Summary

Human uses of the seafloor are growing rapidly in variety and intensity, as population expands, technologies develop, and new economic activities emerge. In the Gulf of Maine, trawling, dredging, aquaculture, mining, fiber-optic and electric power cables, oil and gas pipelines, wind farms, and other activities can affect seabed habitats, which support a diversity of animals and plants.

Successful management of these activities, to balance ecological impacts and conflicting uses, requires comprehensive maps of seafloor characteristics. Ocean zoning, for example, relies on information about seafloor habitats, bathymetry, and geology. Fishermen, oil and gas companies, and other businesses also find such maps valuable. As of 2002, however, only 15 percent of the Gulf of Maine had been mapped in sufficient detail.

Recent technological advances allow seafloor mapping on an unprecedented scale. New technologies enable researchers to survey large underwater areas to produce high-resolution bathymetric, geological, and ecological maps. Multibeam sonar is especially noteworthy. It generates detailed images of bathymetry and geology of the seabed. To ground-truth the multibeam data and produce interpretive habitat maps, researchers conduct video and photographic surveys, and collect sediment and biota. Other mapping technologies include satellite remote sensing, CASI, LIDAR, sidescan sonar, single-beam sonar, and laser line scan.

In the Gulf of Maine, managers, scientists, and businesses are using new seafloor maps to improve decision-making (see case studies, pages 2 and 3). To broaden this capability, an international partnership of government and non-government organizations called the Gulf of Maine Mapping Initiative (GOMMI) is working to map the remaining 85 percent of the Gulf and provide the maps on the Internet.
Applications of Seafloor Mapping

Seafloor maps are used for resource management and commercial operations in the Gulf of Maine, as illustrated in the following case studies.

1. Stellwagen Bank  
Minimizing ecological and financial costs of routing a fiber-optic cable

Between 1994 and 1996, the National Marine Sanctuary Program worked with the U.S. Geological Survey to map Stellwagen Bank National Marine Sanctuary and portions of western Massachusetts Bay. Scientists collected multibeam sonar data on bathymetry and substrate, which they ground-truthed with video, photography, and sediment samples. The maps cover 3,900 square kilometers and provide important information for management and research activities. When a private company needed to place a fiber-optic cable through the Sanctuary in 2000, they used the maps to route it across areas of soft sediment, avoiding hard gravel bottom where the cable could not be buried for its protection. Normally, extensive bottom sampling would have been required, increasing both project costs and ecological impacts on seafloor habitats.

2. Jeffreys Ledge  
Assessing ecosystem effects of an area closed to fishing

In September 2002, scientists from the University of New Hampshire began an ecosystem-level assessment of biological, ecological, and social effects of the Western Gulf of Maine Closure Area, where fishing has been excluded since 1997. The 150-square-mile study encompasses portions of Jeffreys Ledge, a rich fishing ground off New Hampshire and Massachusetts. The scientists will produce GIS-based maps of geological and biological characteristics using satellite remote sensing, multibeam sonar, video, core sampling, fish tagging, studies of trophic interactions, and genetic analysis of fish tissues. They will also incorporate information from fishermen and other sources. Far more detailed than existing seafloor maps, such as this example (right), the forthcoming maps will improve understanding of the ecosystem and help guide resource management.
From 1996 to 2001, scientists from government agencies, non-profit organizations, and research institutions collaborated with fishermen to investigate the status and ecology of the lobster population in Penobscot Bay. The goal was to improve management of the resource. One question was whether the amount of shallow, cobble-and-boulder habitat, which young lobsters favor, limited their numbers. Using sidescan sonar, video surveys, and sediment samples, researchers mapped sediments and rock types in a geographic information system (GIS). By adding data on water depth, researchers found that favored habitat of juvenile lobsters (indicated in dark blue on the map) is widespread enough in Penobscot Bay to not limit the population. Therefore, management activities can target other factors.

Aquaculture is an important commercial activity in the coastal waters of New Brunswick. Typically, salmon pens are sited in calm bays. However, feces and uneaten food can build up in substantial quantities on the seabed below, causing eutrophication. To avoid this problem, managers now prefer to site salmon pens in erosional areas, where currents carry away the pollutants. They use maps of seafloor geology, produced with multibeam sonar, to identify suitable erosional sites.

Off Nova Scotia, the scallop beds of Browns Bank support a valuable fishery. Beginning in the 1990s, several scallop companies worked with the Canadian Hydrographic Service and the Geological Survey of Canada to map the area with multibeam sonar. They produced three-dimensional maps of bathymetry, sediments, and benthic habitat, which helped fishermen improve their efficiency and reduce ecological impacts. These two images show the paths of fishing boats before (left) and after (right) obtaining habitat maps, when they could target scallop habitat precisely. Total catch remained restricted by quotas, but fishing time per metric ton of scallop meat plunged from 6.37 hours to 2.41 hours. The total area dragged declined 74 percent and by-catch decreased. The fishermen could better avoid hazards, and fuel usage dropped 36 percent. Fisheries managers use the maps to monitor individual scallop beds and improve stock assessments.
Mapping the Future

Recognizing the importance of seafloor maps for management, the Gulf of Maine Mapping Initiative (GOMMI) is working to map the entire Gulf. Endorsed by the Gulf of Maine Council on the Marine Environment, GOMMI is a partnership of government and non-government organizations in Canada and the United States. GOMMI grew out of a mapping workshop in October 2001 that was sponsored by the Gulf of Maine Council and the National Oceanic and Atmospheric Administration.

GOMMI is a multi-year project to secure funding and conduct a comprehensive mapping program of areas not already covered by multibeam surveys (right). The goal is to provide seafloor images, maps, and surveys that are fundamental for resource management, planning, and many commercial activities. For more information, visit http://sh.nefsc.noaa.gov/gommi or email Susan.Snow-Cotter@state.ma.us.

Further Reading

Web Sites

http://www.gulfofmaine.org
Includes a directory of information about seafloor mapping in the Gulf of Maine.

http://sh.nefsc.noaa.gov/gommi
The Gulf of Maine Mapping Initiative (GOMMI) is a partnership of government and non-government organizations working to map the entire Gulf.

http://woodshole.er.usgs.gov/project-pages/stellwagen/
Mapping data, images, and information from Stellwagen Bank National Marine Sanctuary.

http://dusk.geo.orst.edu/djl/links.html
Links about seafloor mapping, including overviews of the technology.

http://seamap.bio.ns.ca/
The Seabed Resource Mapping Program (SeaMap) is an initiative of the Canadian government.

http://www.omg.unb.ca/omg/
The Ocean Mapping Group at the University of New Brunswick.

http://www.com.unh.edu/index.htm
The Center for Coastal and Ocean Mapping (C-COM)/Joint Hydrographic Center (JHC) at the University of New Hampshire is a national center for ocean mapping and hydrographic sciences.

Intensive study of Jeffreys Ledge and the Western Gulf of Maine Closure Area.

http://www.ngu.no/geohab/
GeoHab is an international organization of scientists working with acoustic mapping.

Publications


Available at http://www.state.me.us/doc/nrimc/pubedinf/pubs/plcoast.htm.


Links to many of these publications, along with expanded and updated information about seafloor mapping, can be found at http://www.gulfofmaine.org.