New Jersey Geological and Water Survey
Open-File Report 21-2

Efficacy Of Using Marine Seismic Data To Map The Potential Use Of Offshore Sheet Sands For Beach Replenishment In New Jersey

New Jersey Department of Environmental Protection

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Cover photo: Beach erosion on Long Beach Island from Winter Storm Jonas, January 2016 . *Photo by M. Spencer.*

New Jersey Geological and Water Survey Reports (ISSN 0741-7357) are published by the New Jersey Geological and Water Survey, P.O. Box 420, Mail Code 29-01, Trenton, NJ 08625-0420.

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by

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2021

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Efficacy Of Using Marine Seismic Data To Map The Potential Use Of Offshore Sheet Sands For Beach Replenishment In New Jersey

Abstract

New Jersey beaches are a source of economic and recreational livelihood for the State. Stronger and more frequent storms are increasing the need for offshore sand resources to renourish the beaches. Sand shoals have been the preferred source of nourishment sand, but as they become depleted, sheet sands may become a new alternative. However, sheet sands come with their own set of problems owing to the large areas they cover and the thinness of the deposits. Previously collected marine seismic and vibracore data from offshore Cape May County was used to map the sheet sands. An estimated 105,000,000 cubic yards of sand were mapped based on the seismic data, however due to the limited amount of vibracores to ground truth the data, this number is likely high. Nevertheless, a large amount of sheet sands offshore New Jersey may be able to supply beaches if the economic and environmental challenges of dredging them are overcome.

Introduction

New Jersey Geological and Water Survey (NJGWS) geologists study the ocean bottom sediments off the coast of New Jersey to locate potential sources of suitable beach nourishment sand using both geophysical and direct sampling methods to collect information (Uptegrove and others, 1995). Geophysical methods include marine seismic and sidescan and bathymetric sonar. Direct sampling of the seafloor sediments is accomplished with vibracoring. This information is then provided to the United States Army Corp of Engineers (USACE) and other stakeholders to make the ultimate determination of the useability, quality, and quantity of the replenishment source.

In the past, NJGWS has typically looked for sand shoals (or lumps) for beach replenishment due to the compact size, high quantity of sand, and other environmental regulations. However, in recent years these shoals have become depleted or determined to be essential fish habitats, essentially barring them from future use as a replenishment source. Other suitable sources include dredge material from inlets and sand backpassing and bypassing, but these also come with their own set of challenges due to federal and state environmental regulations. A potential source of sand that has not been used or studied in New Jersey are sheet sands. These are large swaths of the ocean floor that are predominantly sand but are only a few meters thick or less. These have not been used because moving a dredge over such a large area is cost prohibitive. However, with increasing frequency and strength of storms, sea level rise, and a diminishing supply of useable sand, sheet sands may become a viable alternative in the future. NJGWS instituted this pilot study to determine the feasibility of mapping these sheet sands using geophysical methods and vibracoring. Existing marine seismic data collected during 2003 and 2005 from an area offshore Cape May County was chosen for this project because of the high-quality of the data and the close survey spacing that was used (Uptegrove and others, in review) (fig. 1).

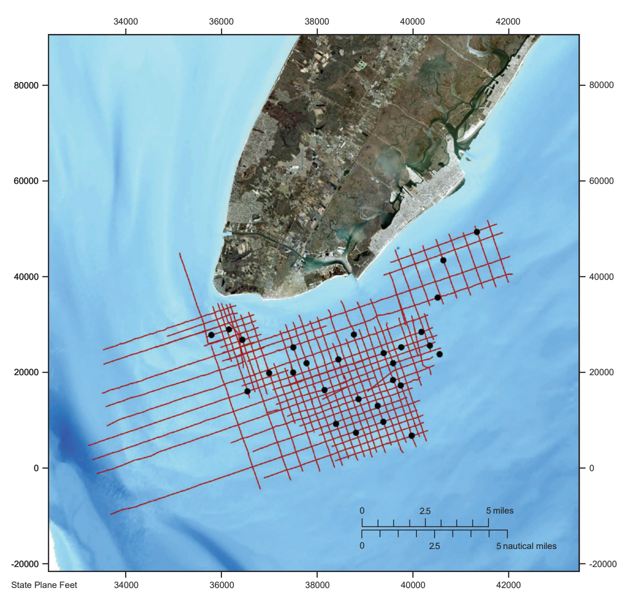

Figure 1. Seismic data (red lines) and vibracores (black dots) previously collected by the New Jersey Geological and Water Survey in 2003 and 2005. Data was chosen due to the closer than normal spacing and high quality.

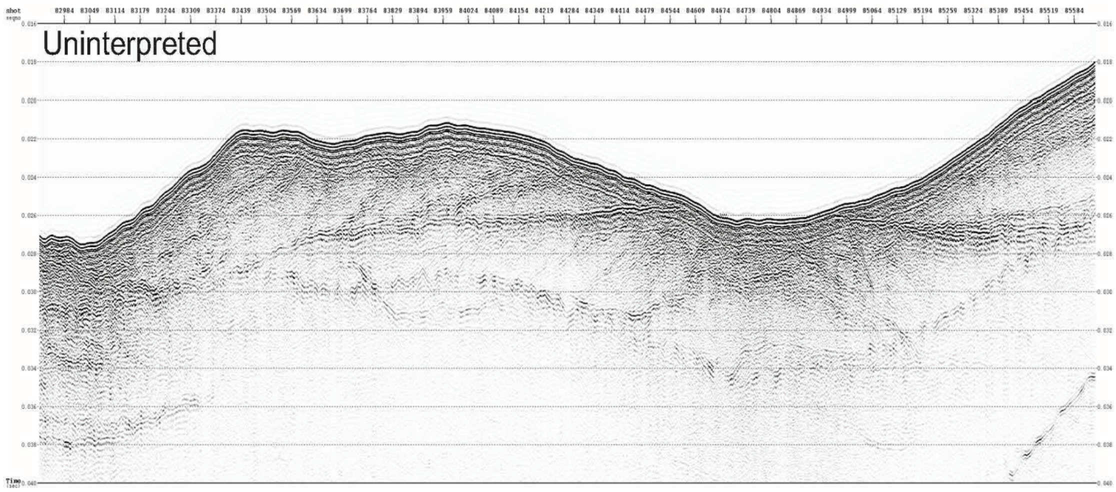

Figure 2. Digital seismic profile showing the seafloor and the stratigraphy of the underlying sediment layers.

Methods

Seismic profiling uses a pulse of sound that is transmitted through the seawater and into the bottom sediments. This sound wave reflects off the sediment layers and is recorded when it returns to the surface. A seismic cross section of the sub-bottom layers is typically about 50 m thick and shown in Figure 2. NJGWS geologists use the seismic data to determine the shape and location of offshore sand deposits. A Subsea Technologies boomer system was used to collect high-resolution seismic to a depth of approximately 250 feet. An array of 8 hydrophones, connected in series-parallel, detect the reflected acoustic signals.

Vibracores are used to determine the composition of the sediment layers and to ground truth the seismic data. Vibracore equipment is lowered from an anchored vessel, and a plastic core barrel is vibrated 20 feet into the seafloor sediments (fig. 3). The extracted core preserves the sediment layers for study in the laboratory.

Figure 3. Vibracore rig onboard vessel. The A-frame and core barrel are lowered to rest on the seafloor. The motor on the top of the A-frame is then vibrated pushing the core barrel and into the sediments to retrieve a relatively undisturbed sediment sample. *Photo by J. Uptegrove*

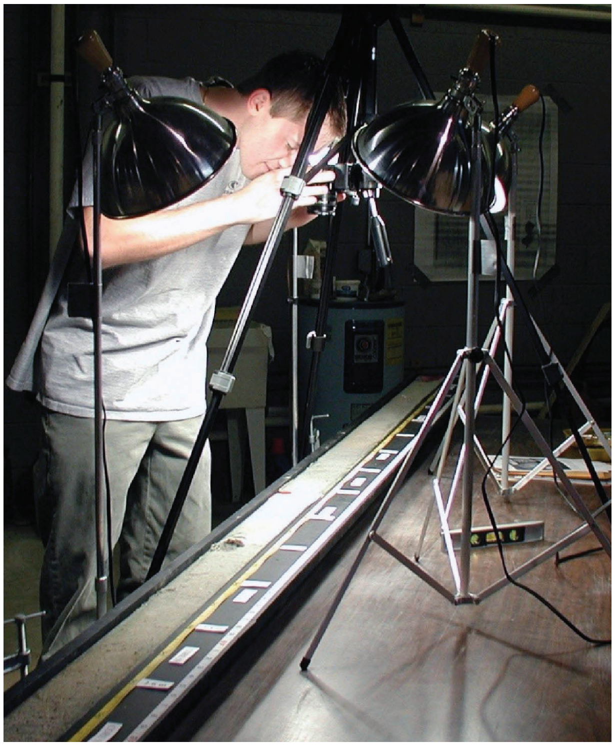

Figure 4. Laboratory work on the vibracoe samples includes photographing, sampling of the sediments, and grain size analyses. *Photo by J. Uptegrove*

Vibracores are sampled, photographed, and grain size analysis is done (Figure 4). By correlating the vibracore information with the seismic data, NJGWS can develop an understanding of the offshore sand deposits. During this process NJGWS also determine if the grain size of the sample deposit and the beach to be nourished is a suitable match. When available, vibracore data were used to ground truth the seismic interpretation. Since vibracore data collected by NJGWS are typically located on the edge of sand shoals, vibracore data of the possible sheet sands were sparse.

SonarWiz™7 software was used to analyze the seismic and vibracore data. Sand reflectors were traced where the base of the sand reflector is evident in the seismic profile (fig. 5). When available, vibracore data was analyzed and plotted onto the seismic profiles to ground truth the reflector that delineates the base of sand. The thickness of the sheet sand in each seismic line was calculated in SonarWiz™7 by converting the two-way travel time from the seafloor to the base of the sand assuming an acoustic velocity of 1750 meters per second. The result is exported as an XYZ text file and then imported into Surfer™16 software to create sand thickness isopach maps and calculate sand volumes.

Base of Sand (feet)	Cubic Feet (ft^3)	Cubic Yards (yds^3)
0	2,842,769,651	105,324,801
3	1,511,617,270	55,985,824

Table 1. Calculated volumes of sand in both cubic feet and cubic yards of the entire bolume of sand and leaving 3 feet of sand behind.

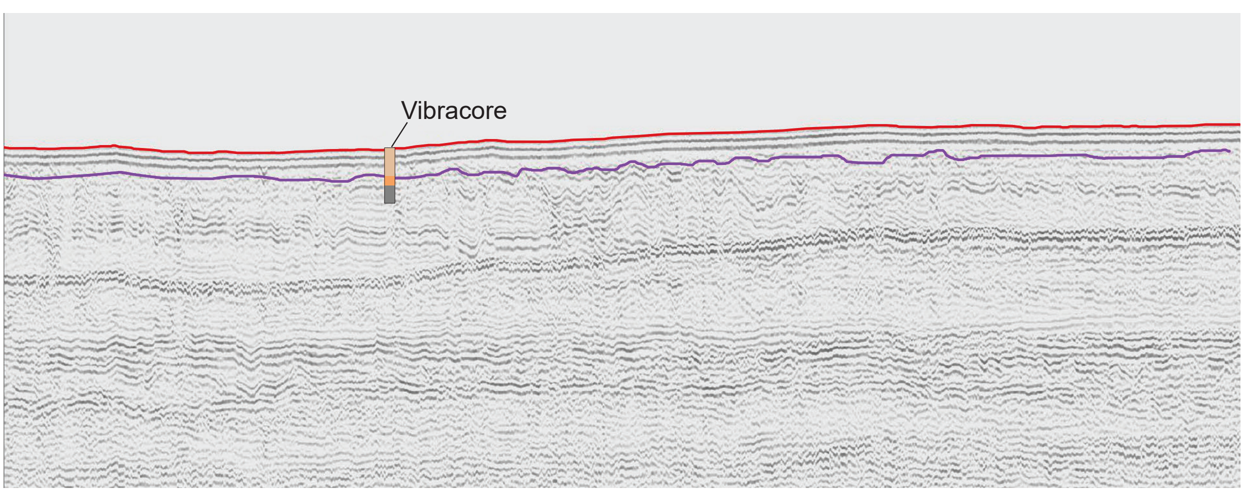

Figure 5. Seismic profile showing the traced seafloor (red), a vibracore with sand (tan) in the top layer, and the tracing of the base of the sheet sand layer (purple).

Results and Discussion

Calculated sand volumes are shown in Table 1. Two volumes were calculated, one that included all sand down to the base of sand reflector, and one volume that left 3 feet of sand remaining above the base of the sand reflector. It is likely that dredging would not take place down to the base of sand due to the dredge becoming clogged, environmental regulations, desire to leave the seafloor in a similar state, or other unforeseen reasons. Even so, NJGWS typically has provided volumes for the likely amount of useable sand, and the volume of all the sand so that USACE can make their own final determination of the efficacy of the sand source. Existing sand shoals that were previously mapped by NJGWS or used by USACE were excluded from the volume calculations because

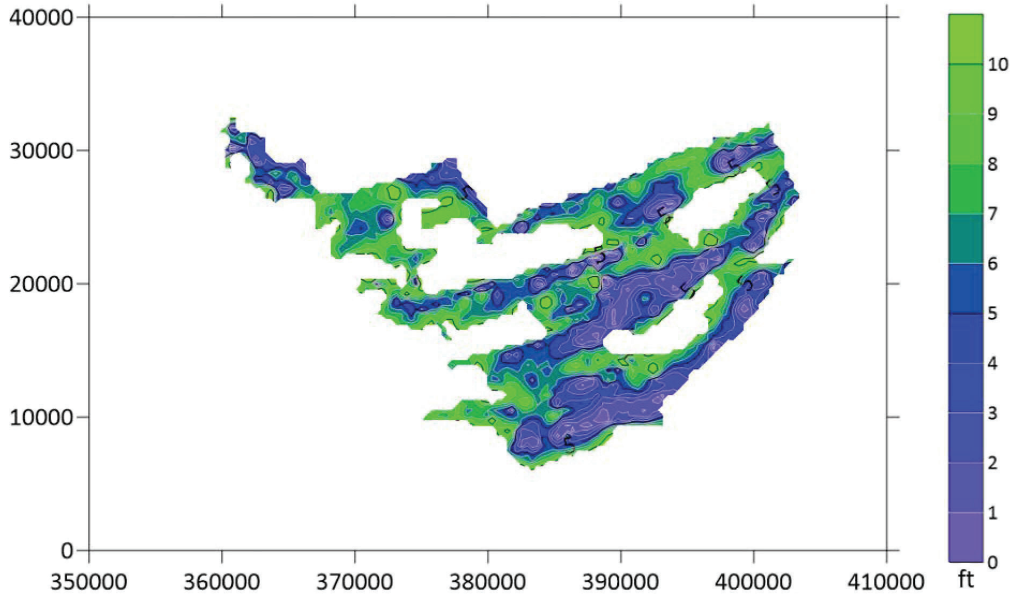

Figure 6. Isopach map of the Cape May sheet sand area showing all sand to the base of the sand shoal.

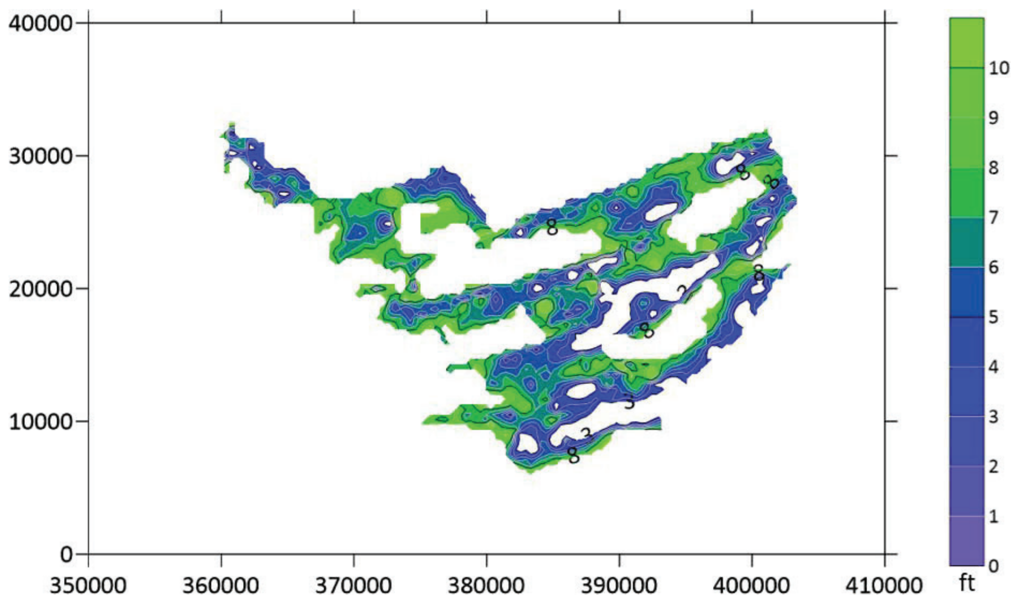

Figure 7. Isopach map of the Cape May sheet sand area showing where the sheet sands are greater than 3 feet thick.

they are a known entity and are likely deemed an essential fish habitat. The isopach maps created in Surfer™ 16 are shown in Figure 6 and Figure 7.

All seismic data was interpreted from the 28 vibracores, the proximity to sand shoals, and previous knowledge of the geology (Uptegrove and others, in review). Due to the lack of vibracore data, it was often difficult to distinguish sand from fine grained sand, cobbles, gravel, clay, or mud in the seismic profile. Best efforts were made to maintain continuity and geologic sense of the interpretations, but at this time there will be areas mapped as sand that are too fine grained or may contain cobbles or gravel, making them unsuitable. There will also be areas mapped as sand that may be clay or mud, making them unusable. Based on this lack of vibracore data, it is likely the actual volumes of useable sand here are between ½ and ⅔ less than the calculated volume.

Figure 8 illustrates the extent of the mapped sheet sand off the coast, illustrating the main problem with sheet sands, namely the large area the dredge must cover.

Future Work and Issues

Future work should consist of collecting strategically located vibracores based on the seismic profiles and possibly grab samples to ground truth and confirm the seismic interpretations. Sidescan sonar would also be beneficial and cost effective as it is relatively rapid method of data collection and can be used to distinguish sediment types. Besides the need for additional geophysical and direct data collection, USACE would need to determine the feasibility of dredging the material for their purposes. Determinations will have to be made about how

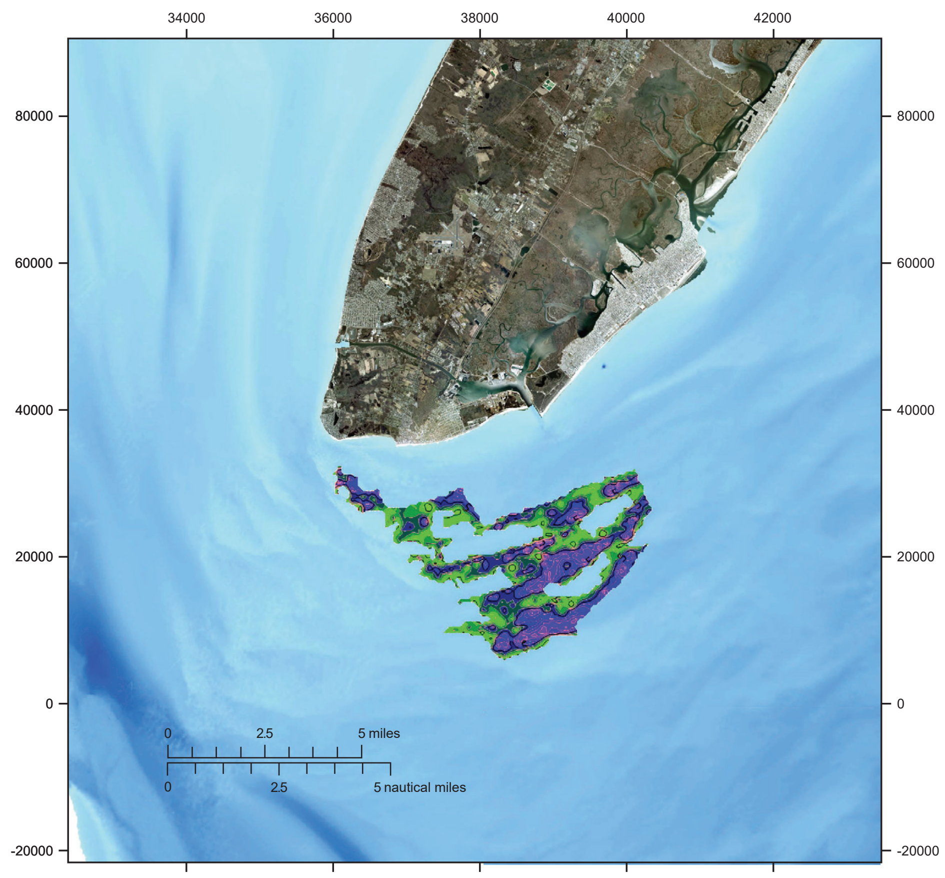

Figure 8. Illustrates the extent of the mapped sheet sand off the coast, illustrating the main problem with sheet sands, namely the large area the dredge must cover.

large an area to dredge, how much sand (if any) to leave behind, and the cost effectiveness of mining sheet sands. Environmental impact studies will need to be performed by USACE. Finally, just as with any dredging and beach nourishment project, outreach and coordination with commercial and recreational fisherman and other stakeholders will likely be an integral part in the potential use of this resource.

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