Southeast Atlantic Marine Monitoring and Prediction Center:

2002-2003 Coastal Ocean Research and Monitoring Program (CORMP)

University of North Carolina at Wilmington
NOAA Award # NA16RP2675
Semi-Annual Progress Report, 1 August 2002 to 31 January 2003

Submitted by:

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The progress report for the CORMP previous Award (# NA16RP1460) for the period 1Feb 2002 to 31 July 2002 covered in great detail management and scientific activities during the period. Award #NA16RP2675 is, at least from a scientific and management perspective, a continuation of the work under Award # NA16RP1460. An attempt will be made in this progress report to be brief and at times only outline the scope of technical and scientific progress. The general format of the submitted proposal will be followed.

The proposal for Award # NA16RP2675 contains three coastal ocean monitoring and science areas with specific proscribed research and monitoring tasks. These sections are, first, the Physical Oceanographic and Meteorological Observing System; second, Cape Fear River Plume Research and Monitoring; and, third, Continental Shelf Research and Monitoring. Since at the start of this award CORMP's sizeable, fixed coastal ocean instrumented moorings for physical oceanography and meteorology were for the most part already deployed at seven strategically located geographical areas within the Southeastern NC coastal ocean, and progress depended primarily upon operations (deployment, data downloads, cleaning, maintenance, redeployment), the first mentioned of the above areas, Physical Oceanography, will be covered within the overall progress made by the CORMP Operations Group. Actual physical oceanographic data collected, data quality and the potential use of the data in modeling efforts for the Southeastern NC coastal region will be covered in the next CORMP progress report.

Progress within these three areas of research and monitoring are described below.

1. CORMP Operations and Physical Oceanography Monitoring

Objectives, August 2002 - January 2003. CORMP operations provide safe, effective field support in the coastal ocean for the observations and sample collections. CORMP operations staff carries out scheduling and reservation of ship and boat time. Operations staff designs, assembles and deploys all offshore moorings. Deployment of the moorings are carried out from UNCW's R/V *Cape Fear* and supported by CORMP and NURC/UNCW diving teams. Mooring maintenance activities at both the Cape Fear River Plume and Onslow Bay stations include recovery, data retrieval, cleaning and refurbishment, and recalibration. Cape Fear River plume stations are sampled monthly using small boats, overseen by technicians from CORMP operations. Bi-monthly cross shelf transects out to 40-63nm offshore in Onslow Bay are conducted aboard the 67' R/V Cape Fear, to collect samples that support significant CORMP research objectives which includes; water quality and chemistry, fisheries oceanography, optical data, and a spectrum of data pertaining to ocean physical parameters and circulation patterns. Operations technicians assist with the processing and storage of samples both aboard ship and back in the lab.

Milestones, August 2002 – January 2003

CORMP Sampling Cruise in Onslow Bay:

- From August 2002 to January 2003:
  3 bi-monthly cruises took place, requiring a total of 3 ship days

  Sampling during cruises consisted of CTD casts with water collected at surface – mid column– and bottom (for chemical and nutrient analyses) and recording Temp, Sal, FlC, DO, and pH. Secchi readings, optical sampling (using Satlantic's Micro-PRO and Micro-SAS instruments as well as Li Cor readings) were collected. Water samples were also collected for DOC and spectral light attenuation studies. Gulf Stream water was collected for use in labs ashore during sample analyses.

CORMP OB27 & OB5 Mooring Sites:

- From August 2002 to January 2003:
  12 trips were made to OB27 & OB5 sites, 9 divers made a total of 76 dives.

  Work at these sites consisted of recovery, downloading, maintenance and re-deployment of the instruments (ADPC, PC-ADP with OBS probes, CT Loggers, SCUFA flurometers, and locator pingers). Sample collection included; box cores, benthic cores for both infaunal and Chl *a* analyses, as well as water collection for flurometer (Chl *a*) calibrations. Site maintenance was also conducted during the trips. Some underwater videos were collected to document instrument placement and seabed morphology at the mooring sites.

NCSU/UNCW CORMP Offshore Oceanographic Instrumentation Moorings

- From August 2002 to January 2003:

9 trips were made to the mooring sites (sites identified in the proposal)

All instruments were recovered, downloaded, maintenance completed and re-deployed during these servicing trips. 8 divers underwent a total of 54 dives at depths ranging from 60-135 fsw. One "6 month" servicing (all ADCPs and CT Loggers recovered) and one "3 month" servicing (only ADCPs recovered) were accomplished as planned. An overview of the NCSU/UNCW CORMP activities at the fixed mooring sites is shown in the chart below (Figure 1).

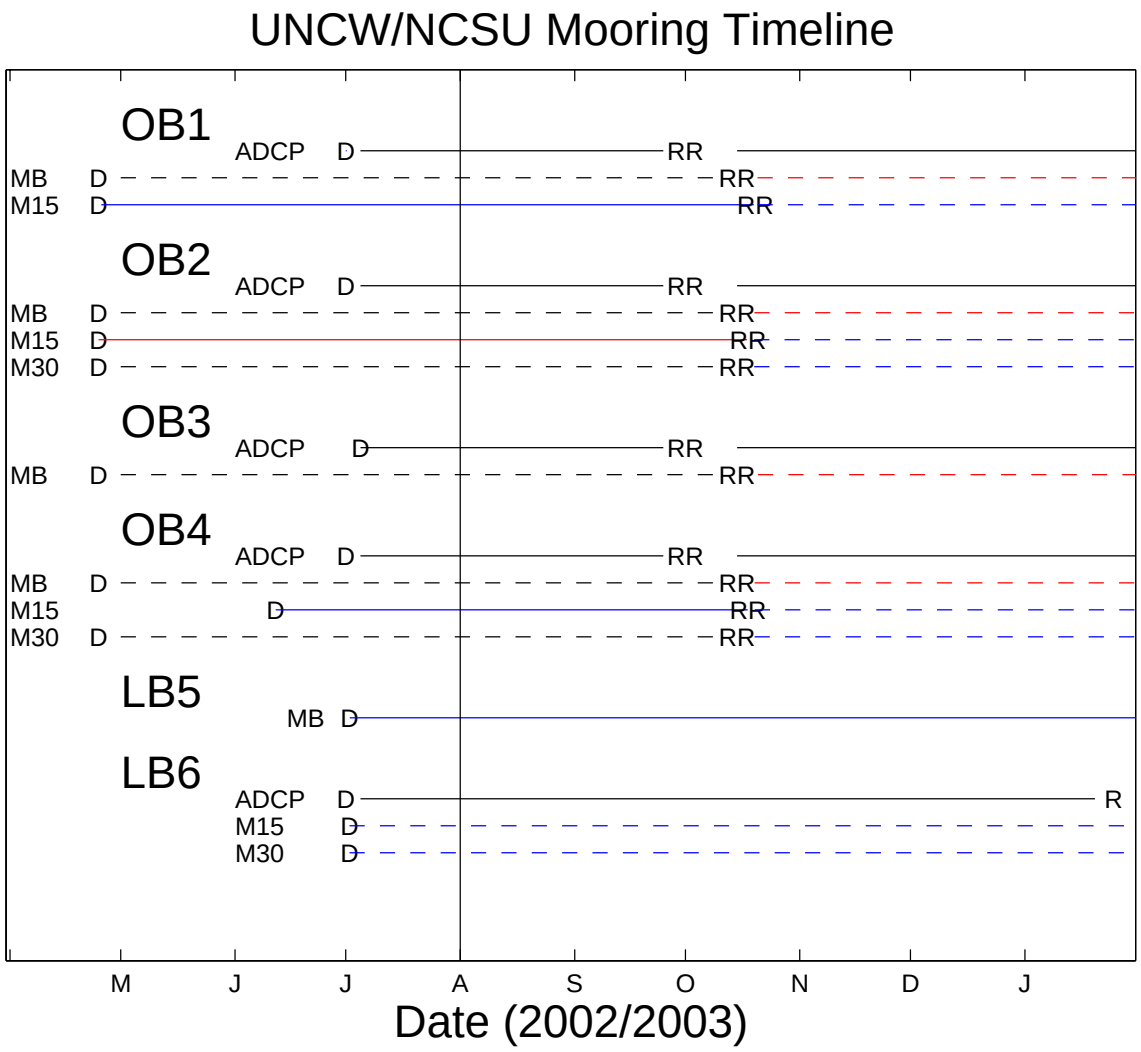

Figure 1. UNCW/NCSU mooring instrument deployment and recovery timeline. The various instruments are designated as follows: ADCP, bottom C/T logger (MB), 15 m C/T logger (M15) , 30 m C/T logger (M30). D - deployment. RR - recovery and redeployment. R - recovery only, no redeployment. Blue line - data quality good. Red line - data quality questionable. Black line - data quality unknown. The period of the progress report is on the right hand side of the figure, 8/1/02-1/31/03. Solid line - ADCP (current velocity) and microcat (temperature, conductivity and pressure). Dashed line - seacat (temperature and conductivity).

Plume Sampling:

- From August 2002 to January 2003:
  7 sampling trips conducted

  Operation's technicians act as crew and/or captain during these sampling trips. Samples collected during trips included: surface water for chemical and nutrient analyses, YSI readings from surface– mid column– and bottom; recording Temp, Sal, DO, pH, and depth. Secchi readings, turbidity readings, and optical sampling (using Satlantic's Micro-PRO and Micro-SAS instruments as well as Li Cor readings) were conducted. Water samples were also collected for spectral light attenuation and CDOM studies. Ship ek grabs were also collected seasonally during Plume trips.

Plume Ichthyoplankton Work in Plume

- From August 2002 to January 2003:
  4 sampling trips were conducted with the participation of operations

  Operation's technicians have acted as crew during these trips. Technicians on occasion assist in the lab with sorting of the samples collected. Work on these trips include the deployment of Bongo nets. Bottom samples were collected with an epibenthic sled.

Sample Processing:

- From August 2002 to January 2003:
  Approximately 880 samples were collected from Onslow Bay and the Cape Fear River plume. Many samples were processed in triplicate. Over 1200 individual samples were processed by operations technical staff.

  Technicians performed chemical analyses on samples from both the Onslow Bay cruises and the Plume cruises. Samples were analyzed for levels of; Chl *a*, DSi, T/N, T/P, NNP, and Ammonium. Surface water samples were processed to partition contributions to $K_d(\lambda)_{total}$ using spectral light attenuation.

Outreach:

- From August 2002 to January 2003:
  2 students from UNCW's *MSC526* graduate level class and 4 graduate students participated in an Onslow Bay cruises.

2. Cape Fear River Plume Research and Monitoring

* *Ecological Impacts of the Cape Fear River Plume*

Progress toward stated objectives:

- We are continuing to collect plume samples for physical parameters, nutrients, chlorophyll *a* and plankton. Samples were collected in August, September, October and November 2002. A spatial pattern continued of highest nutrient and chlorophyll concentrations at station 1 in the lower estuary, followed in turn by station 2 in the estuary mouth, station 6 in the plume, station 7 sometimes in the plume, station 5 sometimes in the plume, station 4 rarely in the plume, and station 3, the control station outside the plume influence. Dissolved oxygen increased away from the estuary and estuary mouth, due to the low dissolved oxygen concentrations often seen in the Cape Fear River. Dissolved oxygen is maximal at Station 6, in the path of the plume.
- We are continuing to accumulate baseline data for the plume that can be compared with future event-driven situations. Wet weather began in late 2002 and will provide an excellent data base against which to compare data from the recent two years of drought.
- Our preliminary statistics show that rainfall-driven river flow leads to enhanced chlorophyll concentrations in the plume, and enhanced nitrate concentrations at the plume's outer edges. Because of these findings, we have initiated the following study:

A set of experiments was initiated in June 2002 that entailed assessing what nutrients limit the growth of phytoplankton in and outside of the Cape Fear River plume. A number of undergraduate students have received training on this project. In these experiments water from the plume and a control station is collected, returned to the laboratory, and placed in 4 L cubitainers. The samples are spiked with different nutrients (nitrate, phosphorus, iron) incubated in flow-through systems outdoors, and sampled for chlorophyll *a* as the response variable. The experiments show consistent nitrogen stimulation of phytoplankton growth, with no phosphorus stimulation and rare iron stimulation. Chlorophyll yield in N-spiked treatments was 3-7X that of control. The magnitude of the food base for the plume food chain may thus be strongly dependent upon weather variations and land use in the upper watershed.

* *Connections Between Coastal Ocean Processes and Estuarine-Dependent Fisheries*

Progress: We are investigating the influence of the Cape Fear River discharge plume on recruitment and production of fishery resource species. This project represents one of several components of UNCW's NOAA-supported "Coastal Ocean Monitoring Program". Associated components (physical, chemical) are generating core data to assist the fisheries component, which is addressing 1) the utilization of the plume environment by larval fishes and crustaceans relative to that of adjacent coastal ocean and estuarine habitats, and 2) the impact of biotic and abiotic conditions within the plume on the

physiological condition (feeding, growth) of larvae. We are thus testing two important hypotheses regarding plume function: "aggregation/utilization" and "trophic enhancement". Our goal is to develop an understanding of the role of river discharge plumes in coastal fisheries production and the implications/consequences of coastal plume variability for sustainable resource use. We are also utilizing larval samples to develop and test molecular genetic markers for distinguishing larval blue crabs from related portunid crabs. The marker will permit accurate indexing of blue crab recruitment and abundance during the larval stage.

Scientific Results

- Effects of plume environment on larval aggregation and abundance:

Ship-based plankton sampling for fish and crustacean larvae has been conducted successfully during the six month reporting period at CORMP plume stations (3 depths per station: surface, 1m and bottom) representing plume, coastal and estuarine sites. Sorting and taxonomic identification of larvae has been completed for the reporting period and through May 2003. Our preliminary findings indicate that overall abundances of commercially-important taxa (e.g., blue crab, penaeid shrimp, spot, croaker, seatrout, red drum) were quite low during Spring 2002, presumably due to drought conditions and extremely reduced river discharge (USGS flow gauge data indicate that annual mean freshwater discharge from the Cape Fear River for 2002 appears to be at a 20-year low). Interestingly, higher abundances of larvae have been observed during spring 2003, coinciding with marked increases in precipitation and river discharge compared to spring 2002. Preliminary analyses for most months sampled suggest that the CFR discharge plume aggregates fish and crustacean larvae. Plume stations are more characteristic of the ichthyofaunal assemblages observed at estuarine stations than those of coastal oceanic habitats.

- Assessment of plume impacts on physiological condition of larva:

The impact of the plume on the physiological condition of larvae (trophic advantage hypothesis) is currently being examined. Collections of fish and crab larvae for biochemical assays is continuing. We have archived additional larval and juvenile finfish samples during the reporting period and into spring 2003. These have been added to our sample archives and are being held at –80C for analysis.

* *Characterization of the Chromophoric Dissolved Organic Matter (CDOM) in the Waters of Onslow Bay, the Cape Fear River Plume and Costal Southeastern North Carolina*

Progress: Surface water samples were collected at all Cape Fear River plume and Onlsow Bay shelf stations during each sampling cruise. Water samples were processed for CDOM analyses after each cruise by having the water samples filtered through 0.2 µm filters and refrigerated in the dark, prior to analysis. Absorption spectra (A), from 200 to 800 nm, of filtered samples were obtained using a Cary 100 spectrophotometer;

data were then transformed to ln A to determine the slope coefficient (S) of the waters as an indicator of photobleaching of CDOM; purified water from Milli-Q system was used as reference. Excitation-emission Matrix Spectra (3-D fluorescence) 3-D synchronous spectra of filtered water samples were obtained using a SPEX FluoroMax III fluorometer; #-D spectra were standardized with quinine sulfate. CDOM data for the period October 2001 through January 2003 were analysed. The data analyses indicated that the variability of CDOM absorption is very high in the CORMP study region with $a_{CDOM}(350)$, extending over nearly the entire range of CDOM absorption reported in the literature: $0.046 \leq a_{CDOM}(350) \leq 29.9\ m^{-1}$. The results of these analyses are being incorporated into a mansucript to be entitled "Characterization of CDOM in an organic rich river and surrounding coastal ocean in the South Atlantic Bight" to be authored by Piotr Kowalczuk, William J. Cooper, Robert F. Whithead, Michael J. Durako, and Wade Sheldon (Univ Ga) and to be submitted to the journal Aquatic Sciences.

* *Optical Characterization of the Waters of Onslow Bay, the Cape Fear River Plume (CFRP) and Coastal Southeastern North Carolina*

Progress: Apparent optical properties were measured at all Cape Fear River plume and Onlsow Bay shelf stations, during each sampling cruise. Spectral attenuation and spectral reflectances were calculated from radiometric data collected by Satlantic Micro-PRO and Micro-SAS radiometric systems. The Micro-PRO was developed for measurements of vertical profiles of downwelled irradiance and upwelled radiance, and Micro-SAS was designed to measure the spectral reflectance above the water surface. The results on analyses of statistical comparisons between these two instruments (ship-based measurements) and SeaWiFS radiometric measurements were presented by Piotr Kowalzcuk, Michael Durako, and William Cooper in a paper entitled "Comparison of radiometric quantities measured in water and above water and derived from SeaWiFS imagery in Onslow Bay and Cape Fear River plume area" which was presented in November 2002 at Ocean Optics XVI in Santa Fe, NM.

Analysis of the inherent optical properties (IOP) of the water samples from CORMP indicate that the absorbance properties of CDOM within the plume may provide a means of describing how river discharge affects carbon sources and transformations in the nearshore waters of the Cape Fear River plume. CORMP IOP data also indicates that the contribution of particles (TSS) to absortion of photosynthetically active radiation (PAR) in the plume is dominant and clearly reflects riverine inputs, while the distribution of pigment absorption suggests a lower plume effect or possibly even a dilution effect by river inflow. As reported previously, during periods of low flow, there is little plume effect on CDOM and TSS distribution. The relatively higher pigment levels in the plume area, during low discharge periods, may reflect both the increased water transparency and a nutrient "memory" effect (remineralization of nutrients from river-deposited sediments) or effect of increased residence time of the plume-area water mass. The results of the bio-optical data analyses were presented by Michael Durako, Piotr Kowalzcuk, Jason Souza, Michael Malin, and Matthew McIver in a paper entitled "Spatial and temporal variation in CDOM in a coastal blackwater river plume" in November 2002 at Ocean Optics XVI in Santa Fe, NM. Data from bi-monthly transects in Onslow Bay and the monthly CFRP

data on attenuation of incident light from the LiCor PAR scalar quantum sensors, and spectral attenuation partitioning by various water components have continued to be posted on the CORMP web site: (http://www.uncwil.edu/cmsr/comp/biooptical/bioopticalindex.htm).

* *Additional Products from Cape Fear River Plume Research and Monitoring: Presentations, Posters, Abstracts, Publications:*

Mallin, M.A., M.R. McIver, M.H. Posey, T.D. Alphin and M.J. Durako. 2003. "The Cape Fear River plume – Water quality and ecology". Southeast Coastal Ocean Science Conference, Charleston, S.C.

Mallin, M.A., M.R. McIver, H.A. CoVan, V.L. Johnson, T.H. Johnston, D.C. Parsons, J.J. Souza and D.H. Wells. 2003. "Enhancement of biological production in the Cape Fear River plume". Meeting of the American Fisheries Society Southern Division, Wilmington, N.C.

Mallin, M.A., T.H. Johnston, M.R. McIver and D.C. Parsons. 2003. "Nutrient limitation of phytoplankton in the Cape Fear River plume." Annual North Carolina Water Resources Research Conference, Raleigh, N.C.

Mallin, M.A., L.B. Cahoon, M.J. Durako, T.A. MacPherson, J.J. Souza and D.H. Wells. 2003. "Chlorophyll and nutrient patterns in river influenced Long Bay versus non-river influenced Onslow Bay ocean regions". Southeastern Estuarine Research Society, Atlantic Beach, N.

Quattrini, A.M., D.G. Lindquist, F.M. Bingham and T.E. Lankford. 2003. Distribution of larval fishes among water masses in Onslow Bay, North Carolina. Contributed talk. Larval Fish Conference. Santa Cruz, CA. planned 8/03

Quattrini, A.M., D.G. Lindquist, F.M. Bingham and T.E. Lankford. 2003. Distribution of larval fishes in shelf and gulf stream waters in Onslow Bay, North Carolina. Contributed paper. American Fisheries Society, 2003 Southern Division Meeting, Wilmington, NC.

Markovsky, W., T. Lankford, A. Wilbur, M. Posey, T. Alphin and S. Kinsey. 2003. River discharge plumes and fisheries production: the trophic advantage hypothesis. Contributed paper. American Fisheries Society, 2003 Southern Division Meeting, Wilmington, NC.

Mr. Walter C. Markovsky remains a member of the CORMP fisheries project. He continues to participate in monthly samples and processing, and is expected to defend his M.S. thesis in late fall 2003.

3. Storm Impact on Sediment Mobility and Biotic Response in Onslow Bay, NC

* *Sediment Mobility*

Progress toward stated objectives: We are making excellent progress meeting our objectives for the year and as stated for August 2002- January 2003 time period. At this time we have:

- Identified key events leading to significant mobilization at the OB27 site and have identified events associated with both storm related and non-storm related phenomena,
- Documented changes in the sedimentary structure of cores resulting from different types of wind events,
- Identified areas where large changes in sediment texture have occurred at OB27 using side scan sonar mapping techniques.
- Quantified spatial changes in sediment distribution for intervals between 1999 and 2001.
- Related spatial changes in sediment distribution to the physical forcing mechanisms identified from the time series data

Progress toward meeting stated tasks: Over the reporting period we have:

- Continued to collect sediment box cores, surface sediment grab samples, benthic cores, and physical (current, temperature, and seafloor altimetry) data at OB27. These data continue to be collected (roughly) at six-week intervals.
- Continued to process box cores. This procedure includes: creation of sediment peels, X-ray imaging of cores, grain size analysis of subsamples, and description of sedimentary structures. All cores collected to date have been completely processed and described.
- Processed and archived benthic cores.
- Digitized and compared boundaries between areas of distinct seafloor reflectivity between 12/1999 and 12/2001 sidescan sonar mosaics to monitor bedform change.
- Performed pixel to pixel comparison of seafloor reflectivity between 12/1999 and 12/2000 sidescan sonar mosaics to monitor bedform change.
- Continued incorporating data into GIS database for OB27 site, including establishing a metadata template.
- Recruited one new graduate student whose thesis work will focus on data collected at OB5. During the reporting period, this student obtained his recreational diver certification.
- Deployed a Wetlabs Eco-sb turbidity sensor at OB5. A SCUFA II was also deployed intermittently at this site.

- Began collection of sediment boxcores and surface sediment grab samples at OB5. Boxcores are collected approximately every six weeks. The cores are also processed and archived as described above.
- Retrieved ADCP current and wave data from OB5 for two deployment intervals covering the period of August 2002-January 2003. We are in the process of analyzing these data.
- Continued development of other MATLAB programs for data specific processing tasks; including determination bottom shear stresses.

Products:

- OB5 (inner shelf site) established with upward looking ADCP and turbidity sensor. Routine box core analyses and sediment surveys have been conducted. This work is a joint effort between this component of CORMP and researchers at NCSU.
- Sidescan sonar survey of the OB5 site conducted and post-processing is underway.
- Collected underwater video at OB5.
- Incorporation of CORMP data into educational curriculum at UNCW. Examples include use of PC-ADP near-bottom current data in GLY555--Sediment Dynamics, use of box cores and sediment samples in GLY591--Grain Size Analysis by Laser Diffraction, side scan imagery in GLY550—Marine Geology, benthic infaunal data in BIO434—Marine Ecology.
- One undergraduate student intern (Susan Blake) who worked on CORMP related projects in Fall 2002.
- The research of two M.S. student and one Ph.D. student were supported by this component of CORMP.

* *Effects of Storm Event-Driven Resuspension of Benthic Microalgae*

The principal objective of my work through CORMP is to evaluate the effects of storm event-driven resuspension of benthic microalgae and other processes on creation of a frequent and wide-spread near-bottom chlorophyll *a* maximum in Onslow Bay.

We have continued our deployments of a SCUFA II fluorescence/turbidity logger at OB-27, in conjunction with deployments of other instrumentation (ADCP, PC-ADP, OBS, CT loggers) by other investigators at that location. As of January, 2003, we had maintained almost continuous deployments of at least one SCUFA unit at OB-27 since late September, 2001 (excepting turnaround times for downloads and battery recharging). We began deployment of a SCUFA II unit at an inshore station, OB 5, during the summer of 2002. This unit is moored ~1m from the bottom, like the unit at OB 27, along with other instruments used by other investigators. We have collected and analyzed additional sets of sediment samples for benthic microalgal biomass as chlorophyll *a* from both locations. We have also collected and analyzed chlorophyll samples from the water column in addition to routine water column profiling by CORMP at these stations.

This project component supported a graduate student, GianLuca Manes, who worked on an M.S. degree in Marine Science during this period. Mr. Manes used the results of this study for his thesis. In addition to the data from the instruments at OB-27, Mr. Manes has obtained and worked with wave data from Frying Pan Tower. He learned to use MatLab, JMP, and ArcView software to analyze and display his data. His progress toward completion is satisfactory. We expect one publication from his work and a second likely to result.

* *Other Products from Continental Shelf Research and Monitoring: Presentations, Posters, Abstracts, Publications*:

Wren, P. Ansley and Leonard Lynn A. Physical Forcing and Sediment Mobilization on the Continental Shelf in Onslow Bay, North Carolina (submitted to Marine Geology).

Bingham F., Moss M., Wilbur, A., Posey, M., Pietrafesa, L., Mallin, M., Leonard, L ., Lankford, T., Grindlay, N., Cooper, W., Cahoon, L., Durako, M., Xie, L, and Alphin, T. 2002. Coastal Ocean Research and Monitoring Program at the University of North Carolina at Wilmington *Eos Trans. AGU, 83*(47), Fall Meet. Suppl., Abstract OS72B-0358.

Head, M., Grindlay, N.R., and L. Leonard. 2002. Mapping and monitoring bedforms on the mid-continental shelf: 23-mile site Onslow Bay, NC. *Eos Trans. AGU, 83*(47), Fall Meet. Suppl., Abstract OS713-0292, 2002.

Wren, A., and L. Leonard. 2002. Physical Processes and Sediment Transport in Onslow Bay, NC. *Eos Trans. AGU, 83*(47), Fall Meet. Suppl., Abstract OS52F-12, 2002.