Announcement M13AS00014: Hurricane Sandy Coastal Recovery and Resiliency - Resource Identification, Delineation and Management Practices

Agreement M14AC00005: Georgia Cooperative Agreement

Geospatial Sand Resource Assessment for Georgia Coastal Recovery and Resiliency

Lead Agency:
Skidaway Institute of Oceanography/University of Georgia

Recipient point of contact information:

Principal Investigator
Dr. Clark Alexander
Skidaway Institute of Oceanography
University of Georgia
Savannah, GA 31411
(912) 598-2329 (Office)
(912) 598-2341(FAX)
clark.alexander@skio.uga.edu

Summary Report

A. Cooperative Agreement Outputs including Project Deliverables:

The primary focus of this cooperative agreement is to synthesize information on seabed sediment character (i.e., grain size, composition, description) and legacy geophysical data (i.e., subbottom profiles) for the Georgia shelf, using existing sample information in local, State and Federal archives, existing unanalyzed samples, and an extensive archive of loosely catalogued, hard-copy geophysical records. The focus of this cooperative agreement is the seabed sand resources in the 3-8 nm OCS zone, particularly seaward of three of the four Georgia developed barrier islands (Jekyll, St. Simons and Sea Islands) where renourishment sands might be needed in the future, and which could be administered by the Federal government if needed. Tybee Island is the fourth developed island on the Georgia coast. We did not focus our work seaward of Tybee because it has a long history of beach renourishment projects (since 1976), and have extensively surveyed and well-established sand resources.

Deliverable 1: Alexander, C.R., Analysis and characterization of Georgia shelf sediment samples within the nearshore OCS, BOEM/Georgia Cooperative Agreement Technical Report.

The sand resources on the Georgia continental shelf are the most poorly known of all the states along the east coast of the United States. This issue has been identified repeatedly as a significant data gap in assessment documents identifying geological research needs in the state. Although there have been a small number of sand resource surveys in limited areas within a mile of shore for some of the developed islands, no resource assessments have been made of the 3-8 nm region anywhere along the Georgia coast. We have identified, located and analyzed 51 existing samples for grain size and content of quartz, carbonate, opaque minerals and rock fragments (Fig. 1). Grain sizes range from 0.33 to 3.2 phi, with coarser sizes observed farther seaward on the shelf. Carbonate content (1-14%), heavy minerals (1-9%) and rock fragments (0-2%) do not display strongly consistent patterns within the relatively narrow zone of interest, but generally decrease seaward. Quartz continent (82-98%) increases seaward across the shelf. These data show that the 3-8 nm zone is a significant zone of transition in sediment grain size on the Georgia shelf, where, in general, very fine and fine sands, similar to those found in the modern beach complex, transition to medium to coarse sands, representing palimpsest and relict materials left behind as the shore zone has moved landward with rising sea level throughout the last Transgression. It is critical to determine just where this boundary lies within the 3-8 nm zone to predict where beach compatible sands would most likely be found. These data are being combined with existing sediment data for areas seaward and landward of this zone in outcome #2 below.

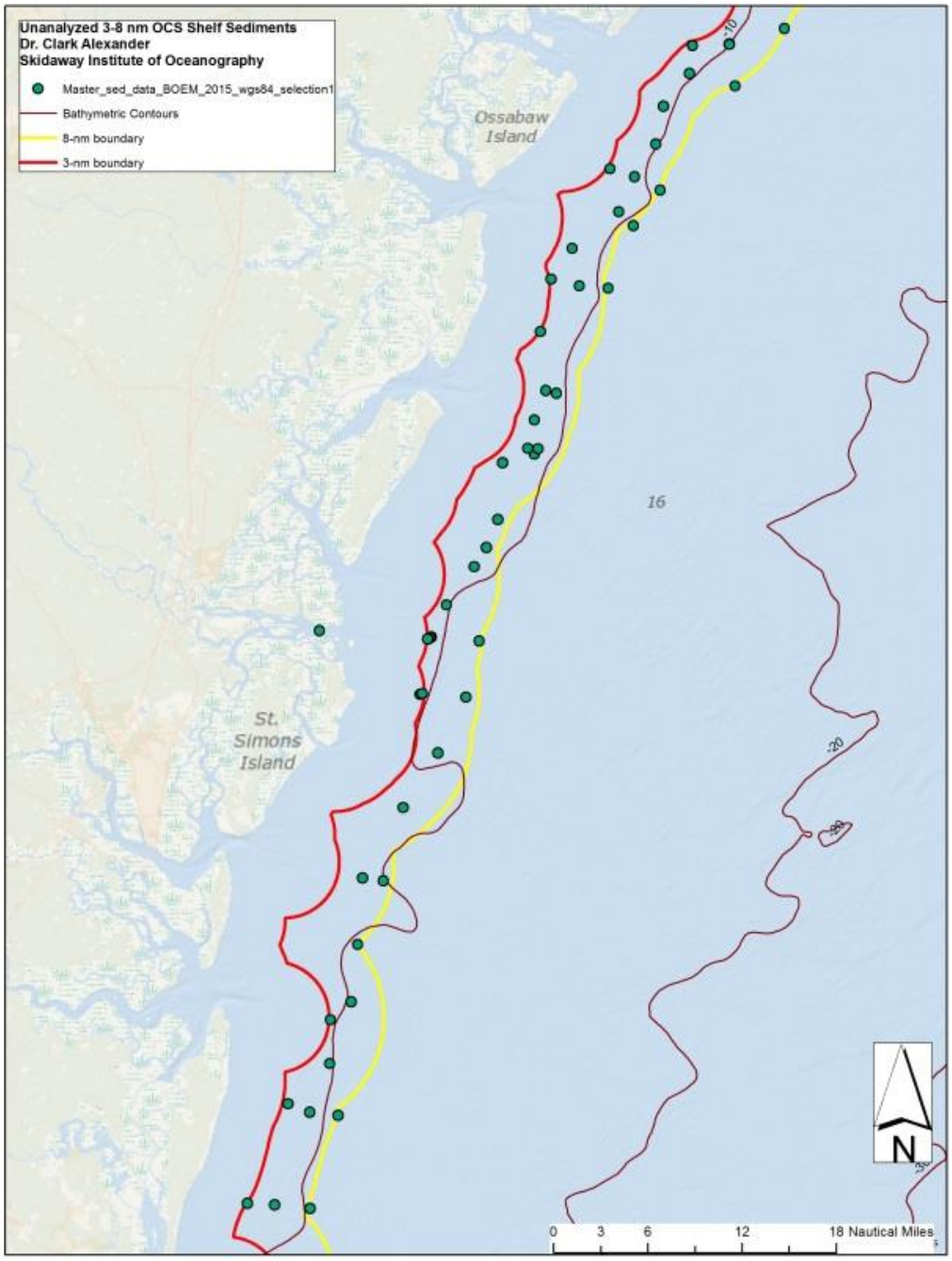

Figure 1: Location of previously unanalyzed sediment samples from the 3-8 nm zone characterized in this study.

Deliverable 2: Alexander, C.R., A synthesis of existing textural and compositional data for Georgia shelf sediment samples. Geospatial dataset accompanying BOEM/Georgia Cooperative Agreement Technical Report.

The most comprehensive regional sediment size and composition dataset for the Georgia shelf was collected in the 1960s by the United States Geological Survey (available from USSeabed). However, these collections had a sample spacing of 10 nm or more, which is far too coarse to inform a detailed sand resource evaluation. A large number of new datasets, currently numbering 30, have been created since that time by several NOAA groups (Hydrographic survey, NMFS, ONMS), Georgia Department

of Natural Resources (GA-DNR), city governments (Tybee, Sea and St. Simons Islands), educational institutions (College of Charleston), and Alexander, the principal investigator of this project (Fig. 2). Different datasets have different levels of analysis. Some data (Alexander lab and some NOAA) have been analyzed for mean size, percent sand/silt/clay, and component make-up, whereas some samples (USSeabed and some NOAA) are simply visual deck descriptions. The new shelf surveys conducted by CB&I and the samples from state waters, the collection and analysis of which is being funded by the GA Sea Grant program, will be creating new data that will be integrated into this dataset in future efforts as well. Sediment size and composition data from all these sources has been combined into a uniform format to create an integrated dataset of coastal and shelf grain size. These data are hosted on the Georgia Coastal Hazards Portal (http://gchp.skio.uga.edu) run by Alexander, and will soon be made available through the GA-DNR Georgia Coastal And Marine Planner (GCAMP) portal (http://www.geospatial.gatech.edu/GCAMP/).

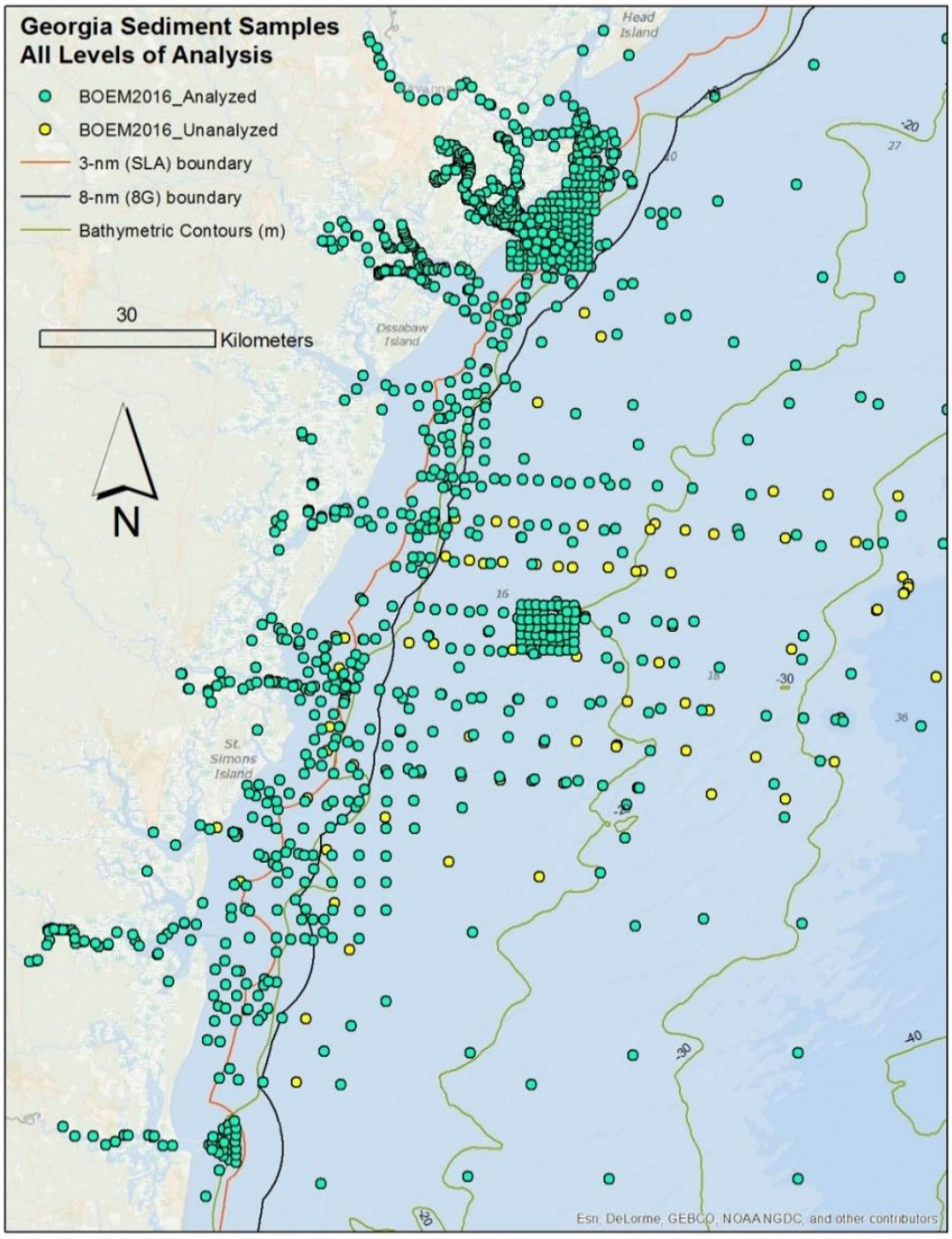

Figure 2: Existing sediment grain size and composition datasets integrated into a consistent geospatial dataset for the Georgia shelf. Yellow dots represent unanalyzed, existing samples in the Alexander lab archive.

Deliverable 3: Alexander, C.R., A catalog and synthesis of legacy geophysical datasets for the Georgia shelf. Geospatial dataset accompanying BOEM/Georgia Cooperative Agreement Technical Report.

Uniboom, geopulse, sparker, airgun, 3.5-kHz, and 12-kHz subbbottom surveys with between-line spatial scales of ~10 nm have been completed for the Georgia shelf, but full spatial coverage and areas surveyed are not well constrained nor in a single digital dataset. Additional sidescan and magnetometer records that complement some of the surveys lines exist and have been catalogued as well. The Georgia Southern Applied Coastal Research Laboratory (ACRL) houses a large collection of the original, paper subbottom seismic records for these surveys, collected in the 1970s and 1980s by Dr. V.J. Henry, who is now deceased, and by Alexander in the 1990s and 2000s. Alexander became the Director of the ACRL in 2003, inheriting this extensive, but poorly catalogued, collection. These records have been inventoried for survey coverage, record quality, media type, number of rolls and lengths of each roll, as a first step toward conversion to digital SEG-Y format so that they can be preserved and made available to other users. Thirty-six boxes of uncatalogued legacy records have been identified and examined, which contained data and tracklines from over 9,400 nm of surveys collected with a variety of seismic sources. Many of these records did not contain adequate navigation information to place them in a geospatial context. However, geospatial information was available for 505 survey lines, 1,585 individual geophysical records (uniboom and other mechano-acoustic subbottom profilers – 506 records; airgun – 8 records; sparker – 263 records; echosounder – 232 records; and in addition, 362 sidescan and 214 magnetometer records, respectively), accounting for 5,805 kms of surveys (Fig. 3). After plotting the survey lines in GIS, it became clear that few lines image the 3-8 nm are of interest in this study. Only data collected by Alexander in the 1990s and 2000s cover this area extensively. However, most of these surveys were conducted seaward of southern South Carolina, and these data have been provided to the SC BOEM collaborative partners for inclusion in their GIS. The ASAP subbottom data for Georgia, which will be integrated into this dataset when it becomes available, will be particularly important in this regard. Alexander has acquired SonarWiz to enhance his capabilities to work with this subbottom data in the future. Further, Alexander has taken advantage of a “ship of opportunity” to collect additional high-resolution subbottom data using the same type of seismic system used by CB&I for the ASAP survey (Edgetech 512i). He has added approximately 50 nm of unprocessed seismic lines near Jekyll, St. Simons and Sea Islands using no BOEM cooperative agreement funds.

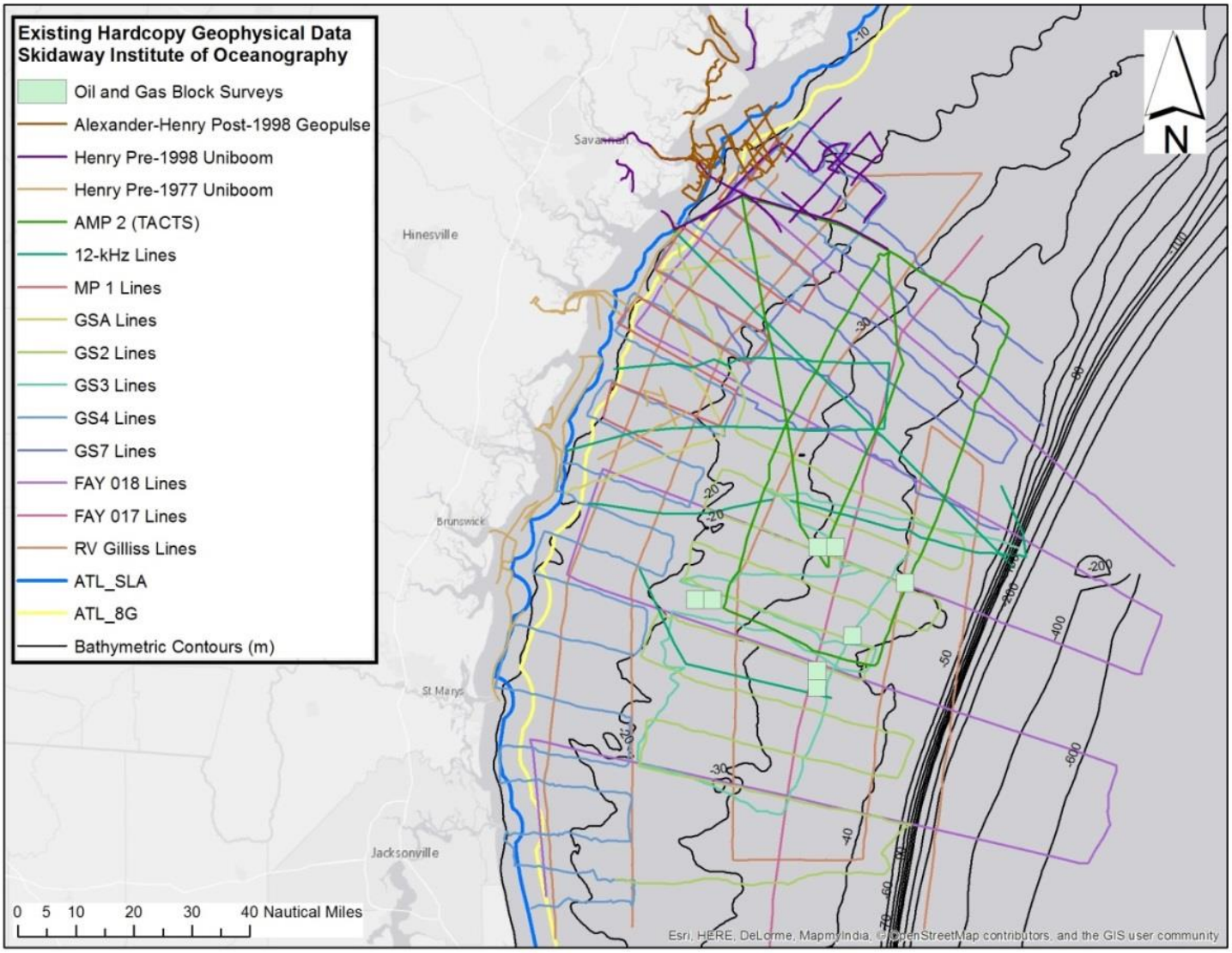

Figure 3: Track lines of legacy geophysical datasets existing in the archives at the Georgia southern University Applied Coastal Research Laboratory on Skidaway Island. Note that few lines cover the 3-8 nm region of interest.

B. Associated Cooperative Agreement Outputs (Presentations with Published Abstracts):

Abstracts #1 and #2 presented at the Southeastern Section of the Geological Society of America - 65th Annual Meeting (31 March–1 April 2016) in Columbia, SC

1) Status of Sand Resource Assessments for Georgia Coastal Resiliency and Recovery

ALEXANDER, Clark, Skidaway Institute of Oceanography, 10 Ocean Science Circle, Savannah, GA 31411, clark.alexander@skio.uga.edu

Hurricane Sandy caused billions of dollars in damages to coastal communities along the east coast of the United States. Given the eventual likelihood of similar storms in the future, coastal communities have begun to develop strategies to increase their resilience to, and speed their recovery from, such an event. A detailed understanding of the distribution and character of nearshore and inner continental shelf sand resources is a critical component in developing these strategies. These sand resource data are critically needed in Georgia, as the sand resources on the continental shelf are the most poorly known of

all the states along the East Coast. The Bureau of Ocean Energy Management and the NOAA Sea Grant Program are funding efforts to collect, analyze and synthesize new, high resolution datasets to build an understanding of the beach-quality sand resources available on the Georgia shelf. Three developed barrier islands along the Georgia coast (Sea, St. Simons and Jekyll Islands) are without identified renourishment resources and are the focus of these studies. This talk will describe the status of these projects, present new and existing samples and datasets compiled for these studies, and outline goals for the future. Eventually, sediment character, bathymetry and sediment trend data will be integrated into a predictive geospatial framework in support of future nourishment efforts.

2) Sediment Size Distributions and the Limits of Recent Sediment in the Georgia Bight

COLLEY, Jennifer, Marine Sciences, Savannah State University, 3219 College Street, Savannah, GA 31404, (jchristie9201@gmail.com) and ALEXANDER, Clark, Skidaway Institute of Oceanography, Savannah, GA 31411.

Reconnaissance studies of Georgia continental shelf sediments in the 1960s and 1970s have shown a zone of influence approximately 5-16 km in width that defines the maximum seaward extent of Recent, river-derived sediments. Seaward of this narrow zone of influence lie relict sediments from the last lower stand of sea level, which are characterized by coarser grain sizes and iron-stained quartz. The purpose of this study was to identify sediment distribution patterns within the Georgia Bight to more precisely determine the present location of the recent-relic sediment boundary. Sediment samples were collected at 103 sites, wet sieved at 4 phi and dry sieved at 0.25-phi intervals from -2 to 4 phi to determine mass per phi interval, and observed under a microscope to collect point count data to determine percentages of quartz, opaques, carbonate, and rock fragments. Grain sizes were calculated using the method of moments, classified using the Udden-Wentworth size scale, and plotted in ArcGIS for spatial data analysis. Grain size analysis showed that the sediments were dominated by 4 grain sizes – coarse, medium, fine, and very fine sands. Coarse sands (mean size = 0.8±0.2 phi) and medium sands (mean size = 1.5±0.3 phi) were located seaward of 13 km offshore and in depths greater than 14 m. Fine sands (mean size = 2.5±0.3 phi) and very fine sands (mean size = 3.1±0.1 phi) were located closer to shore (within 13 km) and in depths less than 13 m. These findings are consistent with previous research (Pilkey and Frankenberg, 1964; Bigham, 1973) and validate the concept of a zone of modern sediment influence. The location of the boundary between the Recent and relict sediments does not appear to have changed, within the limits of our analyses, since these previous studies were conducted. However, the boundary's location is now better constrained between the widely spaced, 1960s-1970s survey transects.

Abstract #3 is to be presented at the American Shore and Beach Preservation Association annual meeting, October 25-28 2016, in Long Branch, NJ.

3) Geospatial And Field-Based Sand Resource Assessments For Georgia Coastal Resiliency And Recovery

ALEXANDER, Clark, Skidaway Institute of Oceanography, 10 Ocean Science Circle, Savannah, GA 31411, clark.alexander@skio.uga.edu

Hurricane Sandy caused billions of dollars in damages to coastal communities along the east coast of the United States. Given the eventual likelihood of similar storms in the future, coastal communities have begun to develop strategies to increase their resilience to, and speed their recovery from, such an event. A detailed understanding of the distribution and character of nearshore and inner continental shelf sand resources is a critical component in developing these strategies. These sand resource data are

critically needed in Georgia, as the sand resources on the continental shelf off of Georgia are the most poorly known of all the states along the East Coast. The Bureau of Ocean Energy Management and the NOAA Sea Grant Program are funding efforts to collect, analyze and synthesize new, high resolution datasets to build an understanding of the beach-quality sand resources available on the Georgia shelf. Three developed barrier islands along the Georgia coast (Sea, St. Simons and Jekyll Islands) are without identified renourishment resources and are the focus of these studies. This presentation will describe the current status of these projects, present new and existing samples and datasets compiled for these studies, and outline goals for the future. Results to date show that coarse (mean = 0.8±0.2 phi) and medium sands (mean = 1.5±0.3 phi) are located seaward of 13 km offshore and in depths greater than 14 m. Fine (mean = 2.5±0.3 phi) and very fine sands (mean = 3.1±0.1 phi) are located closer to shore (within 13 km) and in depths less than 13 m. These findings validate the concept of a zone of modern sediment influence in the nearshore zone. The location of the boundary between the Recent and relict sediments does not appear to have changed, within the limits of our analyses, since previous studies in the 1970s first observed this pattern. However, the boundary's location is now better constrained. Recent, high-resolution surveys in the OCS provide much needed context for further detailed studies, and will be analyzed in the near future. Eventually, sediment character, bathymetry, sediment thickness and sediment trend data will be integrated into a predictive geospatial framework in support of future nourishment efforts.

C. Associated Cooperative Agreement Outputs (Additional Projects)

1) HBCU Student Project: Comparison of 3-8 nm OCS sands with OCS sands farther offshore

Abstract for this completed project is given above, and was presented at the 2016 SE GSA meeting in Columbia, SC. A much earlier talk, describing very preliminary results from a small subset of her samples (Sediment Size Distribution Along the Georgia Bight, J. Colley, presenter), was presented at the Annual Biomedical Research Conference for Minority Students, which all marine science students who attend Savannah State University, a local HBCU, are required to attend if they have research to present. Her research focuses on comparing the characteristics of OCS sands across the shelf to determine where the zone of modern sediment influence ends, and palimpsest/relict sediments dominate. This student worked in Alexander's sedimentology laboratory, and learned valuable skills for sediment size and compositional analysis. She has taken these skills back to her thesis advisor's lab, building capacity at Savannah State University for sediment analysis that did not exist there previously.

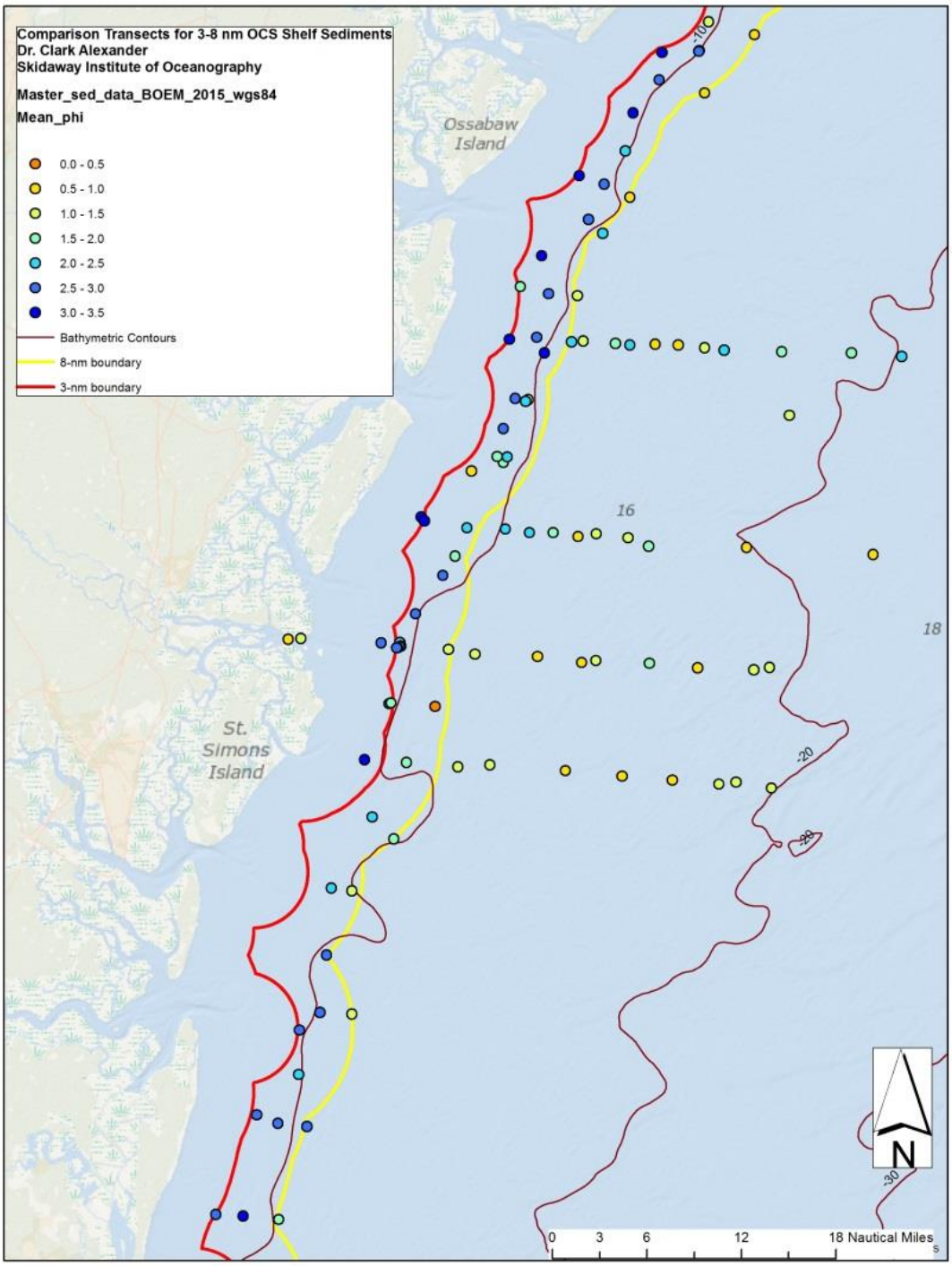

Figure 4: Distribution of sample transects extending across the shelf examined in student project comparing 3-8 nm OCS sand resources with OCS sand resources farther offshore. Note the coarsening with distance offshore, beyond the 10-m isobaths.

2) NOAA/ Georgia Sea Grant project funding

Because of the investment by BOEM in OCS sand resource studies, additional funding has been obtained to support the collection of sediment samples and geophysical data seaward of Georgia's developed barrier islands. Funding is through a competitive process within the Georgia Sea Grant Program, and is funding a 2-y study of sand resources in state waters. This project, which began in Feb 2016, has collected a network of single-beam echosounding lines and bottom sediment grab samples to delineate and quantify sand resources within State waters in an effort to build community resiliency (Fig. 5). Additional subbottom data has been collected in July 2016 from the RV Coastal Explorer,

using an Edgetech 512i subbottom profiling system (Fig. 6). Field operations for our Summer 2016 sampling have been ongoing for the past month, and will be completed within September. The echosounding lines will be converted to a gridded bottom surface to illustrate bathymetric highs (and therefore potentially thicker sand deposits). The bottom sediment samples will be analyzed for comparison with samples collected from the beaches of Jekyll, St. Simons and Sea Islands to identify beach-compatible offshore sand resources. This sampling will be repeated next summer to evaluate the annual variability in these materials. These resources would be the first to be utilized should sand resources be needed after a significant storm to rebuild beaches to protect infrastructure and to restore habitat.

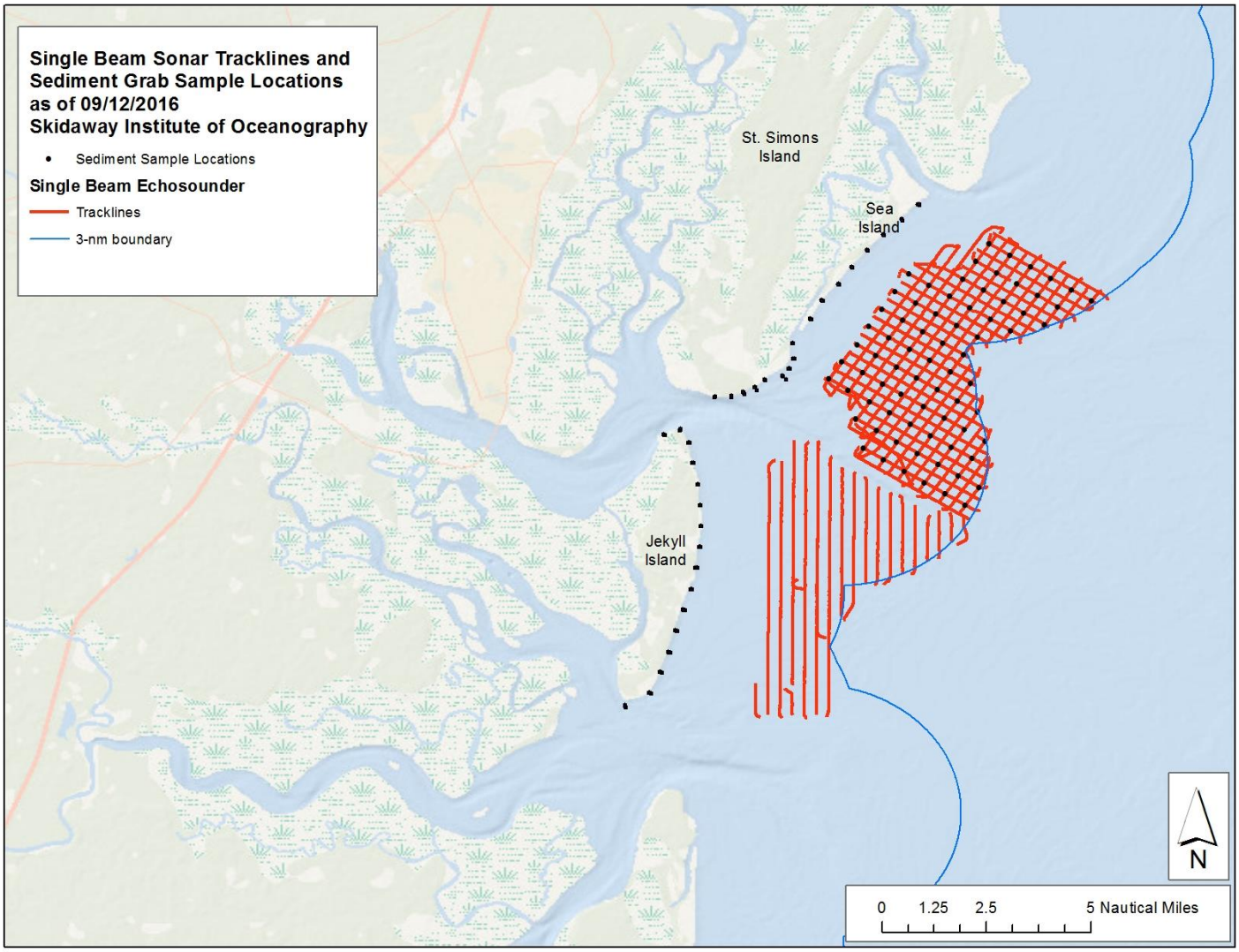

Figure 5: Survey area of Georgia Sea Grant project in front of Jekyll, St. Simon's and Sea Islands. Bottom sediment grabs and beach samples are being collected, and single beam echosounding is being conducted, in summer 2016 and will be conducted in summer 2017 to highlight sediment transport pathways and locate beach compatible sand.

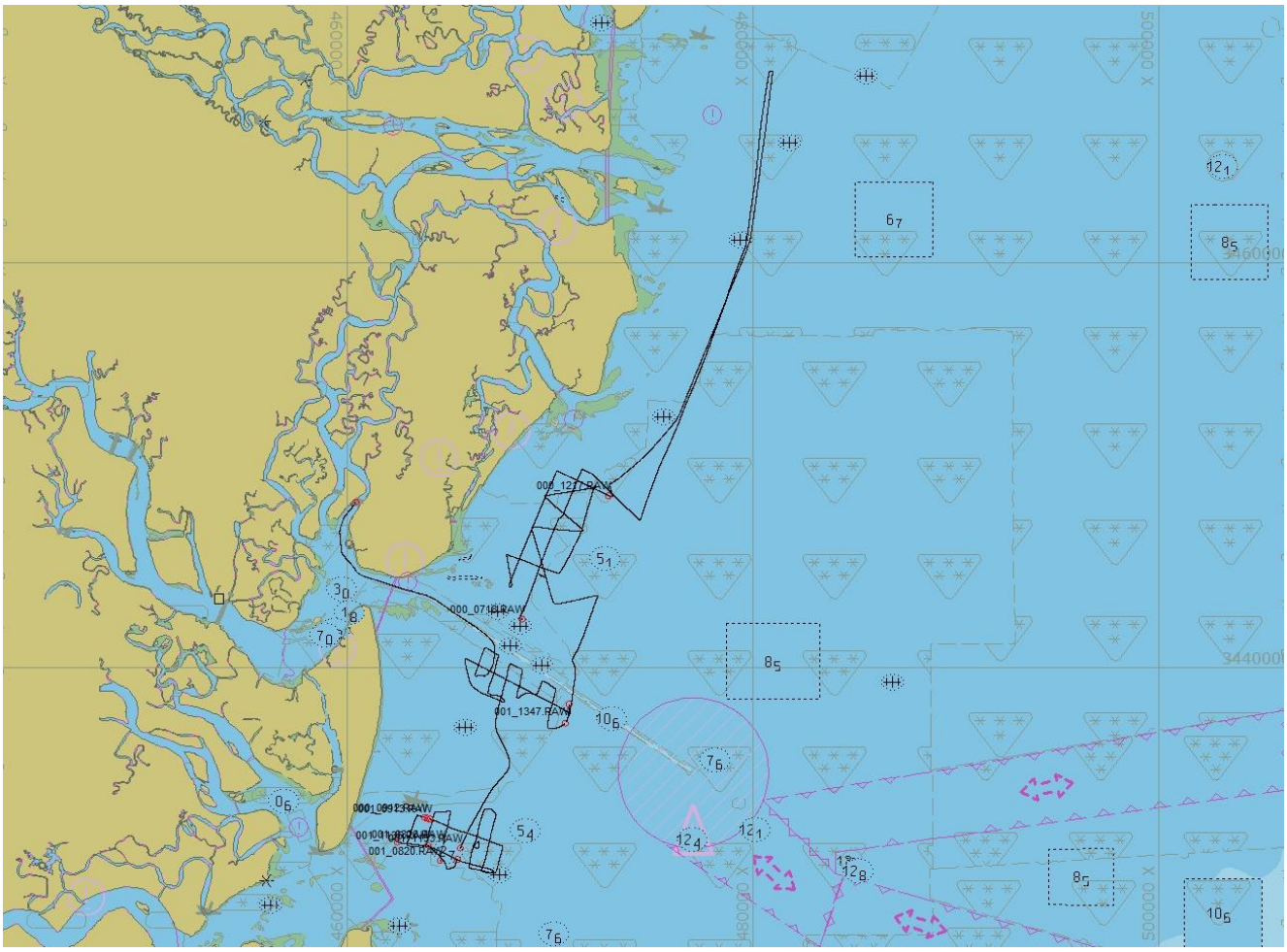

Figure 6: Map showing approximately 50-nm of track lines collected with an Edgetech 512i subbottom system seaward of Jekyll, St. Simons and Sea Islands. These data, when processed, will complement the data collected by CB&I with the same seismic system. Subbottom character inside and seaward of state waters will be combined to highlight subbottom features and explore geologic control on sand resources.