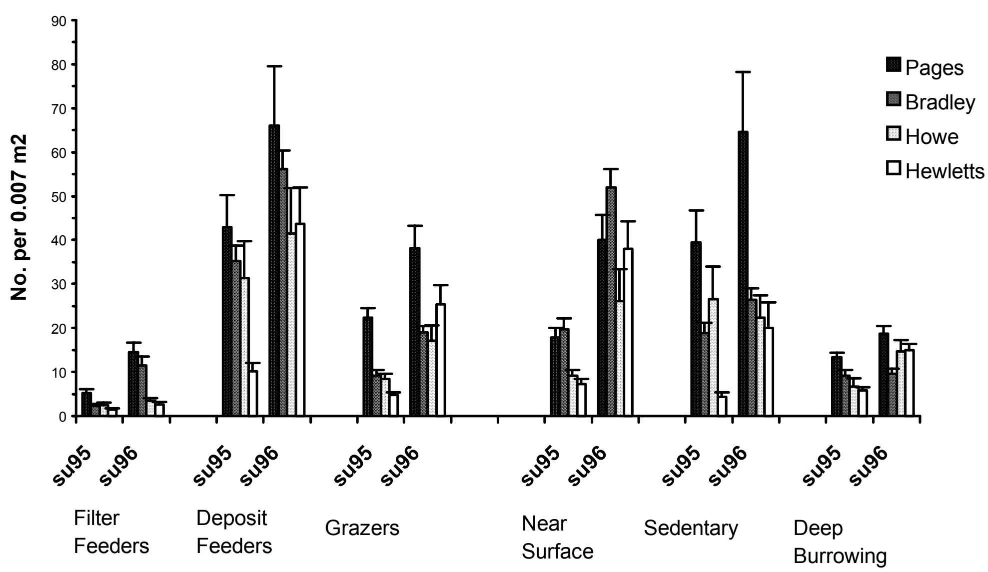
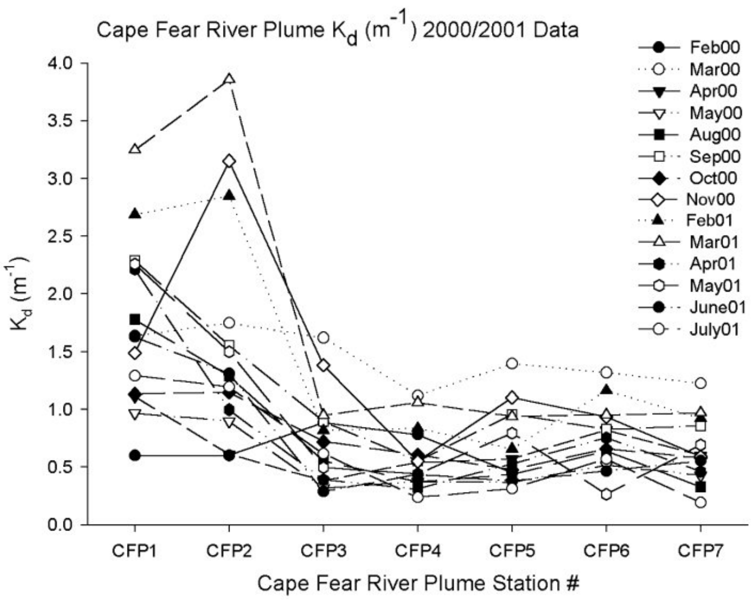
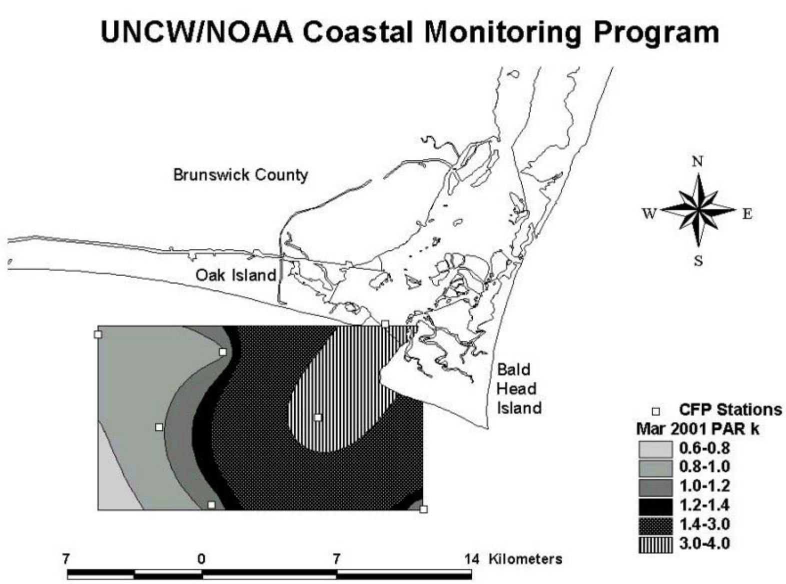


Figure 1. Infaunal abundance in tidal creeks by trophic type; similar data is worked up for CORMP plume adn Onslow Bay samples.

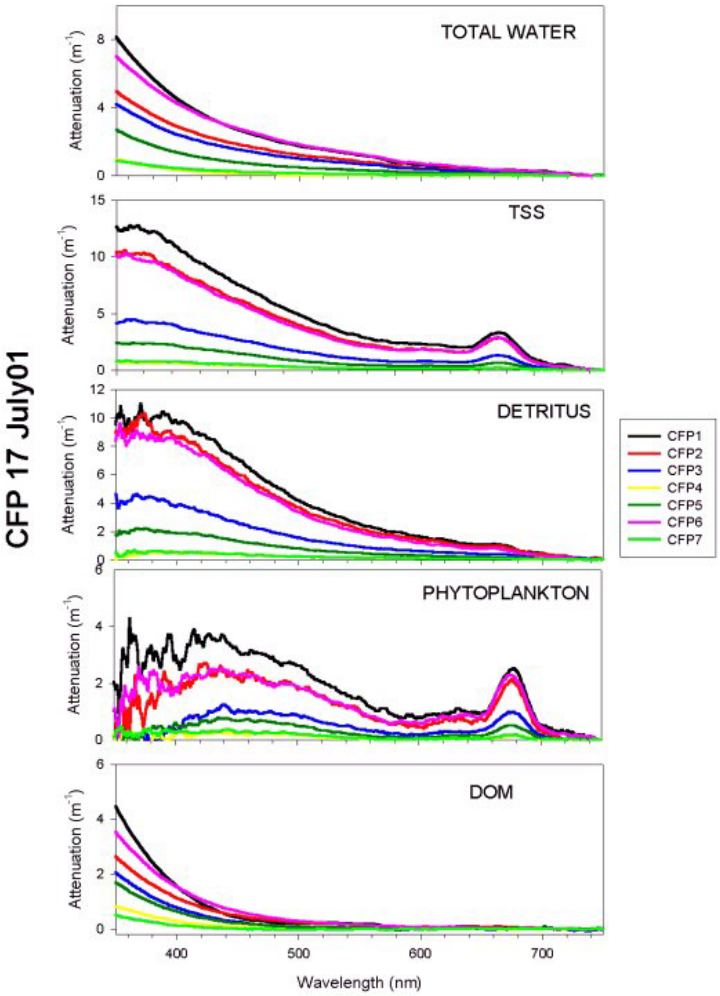
PRODUCTIVITY—REMOTE SENSING
(http://www.uncwil.edu/cmsr/comp/biooptical/biiopticalindex.htm):

Optical Characterization of the Waters of Onslow Bay, the Cape Fear River Plume (CFRP) and Coastal Southeastern North Carolina (Durako)*:* This element of CORMP characterizes the underwater light field within the Cape Fear River plume, examines the component contributions to the optical properties of these waters, and compares them to the optical characteristics of water masses outside of the plume (including Onslow Bay).





<u>Diffuse attenuation coefficient for Photosynthetically Active Radiation (PAR, 400-700nm) KdPAR:</u> At each sampling station, simultaneous scalar irradiance measurements are made in the air and in the water using spherical quantum sensors (LiCor LI-193SA) connected to a LiCor LI-1000 datalogger. The in-air sensor is mounted above a 0.6 m circular black disk on a 2-m pole. This setup minimizes variation due to boat movement and variation gue to light reflected from the water surface. A light profile is determined by lowering the in-water sensor to a series of measurement depths (0.5-1.0 m intervals) and recording average (5-10 sec) scalar irradiance from both sensors. The in-air sensor reading is used to adjust the in-water readings for changes in the incident irradiance over the course of the profile. KdPAR is calculated from the slope of the regression of natural log-transformed percentages of surface irradiance (in water PAR:in air PAR) against depth. The data from the seven CFP stations are krigged to generate contour maps of KdPAR.



Partitioning the spectral diffuse attenuation coefficient Kd(lambda): Surface water samples are analyzed for total and mineral solids, chlorophyll a, turbidity, and absorption by dissolved and particulate matter. Analyses of raw water versus filtered water samples is used to separate the contribution to Kd(lambda) between particulate and dissolved components of the water mass. Absorbance of particulate matter is determined by illuminating material collected from a known volume of water (500 ml to 4l) on a GF/F filter with a fibre optic light source and measuring the absorbance spectra normalized with readings from a moistened blank filter. The sample filter is then soaked in methanol for 1h to extract phytoplankton pigments, and scanned again to estimate absorption by non-algal particulate matter. Absorption is converted to units of m-1 by multiplying by the area of the filter and dividing by the volume filtered. Absorption by colored dissolved organic matter (CDOM) will be measured on water samples filtered through a 0.2µm Nucleopore filter. Absorbance is read using a fibre optic scanning spectrometer in 10 cm cells against distilled water blanks. Absorbance readings are multiplied by 2.303 to convert to base e and divided by 0.1 (dm m-1).

Data from following tasks is now being analyzed:

Spectral diffuse attenuation coefficient for downwelling irradiance [K_d(lambda)], spectral upwelling radiance : Downwelling, cosine-corrected, spectral irradiance measured using 7-channel, cosine-corrected irradiance sensor (OCR-507 I/R) incorporated into a **Satlantic MicroPro profiling radiometer vehicle**. Spectral irradiance determined at a series of measurement depths (0.5-1.0m). Readings normalized to readings from air sensor (OCR-507 I), natural-log transformed, and regressed against depth to calculate K_d(lambda) (wavelength-specific diffuse attenuation coefficient).

Incident [E_d(0-, lambda)], downwelled [E_d(z, lambda)] spectral irradiance, and upwelled spectral radiance [L_u(z, lambda)] : Surface incident irradiance, downwelled spectral irradiance, and upwelled spectral radiance measured using 7-channel irradiance and radiance sensors (OCR-507 I/R) on **Satlantic MicroPro profiler** at a series of measurement depths (0.5-1.0m). All readings normalized to the readings from air irradiance sensor (OCR-507 I). These primary optical measurements used to calculate water-leaving radiance [L_W(0-,lambda)] and remote-sensing reflectance [R_L(0-,lambda)], which are fundamental parameters used in the development and validation of bio-optical algorithms and will provide ground truth data for the calibration and validation of ocean color satellite data.

Spectral reflectance [R_L(z, lambda)]: Above-water estimates of Spectral reflectance obtained using a **Satlantic MicroSAS remote ocean-color sensing system**. Sea surface radiance [L_u(0-, lambda)], spectral sky radiance (for surface glint corrections), and surface incident irradiance [E_d(0-, lambda)] measurements used to calculate upwelled spectral radiance [L_u(z, lambda)], augmenting the in-water measurements and providing direct validation of the radiometric performance of SeaWiFS sensors. We intend to establish an MOU with Dr. Rick Stumpf (NOAA/NOS) to assist in QA oversight for this study element.

Data and Products from Satlantic Instruments:

The optical measurements conducted in the framework of CORMP project on the monthly cruises (Onslow Bay in 2001, CFRP in 2002) are conducted with use of two Satlantic instruments: MicroPro and MicroSAS. The first instrument is a free fall profiling devise, consisting of two optical sensors for downwelling irradiance $E_d(\lambda, z)$ and upwelling radiance $L_u(\lambda, z)$, plus sensors for temperature, depth and tilt. It is designed to measure downwelling solar irradiance and upwelling radiance as a function of depth. In addition, MicroPro casts are conducted with simultaneous recordings of incident solar irradiance $E_s(\lambda)$ above the sea surface. This information is used to reference the depth cast. The MicroSAS instrument consists of two radiance sensors positioned perpendicularly in the nadir plane, and a solar irradiance sensor. One radiance sensor is pointed to the sea and records the upwelling radiance $L(\lambda, \theta, \phi)$ and the second is pointed to the sky and records the sky radiance $L_{sky}(\lambda, \theta, \phi)$. In addition, the radiance cast is conducted with simultaneous recordings of incident solar irradiance $E_s(\lambda)$ above the sea surface. All radiometric sensors have 7 spectral channels: 412, 443, 490, 510, 555, 665, 683 nm. The radiometric measurements are processed using standardized methods developed by the Dalhousie University, Halifax, provided with the instrument's processing software package. The processing products include: downwelling irradiance profile E_d, upwelling radiance profile L_u, incident surface solar irradiance E_s, diffuse attenuation coefficient for downwelling irradiance $K_d(\lambda, z)$, diffuse attenuation coefficient for upwelling radiance $K_u(\lambda, z)$, remote sensing reflectance just below the water surface $R_{rs}(\lambda, z^{-})$ and remote sensing reflectance just above the water surface $R_{rs}(\lambda, z^{+})$. The table below lists the raw data products and units.

Optical measurements property	Spectral wavebands	Units
downwelling irradiance $E_d(\lambda, z)$	412, 443, 490, 510, 555, 665, 683	$\mu W/cm^2/nm$
upwelling radiance $L_u(\lambda, z)$	412, 443, 490, 510, 555, 665, 683	$\mu W/cm^2/nm/sr$
incident solar irradiance $E_s(\lambda)$	412, 443, 490, 510, 555, 665, 683	$\mu W/cm^2/nm$
upwelling radiance $L(\lambda, \theta, \phi)$ above the water surface	412, 443, 490, 510, 555, 665, 683	$\mu W/cm^2/nm/sr$
sky radiance $L_{sky}(\lambda, \theta, \phi)$	412, 443, 490, 510, 555, 665, 683	$\mu W/cm^2/nm/sr$
Optical measurements products		
downwelling irradiance profile E_d	412, 443, 490, 510, 555, 665, 683	$\mu W/cm^2/nm$
upwelling radiance profile L_u	412, 443, 490, 510, 555, 665, 683	$\mu W/cm^2/nm/sr$
incident surface solar irradiance E_s	412, 443, 490, 510, 555, 665, 683	$\mu W/cm^2/nm$
diffuse attenuation coefficient for downwelling irradiance $K_d(\lambda, z)$	412, 443, 490, 510, 555, 665, 683	m^{-1}
diffuse attenuation coefficient for upwelling radiance $K_u(\lambda, z)$	412, 443, 490, 510, 555, 665, 683	m^{-1}
remote sensing reflectance just below the water surface $R_{rs}(\lambda, z^{-})$	412, 443, 490, 510, 555, 665, 683	‰
remote sensing reflectance just above the water surface $R_{rs}(\lambda, z^{+})$	412, 443, 490, 510, 555, 665, 683	‰

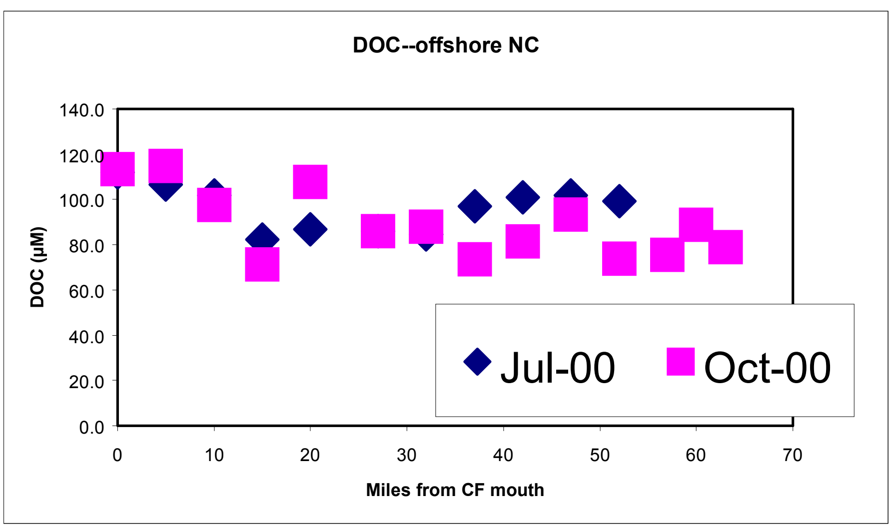
All radiometric measurements and data processing and products are consistent with SeaWiFS validation and calibration requirements listed in Mueller J. L., R. W. Austin, 1992, *Ocean optics protocols for SeaWiFS* *validation.* [in:] NASA Tech. Memo. 104566, S. B. Hooker and E. R. Firestone (eds.), NASA Goddard Space Flight Center, Greenbelt, Maryland, 5, 43 pp.

In Fall 2001, the radiometric measurements were collected during CORMP monitoring stations in Onslow Bay. In addition, water samples are collected for spectrophotometric determination of optical properties of marine waters including: phytoplankton pigments absorption coefficient spectra, CDOM absorption coefficient spectra, and detritus particles absorption coefficient spectra in the spectral range 350 – 700 nm (unit: m^{-1}). Water samples are also collected for determination of fluorometric properties of CDOM with use of 3-dimensional spectrofluorometry. These measurements will be extended to the Cape Fear River plume in 2002.

The radiometric and fluorometric data processing and analysis is performed on Windows operated desktop PC. The SeaWiFS imagery processing workstation, operated under Linux operational system was purchased to run free domain image processing software distributed by NASA. This system will be used to process SeaWiFS imagery and derive products relating chlorophyll *a* concentration, CDOM absorption coefficient, normalized water-leaving radiance spectra, and remote sensing reflectance spectra. This information will be validated against the sea-truth information obtained during the CORMP cruises.

Characterization of the Colored Dissolved Organic Matter (CDOM) in the Waters of Onslow Bay, the Cape Fear River Plume and Costal Southeastern North Carolina (Cooper): primary goal is to characterize CDOM in Onslow Bay, the Cape Fear River Plume and the coastal Southeastern North Carolina using measurements of dissolved organic carbon (DOC), electronic absorption spectra, and, single wavelength and 3-D synchronous fluorescence spectra.

- Water Samples. Surface water samples (CTD/Rosette) collected at plume and shelf stations; samples refrigerated and returned to the laboratory for analysis; filtered through 0.2 µm filters prior to analysis.
- UV/visible Absorption Spectra. Electronic absorption spectra obtained using the Shimadzu 1601 spectrophotometer; spectra recorded from 200 to 800 nm; data transformed to ln A to determine the slope coefficient (S) of the waters as another indicator of photobleaching of CDOM; purified water from Milli-Q system used as reference.
- Fluorescence Measurements. Single wavelength fluorescence measurements and 3-D synchronous spectra made using a Turner Designs Model 10 spectrofluorometer standardized with quinine sulfate; Turner Designs Model 10 spectrofluorometer also used in flow through mode for continuous single wavelength fluorescence data collection at sea.
- Dissolved Organic Carbon (DOC). water samples analyzed using Shimadzu 5000 DOC analyzer according to standard methods accepted for oceanic measurements.



PRODUCTIVITY—IN SITU

Laboratory fluorometric analysis of water samples for Chlorophyll *a*:

Purpose - Chlorophyll *a* is analyzed as a measure of phytoplankton biomass.

Supplies - Rack(s) of 15 ml screw-capped centrifuge tubes, distilled water, 1% HCl solution, forceps, aluminum foil, 3-funnel filtration manifold, Gelman A/E 25mm glass fiber filters (nomimal pore size 1 micron), permanent marker, 10 ml glass pipet, pipet pump, Potter-Elvehjem 30ml tissue grinder with serrated pestle modified with a T handle, squirt bottles, 90% acetone solution

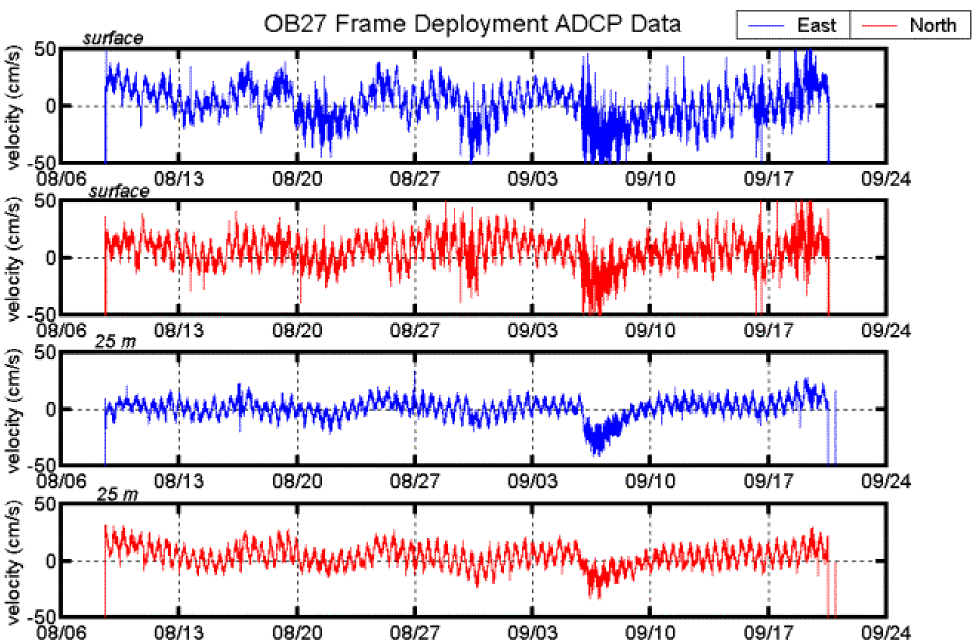
Fluorometer -The Turner 10-AU utilizes very narrow excitation and emission bandwidths to provide a fluorescent measure of chlorophyll *a* that minimizes interference from chlorophyll *b* and phaeopigments (Welschmeyer 1994), while removing the errors inherent in the acidification process.

Major steps include:

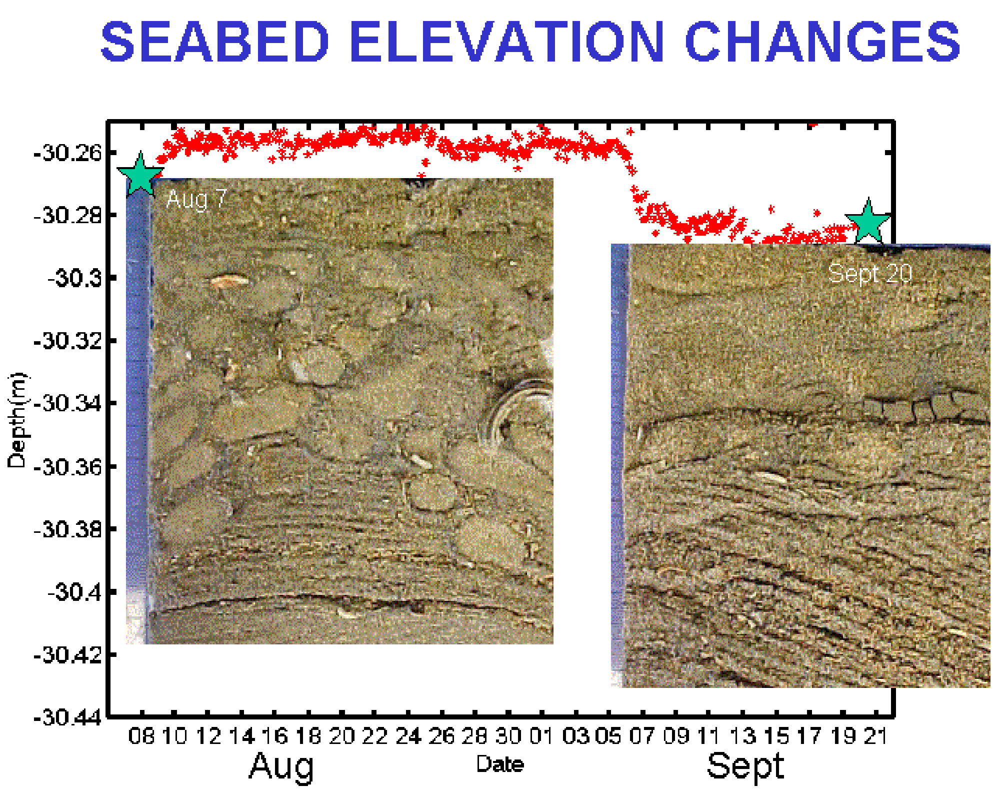
- Filtration: samples should be collected in triplicate, using 125 ml light-proof bottles. Keep on ice or refrigerated until filtered. Filter samples as soon as possible; maximum holding time is 24 hours.
- Extraction of Chlorophyll *a:* performed in fume hood; Chlorophyll is sensitive to heat and light--minimize each.
- Fluorometric Analysis
- Computation of Chlorophyll *a* concentration: to compute chlorophyll *a* concentration in mg/liter (parts per billion), multiply flourometer reading by -- ml 90% acetone added / ml of sample water filtered, e.g. 10/75 = 0.133 or 10/50 = 0.200

SEDIMENT TRANSPORT (http://www.uncwil.edu/people/lynnl/comp/data.htm)

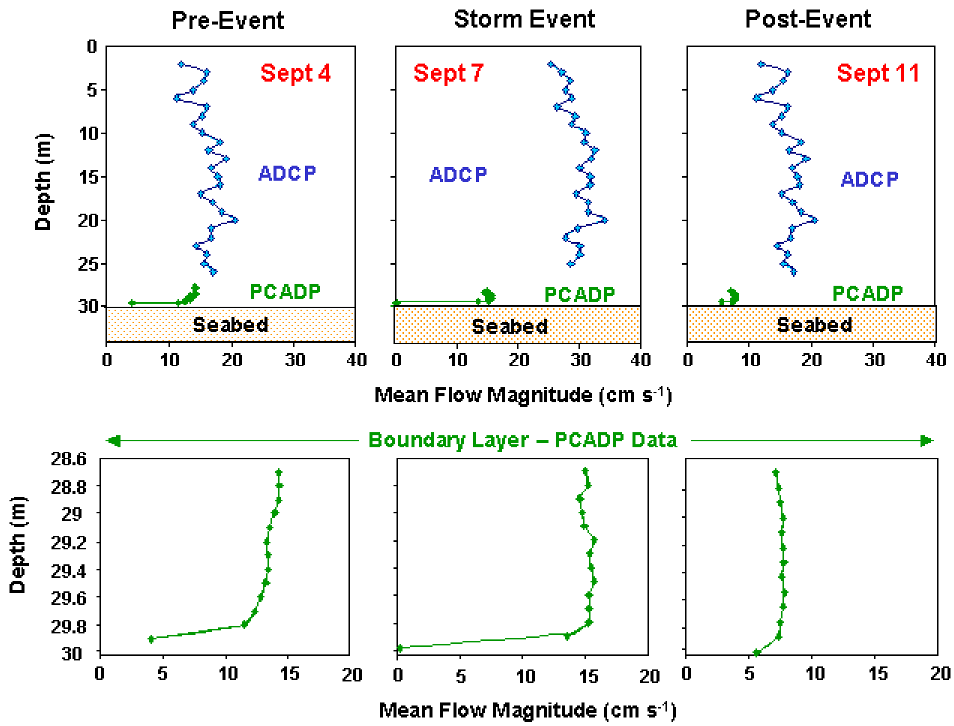
Moored Instrument Package: This instrument package will provide measurements of the physical components of this project. It consists of an aluminum frame moored to the seafloor at the 23 Mile site. Attached to the frame is a Sentinel Workhorse Acoustic Doppler Current Profiler (ADCP), a Sontek Pulse-Coherent Acoustic Doppler Profiler(PC-ADP), and two Optical Backscatter Sensors (OBS)-one at 1.0m above the bottom and another at 0.5m, and one conductivity and temperature logger(CT). Flow velocities in 10 cm bins (beneath the frame) and 1 m bins (above the frame) are measured every 5 minutes. Seawater turbidity measurements are taken for 17 minutes every 2 hours. Temperature and salinity measurements are recorded hourly. These instruments are retrieved and redeployed once every 4-6 weeks. They will provide the necessary physical measurements to assess the impact that storm events have on this area.



Acoustic Doppler Current Profiler (ADCP) data from quadpod frame at "23 Mile Rock" during a recent deployment:

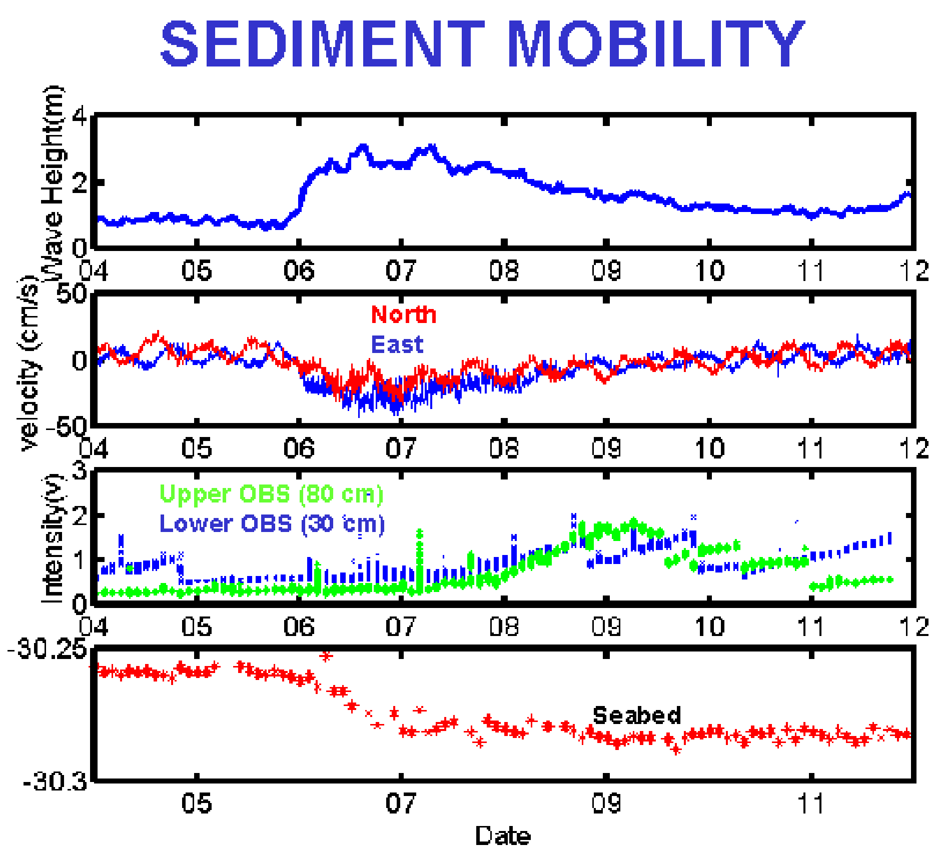


Pulse Coherent Acoustic Doppler Profiler (PC-ADP) seabed elevation data aligned with digital pictures of boxcores taken at the beginning and end of deployment. Erosion occurred during a small northeaster from September 6-9, 2000.



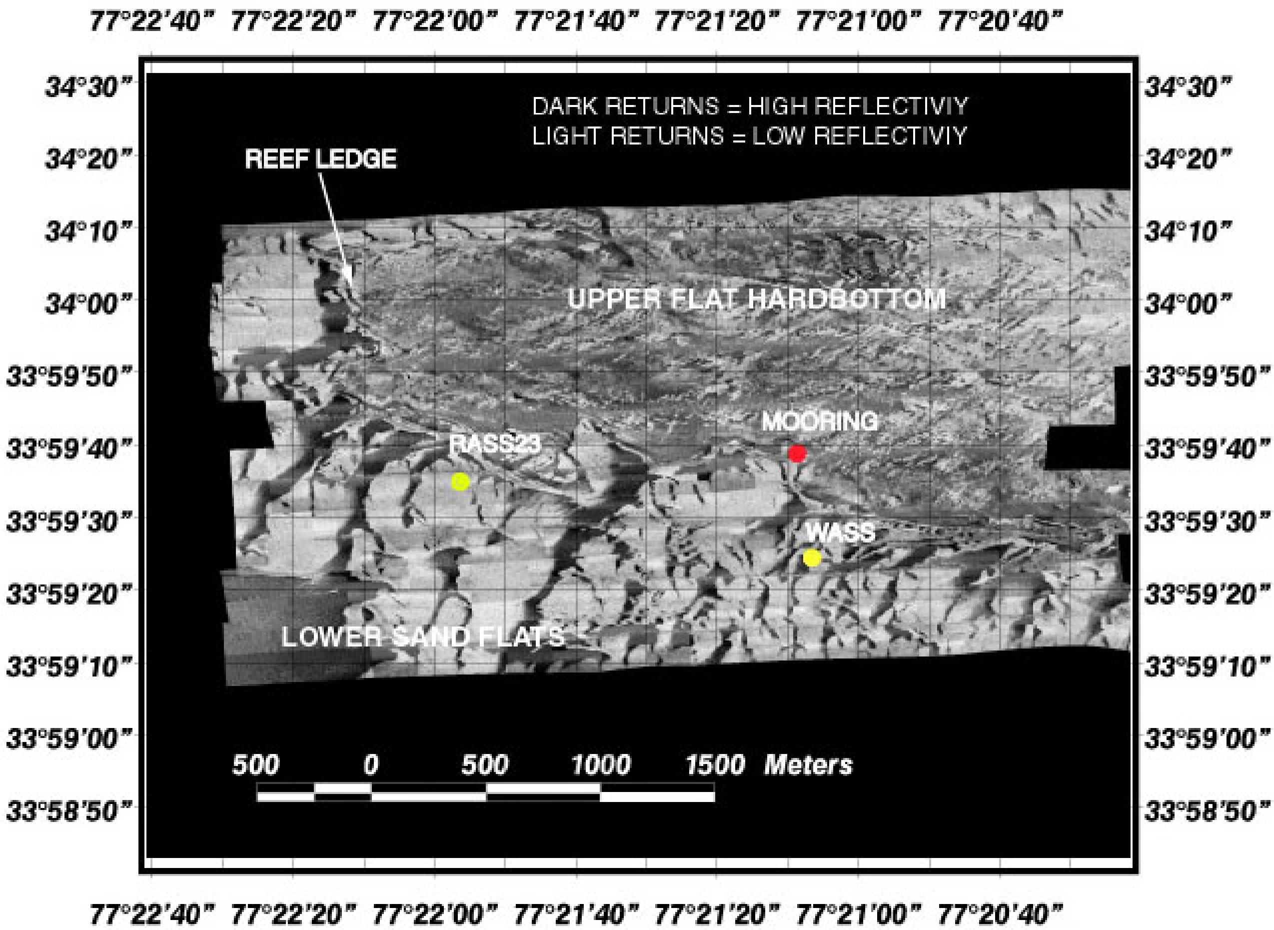
ADCP and PC-ADP flow magnitude profiles during fair weather and a small northeaster from September 6-9 ,2000

ADCP, OBS, and seabed elevation data with wave data from the NOAA C-Man station at Frying Pan Shoals showing sediment mobility during the small September northeaster at the "23 mile Rock" site.



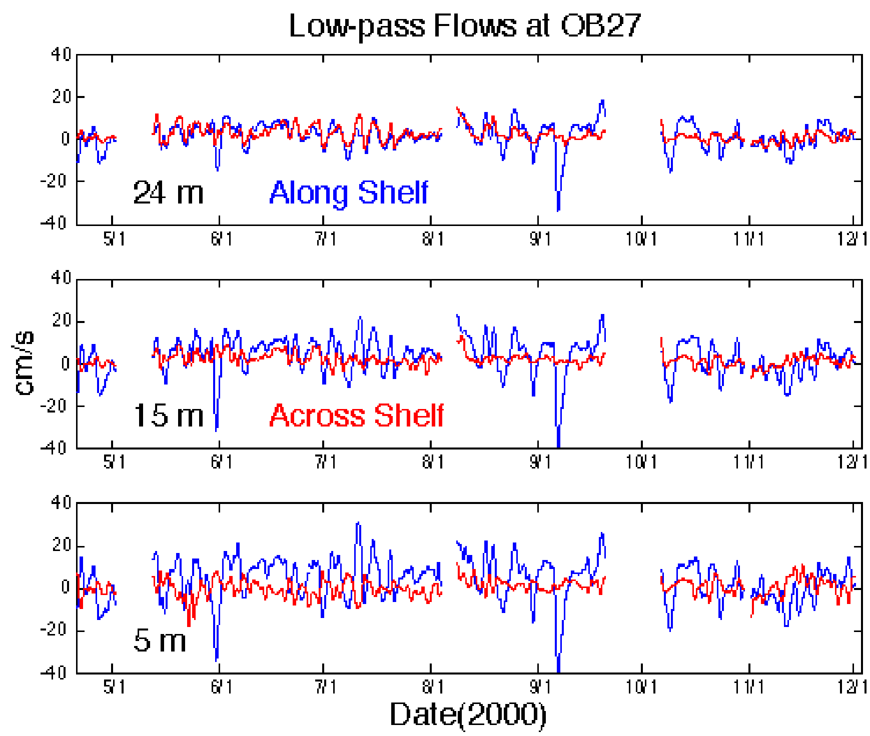
Sidescan Sonar: The system used in this study is the EdgeTech DF1000 digital sidescan sonar system. It is a dual frequency system(100kHz and 500kHz) with a Triton Elics ISIS Sonar acquisition system. Three cruises have been completed, one in December of 1999, one in December 2000, and one in June of 2001. Each of these cruises will result in a digital sidescan sonar mosaic generated using the Triton Elics International suite of software. Initial acquisition takes place using the ISIS Sonar software package. The bathymetry is then processed using BathyPro. This data is then incorporated with the sidescan data in DelphMap to produce a bathymetrically corrected sidescan mosaic. The mosaics are then imported into ESRI's ARCVIEW software, placing them in a geographic framework and allowing for the additional integration of georeferenced data such as instrumentation and sample locations, etc. These mosaics will allow a comparison of the sediment distribution over time and provide a tool for bottom-type classification. This analysis will be aided by the use of textural analysis, a recent methodology developed to increase the quantitative value of sidescan sonar data. The basis of this analysis are GLCM's or Grey-Level Co-occurrence Matrices (Blondel et al., 1998 and Gao et al., 1998). This analysis will take place using the ERDAS Imagine software package. Ground truthing through the use of SCUBA will then be used to calibrate the methodology so that in the future sidescan data can be analyzed quantitatively without necessary ground truthing.

23-Mile Site
Sidescan Sonar Mosaic

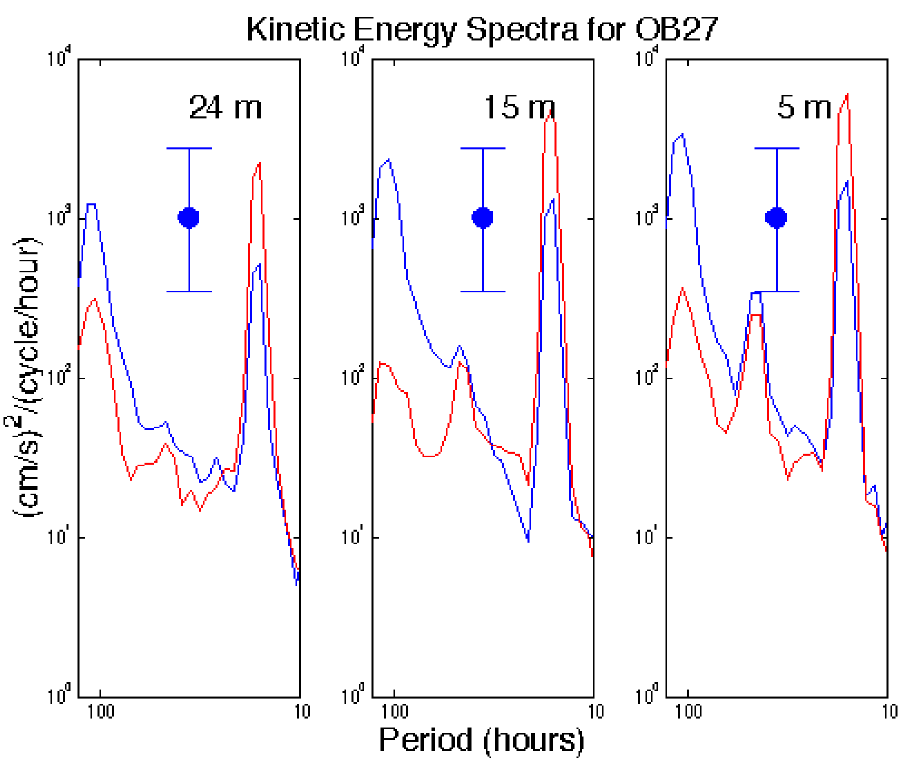


OCEAN CIRCULATION AND WEATHER

<u>Shelf Moorings:</u> Six bottom mounted, upward looking ADCPs, with wave upgrades in 3 of the ADCPs; 4 ADCPs will be placed in a box array in Onslow Bay at the 30 and 70 meter isobaths. 2 ADCP moorings will be located at the 30 and 70 meter isobaths in upper Long Bay to complement the Onslow Bay moorings; ADCPs with gravity wave capability will be located at the 2- 20 meter sites in Onslow Bay and the northern 40 meter site in Onslow Bay. Six salinity and temperature vertical taut wire moorings will be placed next to each of the ADCP sites to provide T, S water column information at 3 levels in the vertical; near surface, interior and near bottom. Moorings will be recovered and re-deployed at 6 month intervals. Meteorological buoy will be located in the geometric center of the box array—a 3-meter toroidal discus buoy with met package on 3-meter high tower.



ADCP data at OB27: Data have been low-pass filtered using a filter of 33 hour half power and 38 hour half amplitude. Velocities have been rotated into along and across-shelf components.



Kinetic energy spectra from three different depths at OB27. Spectra wre computed by taking 5 minute data and smoothing to hourly using an 11 point Hanning filter. Power spectral density was computed using Welch's averaged periodogram method. Spectra from different deployments were computed separately, and then averaged together. To decompose into along and across shelf components, shelf was assumed inclined at an angle of 45 degrees to the northeast.

Determination of Cross-Shelf Dispersion in Onslow Bay Using Radium Isotope Distributions

Radium isotope distributions are used to quantify the mixing of near shore and offshore waters as well as to determine horizontal kinematic eddy diffusivity in Onslow Bay (aka Moore, 2000; Kloster et al, 1998). Each radium sample is collected by first pumping approximately 50 to 100 gallons of water into barrels. The radium is then extracted from water samples by adsorption onto Mn-coated fibers contained in a flow-through cartridge. The cartridges are returned to the shore-based laboratory and the radon daughters of radium, which are released into the gas phase from the fiber are subsequently detected by alpha counting (Moore, 1976): $^{223}Ra \rightarrow {}^{219}Rn$; $^{224}Ra \rightarrow {}^{220}Rn$.

^{226}Ra is quantified by detection of alpha particles associated with the decay of its daughter ^{222}Rn. (half life = 3.8 days).The ^{222}Rn is transferred into a closed static system scintillation cell and the photons which result from the impact of alpha particles and the scintillator (silver activated ZnS) are detected by a photomultiplier tube.

^{223}Ra and ^{224}Ra are determined by delayed-coincidence alpha counting of their daughters, ^{219}Rn (half life = 4.0 secs.) and ^{220}Rn (half life = 55 secs.) respectively, on a single re-circulating closed system (Mathieu et al., 1988; Moore and Arnold, 1996). The delayed coincidence system utilizes the difference in half lives of the short-lived polonium daughters of ^{219}Rn and ^{220}Rn to identify alpha particles derived from ^{219}Rn or ^{220}Rn decay ($^{219}Rn \rightarrow {}^{215}Po$,half life = 1.8 msec; $^{220}Rn \rightarrow {}^{216}Po$, half life = 55 msec). ^{219}Rn results in the production of two alphas separated by approximately 1.8 msec while ^{220}Rn results in the production of two alphas separated by approximately 55 msec. A specifically designed circuit coupled to the output of the photomultiplier tube is used to discriminate between these decays seqquences. Chance coincidence counts are corrected for statistically. The system is calibrated by analyzing standards of known activity. Precision depends on the number of decays detected (N) with the standard deviation given by 1/√N. In our standard procedure the uncertainty associated with ^{223}Ra is approximately 10% and 5% for ^{224}Ra.

There is one additional step in determining the unsupported ^{224}Ra activity. The activity of its parent, ^{228Th}, is determined. This is accomplished by recounting the sample after the unsupported ^{224}Ra has decayed.

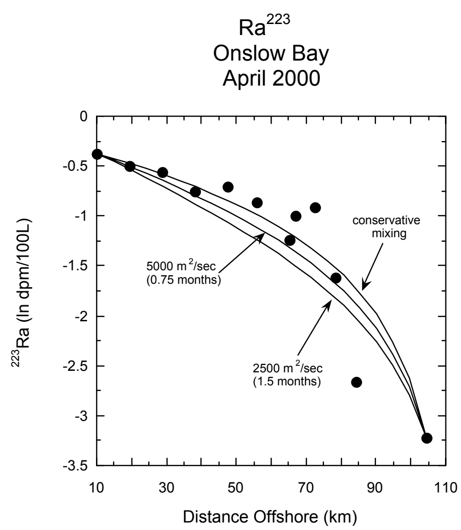


Figure1. Transects of ^{223}Ra. Dots are measured data. Each line represents a model distribution prediction for a different eddy diffusivity

APPENDIX A

CORMP PROJECT PROGRESS REPORTS