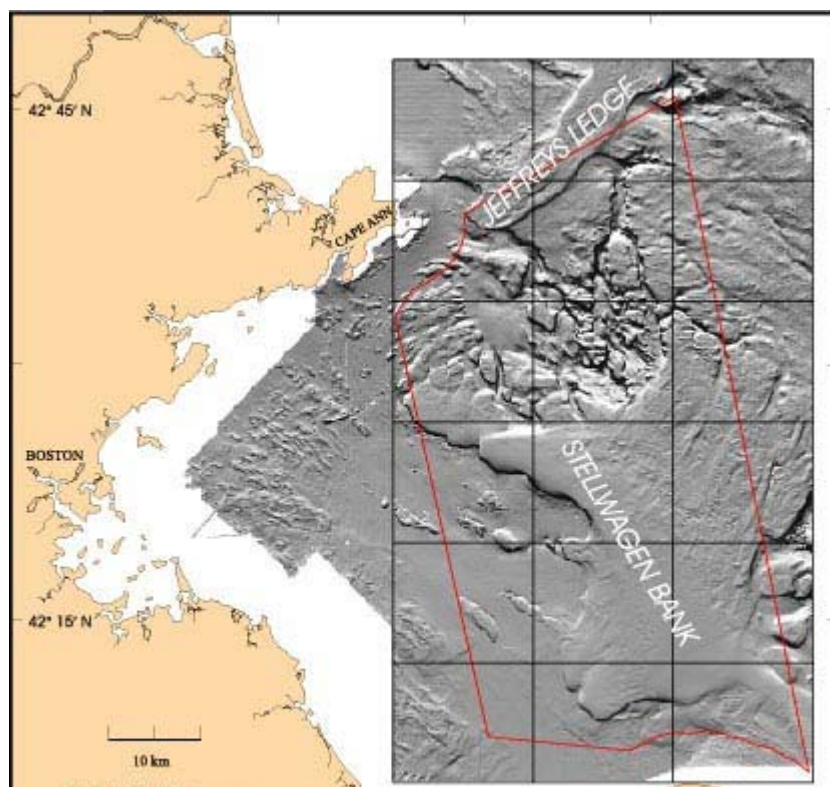




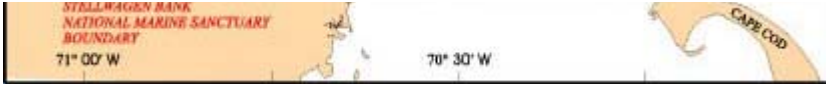
## Mapping the Sea Floor and Biological Habitats of the Stellwagen Bank National Marine Sanctuary Region

National Marine Sanctuaries are marine and coastal areas of special biological significance. The Stellwagen Bank National Marine Sanctuary lies off the Massachusetts coast (fig. 1) and supports active commercial and recreational fisheries. It also serves as a habitat for marine mammals, including endangered species of whales, and draws 1.5 million visitors a year, many of whom are whale watchers. The sanctuary abuts the Massachusetts Bay Disposal Site (fig. 2), which serves as a repository for material dredged from the harbors of Boston and nearby cities. It is near Boston's new ocean outfall that will discharge treated sewage effluent into Massachusetts Bay beginning in 1998. Sanctuary habitats are disturbed by dredging and trawling by fishing gear, and by bottom currents generated by large storms.

The sea floor of the Stellwagen Bank National Marine Sanctuary was surveyed by using a multibeam sea-floor mapping system that utilized sound to measure the water depth and sediment characteristics as the ship steamed over the area of interest. This system provided a new and highly detailed view of the sea floor at a spatial resolution of a few meters. During the survey, the mapping system was mounted on the Canadian Hydrographic Service ship *Frederick G Creed*, a small waterplane twin hull (SWATH) vessel specially designed and equipped for multibeam surveying. Guided by these detailed images, we are using extensive bottom sampling and video and photographic observations to define and map biological habitats.



**Figure 1.** The USGS Stellwagen Bank Mapping Project is producing a series of maps (18 quadrangles at a scale of 1:25,000) that depict topography, backscatter, and the distribution of sedimentary environments and biological habitats in the Stellwagen Bank National Marine Sanctuary region, as well as overview maps at scales of 1:60,000. In this figure, the grid for the 1:25,000 map series is superimposed on the sun-illuminated topography of the region. This plan view was created by vertically exaggerating the topography and artificially illuminating the relief (in this case

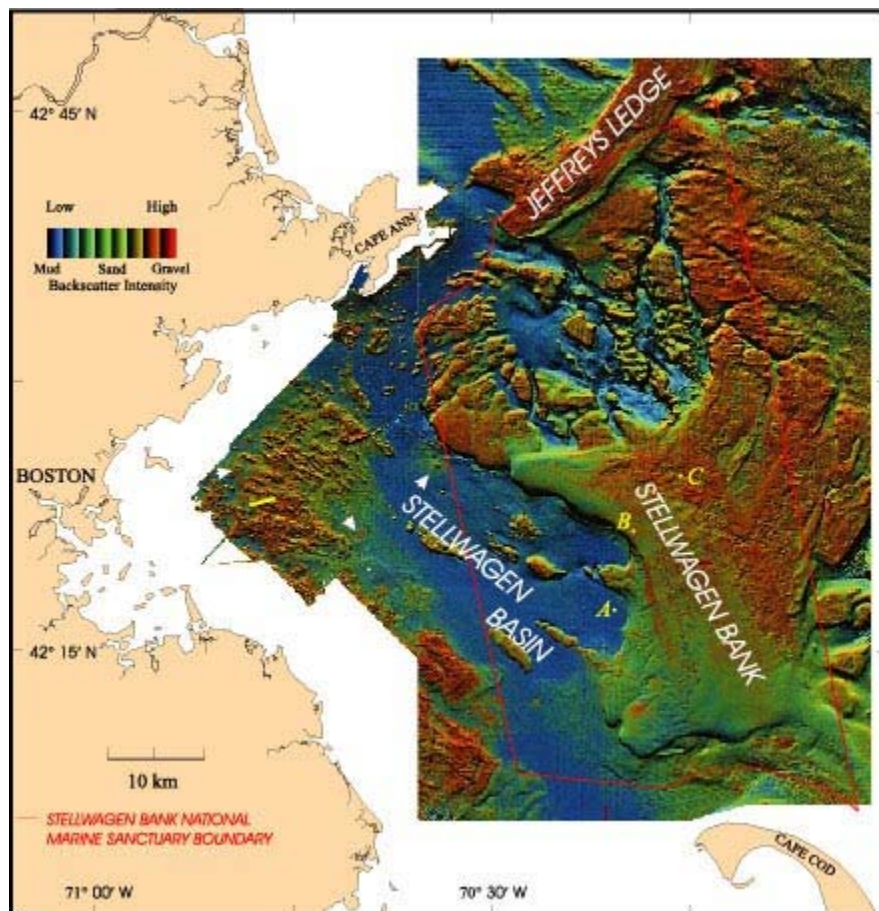


with a sun from the north). The image accentuates the small-scale variability of the topography, which would be difficult to show in a traditional contour map.

The maps of the sea floor produced by this project will be a basis for scientists, policymakers, and managers for understanding this complex ecosystem and for monitoring and managing its economic and natural resources. The maps provide information essential for--

- Determining the distribution of biological habitats and living resources and understanding the natural processes that affect them,
- Assessing natural and human disturbance of habitats and resources, and
- Identifying areas where contaminants might accumulate.

Environmental mapping of sea-floor habitats requires a multidisciplinary approach. This project is being conducted with the cooperation and support of the National Oceanic and Atmospheric Administration (Sanctuaries and Reserves Division; National Marine Fisheries Service; National Ocean Service; National Undersea Research Program), the Environmental Protection Agency, the Canadian Hydrographic Service, and the University of New Brunswick. These agencies have provided ships, equipment, and expertise in the collection and interpretation of seabed imagery and biological observations.



**Figure 2.** Sun-illuminated map of Stellwagen Bank National Marine Sanctuary and Massachusetts Bay with backscatter intensity draped over the topography. Red indicates high-backscatter material including coarse sand, gravel, and rock; green indicates sand; blue indicates mud. Within each backscatter color interval, the intensity varies from dark to light depending on the sun illumination. The image illustrates the wide variety of sedimentary environments in this region of the coastal ocean. The transitions between sediment types are often very sharp. Topographic features observed here were formed for

the most part by glacial processes. Glacial ice containing rock debris moved across the region, sculpting its surface and depositing sediment to form basins, knolls, banks, and other features. Later many of the smaller features were formed during a final period of ice stagnation and melting. Today, the sea floor is mainly modified by storm currents and waves from the northeast. These currents erode sand and mud from the shallow banks and transport them into the basins. Stellwagen Bank and Jeffreys Ledge are shallow banks (20-40 m water depth) covered with sand and gravel. Stellwagen Basin (80-100 m) is floored with mud. In deeper water (85-140 m) in the northeastern part of the image, a fine hummocky pattern on the sea floor was created by gouges (5-10 m deep and up to 120 m wide) caused by icebergs that grounded in the muddy sand at the close of the last period of glaciation. Present and past disposal sites (white arrows) are characterized by high-backscatter material and are especially distinct when the background material is fine grained sediment, such as in Stellwagen Basin. The easternmost arrow points to the presently active Massachusetts Bay Disposal Site. The yellow rectangle in the western part of the map is the location of the new ocean outfall that will discharge treated sewage effluent from the Boston metropolitan area into Massachusetts Bay. Letters *A*, *B*, and *C* indicate locations of bottom photographs in figure 3.



**Figure 3.** Photographs of the sea floor illustrating some bottom environments. See figure 2 for locations. *A*, Muddy sea floor on the eastern edge of Stellwagen Basin at 79 m water depth showing cerianthid burrowing anemones, shrimp, and fish or crab burrows. *B*, Coarse sand with flounder at 37 m. *C*, Pebbles and cobbles in sand with cerianthid burrowing anemone at 58 m. Photographs taken with the USGS video/photo sampling system from the National Oceanic and Atmospheric Administration ship *Ferrel*, 1996.

**For more information**, visit the Stellwagen Bank Information System at <http://vineyard.er.usgs.gov>

or contact

[Page Valentine](#) or [Bradford Butman](#)

U.S. Geological Survey

384 Woods Hole Road

Woods Hole, MA 02543-1598

**U.S. Department of the Interior**  
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