

Background

In 2015, the Massachusetts Executive Office of Energy and Environmental Affairs set aside four offshore areas to be leased for offshore wind development¹. The four lease areas are approximately 12 nautical miles south of Martha's Vineyard and 13 nautical miles southwest of Nantucket Islands. So far, two areas have been leased to companies for future development². Offshore wind turbines have many demanding structural requirements, among them the need for deep foundations. Thus, drilling into the subsurface will be necessary for both characterization of the construction area as well as actual installation of the turbine foundations. Sediments with large boulders or cobbles, commonly found in the glacial till of New England, present a serious problem for subsurface drilling. Thus, it is important to determine whether the ocean sediments found in the lease areas contain gravelly soils.

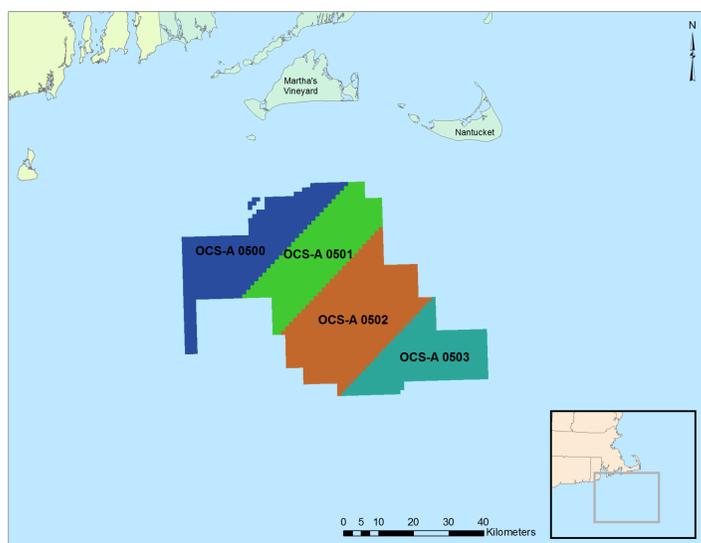
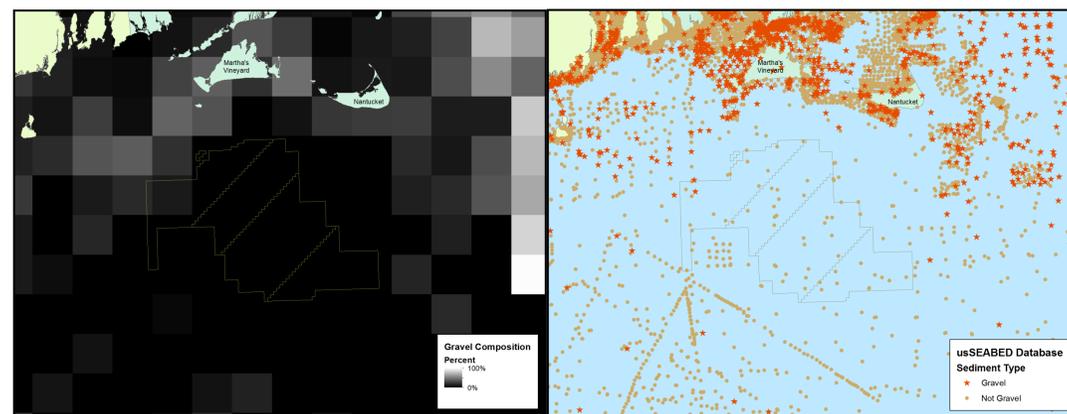


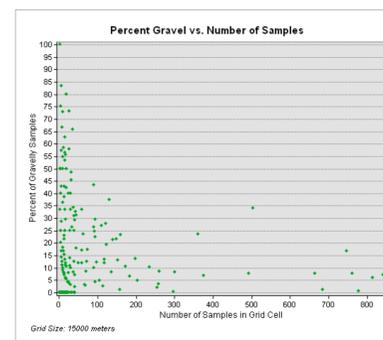
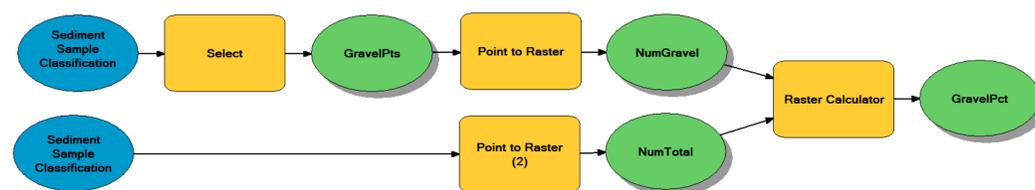
Figure 1: Wind lease areas

Because geological exploration is expensive, it is always preferable to use existing data where possible. This project's aim was to determine what information on sediments has already been collected in and around the wind lease areas, as well as to perform some preliminary analyses on the data to determine its usefulness.

Data Source	Type of Data
US Geological Survey	General geological data. Also includes data from many oceanographic cruises conducted by USGS.
Woods Hole Oceanographic Institute	Data from oceanographic investigations of the WHOI cruises, submersible robots, and buoys.
National Oceanic and Atmospheric Administration	Data related to oceans. Bathymetry, coastal relief models, ocean floor features, and oceanographic cruises conducted by NOAA.
MassGIS	General data such as state outlines.
MassGIS Massachusetts Ocean Resource Information System	Spatial data specifically pertaining to the Massachusetts coastal zone. Examples include bathymetry, tidal gauge stations, and marine protected areas.
Bureau of Ocean Energy Management	Data relating to ocean energy. Examples include wind lease areas, vessel traffic density, and avian migration data.



(above left) Gravel Percent raster, showing the percentage of sediment samples found to have gravel in each cell of a 15km x 15km grid. (above right) usSEABED data used to generate the Gravel Percent raster. The wind lease areas have low sampling density in comparison to areas closer to shore.



(above) The model builder method for calculating the Gravel Percent raster.

(left) To investigate whether the percentage of gravelly samples was affected by sampling bias, I used the Create Graph feature in the attribute table options to plot Percent Gravel against the number of samples in the grid. In this graph, there are two important trends:

1. The occurrence of zero percent gravel is almost completely restricted to sample sizes of <50.
2. The percent of gravel increases as the number of samples decreases.

Methods

Data Collection

Data were collected from online sources such as the National Oceanographic and Atmospheric Administration (NOAA), Massachusetts Institute of Technology's Woods Hole Institute (WHOI), United States Geological Survey (USGS), and MassGIS (see table to the left). After being downloaded, data were organized further prior to being stored in a compressed (zipped) file for the final project deliverable.

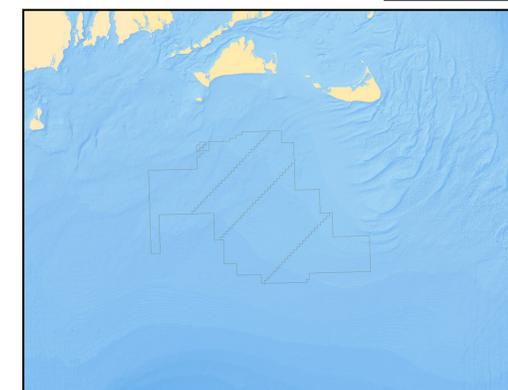
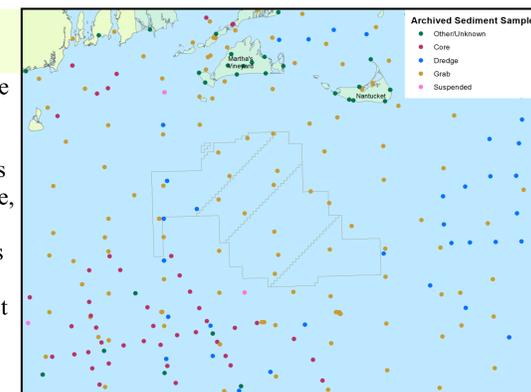
Data Analysis

Data analysis consisted of three steps:

1. Determining the percentage of sediment samples that are classified as gravel in each square of a grid over the study area
2. Adding hyperlinks to the map to facilitate viewing of ocean floor photos
3. Exploring correlations in the data to identify possible models of sediment gravel content

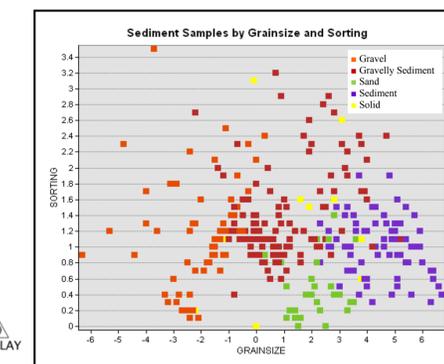
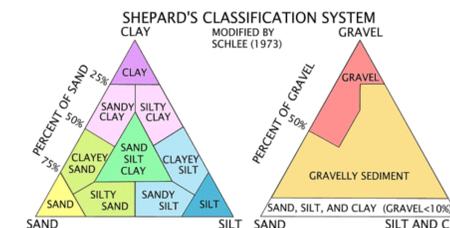
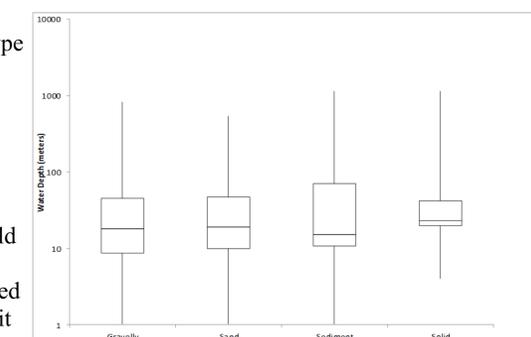
Results

The graphic to the right displays the location of physical sediment samples archived in the sample storage facility of the USGS Woods Hole Science Center in Woods Hole, MA. These samples are available for examination with no constraints and may be available for sub-sampling pending a written contract with the Woods Hole Science Center.



Bathymetry data were also obtained for the study area (left) from NOAA's coastal relief model. Based on a hypothesis that different types of sediment might be associated with different depths, the distribution of depths for each sediment type was plotted in a box-and-whisker plot (below). There were no strong differences noted in the distribution of depths for each sediment type.

A similar attempt was made to find an association between sediment type and grainsize/sorting parameters, since more samples in the database may have grainsize/sorting data as opposed to a sediment type classification. Because soil type classification is theoretically based on grain size (below left), one would expect to find a strong relationship between the two and one was indeed observed (below right). However, it is important to note that there is some overlap between different sediment types, making grainsize/sorting an imperfect indicator of sediment type (especially for consolidated material).



References

1. Executive Office of Energy and Environmental Affairs. (2016, October 18). 2015 Massachusetts Ocean Management Plan. Retrieved from The Official Website of the Executive Office of Energy and Environmental Affairs: <http://www.mass.gov/eea/docs/eea/oceans/ocean-plan/2015-ocean-plan-v2-complete-low-res.pdf>
2. Bureau of Ocean Energy Management. (2016, October 18). Commercial Wind Leasing Offshore Massachusetts. Retrieved from Bureau of Ocean Energy Management: <http://www.boem.gov/Commercial-Wind-Leasing-Offshore-Massachusetts/>

Acknowledgments

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