USGS
science for a changing world

Geophysical and Sampling Data from the Inner Continental Shelf: Northern Cape Cod Bay, Massachusetts.

By Brian D. Andrews, Seth D. Ackerman, Wayne E. Baldwin, and Walter A. Barnhardt

Open-File Report 2010–1006

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
KEN SALAZAR, Secretary

U.S. Geological Survey
Marcia K. McNutt, Director

U.S. Geological Survey, Reston, Virginia: 2010

For product and ordering information:
World Wide Web: http://www.usgs.gov/pubprod/
Telephone: 1-888-ASK-USGS

For more information on the USGS—the Federal source for science about the Earth, its natural and living resources, natural hazards, and the environment:
World Wide Web: http://www.usgs.gov
Telephone: 1-888-ASK-USGS

Suggested citation:
Andrews, B.D., Ackerman, S.D., Baldwin, W.E., and Barnhardt, W.A., 2010,Geophysical and sampling data from the inner continental shelf: Northern Cape Cod Bay, Massachusetts: U.S. Geological Survey Open-File Report 2010-1006, 1 DVD-ROM. (Also available at http://pubs.usgs.gov/of/2010/1006/.)

Contents

Abstract....1
Introduction....1
Data Collection and Processing....2
  Survey Operations....2
  Bathymetry....3
  Acoustic Backscatter....4
  Seismic-Reflection Profiling....4
Ground Validation....5
  Surficial Sediment Samples and Grain-Size Analyses....5
  Photography and Video....5
Acknowledgements....6
References Cited....6
Figures....8
Appendix 1: Geospatial Data....15
  Data Catalog....17
Appendix 2: Textural Analysis....20
Appendix 3: Bottom Photographs....20

Figures

1. Map showing the location of the northern Cape Cod Bay survey area (outlined in red) between Duxbury Beach and Provincetown MA....8
2. Photographs of the research vessels used for the geophysical mapping in this project....9
3. Map showing tracklines along which bathymetric depth data were collected in the northern Cape Cod Bay survey area....10
4. Map showing shaded-relief bathymetry of the seafloor in northern Cape Cod Bay....11
5. Map showing tracklines along which acoustic backscatter data were collected in the Cape Cod Bay survey area....12
6. Map showing acoustic-backscatter intensity of the seafloor in the northern Cape Cod Bay survey area....13
7. Map showing tracklines along which seismic reflection profiles were collected in the northern Cape Cod Bay survey area....14

Tables

1. Survey details for the data collected in the northern Cape Cod Bay study area. Additional data were collected outside the northern Cape Cod Survey area during USGS surveys 06012, 07001, 07003. The data from those surveys, not included in this report, may be found in Barnhardt and others (2010). 3

Conversion Factors

SI to Inch/Pound

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
kilometer (km)	0.5400	mile, nautical (nmi)
meter (m)	1.094	yard (yd)
	Area	
square kilometer (km^2)	247.1	acre
square kilometer (km^2)	0.3861	square mile (mi^2)

Phi Conversion: Particle size in phi units may be converted to millimeters (mm) as follows: $mm=2^{-phi}$

Vertical coordinate information is referenced to Mean Lower Low Water (MLLW).

Horizontal coordinate information is referenced to the World Geodetic System of 1984 (WGS 84).

Geophysical and Sampling Data from the Inner Continental Shelf: Northern Cape Cod Bay, Massachusetts.

By Brian D. Andrews, Seth D. Ackerman, Wayne E. Baldwin, and Walter A. Barnhardt

Abstract

The U.S. Geological Survey (USGS) and the Massachusetts Office of Coastal Zone Management (CZM) have cooperated to map approximately 480 km^2 of the inner continental shelf in northern Cape Cod Bay Massachusetts. This report contains geophysical and sampling data collected by the USGS during five research cruises between 2006 and 2008. The geophysical data include (1) swath bathymetry from interferometric sonar, (2) acoustic backscatter from interferometric and sidescan sonars, and (3) subsurface stratigraphy and structure from seismic-reflection profilers. The seafloor sampling data include sediment samples, photographs, and videos.

These spatial data support research on the influence that sea-level change and sediment supply have on coastal evolution and help identify the type, distribution, and quality of subtidal marine habitats within the coastal zone of Massachusetts.

Introduction

This report presents high-resolution geophysical data of the seafloor between Duxbury Beach and Provincetown, MA, in northern Cape Cod Bay (fig. 1). Approximately 480 square kilometers (km2) of the inner continental shelf were mapped focusing on the northern (deeper) section of Cape Cod Bay. This report is the fifth in a series (Barnhardt and others, 2006, 2009, 2010; Ackerman and others, 2006) published through a cooperative mapping program between the U.S. Geological Survey (USGS) and the Massachusetts Office of Coastal Zone Management (CZM) (Web address: http://woodshole.er.usgs.gov/project-pages/coastal_mass/).

The long-term objectives of this mapping program are to provide a framework for scientific research and to develop geologic information to manage coastal and marine resources. High-resolution spatial data and detailed maps of seafloor geology build a foundation for protecting fish habitat, delineating marine resources, and assessing environmental changes caused by natural or human impacts. This report documents the data collection and processing methods used during the five surveys conducted between 2006 and 2008. Also included in this report are the processed geophysical datasets (bathymetry, acoustic-backscatter intensity, and seismic-reflection), seafloor photographs and, textural analyses of sediment samples. These data products are integrated within a

Geographic Information System (GIS) to help guide future management decisions and will form the basis for interpretive geological maps that will be published for the region.

Cape Cod Bay is a large, semi-enclosed embayment at the southernmost margin of the Gulf of Maine. It is bounded on the east and south by the Cape Cod peninsula, on the west by the mainland, and on the north it opens into Massachusetts Bay (fig. 1). The general configuration of the bay is controlled by the lithology and structural features of the region's underlying bedrock (Oldale and Bick, 1987). During the last glaciation, a large lobe of the Laurentide Ice Sheet advanced from the north and occupied Cape Cod Bay. Sediments deposited along the margins of this ice lobe form the moraines, outwash plains, and other glacial features that characterize the region (Uchupi and others, 1996). During retreat of the ice, proglacial lakes briefly occupied the bay (Oldale, 1982) prior to marine incursion caused by rising sea level in the late Pleistocene. Following deglaciation of the region, relative sea-level change has been the major process shaping the coast and inner shelf over the last 14,500 years (Oldale and others, 1993). Shoreline regression and transgression have reworked a broad expanse of seafloor along the western margin of the bay. These shallow (0-40 m) nearshore areas are characterized by rugged rock outcrops, large piles of boulders, and relatively thin, discontinuous deposits of sand and gravel. In contrast, thick deposits of sandy and muddy sediment have accumulated in the deeper (> 40 meters) central part of the bay, creating a generally low relief, smoothly sloping seafloor (Oldale and O'Hara, 1990; Uchupi and others, 2005).

Data Collection and Processing

Survey Operations

The data presented in this report were collected in northern Cape Cod Bay during four geophysical surveys (USGS field activity numbers 06012, 07001, 07002, and 08002) and one bottom sampling survey (07003) conducted by the USGS between 2006 and 2008 (fig. 1; table 1). Surveys 06012 and 07002 consisted of 24 hours per day operations conducted aboard the R/V Megan T. Miller, (fig. 2A) and focused on the eastern portions of the study area generally deeper than 30 m.

Surveys 07001 and 08002 consisted of daytime only operations conducted aboard the R/V Rafael (fig. 2B) and focused on the western, nearshore portions of the study area that are generally shallower than 30 m. Sampling operations conducted aboard the R/V Connecticut (fig. 2C) during survey 07003 were performed 24 hours per day and covered the entire survey area.

Table 1. Survey details for the data collected in the northern Cape Cod Bay study area. Additional data were collected outside the northern Cape Cod Survey area during USGS surveys 06012, 07001, 07003. The data from those surveys, not included in this report, may be found in Barnhardt and others (2010).

Survey	Vessel	Begin Date	End Date	Backscatter	Seismics	Bathymetry	Sampling
06012	*Megan T. Miller*	16-Aug-06	23-Aug-06	Klein 3000 132 kHz	EdgeTech 512i 0.5-12 kHz	SWATHplus 234 kHz	x
07001	*Rafael*	29-Apr-07	03-May-07	Klein 3000 132 kHz	EdgeTech 424 4-24 kHz	SWATHplus 234 kHz	x
07002	*Megan T. Miller*	25-Jul-07	07-Aug-07	Klein 3000 132 kHz	EdgeTech 512i 0.5-12 kHz	SWATHplus 117 kHz	x
07003	*Connecticut*	06-Sep-07	15-Sep-07	x	x	x	SEABOSS
08002	*Rafael*	29-Apr-08	07-May-08	Klein 3000 132 kHz	Knudsen 3200 3.5-200 kHz	SWATHplus 234 kHz	x

Bathymetry

Bathymetric data were acquired using a Systems Engineering & Assessment, Ltd. (SEA) SWATHplus interferometric sonar system operating at a frequency of 234 or 117 kilohertz (kHz) (figs. 3-4; table 1). During surveys 06012 and 07002, the sonar transducers were mounted on a rigid pole from the starboard side of the R/V Megan T. Miller (fig. 2A), about 2.6 m below the water line. During surveys 07001 and 08002, the sonar transducers were mounted on a rigid pole from the bow of the R/V Rafael (fig. 2B), about 0.5 m below the water line. A motion reference unit (TSS Ltd. Dynamic Motion Sensor (DMS) 2-05 for 06012, and Coda Octopus F180 for 07001, 07002, and 08002) was mounted directly above the transducers and continuously measured vertical displacement (heave) and attitude (pitch and roll) of the vessel during acquisition. Data were acquired with a sonar transmit power of 6-8 (on a relative scale ranging from 1-15 representing 0-100 percent power levels), transmit length of 11-39 cycles, and a receive length of 2,048 or 4,096 samples, depending on the individual survey. Navigation was recorded with a GPS antenna mounted on top of the pole, directly above the SWATHplus transducers. Horizontal and vertical offsets between navigation and attitude antennas and the SWATHplus transducers were applied during acquisition in the configuration files for the SWATHplus and Octopus F180 software. Sound-velocity profiles were collected approximately every 2 hours during all surveys using a hand-casted Applied MicroSystems SV Plus sound velocimeter. A total of 3,289 km of bathymetry were surveyed at an average speed of 5 knots (fig. 3). The lines were spaced 75 to 200 m apart to obtain overlapping swaths of data and complete coverage of the seafloor. The swath width collected by the SWATHplus system was adjusted based on the trackline spacing for the specific survey.

Real-Time Kinematic Global Positioning System (RTK-GPS) navigation was used to determine the horizontal and vertical position (x, y, z) of the GPS antenna mounted above the SWATHplus transducers with sub-meter accuracy. The RTK-corrected coordinates were transmitted to the ship from a land-based RTK-DGPS station established by the USGS at NOAA tidal station # 8446009 in Brant Rock, MA (fig. 1). Vertical water-level heights were referenced to Mean Lower Low Water (MLLW) using the offset between North American Vertical Datum of 1988 (NAVD 88) and MLLW

published for the tidal benchmark at the station. SWATHplus acquisition software and the Computer Aided Resource Information System (CARIS) Hydrographic Information Processing System (HIPS 6.1) were used to process the raw bathymetric soundings. Navigation data were inspected and edited to eliminate erroneous fixes. Soundings were adjusted using corrections from the motion reference unit (MRU), RTK-GPS water-level heights, and sound-velocity profile data. Spurious soundings were eliminated, and the final processed soundings were gridded at a resolution of 5-m per pixel (fig. 4).

Acoustic Backscatter

Approximately 3,009 km of acoustic backscatter data were acquired using a Klein 3000 dual-frequency sidescan-sonar operating at 132/445 kHz, or a SWATHplus interferometric sonar operating at 117-kHz (fig. 5). During surveys 06012 and 07002 the Klein 3000 towfish was deployed from an A-frame and towed approximately 20 m astern and 5 m below the surface and collected data with a 200-m swath width (100 m on either side of the vessel). During surveys 07001 and 08002, the Klein 3000 towfish was deployed approximately 3 m astern from a davit on the port side and 1 m below the sea surface and collected data with a 100-m swath width. Backscatter data collected with the SWATHplus sonar were used for lines L68-L73 of survey 07002 because the A-frame used for the Klein 3000 sidescan sonar was inoperable between August 1 and 2, 2007.

The 132-kHz data were acquired using a 75-100 m range, a 50 millisecond (ms) pulse length, and a time-varying gain (tvg) of 9-12 decibels (dB) as recorded in the Klein SonarPro acquisition software (versions 9.6 and 10.0) and later corrected for beam angle and slant range distortions by using Xsonar/ShowImage as described in Danforth (1997). The SWATHplus backscatter data were acquired with Swath Processor acquisition software and processed for radiometric normalization corrections using SXP Tools (unpublished USGS software). Each survey line was mapped into geographic space at 1-m pixel resolution, then imported into PCI Geomatica (version 10.1) and combined into a single mosaic. The mosaic was exported out of PCI as an 8-bit georeferenced Tagged Image File Format (TIFF) image (fig. 6).

Seismic-Reflection Profiling

Approximately 3,270 km of chirp seismic-reflection data were collected in the northern Cape Cod Bay survey area (fig. 7). During surveys 06012 and 07002, chirp seismic data were collected using an EdgeTech Geo-Star FSSB sub-bottom profiling system and an SB-0512i towfish (FM swept frequency 0.5-12 kHz), which was mounted on a catamaran and towed astern of the R/V Megan T. Miller. EdgeTech J-Star seismic-acquisition software was used to control the Geo-Star topside unit, digitally log trace data in the EdgeTech JSF format, and record GPS navigation coordinates to the JSF trace headers. Data were acquired using a 0.25-second (s) shot rate, a 9-millisecond (ms) pulse length, and a 0.5- to 6-kHz frequency spectrum during survey 06012, and a 0.25-s shot rate, a 5-ms pulse length, and a 0.5- to 8-kHz frequency spectrum during 07002. Recorded trace lengths were either 250 or 266 ms. Northwest-southeast oriented tracklines were spaced 100 m apart for 06012 and 07002. Tielines collected during 07002 were spaced between 1,000 and 3,500 m apart.

During survey 07001, chirp seismic data were collected using an EdgeTech Geo-Star FSSB sub-bottom profiling system and an SB-424 towfish (FM swept frequency 4-

24 kHz), which was mounted on a rigid pole on the starboard side of the R/V Rafael. EdgeTech J-Star and Triton Imaging, Inc. SB-Logger seismic-acquisition software was used to control the Geo-Star topside unit, digitally log trace data in EdgeTech JSF and SEG-Y Revision 1 formats, respectively, and record GPS navigation coordinates to the JSF and SEG-Y trace headers. Data were acquired using a 0.25-s shot rate, a 10-ms pulse length, and a 4- to 16-kHz frequency spectrum. Recorded trace lengths were approximately 250 ms. Northwest-southeast oriented tracklines were spaced between 75 and 100 m apart.

During survey 08002, chirp seismic data were collected using a dual-frequency (3.5 and 200 kHz) Knudsen Engineering Limited Chirp 3200 system with transducers mounted on a rigid pole on the starboard side of the R/V Rafael. Knudsen SounderSuite seismic-acquisition software was used to control the Chirp 3200 system, digitally log trace data in the SEG-Y Revision 1 format, and record GPS navigation coordinates to the SEG-Y trace headers. Data were acquired using a 0.25- or 0.5-s shot rate, a 1- or 2-ms pulse length, and a center frequency of 3.5 kHz. Recorded trace lengths were 67 and 135 ms, depending on the shot rate interval. Northwest-southeast oriented tracklines were spaced between 75 and 150 m apart.

All of the raw chirp seismic-reflection data were post-processed using SIOSEIS (Henkart, 2007) and Seismic Unix (Stockwell and Cohen, 2007). Post-processing included the inspection and editing of navigation data, the auto identification of seafloor reflections based on amplitude, and the removal of sea-surface heave from the trace data. Profiles of the final processed trace data are included in this report as 8-bit, grayscale, variable-density plots in the Joint Photographic Experts Group (JPEG) format. The final shot-point and trackline navigation are also included in two ESRI shapefiles.

Ground Validation

Surficial Sediment Samples and Grain-Size Analyses

Sediment samples were collected at 98 stations with a modified Van Veen grab sampler at the end of the drift. Sediment samples were not obtained at 10 locations because of hard or rocky seafloor. The upper 2 cm of sediment from the top of the Van Veen grab were sampled and analyzed at the USGS sediment laboratory for grain size following the standard procedures described in Poppe and others (2005). The analytical data for each sample included location, bulk weight, percent of sample in each 1-phi size class from -5 phi to 11 phi, sediment classification, kurtosis, and other sediment-related statistics. These data are available in spreadsheet or geospatial format in Appendix 2 (Textural Analyses).

Photography and Video

The USGS SEABed Observation and Sampling System (SEABOSS; Valentine and others, 2000) was deployed from the R/V Connecticut during survey 07003 to validate the geophysical data collected in the northern Cape Cod Bay survey area (fig. 6; table 1). At each of the 109 planned stations, the SEABOSS was lowered to the seafloor from a J-frame on the starboard side of the R/V Connecticut and collected continuous bottom video (not included in this report) as the vessel and sampler drifted for about 5-7

minutes at each station. One hundred of the stations were located within the northern Cape Cod Bay survey area, and nine stations were sampled to the west, at the entrance to Plymouth Bay. Six hundred and seventy-three high-resolution digital photographs were taken with a Minolta Dimage A2 digital camera at user-defined locations along the drift. Photographs were saved to the memory card in the camera in JPEG format with a 3,264 x 2,448 pixel resolution.

Acknowledgements

Funding for this research was provided by the Coastal and Marine Geology Program of the U.S. Geological Survey and the Massachusetts Office of Coastal Zone Management. We wish to thank Anthony Wilbur, Bruce Carlisle, and Daniel Sampson from CZM for their collaboration in this project. We thank the Captains and crews of the *R/V Megan T. Miller*, *R/V Rafael*, and *R/V Connecticut* for their expertise during data collection. Assistance in the field was provided by USGS personnel including Sandy Baldwin, Emile Bergeron, Dann Blackwood, Brian Buczkowski, William Danforth, David Foster, Emily Himmelstoss, Barry Irwin, Thomas O'Brien, Elizabeth Pendleton, Charles Worley, Student Interns Maiana Hanshaw (Duke University), and Ankur Agarwala (City University of New York) provided assistance during surveys 06012 and 07002.

References Cited

Ackerman, S. D, Butman, B., Barnhardt, W. A., Danforth, W. W., and Crocker, J. M., 2006, High-resolution geologic mapping of the inner continental shelf: Boston Harbor and Approaches, Massachusetts: U.S. Geological Survey Open-File Report 2006–1008. Available on DVD and online at *http://pubs.usgs.gov/of/2006/1008/*.

Barnhardt, W. A., Ackerman, S. D., Andrews, B. D., and Baldwin, W. E., 2010, Geophysical and Sampling Data from the Inner Continental Shelf; Duxbury to Hull, Massachusetts: U.S. Geological Survey Open-File Report 2009-1072, available online at *http://pubs.usgs.gov/of/2009/1072/*.

Barnhardt, W. A, Andrews, B. D, Ackerman, S. D., Baldwin, W. E., and Hein, C. J., 2009, High-resolution geologic mapping of the inner continental shelf: Cape Ann to Salisbury Beach, Massachusetts: U.S. Geological Survey Open-File Report 2007-1373. Available on DVD and online at *http://pubs.usgs.gov/of/2007/1373/*.

Barnhardt, W. A., Andrews, B. D. and Butman, B., 2006, High-resolution geologic mapping of the inner continental shelf: Nahant to Gloucester, Massachusetts: U.S. Geological Survey Open-File Report 2005–1293. Available on DVD and online at *http://pubs.usgs.gov/of/2005/1293/*.

Danforth, W. W., 1997, Xsonar/ShowImage; a complete system for rapid sidescan sonar processing and display: U.S. Geological Survey Open-File Report 97–686, 77 p.

Henkart, P, 2007, SIOSEIS -The introduction, accessed July 1, 2008, at *http://sioseis.ucsd.edu/sioseis.html*.

Oldale, R.N., 1982. Pleistocene stratigraphy of Nantucket, Martha's Vineyard, the Elizabeth Islands, and Cape Cod, Massachusetts. In: Larson, G.J., Stone, B.D. (Eds.), Late Wisconsinan Glaciation of New England: Proceedings of the Symposium. Kendall/Hunt, Dubuque, IA, pp. 1–34.

Oldale, R.N. and Bick, J., 1987, Geology of the inner continental shelf, Massachusetts Bay, Massachusetts: U.S. Geological Survey Field Study Map MF-1923, scale 1:125,000.

Oldale, R.N., and O'Hara, C.J., 1990. Maps showing the geology of the inner continental shelf, Cape Cod Bay, Massachusetts. US Geol. Surv. Miscel. Field Stud. Map MF-2118, 4 sheets.

Oldale, R. N., Colman, S. M. and Jones, G. A., 1993, Radiocarbon ages from two submerged strandline features in the western Gulf of Maine and a sea-level curve for the northeastern Massachusetts coastal region: Quaternary Research, v. 40, p. 38–45.

Poppe, L., Williams, S. J., and Paskevich, V. F., eds., 2005, USGS East-Coast Sediment Analysis; Procedures, Database, and GIS Data: U.S. Geological Survey Open-File Report 2005–1001, supersedes 2000–358 DVD ROM. Available online at *http://pubs.usgs.gov/of/2005/1001/*.

Stockwell, J.W., Jr., and Cohen, J.K., 2007, The New SU User's Manual (version 3.3): Golden, Colo., Center for Wave Phenomena - Colorado School of Mines, 153 p.

Uchupi, E., Giese, G.S., Aubrey, D.G., Kim, D.-J., 1996, The late Quaternary construction of Cape Cod, Massachusetts: a reconsideration of the W.M. Davis model. Geol. Soc. Am. Spec. Paper, vol. 309, 69 p.

Uchupi, E., Giese, G., Driscoll, N., Aubrey, D.G., 2005, Post-glacial geomorphic evolution of a segment of Cape Cod Bay and adjacent Lower Cape. J. Coast. Res. 21, 1085–1106.

Valentine, P.C., Blackwood, D.B. and Parolski, K.F., 2000, Seabed Observation and Sampling System: U.S. Geological Survey Fact Sheet FS–142–00. Available online at *http://pubs.usgs.gov/fs/fs142-00/fs142-00.pdf*.

Figures

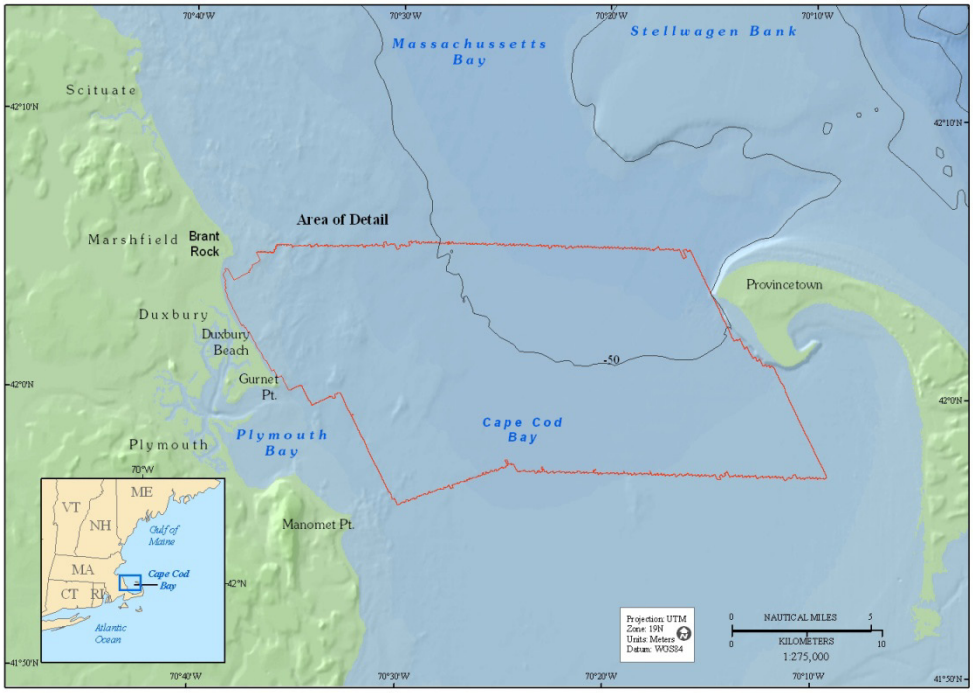


Figure 1. Map showing the location of the northern Cape Cod Bay survey area (outlined in red) between Duxbury Beach and Provincetown MA. The 50-meter depth contour is shown for reference. Area outlined in red indicates area shown in figures 3-8.

Figure 2. Photographs of the research vessels used for the geophysical mapping in this project. *A*: R/V *Megan T. Miller* (06012, 07002), *B*: R/V *Rafael* (07001, 08002), *C*: R/V *Connecticut* (07003). Field-activity numbers are shown in parentheses.

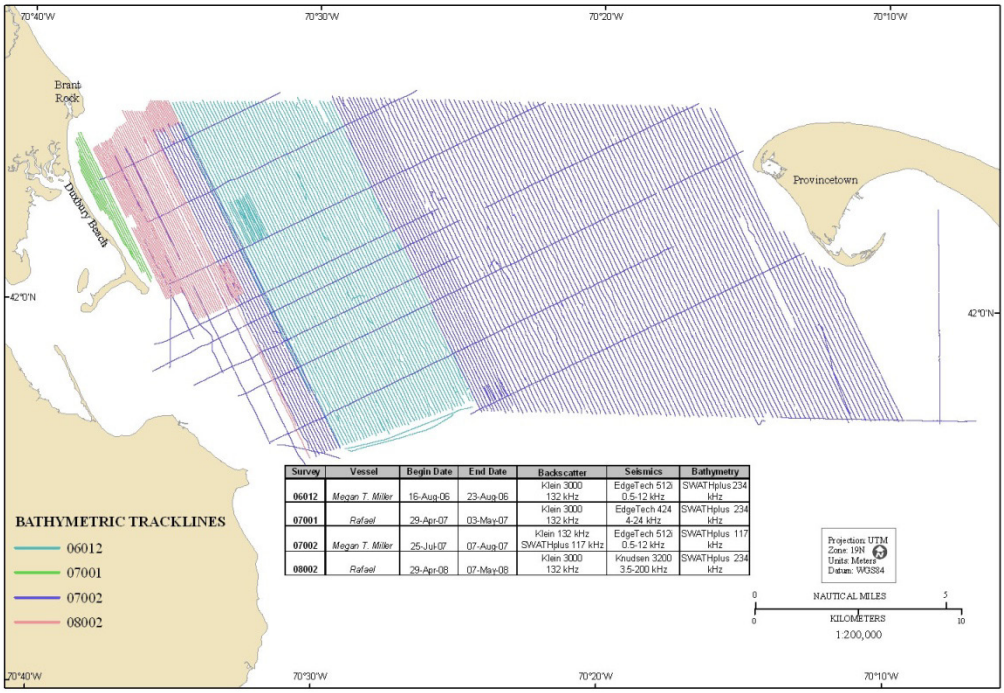


Figure 3. Map showing tracklines along which bathymetric depth data were collected in the northern Cape Cod Bay survey area. Tracklines are color-coded by field activity serial number.

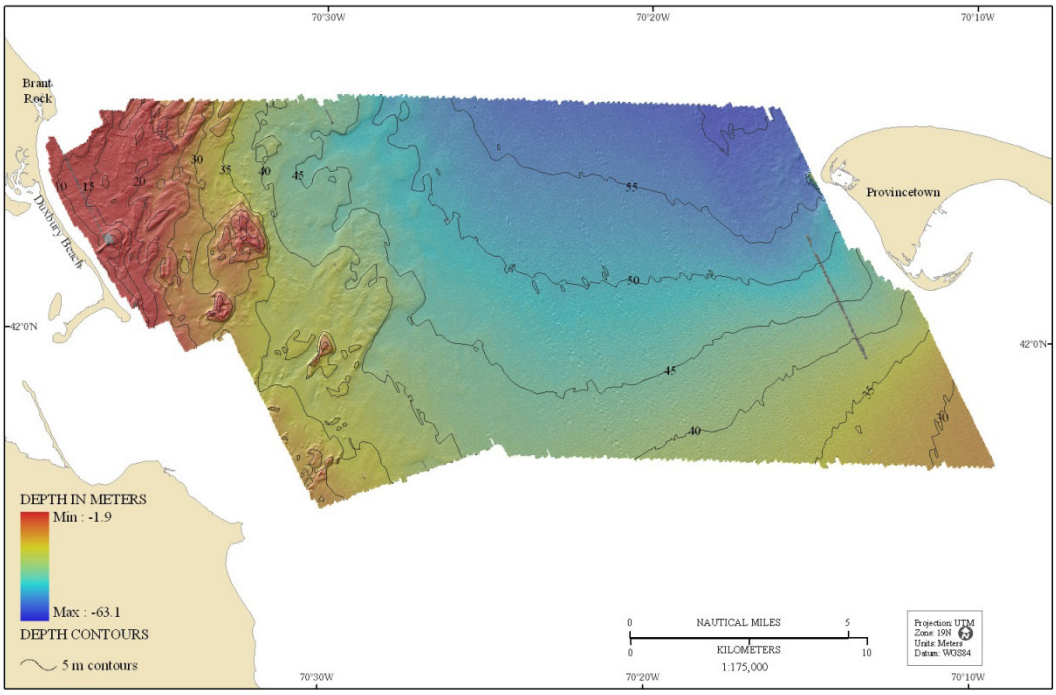


Figure 4. Map showing shaded-relief bathymetry of the seafloor in northern Cape Cod Bay. Coloring and bathymetric contours represent depths in meters, relative to the Mean Lower Low Water (MLLW) datum. Areas shown in gray hillshade indicate gaps in the bathymetric coverage that were filled during post-processing using interpolation

Figure 5. Map showing tracklines along which acoustic backscatter data were collected in the Cape Cod Bay survey area. Tracklines are color-coded by field activity serial number.

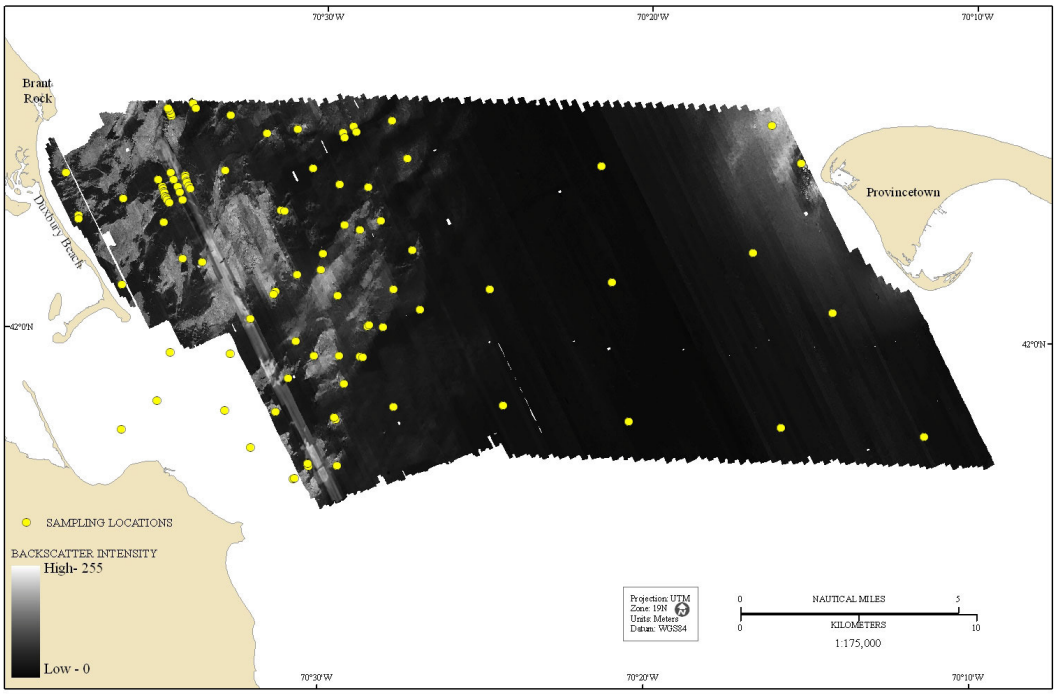


Figure 6. Map showing acoustic-backscatter intensity of the seafloor in the northern Cape Cod Bay survey area. Backscatter intensity is an acoustic measure of the hardness and roughness of the seafloor. In general, higher values (light tones) represent rock, boulders, cobbles, gravel, and coarse sand. Lower values (dark tones) generally represent fine sand and muddy sediment. Locations of sediment samples are identified as yellow circles.

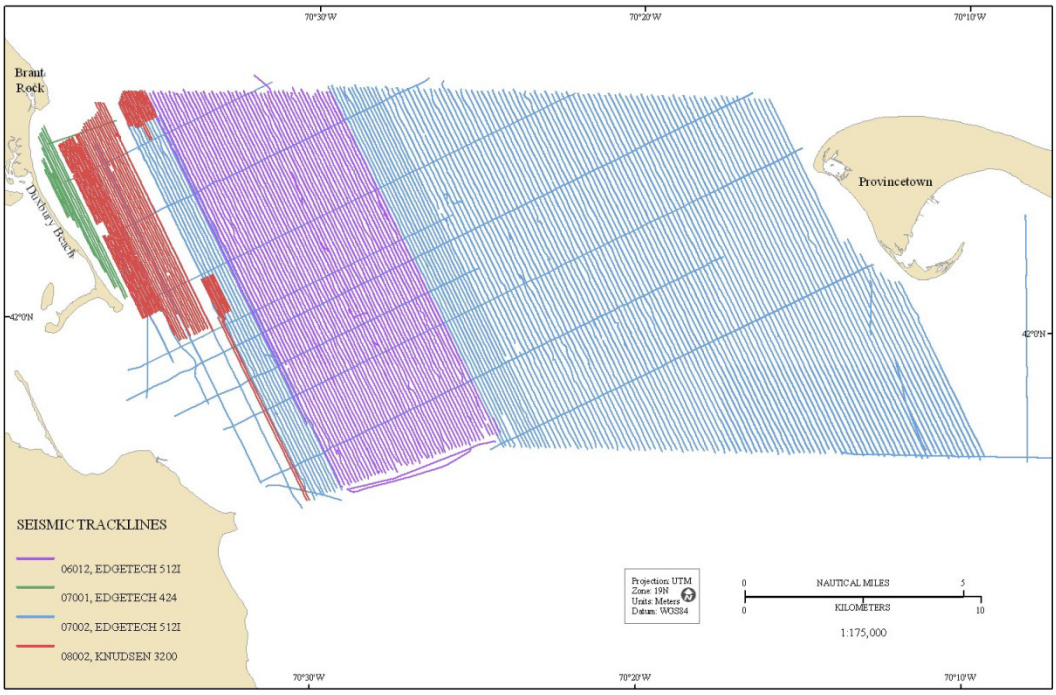


Figure 7. Map showing tracklines along which seismic reflection profiles were collected in the northern Cape Cod Bay survey area. Tracklines are color-coded by survey and seismic system.

Appendix 1: Geospatial Data

This section describes the data collected for this project, the location of the data, and how to access them.

Data Format and Projection

All vector data are delivered as ESRI shapefiles in the geographic coordinate system (WGS84). The raster data are GeoTIFFs and ESRI Grids in Universal Transverse Mercator, Zone 19, WGS84 projection.

All spatial data are distributed with Federal Geographic Data Committee (FGDC) compliant metadata in Extensible Markup Language (*.xml) format. Metadata are also provided for all spatial data in text (*.txt) and FGDC Classic (*.html) format. ESRI ArcCatalog 9.x can also be used to examine the metadata in a variety of additional formats.

Data Access

The complete datasets from this project can be accessed in two different ways, depending on available software.

1. If you have ArcGIS 9.x or ArcView 3.x, all shapefile and grid data may be viewed and manipulated, although Spatial Analyst extension will be required to fully examine and work with the ESRI grids.
2. If you do *not* have any GIS software, a free software download is available to view the data.

If you have ArcGIS 9.3 or higher

Copy the following folder *GIS/* or download the *GIS/OFR2010_1006 WinZip file* (440 megabytes) to your computer and open the ArcMap document *OFR_2010_1006.mxd*. This map document has all the data layers loaded in the table of contents and uses relative links, so there is no need to change any pathways or drive letters, if all folders remain the same under the parent directory (GIS).

*Note: The bottom photographs, seismic images, and raw navigation are not included in this zip file. Download these files separately from the data catalog below and copy the files to the unzipped directory.

If you do *not* have any GIS Software

View all the data via ArcReader, a free mapping application distributed by ESRI for Windows, Linux, and Unix operating systems. Download ArcReader and install it. Go to the ESRI website at *http://www.esri.com/software/arcgis/arcreader/download.html* and follow the directions for downloading and installing the free software. Once ArcReader is installed, all the data can be viewed by opening the Published Map File (pmf) at *GIS/OFR_2010_1006.pmf*.

Data Organization

The data are organized in folders on the DVD and Website. The file structure is the same for both types of media and is described below. Data layers can be downloaded individually using the table below. Individual layers are provided in WinZip files. If WinZip® is not currently installed on the local system, go to *WinZip*(*http://www.winzip.com*) to download the latest version.

GIS — top-level directory for all spatial data. Copy or download this folder to a local hard drive. Note: the size of the uncompressed version of this directory on the DVD is approximately 4.2 gigabytes (GB), whereas the size of the compressed version is 440 megabytes (MB). The compressed version does not include Hypack navigation, bottom photographs or seismic-profile images in JPEG format that can be downloaded separately (see below).

OFR2010_1006.mxd – ArcGIS 9.3 map document with all data loaded in the table of contents.

OFR2010_1006.pmf – ESRI ArcReader (created with Publisher 9.3) map document for use with free ArcReader software. Download ArcReader at *http://www.esri.com/software/arcgis/arcreader/download.html*

raster – Folder containing all raster data in either ESRI Grid, ASCII grid, or GeoTIFF format. Contains subdirectories: bathy and backscatter.

bathy – Contains bathymetry and hillshade grids.

backscatter – Contains the backscatter mosaics in GeoTIFF format.

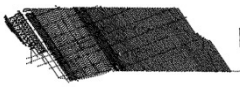
hyperlink_images – Contains seismic profile and bottom photography images in JPEG format. Seismic profile images are hyperlinked to the SeismicTracklines layer in the ArcMap Document table of contents. Bottom photographs are hyperlinked to the BottomPhotos data layer. Use the hyperlink tool in ArcGIS to click on these data layers features and view the linked image.

shapefile – Contains the eight feature classes from the geodatabase in shapefile format (geographic coordinate system WGS84).

navigation – Contains raw HYPACK navigation files from surveys 07002 and 08002.

Data Catalog

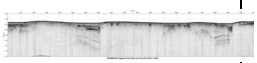
Vector Data. The vector data are delivered in ESRI shapefile format in geographic coordinate system. The hyperlinks in the first column below (Layer (metadata)) are linked to the layer metadata in html format.

Layer (metadata)	Description	Thumbnail view	Download format and size (Mbytes)
CCB_5mCntr	Bathymetric contours at 5-m intervals		Shapefile(0.1 Mb)
CCB_BackscatterTracklines	Backscatter Tracklines		Shapefile (0.5 Mb)
CCB_BathTracklines	Bathymetric Tracklines		Shapefile (12 Mb)
CCB_BottomPhotos	Locations of SEABOSS bottom photographs		Shapefile (0.6 Mb)
CCB_SeabossTrackline	Tracklines for SEABOSS bottom videos		Shapefile (0.3 Mb)
CCB_SedSamples	Locations and lab results of sediment samples		Shapefile (0.7 Mb) MS Excel (0.3 Mb)
CCB_SeismicShot_500	Locations of seismic shotpoints at 500 shot intervals		Shapefile (25.3 Mb)
CCB_SeismicTrackline	Tracklines for seismic profiles		Shapefile (9.1 Mb)

Raster Data- Grids and tiffs are published in the Universal Transverse Mercator (UTM) Coordinate System, Zone 19, WGS84.

Metadata	Description	Thumbnail View	Download format and size (Mbytes)
ccb_bath_5m	5-m gridded bathymetry		ESRI 32-bit (60 Mb)
ccb_bath_f	5-m gridded bathymetry –gaps filled		ESRI 32-bit (60 Mb)
ccb_fill_hs	Bathymetric Hillshade		ESRI 8-bit (8 Mb)
CCB_Swath_bs_1m.tif	Backscatter		GeoTIFF (15 Mb)
CCB_Klein_bs_1m.tif	Backscatter		GeoTIFF (250 Mb)

Image Data- The link in the Download column provides access to a WinZip file containing the JPEG images.

Hyperlink Images (metadata)	Description	thumbnail	Download* file size (Mbytes)
CCB_SeismicProfiles	Sesmic reflection profile images in jpg format		CCB_SeismicProfiles.zip (170 Mb)
CCB_BottomPhotos_JPEG	Bottom photographs in JPEG format		CCB_BottomPhotos_JPEG.zip (70 Mb)

*Note: These zip files contain downsampled and resized versions of the original JPEG images. Higher resolution images can be downloaded individually from the appropriate directory within the GIS/hyperlink_images/ folder or by obtaining the DVD version of this report.

Navigation

Metadata file	Description	download
07002/08002	Navigation data for USGS surveys 07002 and 08002 in Hypack format	CCB_Hypack_nav.zip (120 Mb)

Appendix 2: Textural Analysis

The analysis of sediment texture for 98 sediment samples collected in this study is presented in a summary table in comma-separated value (*.csv) format (CCB_SedSamples.csv), which can be accessed with any text reader. These data are also available in Appendix 1 (*Geospatial Data*) as an ESRI shapefile. See Poppe and others (2005) for a full description of the procedures used for the analysis.

Appendix 3: Bottom Photographs

A total of 673 bottom photographs were obtained along 109 drift lines in the northern Cape Cod Bay study area. (See *Ground Validation* in the Data Collection and Processing section of this report). Typically 5-15 bottom photographs were obtained at each station with the SEABOSS system as the survey vessel drifted over the seafloor. The field of view of each image is approximately 50 cm wide when the camera is 50 cm off the bottom.

Photographs can be viewed in the photo-gallery pages below or with associated GIS data from Appendix 1 (*Geospatial Data*).