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

Cooperative Agreement: M14AC00011 University of Rhode Island
Identification of Sand/Gravel Resources in Rhode Island Waters While working Toward a Better Understanding of Storm Impacts on Sediment Budgets

Deliverable F:
FINDINGS REPORT

Identification of Submerged Relict Landscapes and Potential Paleocultural Sensitivity on the Outer Continental Shelf in Areas Targeted for Sand and Gravel Borrow Activities: Information Derived from the "Submerged Paleolandscapes Project" (BOEM - URI Cooperative Agreement M12AC00016)

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*** Note:** The project team was deeply saddened by the loss of Co-PI Dr. Jon C. Boothroyd, who passed away unexpectedly before the conclusion of this project. Dr. Bryan Oakley, a former PhD student and close colleague of Boothroyd's, assumed his responsibilities on this project.

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1. INTRODUCTION

The Coastal Mapping Laboratory at the Graduate School of Oceanography, University of Rhode Island (GSO-URI) and its research partner, the Narragansett Indian Tribal Historic Preservation Office (NITHPO), are currently participating in a five year BOEM-funded study entitled "Developing Protocols for Reconstructing Submerged Paleocultural Landscapes and Identifying Ancient Native American Archaeological Sites in Submerged Environments" (Cooperative Agreement M14AC00011) ("The Submerged Paleolandscapes Project"). Multidisciplinary field investigations of four areas located in nearshore and offshore Rhode Island waters are being conducted to develop and test best practice methodologies for evidence-based reconstruction of submerged paleocultural landscapes, in addition to developing, testing and refining modeling approaches for predicting the locations of ancient Native American cultural and archaeological sites submerged by post-glacial sea level rise. Results from this study will assist the Bureau of Ocean Energy Management (BOEM), individual states, and Tribal communities to develop recommended information gathering protocols and survey guidelines for identifying, avoiding or mitigating adverse effects to submerged ancient Native American cultural and archaeological sites which might be at risk from offshore development. Since sand and gravel borrow activities have significant impact on the seafloor and could cause major damage to submerged culturally sensitive sites, the information resulting from the Submerged Paleolandscapes Project is particularly pertinent to targeting locations for sand and gravel resources. However, at the time this report was written, the best practices and predictive model components of the Submerged Paleolandscapes project were still under development, and could not be applied in detail to the sand and gravel resource area targeted by the project team in its Phase I investigation. The information and discussion that follows provides a brief overview of the Submerged Paleolandscapes project, and provides a preliminary assessment regarding the liklihood of paleolandscape preservation in the target area based on an initial examination of subbottom sonar data.

2. SUBMERGED PALEOLANDSCAPES PROJECT BACKGROUND

States within the New England Region are increasingly becoming the focus of proposed offshore wind energy development to supplement or fulfill BOEM's national and state alternative energy objectives. BOEM, within the U.S. Department of the Interior, relies on the best available science to make informed decisions when leasing offshore areas for potential renewable energy development. The absence of a scientifically proven, standardized, "best practices" methodology for identifying submerged relict landscapes on the Atlantic Outer Continental Shelf (OCS), and the ancient Native American archaeological resources these landscapes may potentially contain, is a significant concern among Federal, State and Tribal historic preservation officers. In its 2011 Atlantic Wind Energy Workshop, BOEM identified both the development of geospatial databases of known submerged ancient Native American cultural resources and areas of cultural sensitivity, and standardized methodologies for identifying these resources on the Atlantic OCS as critical data needs.

One of the primary goals of the Submerged Paleolandscapes project is to help address this need by developing a geospatial predictive model that can be used as a tool to identify submerged environments with varying sensitivity for containing ancient Native American archaeological resources. Of primary importance to the project is the collaboration with representatives from the Narragansett Indian Tribe and the Narragansett Indian Tribal Historic Preservation Office, in order to incorporate Tribal oral history knowledge into the archaeological sensitivity assessment process. Since the primary goal of the Submerged Paleolandscapes project is to develop an understanding of the ancestral culture and surviving cultural resources of Native American peoples, open and respectful collaboration with descendent Tribal communities is required to guide and inform the archeological modeling process. The Tribal community's knowledge about the land-use and resource preferences and patterns of their ancestors is invaluable for creating an effective archaeological sensitivity model. Therefore, surveying methods and other data collection protocols are being developed to be respectful of Tribal cultural sensitivities and to encourage Tribal participation in the scientific process.

3. METHODS

The model being developed as part of the Submerged Paleolandscapes project represents a comprehensive information-gathering and data processing protocol for identifying paleolandscapes on the OCS that could have been occupied by ancient Native Americans prior to post-glacial marine inundation. It is a pragmatic approach designed specifically for cultural resource management, and is based on the premise that the amount and type of data that is available (or can be acquired within the scope of project resources), and the preservation potential resulting from primary and post-depositional geologic processes, will dictate the extent to which archaeological sensitivity can be assessed. Consequently, the model consists of five sequential "tiers" designed to:

1. Assess the extent to which the currently submerged environment in the area of interest (AOI) was subaerially exposed during the time period(s) of interest (Tier 1);
2. Reconstruct the paleotopography of the AOI during subaerial exposure, and statistically assess the validity of the reconstruction (Tier 2);
3. Assess the cultural resource preservation potential for the reconstructed paleotopography based on an analysis of the primary depositional and post-depositional geologic processes characteristic of the AOI (Tier 3);
4. Develop archaeological sensitivity maps for the AOI by combining the preservation potential information derived from the Tier 3 analysis with environmental sensitivity variables associated with ancient Native American site habitation (Tier 4); and
5. Test the sensitivity hypotheses with additional field surveys (Tier 5).

Because this model defines the *process* of assessing sensitivity, it provides BOEM with a method that can be applied to other study areas after the conclusion of the project.

The modeling approach being developed as part of the Submerged Paleolandscapes Project results from literature reviews, discussions between project personnel, consultation with outside experts, and ongoing field research conducted as part of the project. Preliminary versions of Tiers 1 and 2 of the model are being finalized, and are currently being tested in the project study area. Tiers 3 through 5 are still under development, since these tiers are dependent on data currently being collected. The goal of the project team is to present BOEM with a flow-chart model detailing the steps required for each Tier of the predictive model, as well as an Arc-GIS compatible data processing module designed to complete the geospatial analyses that are part of each Tier.

4. PRELIMINARY RESULTS & DISCUSSION

Currently, the project team has identified a potential sand and gravel borrow area in federal and state waters off the southwest coast of Rhode Island (Figure 1) which may contain adequate sand resources to meet Rhode Island's beach replenishment needs. Although the best practices and geospatial predictive model being developed as part of the concurrent Submerged Paleolandscapes Project are still under development and not yet available to provide an assessment of the potential cultural sensitivity of the target area, subbottom sonar imagery resulting from the Phase I geophysical survey can provide initial information regarding the presence or absence of relict paleolandscape features in the targeted resource areas.

4.1 Geological processes affecting paleolandscape preservation in submerged areas

The chronology, rate, and magnitude of relative sea level rise following glacial retreat is a function of the relationship between eustatic flooding, sedimentation and isostatic rebound as a result of glacial melting (McMaster 1984). Initially, the rate of sea level rise in the study area was relatively fast. At about 11,500 B.P., sea level was estimated to have reached a point about 165 ft (50 m) lower than today. Just 1,500 years later, sea level had risen more than 65 ft (20 m) to a level about 98 ft (30 m) lower than present. Therefore at about 10,000 years ago, the coastline off of southern Rhode Island was located near the foot of the large deltaic deposits that we have identified as potential sand and gravel borrow areas. The general trend of rapid sea level rise during this period did not follow a smooth curve, but instead fluctuated and was punctuated by episodes of still-stand and negative sea level oscillations during times of climatic cooling and glacial advance (Rampino and Sanders 1980). As glacial ice volumes decreased, the rate of sea level rise gradually slowed.

In general, episodes of marine transgression are frequently periods of erosion, a destructive process that creates less than ideal depositional sequences from an archaeological perspective. Marine transgression can be thought of as proceeding in one of two basic ways: by "shoreface" retreat, when the coastline slowly regresses inland, or by "stepwise" retreat, when in- place drowning of coastal features occurs (Waters 1992). Shoreface retreat describes the erosion of previously deposited sediments by wave and current processes as the shoreline transgresses, and is the dominant inundation regime during the marine transgression process (Waters 1992). As the glaciers melted and sea level rose, shoreface erosional zones sequentially passed across the subaerially exposed portions of the harbor floor. Older sediments that had been deposited in coastal and terrestrial environments inland of the shoreline would have been reworked, first by the swash and backwash processes of the beachface, then by waves and currents. The erosion of the shoreface associated with transgression would have reworked these deposits into a thin unconformable geological unit of transgressive lag (i.e., gravel and coarse sand deposits) forming the top of a time-transgressive geological unit known as a marine unconformity (i.e., the surface defined by the top of the buried paleosol and the base of the overlying marine deposit). Reworking terrestrial and coastal sediments are referred to as palimpsest sediments (Swift et al. 1971), and the erosional surface, marked by the depth of the maximum disturbance by transgression, is called the ravinement surface. This surface often shows up quite clearly in sub-bottom profiler data and can be a useful indicator for the potential presence of relict paleolandforms below it (Waters 1992).. Shoreface retreat is usually the prevailing marine transgressive regime, especially during stillstand episodes, and after about 5,000 years ago, when the regional rate of sea level rise appears to have slowed considerably.

Alternatively, marine transgression may occur by the process of stepwise retreat, which is the sudden inundation or in-place drowning of coastal landforms and sediments. Stepwise retreat most commonly occurs at times and in areas of rapidly rising sea level, where the coast is quickly subsiding and the gradient of the transgressed surface is shallow. In this case, instead of the waves and currents of the shoreface sequentially reworking older sediments during transgression, the shoreline zones jump from the active shoreline to a point farther inland, submerging the older coastal landforms and sediments in an area seaward of the more destructive shoreface zones. The shoreface's wave zones then stabilize and develop a new shoreline farther inland. Instances of in-place drowning during stepwise retreat, preserving forested topographic lows, river and pond margins, marshes and swamps, paleochannels and other relict paleolandscape features, have been documented in a variety of places along the Atlantic coast, including in Rhode Island off of Cedar Tree Beach in Greenwich Bay and in nearshore waters off of the west side of Block Island by the BOEM-URI Submerged Paleolandscapes Project team. Relict paleolandscape features are potential areas of cultural sensitivity, since these areas were subaerially exposed and available for human habitation.

4.2 Potential for paleolandscape preservation in targeted Phase I resource areas

The project team conducted a preliminary examination of all subbottom profile images obtained during the 2015 and 2016 survey seasons, representing approximately 237 line-miles of data. The relatively steep topography characteristic of the deltaic deposits in these profiles strongly favors the shoreface retreat model discussed above, and the associated erosional processes suggest that limited intact paleolandscapes may be preserved. For example, the dipping forset beds shown in Figure 2 are clearly truncated by erosion, and the topset beds appear to have been removed. Examining glacial deltas in central New England, Koteff, et al. (1993) assumed that less than approximately 6.5 ft. (2 m) of the deltaslope beds had been removed based on a detailed examination of borrow pit exposures. In addition, the ravinement surface occurs only sporadically preserved within the study area, and relict paleolandscape features appear limited to a few paleochannels. Figure 3 illustrates a representative west-to-east transect obtained in the central portion of the target area. The ravinement surface is not immediately visible in this profile and may not be preserved, suggesting that extensive reworking of marine sediments is occurring in the study area.

Additional geophysical and geological surveying planned for Phase II of this project will test the project team's initial hypothesis that intact paleolandscape preservation in the Phase I target resource area may be limited. In addition, research from the Submerged Paleolandscapes project will be completed in late 2017, and the resulting geospatial predictive model will be available for use in Phase II of this project.

5. REFERENCES

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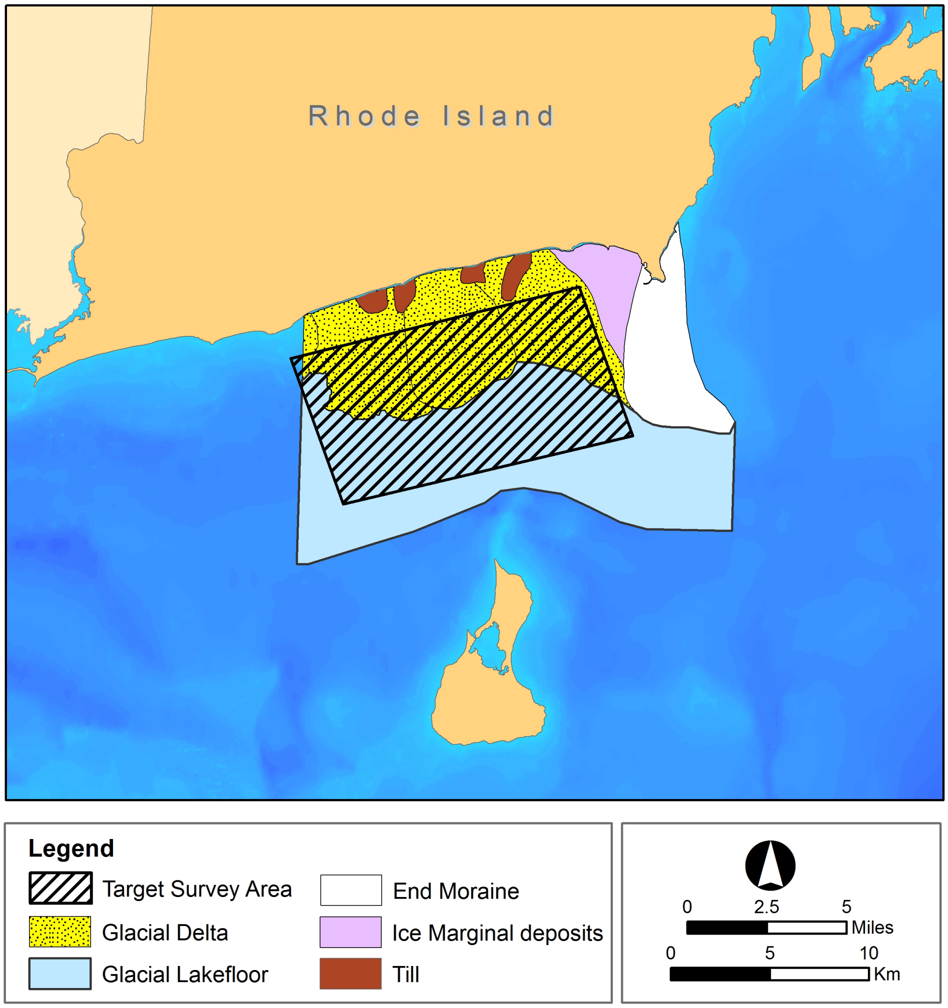

Figure 1. Potential sand and gravel resource area identified as the result of Phase I geophysical and geological surveying. (Geology modified from Oakley, 2012 and Needell and Lewis, 1984).

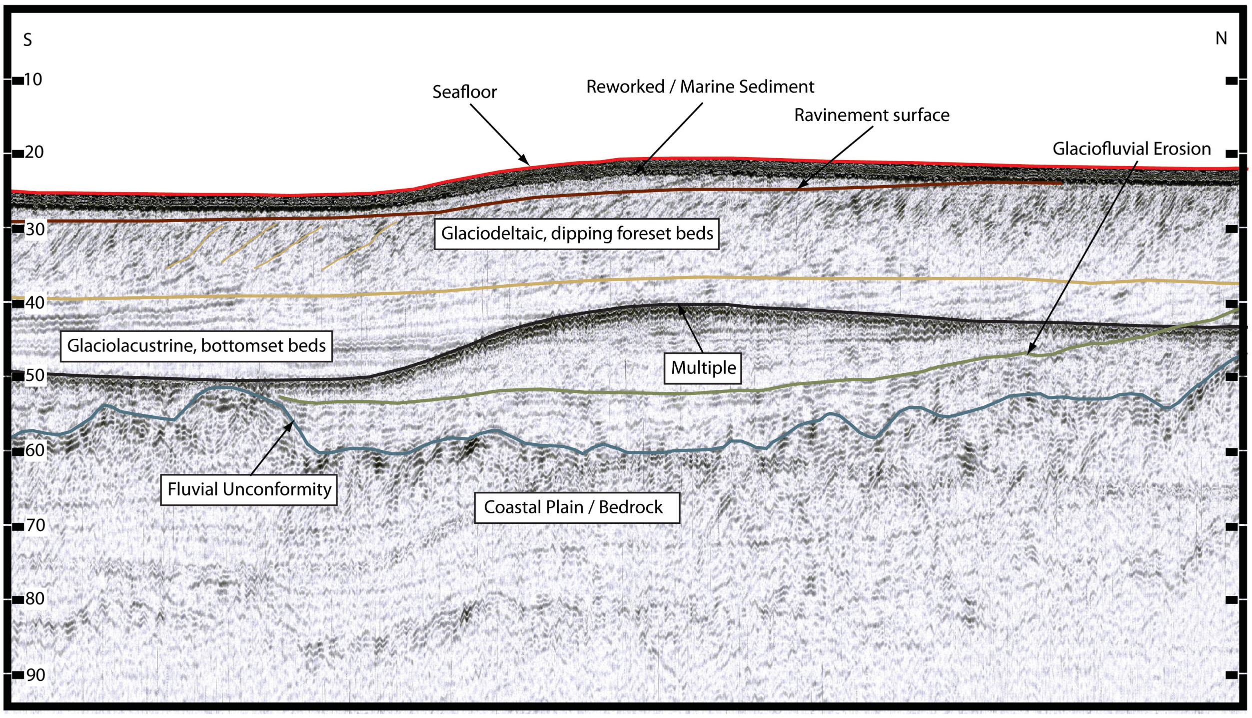

Figure 2: Portion of representative north (left) to south (right) subbottom profile image obtained in the target area. Vertical scale is in meters below sea level. Note the eroded glaciodeltaic forset beds visible in the upper part of the image.

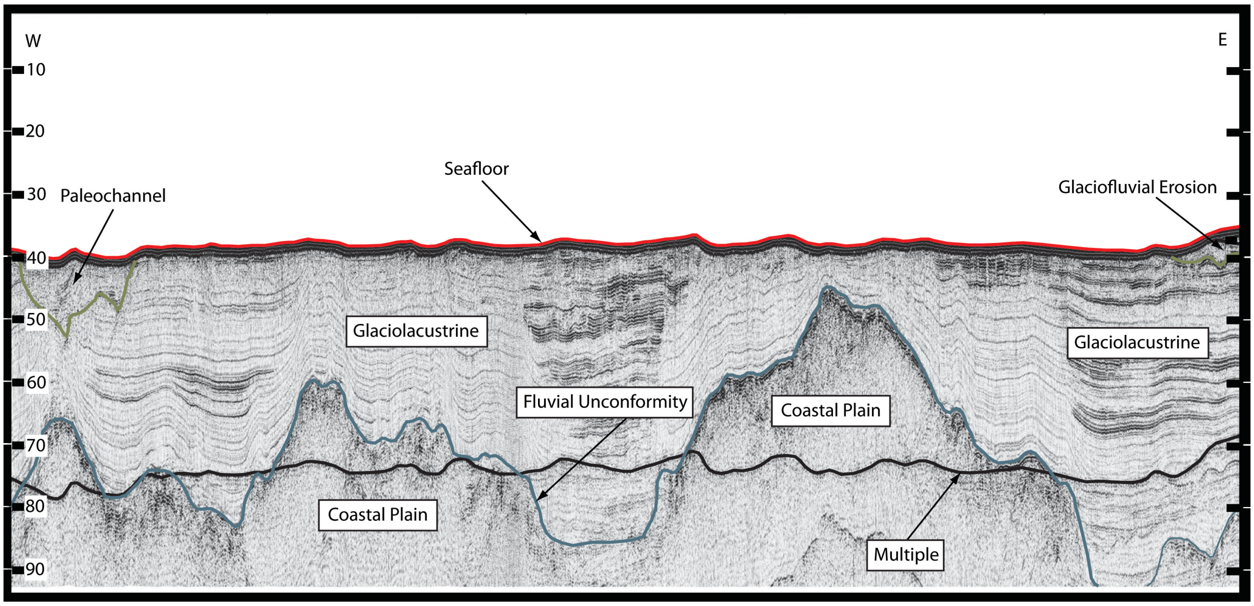

Figure 3: Portion of representative west (left) to east (right) subbottom profile image obtained in the target area. Vertical scale is in meters below sea level. Note the absence of an identifiable ravinement surface.