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

Agreement M14AC00008: Maine Geological Survey's "Aggregate Exploration and Habitat Classification: Tools for Building Resiliency in Maine"

Lead Agency: Maine Coastal Zone Management Program

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*Note - The Maine Coastal Program would like to acknowledge the efforts of former Maine Coastal Mapping Initiative Coordinator, Emily Norton. Ms. Norton coordinated the work of this Program for 12 of the 18 months of Cooperative Agreement M14AC00008.

SUMMARY REPORT

Cooperative Agreement Outputs including Project Deliverables:

1. Armstrong, D., 2014. Descriptive report for seafloor mapping of areas off southern Maine. Maine Coastal Program, Augusta, ME. 11 p.

The Maine Coastal Mapping Initiative conducted a multibeam survey using a Kongsberg EM 2040C multibeam in the waters off the coast of southern Maine. Data was acquired from June to October 2014. The survey was conducted as part of a grant from Bureau of Ocean and Energy Management (BOEM), for beach restoration and reconciliation. The bathymetry and backscatter will primarily be used to determine the potential for sandy deposits. The project also coincides with state efforts to update coastal data sets, and bring high resolution bathymetric maps into Maine waters. This grant allowed for the purchase of new multibeam sonar, positioning equipment, and other equipment needed for bathymetric mapping and bottom sampling. In addition to multibeam work the survey also conducted drop camera and bottom sampling to ground truth the data. The project provides new data in the areas covered by NOAA nautical charts 13286 in southern Maine, and 13296 and, 13288 in the Boothbay Harbor/ Linekin Bay region of Maine. These data were not collected or processed for navigational purposes, but are freely provided to NOAA for any use as the agency deems appropriate.

2. Dobbs, K., 2016. 2014 Seafloor sediment analysis and mapping - Southern Maine: Maine Coastal Program, Augusta, ME. 15 p.

One goal of the Maine Coastal Program's cooperative agreement with the Bureau of Ocean Energy Management was to characterize offshore sediment deposits in order to identify potential sand resources that may be used for beach nourishment in the event of an erosional storm. In 2014, the Maine Coastal Mapping Initiative collected 28 sediment samples in the federal portion of the focus area located offshore of Kennebunkport in Southern Maine, though 49 additional samples were collected nearer to shore. Samples were processed to determine the relative concentrations of gravel, sand, and mud (Folk 1954), and the sand fraction was further analyzed to determine the degree of sorting and the distribution of grain sizes within the fraction (Wentworth 1922). Additionally, sediment color (Munsell, 1923) was also determined to further explore the potential compatibility of nourishing existing beaches with sediment dredged from offshore deposits. Although sand was more abundant closer to shore, 16 out of the 28 samples
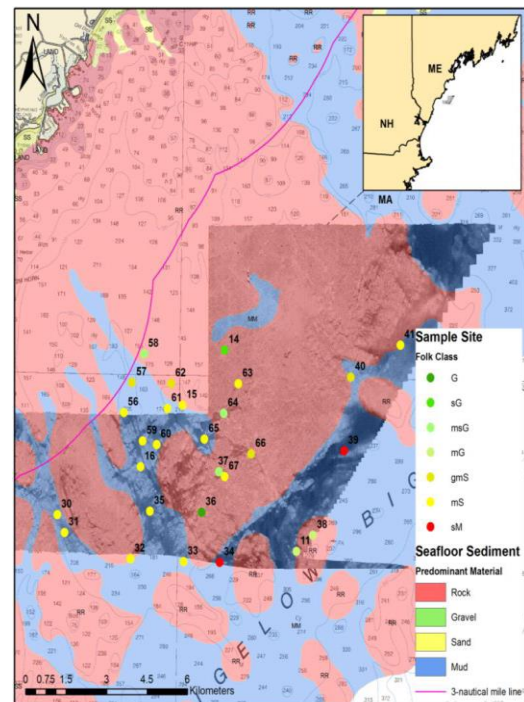

Figure 1. *Generalized seafloor sediment map from Barnhardt et al. (1996) showing interpreted extent of seafloor substrates (Barnhardt et al., 1998) and sample site Folk (1954) classification.*

collected in federal waters contained >50% sand (mean sand composition of all samples = 46.3% ± 22. 4%). Prior to sediment dredging for beach nourishment purposes, more extensive coring and/or sub-bottom profiling would need to be conducted to estimate the volumes of these sediment deposits. In addition, these data are a critical component of benthic habitat classification and modeling performed by MCMI (see Ozmon, 2016). Overall, these data have a variety of applications and are an invaluable resource to public and private agencies who wish to more effectively manage and understand coastal and marine resources.

3. Dobbs, K., 2016. 2015 Seafloor sediment analysis and mapping – Midcoast Maine. Maine Coastal Program, Augusta, ME. 22 p.

The collection and analysis of geophysical and seafloor sediment data allow state and federal agencies to proactively identify the resources available to enhance resiliency, improve management of resources within their jurisdiction, and develop a more comprehensive
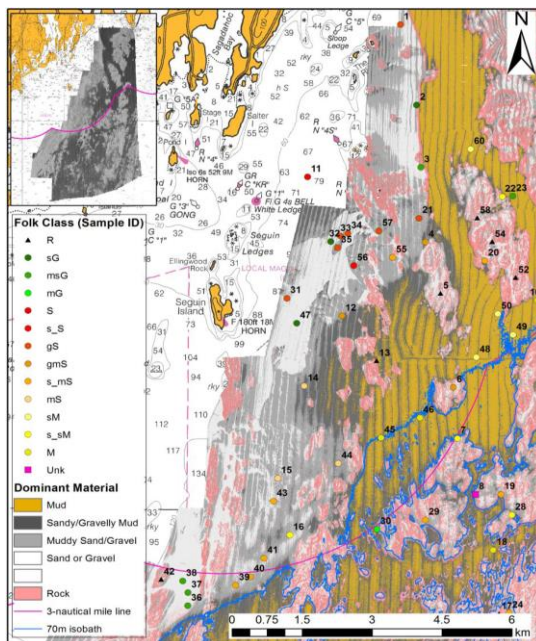

understanding of potential resources. The purpose of this investigation was to describe and characterize marine sediment samples in the focus area to enable benthic habitat classification via the federally-approved Coastal and Marine Ecological Classification Standard (CMECS; FGDC, 2012), help characterize potential sediment resources for beach nourishment as outlined by BOEM, and investigate the relationship between sediment grain size and multibeam backscatter intensity to refine interpretations of seafloor sediment distribution across mapped areas. During the 2015 survey season the Maine Coastal Mapping Initiative mapped approximately 80 mi^2 (207 km^2) of seafloor and collected bottom samples in 61 locations, 43 in state water and 18 in federal waters, in the vicinity of the Kennebec River paleodelta. Grain-size analyses of sediment samples combined with interpretations of backscatter intensity and bathymetric data are consistent with general interpretations of seafloor sediment distribution and morphology in the region (e.g. Barnhardt et al., 1998 and Kelley, et al., 1997).

Figure 2. *Reclassified, unfiltered backscatter intensity map zoomed to central portion of survey area showing laterally extensive coarse-grained sediments concentrated along distal portion of paleodelta at depths <70 m.*

Within the survey area, laterally extensive surficial deposits of predominantly sandy and/or gravelly material were restricted to depths less than 70 m and were most commonly associated with the Kennebec river paleodelta/nearshore ramp. Similarly, backscatter and grab sample data suggest these deposits were even more scarce within federal waters of the survey area.

4. Dobbs, K., 2016. 2015 Descriptive report for seafloor mapping – Midcoast Maine. Maine Coastal Program, Augusta, ME. 45 p.

During the survey season (May-November) of 2015 the Maine Coastal Mapping Initiative (MCMI) conducted hydrographic surveying using a multibeam echosounder (MBES) in the waters off of mid-coast Maine. The survey was conducted in part to support the federal Bureau of Ocean and Energy Management's (BOEM) efforts to enhance coastal resiliency through identification and characterization of potential sand and gravel resources on the outer continental shelf that may be used for beach renourishment and for state efforts to update coastal data sets and increase high resolution bathymetric coverage for Maine waters. A total of approximately 82.5 mi^2 (213.5 km^2), 80 mi^2 (207 km^2) mainscheme and 2.5 mi^2 (6.5 km^2) inshore, of high-resolution multibeam data were collected by MCMI between May and November 2015. During the 2015 survey season the MCMI also collected sediment samples in 61 locations, 43 in state water and 18 in federal waters, in the approximately 80mi^2 (207 km^2) mainscheme survey area. In the coming months, MCMI plans to utilize final data products for high-resolution backscatter and bathymetry to refine existing seafloor sediment maps and determine the spatial extent of sand deposits within federal water. When combined with existing geophysical (e.g. seismic reflection profiles and side-scan sonar) data, these data may also be used to refine interpretations of coastal/nearshore geomorphology and three-dimensional assessments of potential sediment resources/valley fill in the region.
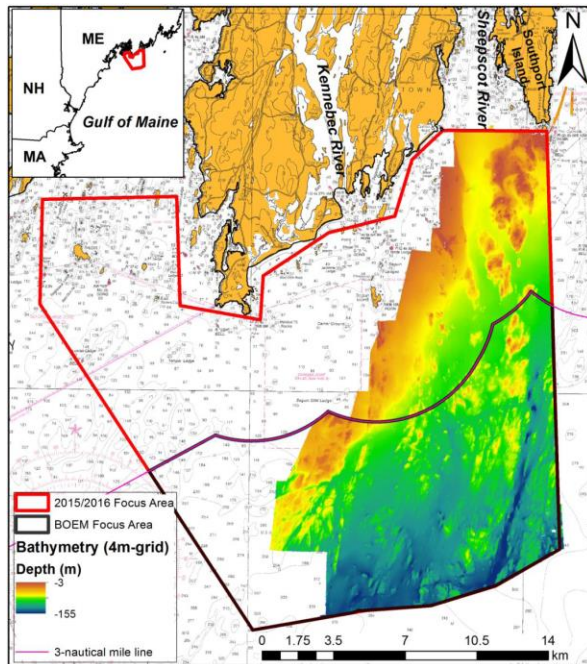

Figure 3. *MCMI collected ~80 mi2 of high resolution bathymetric off of Midcoast Maine in the 2015 mainscheme focus area, which includes portions of NOAA nautical charts 13288, 13293, and 13295.*

Presentations/Posters:

Dobbs, K., Ozmon, I., Norton, E., and M. Nixon. Maine Coastal Mapping Initiative progress update: Applications and utilization of high resolution multibeam echosounder data. Southern Maine Community College, Marine Technology course invitational lecture. South Portland. November 6, 2015. Oral presentation.

Dobbs, K., Ozmon, I., Norton, E., and M. Nixon. Maine Coastal Mapping Initiative progress update: Applications and utilization of high resolution multibeam echosounder data. Maine Geological Survey Annual Meeting. Augusta, ME. November 11, 2015. Oral presentation.

Nixon, M., and E. Norton. Mapping Maine's Seafloor: Maine Coastal Mapping Initiative. Port Safety Forum. Portland, ME. December 16, 2015. Oral presentation.

Norton, E., Dobbs, K., Ozmon, I., and M. Nixon. Under the sea: Exploring submerged geologic features using multibeam sonar. Maine Geological Society Annual Meeting. Augusta, ME. November 11, 2015. Poster presentation.

Norton, E., and M. Nixon. Mapping Maine's seafloor: Maine Coastal Mapping Initiative. The Nature Conservancy Brown Bag Webinar. Brunswick, ME. April 15, 2015. Oral presentation.

Norton, E., and I. Ozmon. Aggregate exploration and habitat classification: Tools for building resiliency in Maine. Geological Society of America Northeastern Section Meeting. Bretton Woods, NH. March 24, 2015. Oral presentation.

Norton, E., and I. Ozmon. Mapping Maine's seafloor: Maine Coastal Mapping Initiative. Bowdoin College 2015 Summer Research Symposium. Brunswick, ME. July 23, 2015. Oral presentation.

Norton, E., Ozmon, I., and M. Nixon. Developing high resolution bathymetric maps for ocean planning in Maine. Tech Night for high school students. Augusta, ME. March 19, 2015. Poster presentation.

Norton, E., Ozmon, I., and M. Nixon. Maine bathymetric update: Maine Coastal Mapping Initiative. Maine GIS Users Group Annual Conference. Portland, ME. February 2, 2015. Oral presentation.

Norton, E., and Ozmon, I., and M. Nixon. Mapping Maine's seafloor: Maine Coastal Mapping Initiative. Coastal Caucus of the Maine Legislature. Augusta, ME. March 12, 2015. Oral presentation.

Note: Ten oral and poster presentations were conducted for diverse audiences over the course of the two year cooperative agreement. In all instances, the aim of the presentation was to update the audience, whether it was composed of legislators, geological professionals, or college or high school students, on the mapping progress made by the Maine Coastal Mapping Initiative as part of the cooperative agreement with BOEM. Methods of bathymetric and backscatter data collection, ground truthing, data processing and analysis were discussed, and applications for the data were highlighted, including increased coastal resiliency through identification of offshore sand deposits, improved navigation, and informed ocean planning.

Available data
Bathymetric data will be available for viewing and downloading via the Northeast Ocean Data Portal and the Maine Coastal Atlas. Backscatter and habitat classification maps, along with all other physical, geological, and biological raw data will be available upon request to Matthew Nixon (matthew.e.nixon@maine.gov) or Emily Norton (emily.norton@maine.gov) at the Maine Coastal Program.

Associated Cooperative Agreement Outputs:

Ozmon, I.M., 2016, Maine Coastal Mapping Initiative benthic infauna analyses and habitat classification in Southern Maine. Maine Coastal Program, Augusta, ME. 45 p.

In 2014 a multibeam sonar survey was completed for a 40 mi^2 area off of Southern Maine to create high resolution bathymetric and backscatter intensity products. Benthic sampling, conducted to ground truth surficial sediment grainsize, also was used to benthic habitat classifications. Twenty one grab samples were collected in the survey area to determine benthic substrate composition and quantify abundance and diversity of the infauna at those sites. Individuals from 66 taxa (54 species and 12 to Family level) were identified in the grab samples dominated by Phylum Mollusca and Class Polychaeta on the basis of either biomass or abundance. Average infauna abundance measured 1531 ± 864 (s.d.) individuals m^{-2} and the mean biomass was 134 ± 194 (s.d.) g wet weight m^{-2}. Diversity (Shannon-Wiener index) ranged from 0.35 to 2.69, and species richness measured 14 ± 5 (mean ± s.d.). Infauna abundance data were combined with water column data (temperature and salinity) and identifications of major geologic features to classify benthic habitat at the grab sampling sites according to the Coastal and Marine Ecological Classification System (CMECS; FGDC 2012). Results were explored using a variety of multivariate statistical methods to determine whether a relationship between environmental variables (sediment grain size distributions, bathymetry and backscatter intensity) and infauna communities existed. Five subtly distinct groups of infauna communities emerged from results of the multi-dimensional scaling ordination and hierarchical cluster analysis based on Bray-Curtis dissimilarities between communities observed at grab sampling sites. However, strong relationships between environmental and biological variables were not found, likely due to limitations of the dataset. Future efforts will be made to gather a higher diversity of grab samples in study areas to improve the capacity to develop a predictive model that could be used to generate comprehensive habitat maps based on multibeam survey data products.