

**SEAFLOOR MAPPING SCIENCE AND HABITAT CLASSIFICATION
TO FACILITATE INTEGRATED MULTI-USE OCEAN
MANAGEMENT IN MASSACHUSETTS**

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Overview

Seafloor mapping provides unparalleled views of the underwater landscape which helps scientists understand the ocean environment, helps regulators manage coastal and ocean resources, and inspires a greater appreciation of the diversity of marine habitat and life. The Massachusetts Office of Coastal Zone Management (CZM) and United States Geological Survey (USGS) Woods Hole Science Center initiated the Massachusetts Seafloor Mapping Cooperative in 2003 to address the need for acquiring datasets on the spatial distribution of benthic resources to help resource management. The goal of the cooperative is to comprehensively map the bathymetry and surficial geology of the seafloor in Massachusetts.

History

In 2001, CZM organized a workshop, in cooperation with the Gulf of Maine Council on the Marine Environment, to develop a strategy for regional seafloor mapping. This workshop was followed by CZM developing a successful proposal to the National Oceanic and Atmospheric Administration's Coastal Service Center (NOAA's CSC) for a fellow to draft a strategy to map benthic habitats for all state waters. These regional and state-specific efforts set the foundation for implementing a statewide mapping program.

Funding obtained through a monetary mitigation settlement with a natural gas company in 2003 was used to initiate the Massachusetts seafloor mapping program. The settlement – \$1.5 million – was used to create the Massachusetts Seafloor Mapping Trust within the Office of Coastal Zone Management. CZM, with the background information of regional activities and a statewide strategy, approached the USGS Woods Hole Science Center to enter into a partnership to initiate mapping state waters. USGS mapped the seafloor of Stellwagen Bank and Massachusetts Bay (1994-1998), including a portion of but mostly adjacent to state waters (Butman et al. 2004). The Stellwagen Bank-Massachusetts Bay mapping demonstrated the application of mapping technologies and the value of these data to understand the seafloor environment and guide resource management. The Massachusetts CZM-USGS Seafloor Mapping Cooperative was formally established in 2003, and mapping began in 2004.

The Massachusetts Ocean Management Initiative (OMI) was launched in 2004 to evaluate trends in resources, identify data and information gaps, review existing governance, and recommend required changes to improve ocean management (Tierney 2004). Among the findings of the OMI was a recommendation for statewide mapping of the seafloor environment. In support of the OMI, Massachusetts provided \$1 million in capital assets in 2006 to support and advance the seafloor mapping cooperative.

Additional mitigation money (\$3 million) was received in 2007 from another natural gas company for compensation to impacts associated with the construction and operation of a deepwater port. The recently received money is allowing expansion of the mapping cooperative to new areas.

Critical to the cooperative is the federal-state cost share. Seafloor mapping is an expensive venture, and a nearly equal (1:1) cost share between Massachusetts and the USGS effectively doubles the amount of mapping accomplished in Massachusetts waters.

Mapping Technologies & Results

The character of the seafloor is mapped by collecting and interpreting complex data sets. Acoustic – or sonar – systems, including swath bathymetry, sidescan sonar, and sub-bottom profiling, are used to map the physical structure of the seafloor. A research vessel equipped with specialized technologies maps a band or swath of seafloor perpendicular to the vessels' track. Mapping cruises are planned and implemented to provide 100% coverage acoustic data.

Seafloor topography is measured from swath bathymetry. The type and distribution of seafloor sediments are determined from backscatter intensity of the sidescan sonar. Backscatter intensity is interpreted by the strength of sound waves reflected from the surface of the seafloor, with low backscatter representative of fine-grain sediments and high backscatter indicative of coarse-grain sediments or bedrock. The thickness of sediment is determined through a sub-bottom profile, which emits sound through the water column and into the seafloor. Information on the thickness of sediments enables interpretation of the geologic structure of the seafloor and improves the understanding of the geologic history of the coastal environment.

Data gathered from sonar technologies are only as good as the groundtruth data. Equipment such as USGS's SEABOSS (short for SEABed Observation and Sampling System) is used to validate acoustic signatures by collecting photography, video, and sediment samples of the seafloor. The acoustic and groundtruth data are combined in a GIS (geographic information system) to facilitate data interpretation, map production, and data distribution.

Mapping areas were initially prioritized for northern Massachusetts Bay and progressed to Cape Cod Bay when additional funding was acquired (Figure 1). CZM and USGS are also currently developing a strategy for the next phase of the cooperative, which includes mapping Buzzards Bay and Vineyard Sound.

From 2003-2007, more than 1,300km² (500mi²) of the seafloor was mapped from the northern border of Massachusetts (area 3) to northern Cape Cod Bay (area 5) and outer Cape Cod (area 6). Maps and geospatial data are available for the North Shore (Gloucester to Nahant; Barnhardt et al. 2006), Boston Harbor (Ackerman et al. 2006), and eastern Cape Cod (Pope et al. 2006). The Boston Harbor project was unique in that it rescued data acquired during nautical chart mapping by NOAA. The publication of seafloor mapping data for Ipswich Bay (Cape Ann to Salisbury) is in preparation, and mapping cruises were recently finished for the South Shore (Duxbury to Hull) and northern Cape Cod Bay.

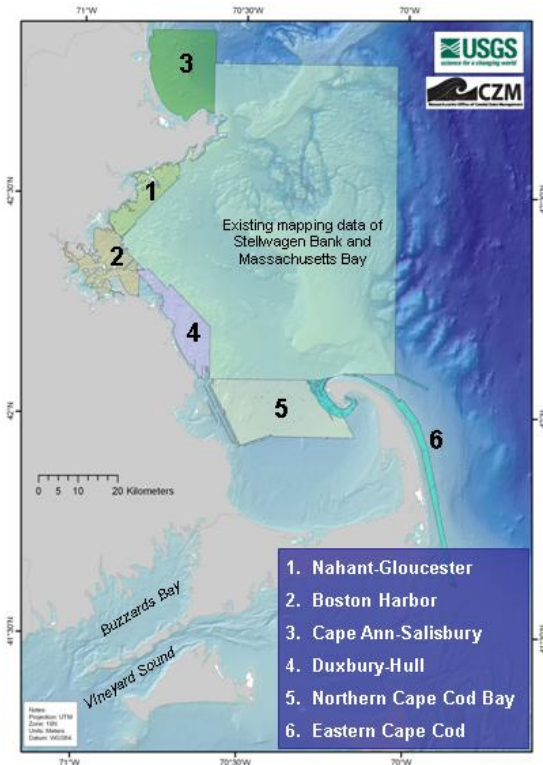


Figure 1. Map showing areas of seafloor mapping in Massachusetts.

Facilitating Ocean Management and Habitat Classification

These maps are used to identify shipwrecks, guide scientific research and monitoring, track distribution of invasive species, mark navigation routes and

potential hazards, site construction projects, locate suitable sediment for beach fill, and design dredging and dredged material disposal plans. Maps depicting the physical nature of the seafloor are a source of baseline information for reviewing projects with potential impacts to the ocean environment and proactive ocean resource management.

Advancing ocean management requires – among other needs – a standardized approach to name and map seafloor habitats. The mapping data are critical for investigating approaches to classify and delineate potential seafloor habitats through a systematic series of automated data processing techniques. The term potential seafloor habitat is used because of the inherent relationship between habitat and biological resources and the difficulty in mapping the wide and incomplete understanding of the spatial and temporal variability in biological characteristics. On the other hand, the regional physical data (*i.e.*, bathymetry and backscatter intensity) collected in this mapping program are not as variable and show stable features on the seafloor. The focus of current classification efforts is on developing procedures to map combinations of physical features, such as areas with steep slope and high backscatter that are likely important to biological resources. Mapping rules are required to maintain consistency in delineating bottom types. As biological sampling advances, physical data will be combined with fine-scale biological observations to improve the understanding of the ecology of the seafloor and the extent of seafloor habitat types.

The imagery of the seafloor, along with interpreted habitat classification, facilitates proactive planning for ocean uses and protection. The seafloor mapping program in Massachusetts relies on cooperative efforts. Government agencies, academic institutions, fishermen, and others with an interest in a sustainable ocean are working together to produce GIS data, digital products, paper maps, and outreach materials intended to educate and inform a wide audience. The Massachusetts seafloor mapping program is a success story in partnership, funded by a combination of state, federal (USGS and NOAA), and private sector contributions, while effectively leveraging expertise and technology within state and federal agencies and applying results to a variety of ocean management issues.

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Further Information

CZM-USGS Seafloor Mapping Cooperative Website:
http://woodshole.er.usgs.gov/project-pages/coastal_mass/

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