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High-Resolution Geophysical Data from the Inner Continental Shelf: Vineyard Sound, Massachusetts

By Brian D. Andrews, Seth D. Ackerman, Wayne E. Baldwin, David S. Foster, and William C. Schwab

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2009-002-FA: Walter Barnhardt, Thomas O’Brien, Emile Bergeron, Brent Taylor, Bill Danforth, Wayne Baldwin, Brian Buckowski, Danijela Vesovic (City College of New York student intern).
2010-004-FA: William Danforth, Emile Bergeron, Charles Worley, and Aaron Turecek.
2011-004-FA- William Danforth, Emile Bergeron, Charles Worley, Eric Moore, and Aaron Turecek.

Contents

Conversion Factors and Datum

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)
Flow rate		
meter per second (m/s)	3.281	foot per second (ft/s)
Area		
square kilometer (km^2)	0.3861	square mile (mi^2)
square meters (m^2)	10.7639	square feet (ft^2)

Horizontal coordinate information is referenced to the World Geodetic System 1984 (WGS 84).
Mean Lower Low Water (MLLW) is the average of the lower low water height of each tidal day observed over the National Tidal Datum Epoch.

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Abstract

The U.S. Geological Survey (USGS) and the Massachusetts Office of Coastal Zone Management (CZM) have mapped approximately 340 square kilometers of the inner continental shelf in Vineyard Sound, Massachusetts, under a cooperative mapping program. The geophysical data collected between 2009 and 2011 by the U.S. Geological Survey as part of this program are published in this report. The data include (1) swath bathymetry from interferometric sonar, (2) acoustic backscatter from sidescan sonar, and (3) seismic-reflection profiles from a chirp subbottom profiler. These data were collected to support research on the influence of sea-level change and sediment supply on coastal evolution and sediment transport processes and to provide baseline seabed characterization information required for management of coastal and offshore resources within the coastal zone of Massachusetts.

Introduction

This report presents high-resolution geophysical data of the seafloor in Vineyard Sound, Massachusetts (fig. 1), collected during three surveys between 2009 and 2011. Approximately 340 square kilometers (km^2) of the inner continental shelf within Vineyard Sound was mapped between the State border to the west and Cape Pogue to the east. This report is the ninth in a series (Barnhardt and others, 2006, 2009, 2010; Ackerman and others, 2006, 2012; Andrews and others, 2010; Pendleton and others, 2011; Turecek and others, 2012) published through a cooperative mapping program between the U.S. Geological Survey (USGS) and the Massachusetts Office of Coastal Zone Management (CZM). The program focuses on the inshore waters of coastal Massachusetts primarily in water between 3 and 30 meters deep.

The long-term objectives of this mapping program are to provide a framework for scientific research and develop geologic information for the management of coastal and marine resources. High-resolution spatial data and derivative maps of seafloor geology are fundamental baseline information required for fisheries management and habitat studies, delineating marine resources, and assessing environmental changes caused by natural processes or human activities.

This report documents the data collection and processing methods used during three surveys conducted between 2009 and 2011. The appendix of this report contains the processed geophysical data (bathymetry, acoustic-backscatter intensity, and seismic-reflection profiles), which are integrated within a geographic information system (GIS) to facilitate future management decisions and research. In addition, these data will form the basis for interpretive marine geologic maps that will be published for the region.

Geologic Setting

Vineyard Sound is a narrow seaway in southeastern Massachusetts that connects western Nantucket Sound to the Atlantic Ocean between Cape Cod and the Elizabeth Islands and Martha's Vineyard (fig. 1). The geology of Vineyard Sound is a product of glacial processes related to late Pleistocene advance and retreat of the Buzzards Bay lobe of the Laurentide Ice Sheet and fluvial and marine processes associated with postglacial relative sea level (O'Hara and Oldale, 1980; Oldale and O'Hara, 1984).

The eastern margin of Vineyard Sound was established when the Buzzards Bay ice lobe reached its maximum extent about 23,000 years before present (BP) and formed the western part of the Martha's Vineyard terminal moraine (fig.1; Oldale and O'Hara, 1984; Uchupi and others, 1996; Balco and others, 2002). As the ice began to recede northward, ice contact, outwash, and glaciolacustrine sediments were deposited between the retreating ice front and the Martha's Vineyard moraine (O'Hara and Oldale, 1980). About 18,000 years BP, the western margin of the sound was established when the Buzzards Bay ice lobe readvanced across previously deposited glacial drift and formed the Buzzards Bay moraine (fig. 1; Oldale and O'Hara, 1984; Uchupi and others, 1996; Balco and others, 2002). Nearshore areas of Vineyard Sound are generally high relief, consisting of rugged exposures of boulders located within glacial outwash deposits along the margins of the bounding moraines (O'Hara and Oldale, 1980).

As deglaciation continued, subaerially exposed preglacial and glacial drift deposits in Vineyard Sound were deeply incised by fluvial runoff from melting ice and proglacial lake drainage (O'Hara and Oldale, 1980; Uchupi and others, 1996). The drainage valleys were partially filled by fluvial and estuarine sediment as sea level rose and submerged Vineyard Sound during the later Holocene (O'Hara and Oldale, 1980). From the time of submergence (less than 5,000 years BP; O'Hara and Oldale, 1980), wind-driven waves and strong tidal and littoral currents have reworked the preglacial, glacial, and postglacial sediments of Vineyard Sound to form large linear sand ridges, fields of sand waves, and smaller rippled bedforms (O'Hara and Oldale, 1980).

Data Collection and Processing

The data presented in this report were collected in Vineyard Sound during three geophysical surveys (USGS field activity serial numbers 2009-002-FA, 2010-004-FA, and 2011-004-FA) conducted by the USGS between 2009 and 2011 (fig. 1; table 1). Surveys consisted of 24 hours-per-day operations aboard the M/V Megan T. Miller (2009-002-FA and 2010-004-FA), and the M/V Scarlett Isabella (2011-004-FA) (figs. 2A & 2B).

This section provides basic descriptions of acquisition and processing of the data contained in this report. Detailed descriptions of acquisition parameters, processing steps, and accuracy assessments for each data type are provided within the metadata files for each dataset listed in appendix 1.

Table 1. Survey details for the data collected in the Vineyard Sound study area.

[The field activity survey numbers (for example, 2009-002-FA) are also abbreviated (for example, 09002) in parentheses. Additional data collected in Buzzards Bay during U.S. Geological Survey field activity surveys 2009-002-FA, 2010-004-FA, and 2011-004-FA are included in Ackerman and others (2012). kHz, kilohertz]

Survey	Vessel	Begin date	End date	Backscatter	Seismics	Bathymetry
2009-002-FA (09002)	*Megan T. Miller*	28-May-09	18-Jun-09	Klein 3000 132 kHz	EdgeTech 512i 0.5-12 kHz	SWATHplus 234 kHz
2010-004-FA (10004)	*Megan T. Miller*	15-May-10	4-Jun-10	Klein 3000 132 kHz	EdgeTech 512i 0.5-12 kHz	SWATHplus 234 kHz
2011-004-FA (11004)	*Scarlett Isabella*	7-May-11	17-May-11	Klein 3000 132 kHz	EdgeTech 512i 0.5-12 kHz	SWATHplus 234 kHz

Bathymetry

Approximately 340 km^2 of bathymetric data were acquired using a Systems Engineering & Assessment, Ltd. (SEA) SWATHplus interferometric sonar operating at a frequency of 234 kilohertz (kHz) (fig. 3; table 1). During surveys 2009-002-FA and 2010-004-FA, the sonar transducers were mounted on a rigid pole from the starboard side of the M/V Megan T. Miller (fig. 2A), about 2.4 meters (m) below the water line. During survey 2011-004-FA, the sonar transducers were mounted on a rigid pole from the port side of the M/V Scarlett Isabella (fig. 2B) about 2.17 m below the water line. A motion reference unit (Coda Octopus F180) was mounted directly above the sonar transducers and continuously measured vertical displacement (heave) and attitude (pitch and roll) of the vessel during data acquisition. Sound-velocity profiles were collected approximately every 2 hours using a hand-casted Applied MicroSystems SV Plus sound velocimeter (2009-002-FA) or an ODIM Brooke Ocean MVP30 moving vessel profiler (2010-004-FA and 2011-004-FA). Data were collected with a sonar transmit power of 6 to 8 (on a relative scale ranging from 1 to 15 representing 0 to 100 percent power levels), transmit length of 12 to 43 cycles, and a receive length of 3,072 or 4,096 samples, depending on the survey.

Navigation was recorded with a Global Positioning System (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 Coda Octopus F180 software. Data were collected along approximately 3,920 kilometers (km) of tracklines spaced 75 to 100 m apart to obtain overlapping swaths of data and complete coverage of the seafloor (fig. 4). The average speed of the survey vessel was 5 knots (nautical miles per hour). The swath width collected by the SWATHplus system was adjusted based on the trackline spacing for the specific survey.

Differential Global Positioning System (DGPS) navigation was used to determine the horizontal position (x- and y-coordinates) of the GPS antenna mounted above the SWATHplus transducers with centimeter accuracy. The vertical height of the antenna was determined by real-time kinematic (RTK) GPS-corrected coordinates that were transmitted to the survey vessel from a base station established at the USGS Marine Operations Facility (MOF) in Falmouth, Massachusetts (fig. 1). Vertical water-level heights were referenced to Mean Lower Low Water (MLLW) datum using the value published for the tidal benchmark (National Ocean Service identification number 8447930) located in Woods Hole, Massachusetts. GPS calibration measurements were made at the vertical benchmarks and referenced to the MOF base station. SWATHplus acquisition software and the CARIS Hydrographic Information Processing Software (HIPS) 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. 3). The bathymetric tracklines, 5-m depth grid, and 5-m hill-shaded grid are available in appendix 1.

Acoustic Backscatter

Approximately 340 km^2 of acoustic backscatter data were acquired during the three surveys using a Klein 3000 dual-frequency sidescan sonar (132/445 kHz) that was towed approximately 20 m astern and 5 to 10 m above the seafloor. Navigation was recorded with a GPS antenna mounted on top of the acquisition van (surveys 2009-002-FA and 2011-004-FA) or on the pole directly above the SWATHplus (bathymetry system) transducers (survey 2010-004-FA). Horizontal offsets between the GPS antenna and the towed sidescan-sonar system, including the linear layback associated with the amount of cable out were measured and accounted for in the Klein SonarPro acquisition software. During most of the survey, sidescan-sonar data were acquired with a swath width of 200-m (100-m to either side of vessel). Approximately 3,570 km of data were collected along survey tracklines spaced 75 to 100 m apart to obtain overlapping swaths of data and complete coverage of the seafloor (fig. 5). For all three surveys, the transmit pulse was set to 50 microseconds (low frequency) and 25 microseconds (high frequency) with a 12-decibel (dB) fixed gain for both frequencies.

The low frequency (132-kHz) sonar data were processed using Xsonar/ShowImage software (Danforth, 1997) to correct for slant-range and beam-angle distortions. Each survey line was mapped into geographic space at 1-m pixel resolution, then imported into PCI Geomatics Geomatica software and combined into a single mosaic. The mosaic was exported as an 8-bit georeferenced tagged image file format (TIFF) image (fig. 6; appendix 1).

Seismic-Reflection Profiling

Approximately 3,800 km of chirp seismic-reflection data were collected in the Vineyard Sound survey area using an EdgeTech Geo-Star FSSB subbottom profiling system and an EdgeTech SB-0512i towfish (frequency modulation swept frequency 0.5-12 kHz), which was mounted on a catamaran and towed between 30 and 50 m astern of the survey vessels (fig 7). SonarWiz seismic-acquisition software was used to control the Geo-Star topside unit, digitally log trace data in the SEG-Y rev. 1 format (IEEE floating point), and record GPS navigation coordinates to the SEG-Y trace headers (in arcsecond of latitude and longitude, multiplied by a scalar of 100). During 2009-002-FA, data were acquired using a 0.12-second (s) shot rate, a 20-millisecond (ms) pulse length, and a 0.7- to 12-kHz frequency sweep, with trace lengths of approximately 66 m (1,250 samples per trace and 0.053-ms sample interval). During 2010-004-FA, files l113f1 through l115f1 were acquired using a 0.25-s shot rate, a 5-ms pulse length, and a 0.5- to 8-kHz frequency sweep, with recorded trace lengths of approximately 200 ms (4,340 samples per trace and 0.046-ms sample interval). The remaining files from 2010-004-FA (Julian days 141–155) were acquired using a 0.25-s shot rate, a 50-ms pulse length, and a 0.5- to 4.5-kHz frequency sweep, with recorded trace lengths of approximately 199 ms (4,328 samples per trace and 0.046-ms sample interval). During 2011-004-FA, data were acquired using a 0.25-s shot rate, a 5-ms pulse length, and a 0.5- to 8-kHz frequency sweep, with recorded trace lengths of approximately 200 ms (4,340 samples per trace and 0.046-ms sample interval). Traces were converted from two-way travel time to depth in meters, assuming a constant speed of sound in seawater of 1,500 meters per second (m/s).

Seismic-reflection data were processed using SIOSEIS (2011) and Seismic Unix (Stockwell and Cohen, 2008). All navigation data were extracted from trace headers, edited, and saved as ASCII text files. Water column portions of the traces were muted (2009-002-FA and 2010-004-FA data), and the effects of sea-surface heave were minimized (2010-004-FA data). A gain was applied to trace amplitudes using a time varying function (2009-002-FA and 2010-004-FA data) and normalized using automatic gain control. Profiles of the final processed trace data are included in this report as 8-bit, grayscale, variable-density plots in portable network graphic (png) format. The final shot-point and trackline navigation are available in appendix 1. Additional details about the acquisition and processing of seismic-reflection data can be found in the metadata for the trackline and shot-point spatial datasets and in the metadata for the png profile images in appendix 1.

Summary

The U.S. Geological Survey (USGS) and the Massachusetts Office of Coastal Zone Management (CZM) conducted three surveys between 2009 and 2011 to map approximately 340 square kilometers of the inner continental shelf in Vineyard Sound, Massachusetts. The program focuses on the inshore waters of coastal Massachusetts primarily in water between 3 and 30 meters deep. The data published in this report include swath bathymetry from interferometric sonar, acoustic backscatter from sidescan sonar, and seismic-reflection profiles from a chirp subbottom profiler. These data were collected to support research on the influence of sea-level change and sediment supply on coastal evolution and sediment transport processes and to provide baseline seabed characterization information required for management of coastal and offshore resources within the coastal zone of Massachusetts. This report publishes the spatial data collected during this project and details the methods used to collect, process, and analyze these data.

References Cited

Ackerman, S. D., Andrews B. D., Foster D. S., Baldwin, W. E., and Schwab,W. C., 2012. High-resolution geophysical data from the inner continental shelf: Buzzards Bay, Massachusetts: U.S Geological Survey Open-File Report 2012-1002. Available on DVD and online at http://pubs.usgs.gov/of/2012/1002/

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/

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. (Available on DVD and online at http://pubs.usgs.gov/of/2010/1006/).

Balco, G., Stone. J.O.H., Porter, S.C., Caffee, M., 2002. Cosmogenic-nuclide ages for New England coastal moraines, Martha's Vineyard and Cape Cod, Massachusetts, USA. Quaternary Science Reviews 21, pp. 2127-2135.

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/

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., 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/

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, 2011, SIOSEIS - The introduction: software package sponsored by the National Science Foundation and the Scripps Industrial Associates, accessed July 1, 2011, at http://sioseis.ucsd.edu/sioseis.html.

O'Hara, C.J., and Oldale, R.N., 1980, Maps showing geology and shallow structure of eastern Rhode Island Sound and Vineyard Sound, Massachusetts: U.S. Geological Survey Miscellaneous Field Studies Map MF-1186, 5 sheets.

Oldale, R.N., and O'Hara, C.J., 1984, Glaciotectonic origin of the Massachusetts coastal end moraines and a fluctuating late Wisconsinan ice margin: Geological Society of America Bulletin, v. 95, p. 61-74.

Pendleton, E.A., Twichell, D.C., Foster, D.S., Worley, C.R., Irwin, B.J., and Danforth, W.W. 2011, High-Resolution Geophysical Data From the Sea Floor Surrounding the Western Elizabeth Islands, Massachusetts: U.S. Geological Survey Open-File Report 2011-1184, available at http://pubs.usgs.gov/of/2011/1184/.

Stockwell, J.W., Jr., and Cohen, J.K., 2008, The new SU user's manual (version 4.0): Golden, Colo., Center for Wave Phenomena - Colorado School of Mines, 153 p.

Turecek, A.M., Danforth, W.W., Baldwin, W.E., and Barnhardt, W.A., 2012, High-resolution geophysical data collected within Red Brook Harbor, Buzzards Bay, Massachusetts, in 2009: U.S. Geological Survey Open-File Report 2010-1091, available at http://pubs.usgs.gov/of/2010/1091/.

Uchupi, E.M., Giese, G.S., Aubrey, D.G., and Kim, D.J., 1996, The Late Quaternary construction of Cape Cod, Massachusetts—A reconsideration of the W.M. Davis model: Geological Society of America Special Paper 309, 69 p.

Abbreviations

Is.   Island
FA   Field Activity
m   meter
MA   Massachusetts
Mass GIS   Massachusetts Office of Geographic Information Systems
MLLW   Mean Lower Low Water
MOF   Marine Operations Facility
M/V   Motor Vessel
USGS   U.S. Geological Survey
UTM   Universal Transverse Mercator
WGS84   World Geodetic System of 1984.

Appendix 1. Spatial Data

All vector data are delivered in Esri shapefile format in the geographic coordinate system (World Geodetic System of 1984 (WGS84)). The raster data are delivered in GeoTIFF and Esri grid formats using the Universal Transverse Mercator (UTM), Zone 19, WGS84 projection. All spatial data are distributed with Federal Geographic Data Committee (FGDC)-compliant metadata in the following formats: extensible markup language (.xml), text (.txt) and FGDC classic (.html). ArcCatalog can also be used to examine the metadata in a variety of additional formats. Background data or “base map” shapefiles of Massachusetts State boundaries are not published in this report because they can be accessed from numerous existing sources including:

Massachusetts Ocean Resource Information System (MORIS) (*http://www.mass.gov/czm/mapping/index.html*)

Coastal and Marine Geology Program Web map service, Massachusetts Seafloor Mapping Cooperative (http://coastalmap.marine.usgs.gov/regional/contusa/eastcoast/msmc_cvm/index.html)

Esri ocean base map: This is a Web-based map service published by Esri. A user with a connection to the Internet) can add this Ocean base map layer directly to a ArcGIS map document from *http://services.arcgisonline.com/ArcGIS/rest/services/Ocean_Basemap/MapServer?f=lyr&v=9.3*. This map service is already loaded in the table of contents of the ArcMap document published with this report.

Data Access

The spatial data in this report can be accessed with ArcGIS 9.x (all shapefiles and raster data may be viewed and manipulated) or through free software for viewing the data.

If You Have ArcGIS 9.3 or Higher

Copy the DVD/ GIS/ folder from the root directory on the DVD-ROM or from the link on the Internet home page for the report to your computer and open the ArcMap document OFR2012_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).

If You Do Not Have ArcGIS 9.3 or Higher

View the data via ArcReader, a free mapping application distributed by Esri for Microsoft 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 (OFR2012_1006.pmf) in the root GIS directory.

Data Organization

The data are organized in the folders shown below on both the DVD and Web site. The file structure is the same for both types of delivery methods and described below. The DVD does not contain the data in compressed file format because of space limitations on the DVD. The compressed files are only for data delivery via the Web site version of the report. If accessing data from the website, make the blank folder structure as described below on the user's local machine before downloading individual compressed zip files to the appropriate folders. Data layers can be downloaded individually in compressed format using the table below.

- **GIS**—top-level directory for all spatial data.
  - **OFR2012-1006.mxd—**ArcGIS 9.3 map document with all the data loaded in the table of contents
  - **OFR2012-1006.pmf**—Esri ArcReader map document (created with Publisher 9.3) for use with free ArcReader software.
  - **browse_jpg**—folder containing thumbnail graphics of data for use in metadata
  - **hyperlink_images**—folder containing seismic-profile images in portable network graphic (png) format; seismic-profile images are hyperlinked to the VS_SeismicTrackline layer in the ArcMap document table of contents (use the hyperlink tool in ArcMap to click on these features and view the linked image)
    - **2009-002-FA**—seismic images collected during USGS survey 2009-002-FA
    - **2010-004-FA**—seismic images collected during USGS survey 2010-004-FA
    - **2011-004-FA**—seismic images collected during USGS survey 2011-004-FA
  - **Layers**—folder containing ArcGIS 9.3 layer files that set rules for displaying and working with data in ArcMap. Layer definitions include symbol assignments, classifications, labeling, and other map use properties; these layer files store the symbology for the data to view them as in the figures of this report
  - **raster—**folder containing all the raster data in either Esri Grid or GeoTIFF format
    - **backscatter**—folder containing the backscatter mosaics in GeoTIFF format
    - **bathymetry**— folder containing the bathymetry and hill-shade grids.
  - **Shapefile**— folder containing the five vector datasets listed in table 1–1 in shapefile format

Data Catalog

Vector Data

The vector data are stored and delivered in Esri shapefile format in geographic coordinate system. The text in the "Layer (metadata)" column of table 1–1 is hyperlinked to the Web-based (html) format of the metadata describing the data. The link in the "Download" column provides access to the compressed zip file containing the data in shapefile format.

Table 1–1. List of vector data published in this report.
[MB, megabyte]

Layer (metadata)	Description	Preview	Download
VS_5mCntr.shp	Bathymetric contours at 5-meter intervals		VS_5mCntr.zip 0.21 MB
VS_BackscatterTracklines.shp	Survey tracklines for backscatter (sidescan sonar) data		VS_BackscatterTracklines.zip 0.46 MB
VS_BathymetryTracklines.shp	Survey tracklines for bathymetry data		VS_BathymetryTracklines.zip 65.6 MB
VS_SeismicShot_500.shp	Chirp shot point navigation data at 500-shot intervals		VS_SeismicShot_500.zip 40 MB
VS_SeismicTracklines.shp	Survey tracklines for seismic profile data		VS_SeismicTracklines.zip 14.2 MB

Raster Data

Raster data are delivered in Esri binary grids or GeoTIFF format. The text in the "Layer (metadata)"column of table 1-2) is hyperlinked to the Web-based (html) format of the metadata describing the data. The link in the "Download" column provides access to the compressed zip file containing the data in Esri grid or GeoTIFF format.

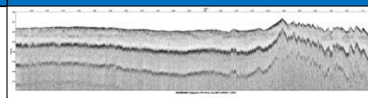
Table 1–2. List of raster data published in this report [m, meter; MB, megabyte]

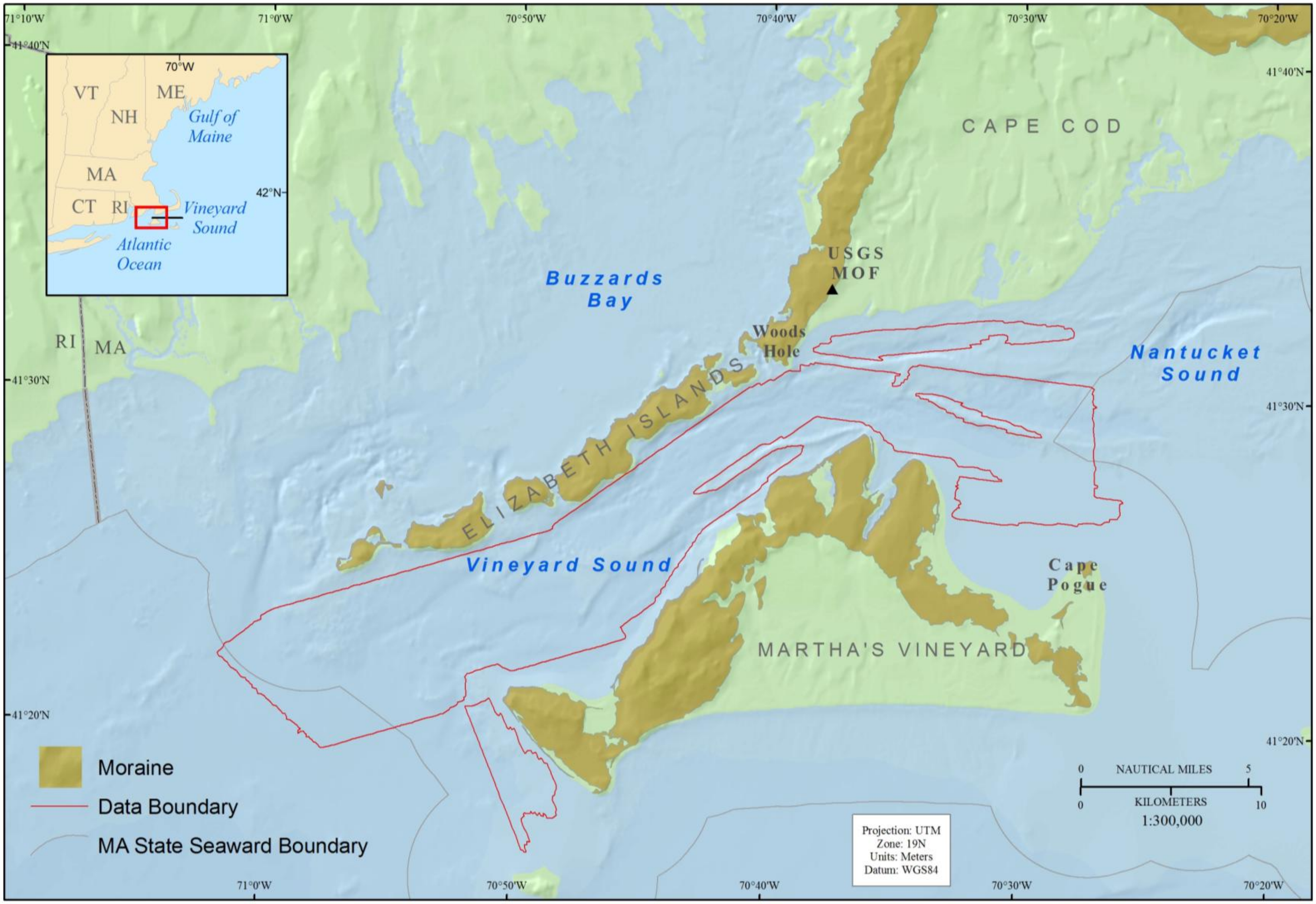
Layer metadata	Description	Preview	Download
vs_bath_5m	5-m gridded bathymetry Esri 32-bit		vs_bath_5m.zip (37 MB)
vs_bath_5mhs	5-m hillshaded bathymetry Esri 16-bit		vs_bath_5mhs.zip (9 MB)
vs_backscatter_1m	1-m backscatter mosaic GeoTIFF		Vs_backscatter_1m.zip (261 MB)

Image Data

Chirp seismic profile images are available in png format. The hyperlinked text in the "Hyperlinked Images (metadata)" column of table 1-3 are linked to the Web-based (html) format of the metadata describing the seismic profile data. The link in the "Download" column provides access to a compressed zip file containing the seismic profile images.

Table 1–3. List of images published in this report.
[MB, megabyte; png, portable network graphics format]

Hyperlinked images (metadata)	Description	Preview	Download
VS_SeismicProfiles	Seismic-reflection profile png		2009-004_FA.zip (168 MB) 2010-004-FA.zip (729 MB) 2011-004-FA.zip (324 MB)

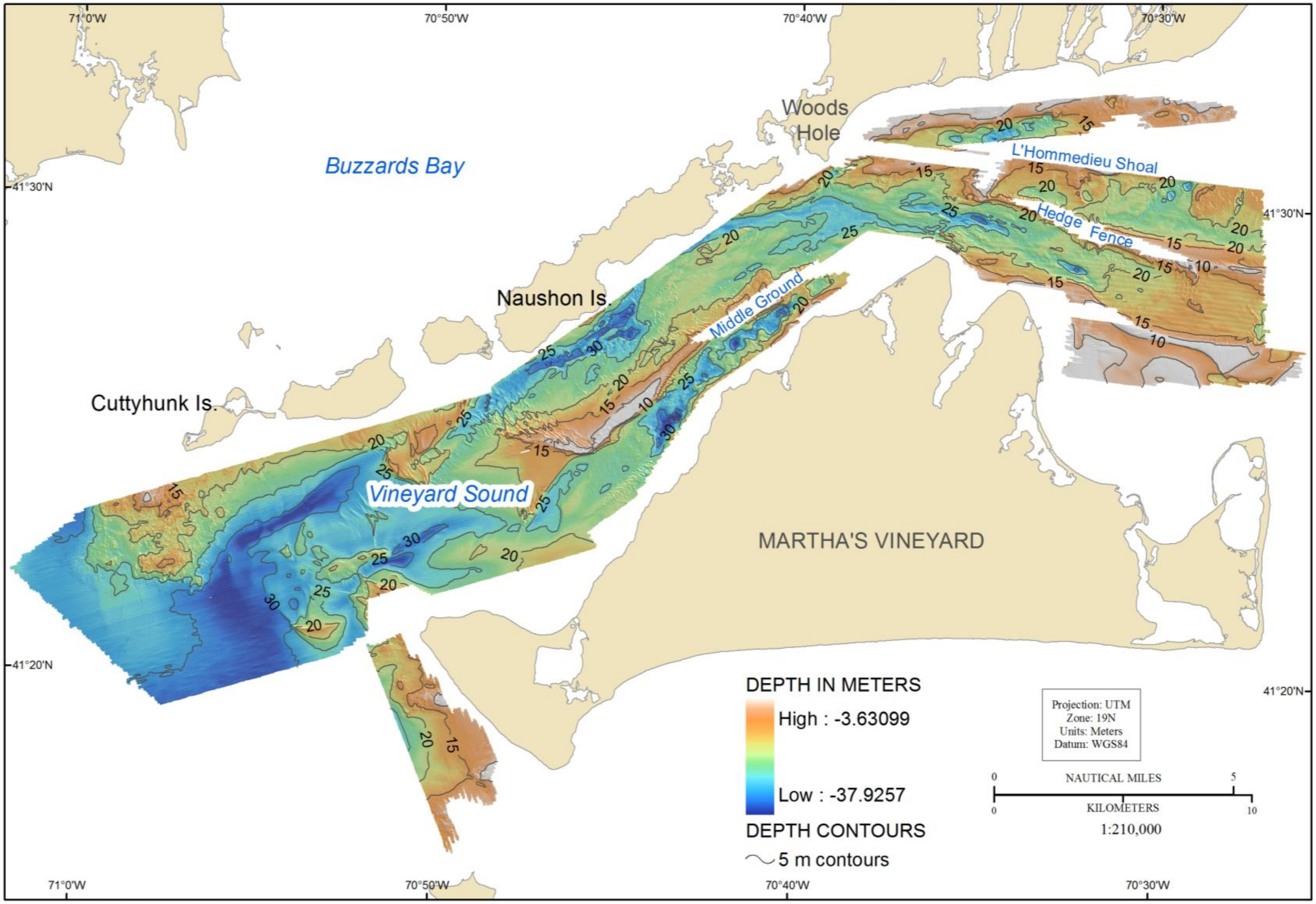


Data Source: MassGIS, USGS

Figure 1. Map showing location of the Vineyard Sound survey area (outlined in red). Abbreviations on figure are explained in the Abbreviations.

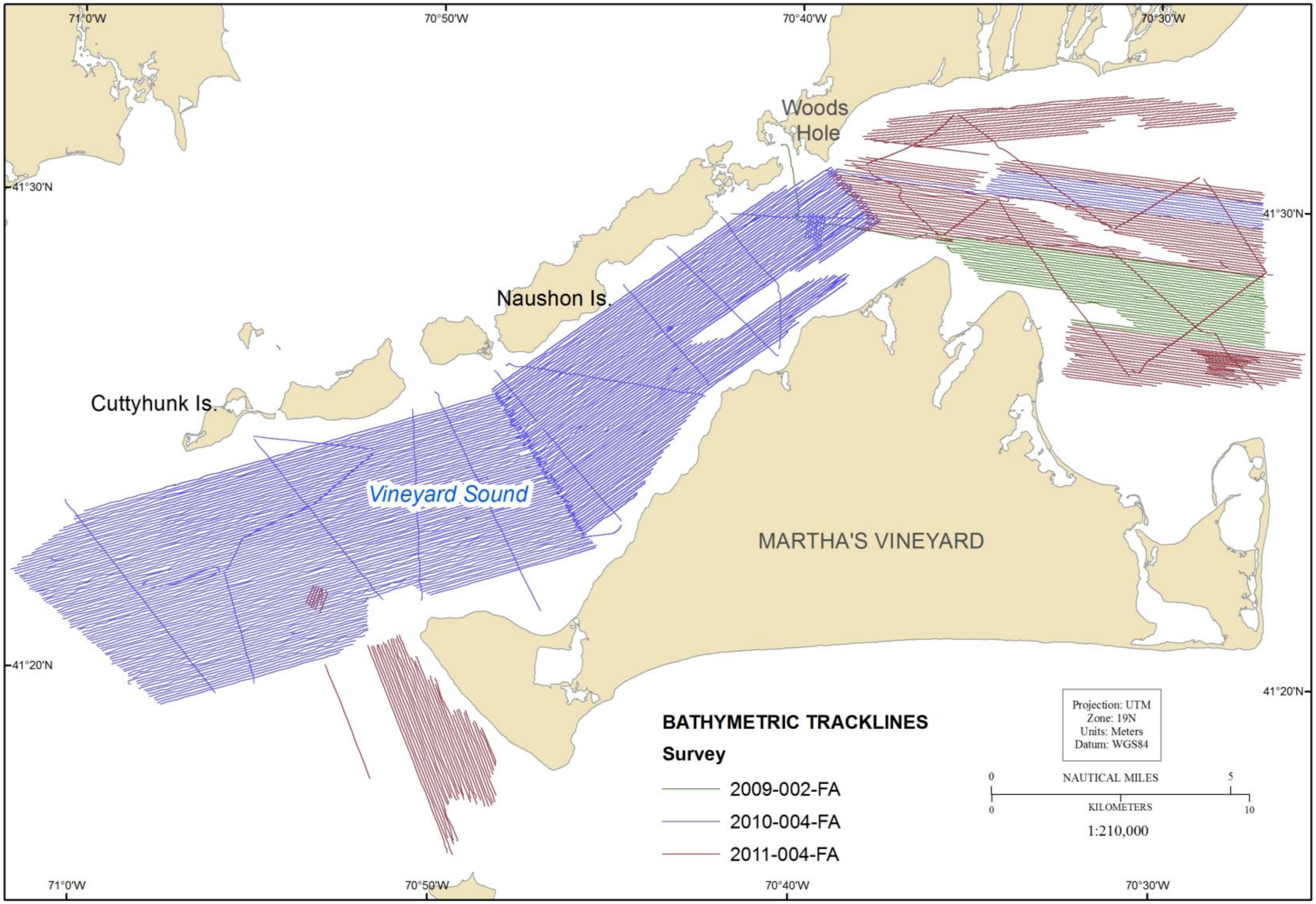
A ***B***

Figure 2. Photographs of the vessels used for the geophysical mapping in this project. A, M/V *Megan T. Miller* (2009-0020-FA, 2010-004-FA), B: M/V *Scarlett Isabella* (2011-004-FA). Field-activity numbers are shown in parenthesis. Photo credits: A: Christopher Polloni, B: David Foster.



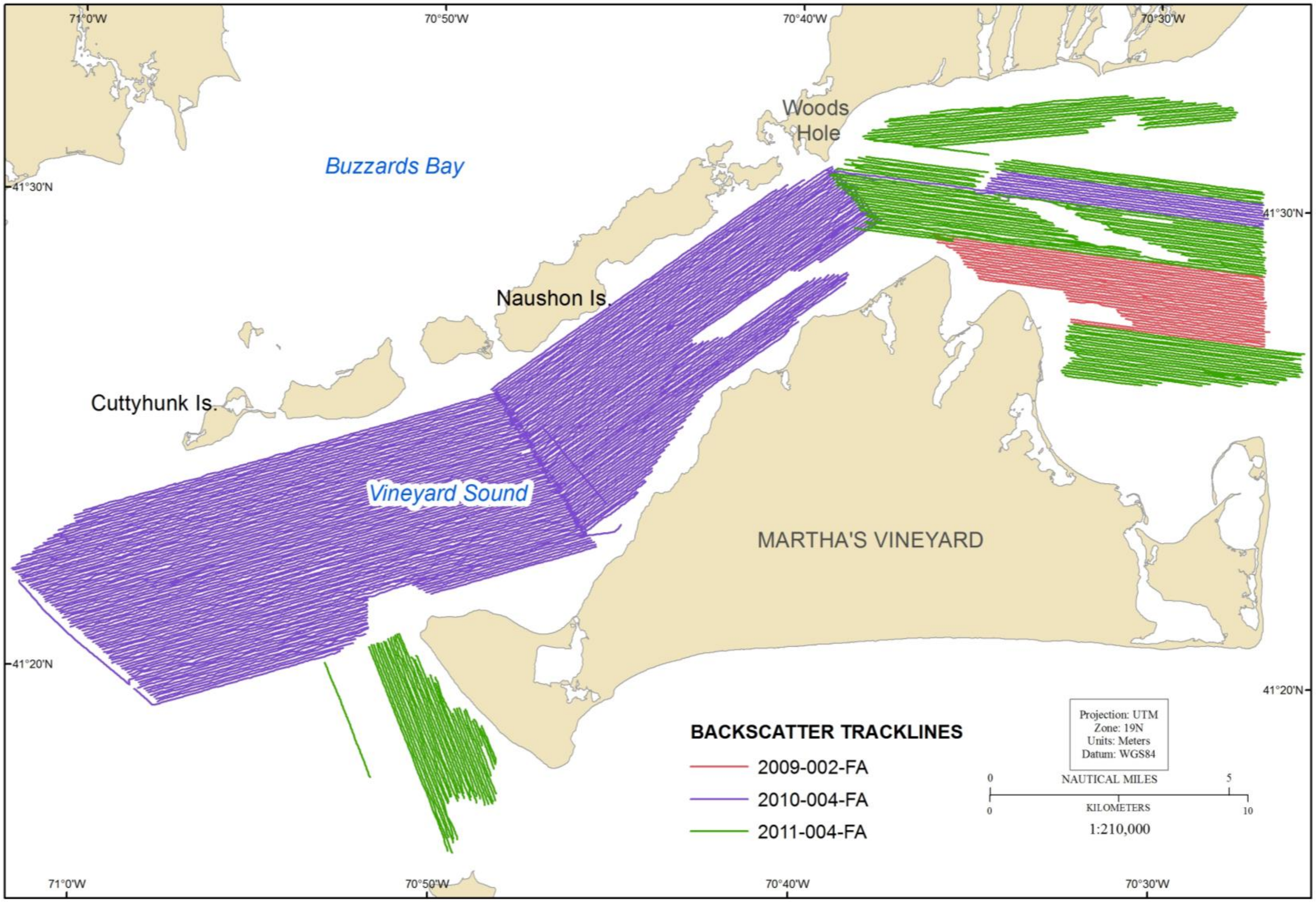
Basemap Data Source: MassGIS

Figure 3. Map showing shaded-relief bathymetry of the seafloor in Vineyard Sound, Massachusetts. Coloring and bathymetric contours represent depth, in meters, relative to Mean Lower Low Water (MLLW) datum. Abbreviations on figure are explained in the Abbreviations.



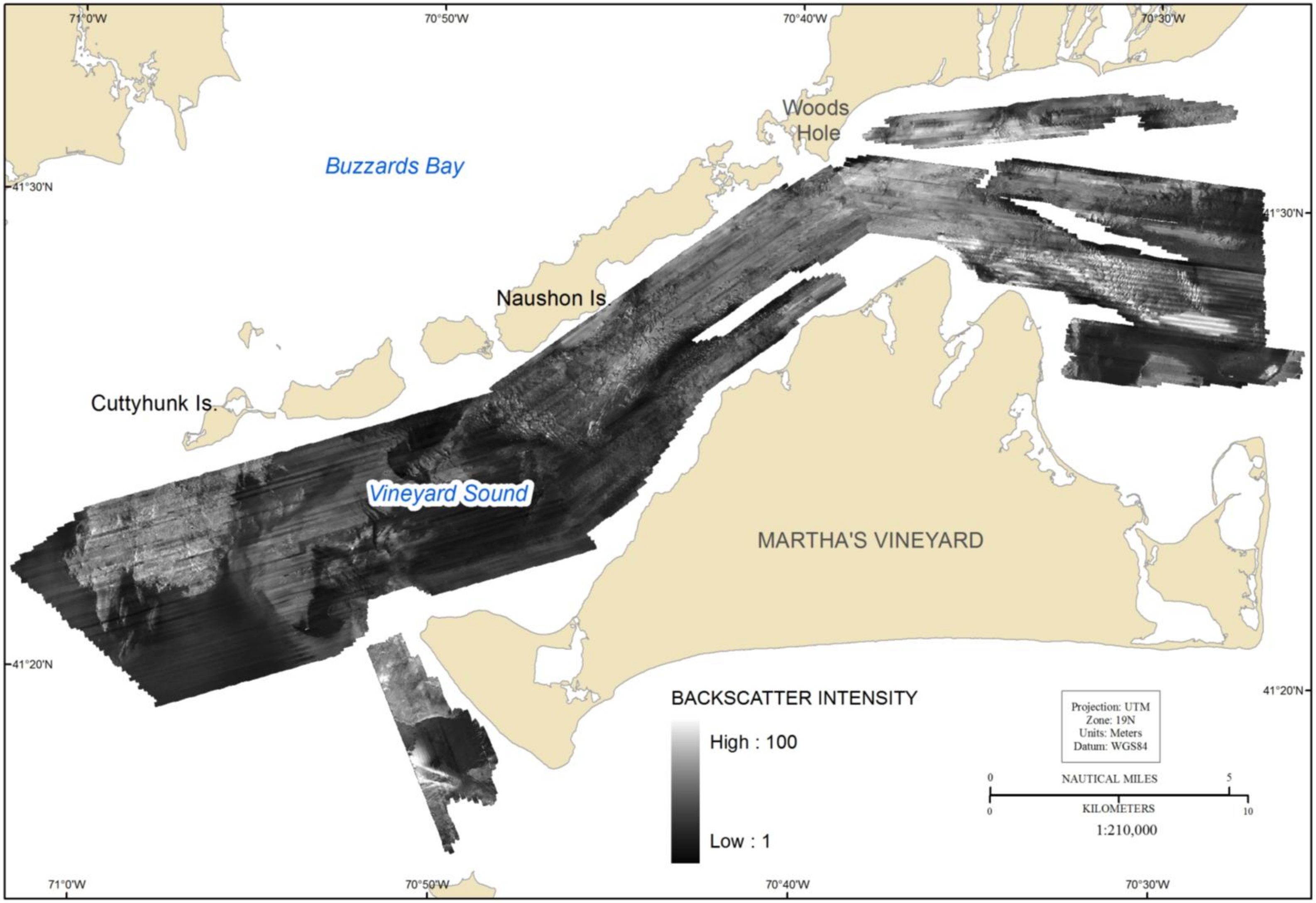
Basemap Data Source: MassGIS

Figure 4. Map showing tracklines along which bathymetry data were collected in the Vineyard Sound, Massachusetts, survey area. Tracklines are color coded by U.S. Geological Survey (USGS) survey number. Abbreviations on figure are explained in the Abbreviations.



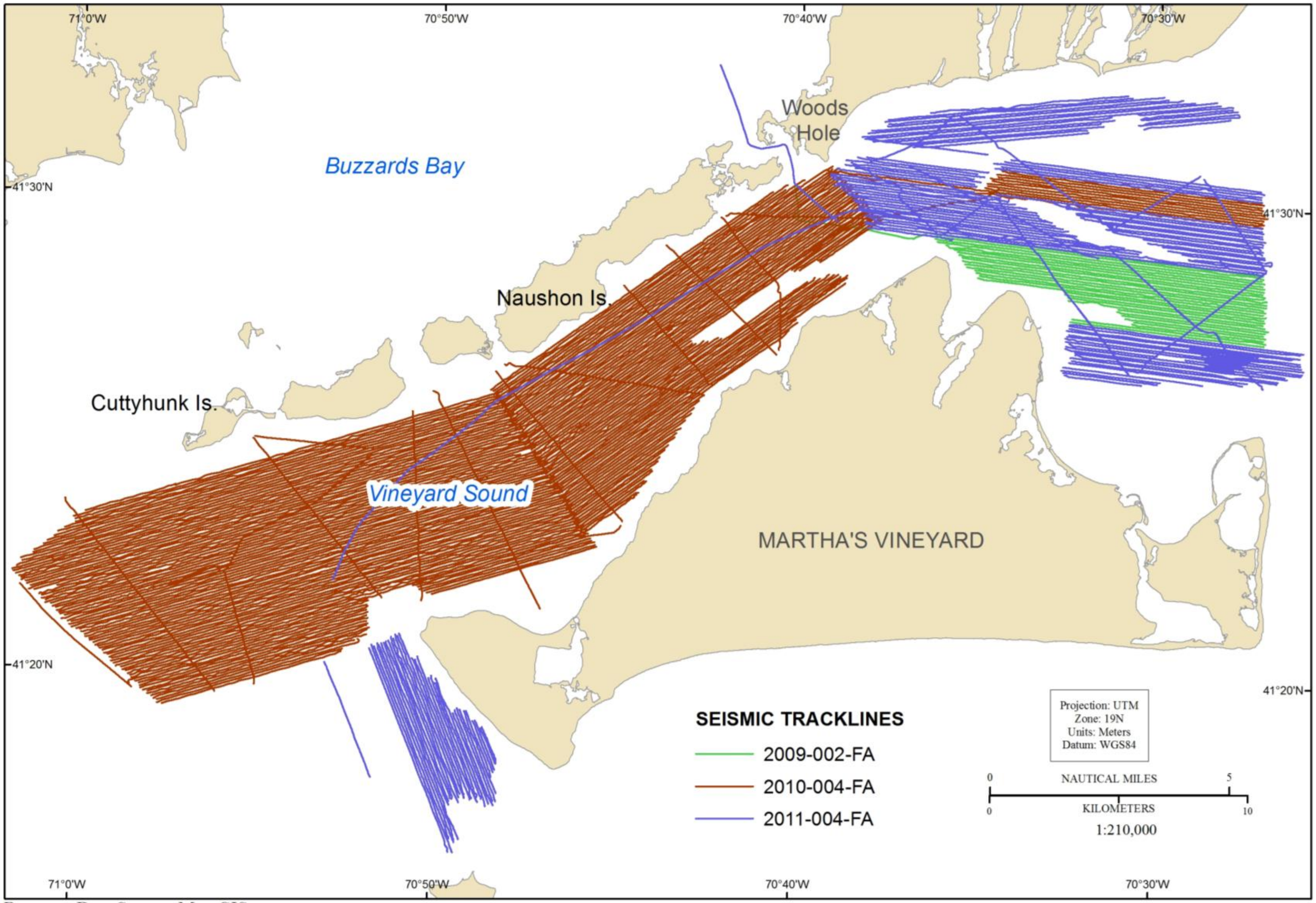
Basemap Data Source: MassGIS

Figure 5. Map showing tracklines along which acoustic-backscatter data were collected in the Vineyard Sound, Massachusetts, survey area. Tracklines are color-coded by U.S. Geological Survey (USGS) survey number. Abbreviations on figure are explained in the Abbreviations.



Basemap Data Source: MassGIS

Figure 6. Map showing acoustic-backscatter intensity of the seafloor in the Vineyard Sound, Massachusetts, survey area. Backscatter intensity is an acoustic measure of reflectivity 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. Backscatter intensity scale values are relative digital number (DN) values based an 8-bit data range (0-255). Abbreviations on figure are explained in the Abbreviations.



Basemap Data Source: MassGIS

Figure 7. Map showing tracklines along which seismic-reflection profiles were collected in the Vineyard Sound, Massachusetts, survey area. Tracklines are color-coded by U.S. Geological Survey (USGS) survey number. Abbreviations on figure are explained in the Glossary.