Mapping the Sea Floor of the Stellwagen Bank National Marine Sanctuary, Massachusetts Bay using GIS

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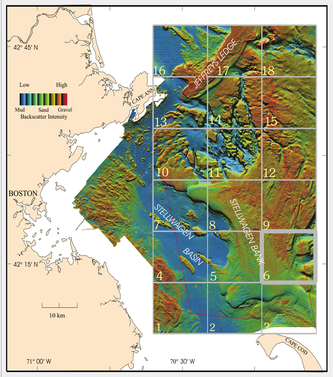
Introduction



Location map - Shows the area mapped and individual quadrangles of the SBNMS mapping project (quadrangles outlined in gray boxes). The imagery is a composite map of both the sun-illuminated and backscatter images (shown to the right). Red indicates high-backscatter material including coarse sand, gravel, and rock; green indicates sand; blue indicates mud. SBNMS boundary shown as red line.

Background

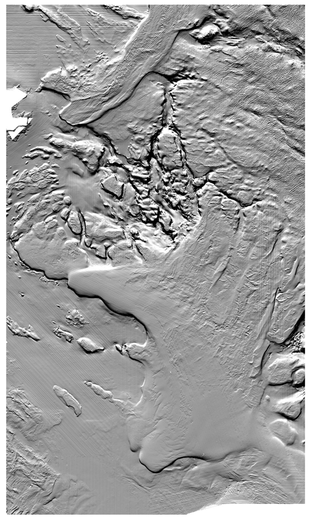
The Stellwagen Bank National Marine Sanctuary (SBNMS), administered by NOAA, is located about 50 km east of Boston, MA; it supports both commercial and recreational fisheries and provides a critical habitat for marine mammals, including the endangered Northern Right Whale. Recently the SBNMS region has suffered a significant decline in commercial fish species, possibly because of over-fishing and surficial disturbance of seafloor habitats by trawling and dredging. Accurate seafloor characterization is needed to understand the effects of natural (i.e., storm) and human influences on the sediments, habitat, and biota within the SBNMS.

The SBNMS Mapping Project

The U.S. Geological Survey(USGS), Woods Hole Field Center began mapping the SBNMS region in cooperation with NOAA in 1994. The mapping survey was conducted over a period of two years using a Simrad EM-1000 multibeam echo-sounder installed aboard the Canadian Hydrographic Service research vessel *Frederick G. Creed*. The survey provided the first detailed topographic and acoustic backscatter images of the region(shown to the right). Using this imagery along with sample, video, and photo observations in GIS, the USGS has been able to develop a method for effectively mapping and characterizing the different sea floor environments in the SBNMS.

Multibeam Sonar Imagery

Sun-Illuminated Topography



Resolution: 10m/pixel
Sun-illuminated from the north 350 degrees

Acoustic Backscatter Imagery

Resolution:
5m/pixel

Methods

Data Acquisition

- Conducted a multibeam sea-floor mapping survey of the SBNMS region, providing the first highly detailed topographic and acoustic backscatter images of the area.
- Ground truthing of the image data was done with the use of a Sea Bed Observation and Sampling System (SEABOSS) designed by the U.S. Geological Survey. The SEABOSS contains two video cameras, a still camera, a pressure-depth sensor, and a modified Van Veen sediment grab sampler. This allows for rapid and effective collection of seabed images and sediment samples.

Data Processing

- The depth information from the topographic imagery was brought into Arc/Info, where it was gridded and contoured. The gridding was done at a 13 meters/pixel cell size resolution, and the contours were generated at 5 meter intervals.
- The sample, video, and photo information collected by the SEABOSS were transferred into a GIS database along with the multibeam imagery. The database now contains 8 thematic layers, including: sun-illuminated imagery, acoustic backscatter imagery, sea-floor feature polygons, 1-and 5-meter contours, videography tracklines, still photos, sediment sample information, and sediment classification polygons. Each of these layers was utilized within the GIS to provide a comprehensive analysis of the SBNMS region.
- Detailed digital maps are being compiled from this database, using GIS to overlay and analyze the different themes. Map layouts are created in Arc/Info and transferred into a drawing program for printed output. The published maps and digital database are now being distributed on web pages or CD-ROMs for use by scientists, managers, and the general public.
- In addition to these published products, three dimensional perspective views and fly-overs are being created from the multibeam imagery. These types of output provide additional visualization capabilities for the region.
- The digital database is now easily updateable and can be used along with navigation software to aid in additional data collection while at sea.

GIS Database Layers

Photographs in Digital Format

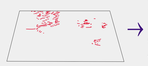
Still photos taken with the SEABOSS each have information on location, date taken, time, and description.

Sediment Sample Locations

Sediment samples were analyzed for grain size and brought into GIS. The database now contains over 50 fields of information for the sediment data, including percent sand, silt or clay, class, and mean grain size.

Videography Track Lines

Video track lines generated from the SEABOSS were used for a qualitative description of the sedimentary environments.



Feature Polygons

Feature polygons were depicted from the sun-illuminated imagery and digitzed using Arcview Spatial Analyst.

1-and 5-Meter Topographic Contours

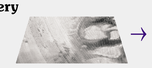
Bathymetric information obtained from the topographic imagery was gridded and contoured in Arc/Info at both 1- and 5-meter intervals.

Sediment Texture Polygons

Sediment texture polygons were interpreted based on each of the data layers. Boundaries were determined using video tracks, still photos, sediment samples, and multibeam imagery. ArcView spatial analyst was used in digitizing the polygons.

Multibeam Topographic Imagery

Bathymetry obtained from the multibeam survey was used to create sun-illuminated imagery and generate contours.

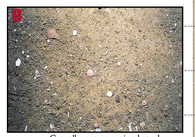


Multibeam Acoustic Backscatter Imagery

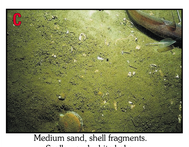
Backscatter imagery is used to help in determining the sediment texture distribution.

Interpretive Map of Quadrangle 6 with bottom photos

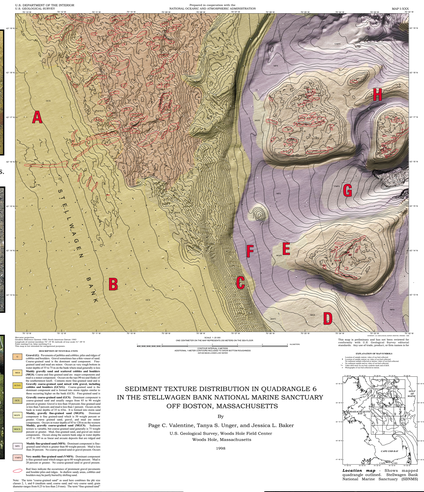
Gravelly, coarse-grained sand.
Storm ripple with pebble gravel in ripple troughs.



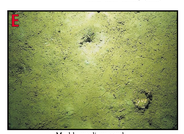
Gravelly, coarse-grained sand.



Medium sand, shell fragments.
Scallop and white hake.

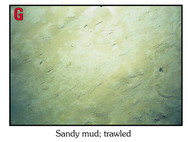


Gravelly, muddy sand over gravel.

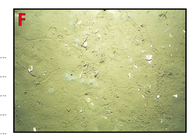


Muddy medium sand.
Small burrows of worms or crustaceans.

Muddy, gravelly coarse sand on gravel.



Sandy mud; trawled

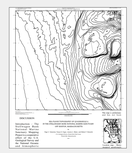


Fine sand; shell fragments; small worm burrows.

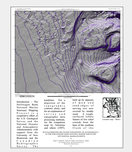
End Products

Published Maps

Sea Floor Topographic Maps



Sun-Illuminated Sea Floor Topographic Maps

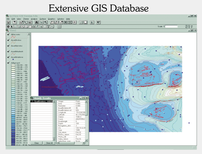


Sediment Texture Distribution Maps

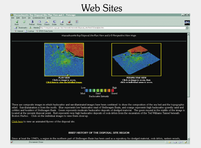
Digital Products

CD-ROMS

Extensive GIS Database

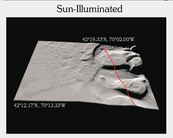


Web Sites



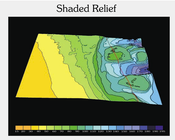
3-D Perspective Views

Sun-Illuminated



SBNMS boundary shown as red line.

Shaded Relief



SBNMS boundary shown as red line.
Bathymetry in meters.