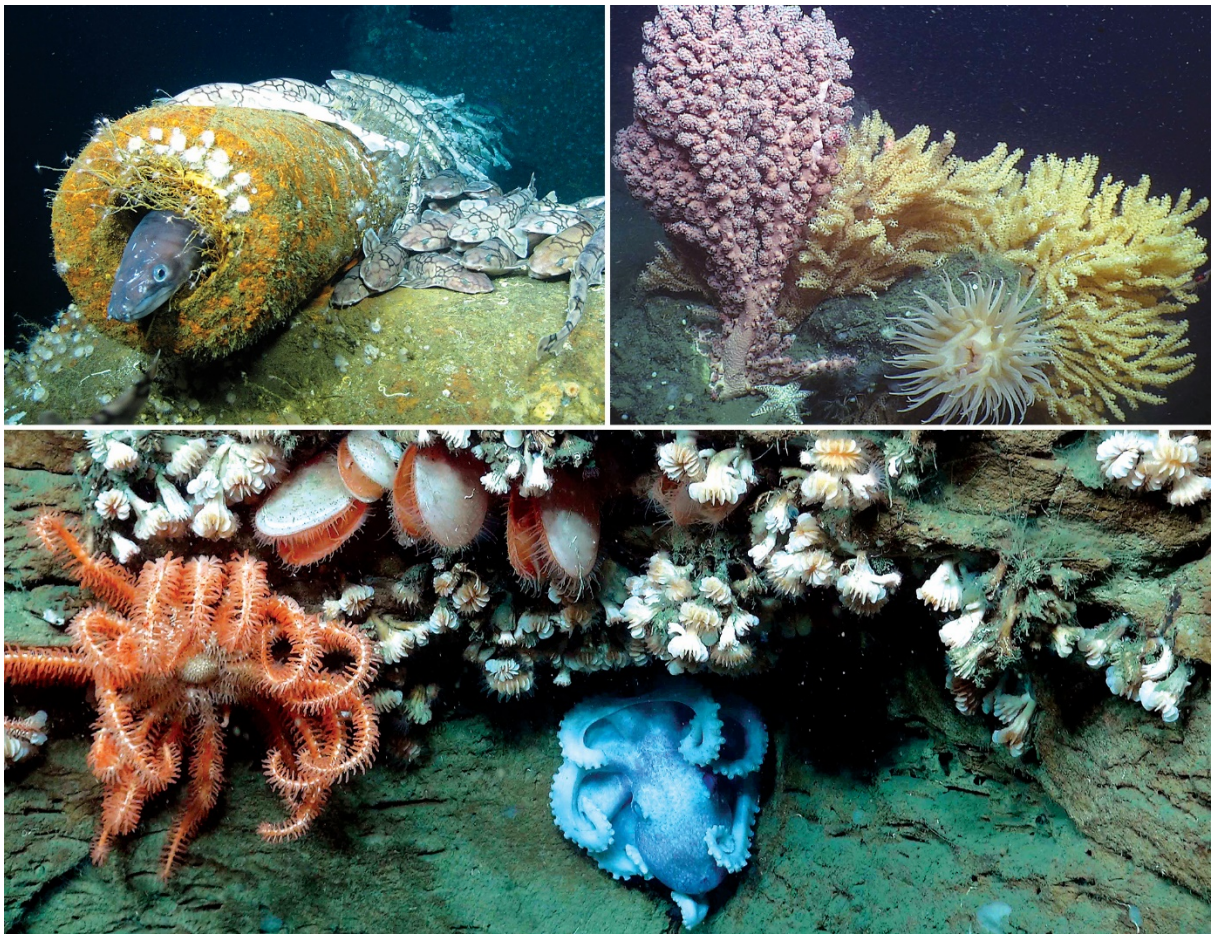
OCS Study
BOEM 2017-061

Exploration and Research of Mid-Atlantic Deepwater Hard Bottom Habitats and Shipwrecks with Emphasis on Canyons and Coral Communities: Atlantic Deepwater Canyons Study

Volume II: Final Appendices



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Volume II: Final Appendices

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DISCLAIMER

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[1] The affiliation of the Principal Investigators is different than that listed for Project Manager. The order of principal investigators begins with the CSA team technical leads (Ross and Brooke), followed by other principal investigators from the CSA team and the U.S. Geological Service arranged in alphabetical order by surname.

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Appendix A

2011 Mapping Cruise Report

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2011 Mapping Cruise

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Exploration and Research of Mid-Atlantic Deepwater Hard Bottom Habitats and Shipwrecks with Emphasis on Canyons and Coral Communities: Atlantic Deepwater Canyons Study

2011 Mapping Cruise

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Funding for this cruise was largely supplied by the Bureau of Ocean Energy Management's (BOEM's) contract with CSA Ocean Sciences Inc. (CSA). We thank Greg Boland (BOEM) and Stephen Viada (CSA) for their support during the development of this cruise. The *Nancy Foster* was provided by the National Oceanic and Atmospheric Administration (NOAA) Office of Exploration and Research. The U.S. Geological Survey (USGS) made substantial contributions to the mapping effort before, during, and after the cruise, providing skilled scientists and other support. The USGS mapping team supervisor, Uri Ten Brink, played a vital role in the mapping effort. Amanda Demopoulos (USGS) provided a technician to assist with cruise activities. We thank all cruise personnel mentioned herein for their hard work and dedication while at sea and in dealing with logistics and data before and after the cruise. We thank Karen Swain and Liz Baird (North Carolina Museum of Natural Sciences) for shore-side support of outreach and web-related activities. Mike Rhode of the University of North Carolina, Wilmington (UNCW) organized and archived the multibeam data and produced maps and hydrographic profile plots. Tara Casazza (UNCW) prepared **Table 2**. We thank the ship- and shore-based personnel that operated the *Nancy Foster* for exemplary service during this mission.

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Appendix A: 2011 Mapping Cruise

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1 INTRODUCTION

CSA International, Inc. (CSA) is contracted to conduct three field sampling efforts, or cruises, associated with the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE)—funded contract "Exploration and Research of Mid-Atlantic Deepwater Hard Bottom Habitats and Shipwrecks with Emphasis on Canyons and Coral Communities," Contract No. M10PC00100. This report describes the first cruise of the Canyons project field effort using the National Oceanic and Atmospheric Administration, Office of Ocean Exploration and Research's (NOAA, OER's) ship *Nancy Foster* (4-17 June 2011) to conduct mapping of the target study areas.

1.1 BACKGROUND AND OBJECTIVES

Submarine canyons are dominant features of the outer continental shelf and slope of the U.S. East Coast from Cape Hatteras, North Carolina to the Gulf of Maine. They are important conduits of anthropogenic pollutants, organic carbon, and sediments from shallow to deeper waters and support ecologically important ecosystems, such as cold seeps and hard bottom and coral habitats. The geology of these features has been well studied; however, despite their high productivity, biological data are limited (particularly deeper than 200 m). Much of the biological data available for these canyons is represented by unpublished reports, unanalyzed data sets, and anecdotal observations. The canyons between Cape Hatteras and Cape Cod, Massachusetts are the subject of potential oil exploration, intensive fisheries, and are possible National Marine Sanctuary candidates, yet are less well known than those further north.

In 2010, BOEMRE initiated a 4-year, multidisciplinary "Atlantic Deepwater Canyons" study which focuses on ecologically significant habitats (cold seeps, hard bottoms, and shipwrecks) in Norfolk, Washington, and Baltimore canyons. One of the first activities preceding intense multidisciplinary sampling is to obtain detailed bathymetric maps of the major Mid-Atlantic canyons, which will help guide future sampling activities. Such multibeam sonar mapping was the primary activity during the 2011 Mapping Cruise (**Figure 1**). The project study region was off Virginia, Maryland, and Delaware, including Norfolk, Washington, Accomac, and Baltimore canyons, and the areas surrounding them, in water depths of approximately 100-1,000 m (see **Figures 1**, **2**, and **3**). Additional areas were mapped during the cruise, including a small wreck off North Carolina (as a system test), deep water survey lines going to and returning from the canyons study area, and a section of The Point off Cape Hatteras, North Carolina. Some multibeam surveys have already been conducted in the study area (**Figure 2**), and we prioritized those areas that had not been mapped (e.g., Baltimore Canyon, **Figure 2**) or that needed improved resolution over existing data (e.g., Norfolk Canyon area, **Figure 2**). Additional cruise activities included hydrographic profiles, water sampling, and searching for a benthic lander. Education and outreach activities were incorporated into the cruise using the North Carolina Museum of Natural Sciences' internet site. The internet site was established before the cruise to document progress and facilitate public awareness of the project. The site will be maintained and expanded as the project progresses and can be viewed at: http://naturalsciences.org/education/online-adventures. The objectives of the cruise were as follows:

1. Conduct multibeam sonar mapping of selected Middle Atlantic Bight deep water canyons, shipwreck sites, and surrounding areas and process data at sea to the extent possible.
2. Conduct hydrographic profiles of the water column to support multibeam mapping.
3. Collect water samples for analysis of aragonite saturation state and particulate organic matter (POM).
4. Attempt the retrieval of the Cape Lookout benthic lander (in route to and/or from study area).
5. Conduct limited education and outreach activities (internet postings, essays).

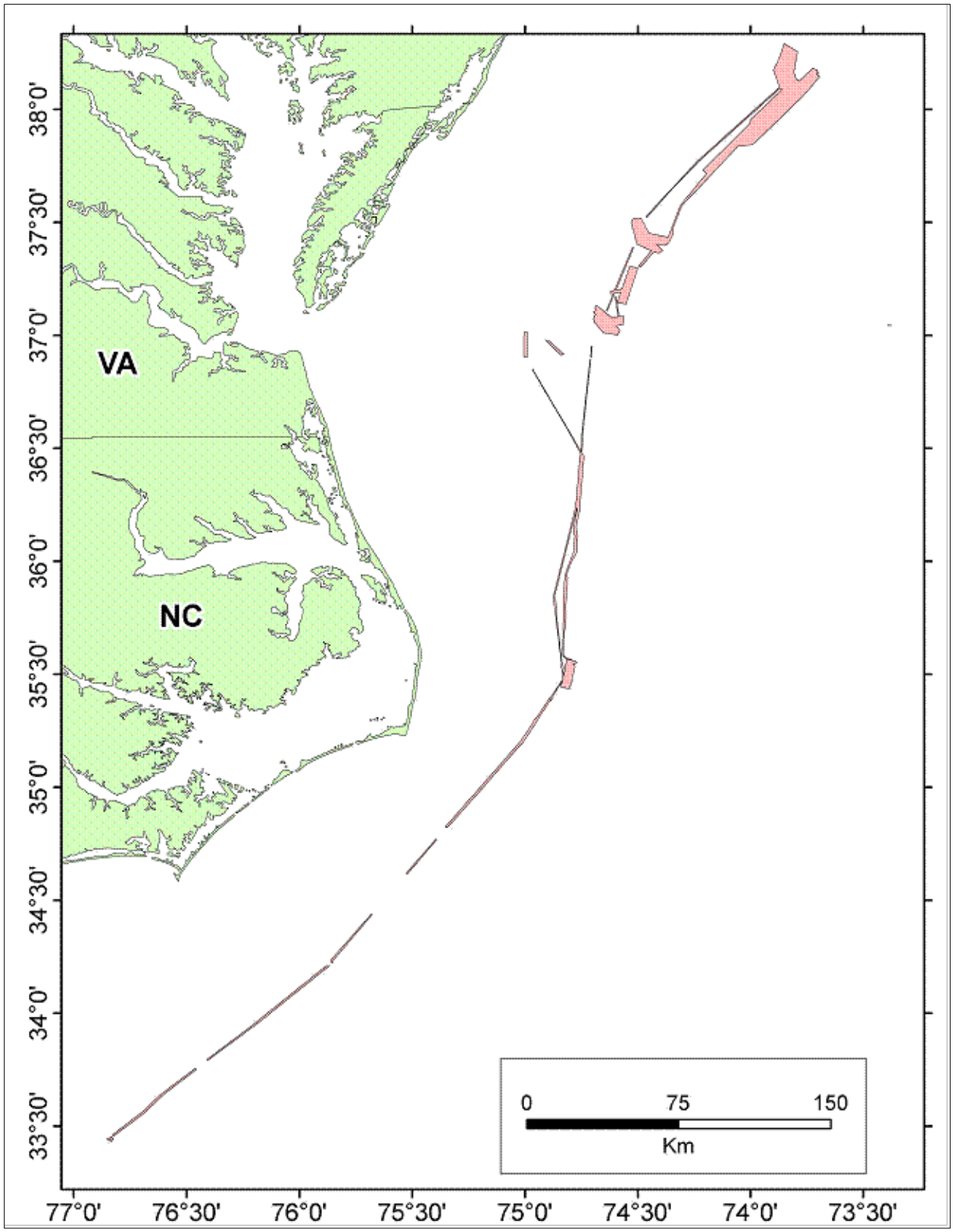

Figure 1. Total area mapped with multibeam sonar (shaded) during the 2011 Mapping Cruise, representing 1,397.65 km^2.

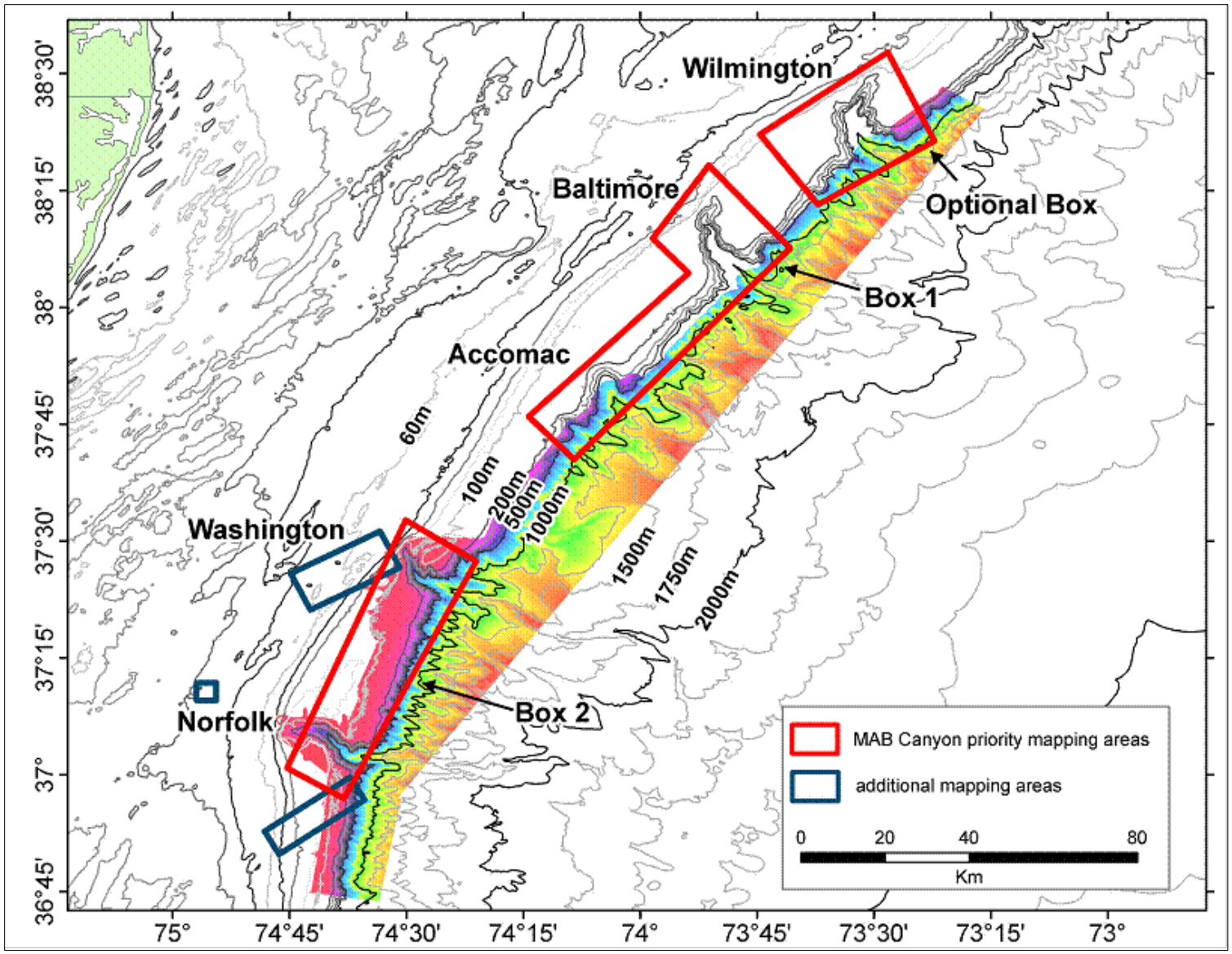

Figure 2. Middle Atlantic Canyon target areas for multibeam sonar mapping during the 2011 Mapping Cruise. Multicolored areas represent existing multibeam sonar data collected by USGS.

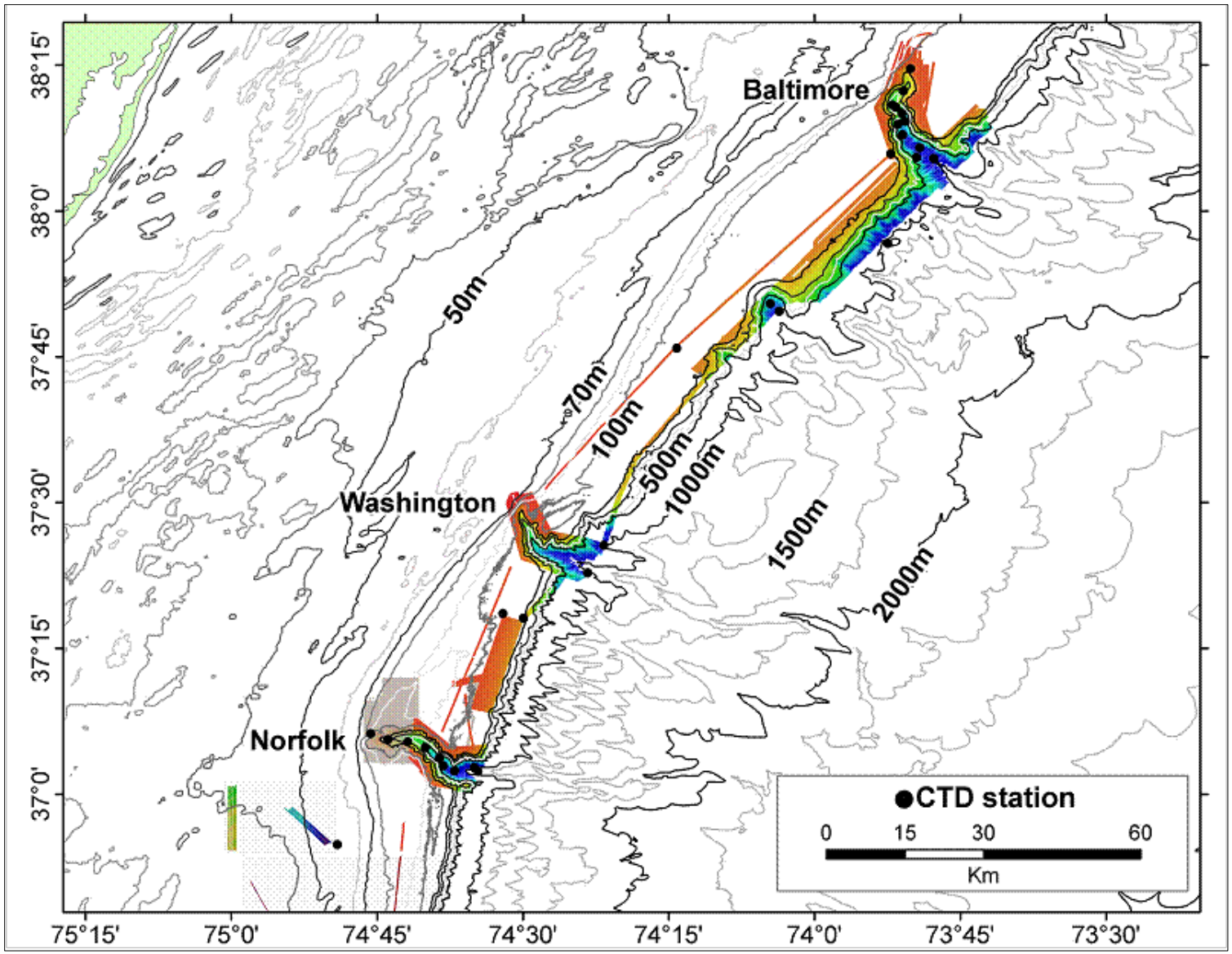

Figure 3. Color shaded areas represent new multibeam sonar data collected for Middle Atlantic canyons during the 2011 Mapping Cruise. Hydrographic profile stations also are plotted on the map. Some additional data were collected outside this area.

2 METHODS

2.1 SURVEY PERSONNEL

Participants for the survey are presented in **Table 1**. The science crew came from North Carolina, Washington, Florida, Rhode Island, and Massachusetts, assembling on the ship in Charleston, South Carolina, on 3–4 June 2011. We conducted 24-hour operations. The scientific crew was divided into a day and a night watch.

Table 1. Survey personnel, affiliations, and roles during the 2011 Mapping Cruise.

Name	Affiliation	Role
Dr. Steve W. Ross	University of North Carolina – Wilmington (UNCW)	Chief Scientist
Dr. Sandra Brooke	Oregon Institute of Marine Biology (OIMB)	Co-Chief Scientist
Dr. Rod Mather	University of Rhode Island (URI)	Scientist-archaeology
Dr. Daniel Brothers	USGS	Scientist-mapping
Dr. Jason Chaytor	USGS	Scientist-mapping
Megan Prescott	University of Washington (UW)	Student
Veronica Holton	College of Charleston	Student
Caitlin Casar	USGS	Student/technician

2.2 FIELD METHODS

Survey data collection included systematic multibeam sonar mapping, along with the collection of hydrographic profiles and seawater samples at discrete locations. This section presents a brief description of field data collection methods for these sampling parameters.

2.2.1 Multibeam Sonar Mapping

Most multibeam sonar mapping was conducted using a hull-mounted Simrad EM 1002, a 95-kHz echo sounder capable of mapping to water depths of approximately 1,000 m utilizing 111 beams per ping over a maximum coverage sector of 150° (equidistant beam spacing). A Reson 7125 multibeam system was used for mapping selected sites in shallower waters. This is a dual frequency system (200 and 400 kHz) capable of mapping at high resolution to water depths of about 300 m. Raw data were corrected for sound velocity and tidal variation and post-processed using Caris hydrographic and sonar data processing software (CARIS HIPS and SIPS, version 7.0) to produce bathymetric and backscatter maps. The multibeam mapping was conducted during transit at normal cruising speed, as well as slower speed (about 6 kn) for the major sites of interest.

2.2.2 Hydrographic Profiles and Water Sampling

Water column sampling was conducted using a recording hydrographic profile probe or CTD (conductivity, temperature, depth), mounted on a rosette sampler device fitted with water sampling bottles. Hydrographic profiles of the water column were collected at selected locations using a SeaBird 911*Plus* recording probe measuring turbidity using an accessory Seapoint turbidity probe (formazin turbidity units [FTU]), dissolved oxygen (mg/L), altitude (m), depth (m), conductivity (Siemens/m), temperature (°C), salinity, and pH. In addition to these selected point samples, two hydrographic profile transects were collected down the axes of Baltimore and Norfolk canyons. Water samples were collected in 1.5 L Niskin water sampling bottles from specific depths in the water column at selected stations during the hydrographic profile upcast. Collected water samples are being processed according to standard protocols for analysis of aragonite saturation state, nutrient concentrations, and POM.

3 FIELD RESULTS

Overall, the cruise was successful, and all objectives were accomplished, except retrieval of the benthic lander. The weather was extremely good and contributed to cruise success.

3.1 SURVEY CHRONOLOGY

5 June 2011 – The *Nancy Foster* departed Charleston, South Carolina at approximately 1,000 h, enroute to the benthic lander location off Cape Lookout, North Carolina. In transit, a test was conducted of the two different multibeam systems was conducted on a small shipwreck site off Cape Fear, North Carolina. The vessel arrived at the benthic lander location at approximately mid-morning, where approximately 1.5 h was spent acoustically interrogating the lander. No response was received from the lander, so the vessel transited to Baltimore Canyon, approximately 260 nautical miles (nmi) north. Upon reaching deep water, multibeam mapping commenced at normal cruising speed. Before reaching the Baltimore Canyon location, the vessel slowed to locate and map a shipwreck in the southeast corner of Norfolk Canyon.

6 June 2011 – The vessel arrived in the Baltimore Canyon area about noon and began hydrographic profile and multibeam mapping operations.

7 June 2011 – Hydrographic profile and multibeam mapping operations continued.

8 June 2011 – Hydrographic profile and multibeam mapping operations continued.

9 June 2011 – Multibeam mapping area continued until 1230 h. A seven-station hydrographic profile transect was then conducted down the axis of Baltimore Canyon. Water samples were taken at three of these stations (three depths at each station) for analysis of aragonite saturation state, and three additional stations (two depths at each station) were sampled for POM. The final cast at the head of Baltimore Canyon was for hydrographic profile data only.

10 June 2011 – Multibeam mapping was completed at Baltimore Canyon and the head of Accomac Canyon. Some time was spent searching for two shipwreck locations (unsuccessfully), and the vessel began a transit to Washington Canyon about 1700 h.

11 June 2011 – Most of the day was spent mapping Washington Canyon. Later that day, the vessel surveyed the large shipwreck target box.

12 June 2011 – The vessel continued the survey of the shipwreck target box and found four wrecks. The wrecks were first mapped using the lower-resolution multibeam system and one of the wrecks was later mapped using the higher-resolution system.

13 June 2011 – Mapping of the shipwreck locations was completed at about 0830 h. A six-station hydrographic profile transect was then conducted down the axis of Norfolk Canyon, along with the collection of water samples from three of the stations for aragonite saturation state analysis and three stations for POM. After completion of this transect and sample collection, the vessel surveyed another section of the shipwreck target box and located one wreck (totaling five wrecks within this area). The remainder of the day was spent surveying this area for additional shipwrecks.

14 June 2011 – Surveys for shipwrecks were completed with no additional wrecks located. At this point, all survey objectives were completed within the canyons study area, and the vessel began its transit back to Charleston. On the way back, a portion of a very rugged canyon area off Cape Hatteras (The Point) was mapped.

15 June 2011 – Continued transit to Charleston.

16 June 2011 – The vessel arrived in port at 0900 h and began demobilization.

3.2 MULTIBEAM MAPPING

3.2.1 Bathymetry Mapping

Overall, 1,397.65 km^2 of the seafloor was mapped with the multibeam sonar during this cruise (**Figure 1**). Of this total area, 997.63 km^2 (71%) were mapped in the Mid-Atlantic Bight in and around the major canyons. **Figures 4**, **5**, and **6** provide bathymetric details of Baltimore, Washington, and Norfolk canyons, respectively.

3.2.2 Archaeological Discoveries and Mapping

Mapping in the vicinity of Baltimore and Washington canyons produced three low-priority targets that could be indicative of shipwrecks, whereas the mapping in and to the north of Norfolk Canyon produced six high-priority targets that are certainly indicative of shipwrecks. Included among the latter were five previously unidentified sites which are likely to be the remains of the Billy Mitchell Project B fleet. Those sites almost certainly include the remains of the battleship *Ostfriesland*, the cruiser *Frankfurt*, and the destroyers G-102, S132, and V-43. The remainder of the Billy Mitchell Project B fleet sunk off Virginia consists of the submarines U-117, U-140, and UB-148, all of which have been identified by Rod Mather during previous cruises to the Mid-Atlantic Bight. An unidentified shipwreck was also discovered just to the south of Norfolk Canyon. In addition, high-resolution multibeam mapping of Norfolk, Baltimore, and Washington canyons revealed what are likely to be paleo-shorelines dating back to the last glacial maximum. This information is important for paleo-archaeological landscape reconstructions that could identify areas of possible ancient human habitation.

3.3 WATER COLUMN SAMPLING

Thirty-two hydrographic and water profile stations were sampled during this cruise (**Table 2**), and plots from the two transects down Baltimore and Norfolk canyon axes are provided (**Figure 7**). Niskin bottles were triggered at several depths at eight of the hydrographic and water profile sampling stations (**Table 2**), and these are being processed for aragonite saturation and nutrient data. Water samples were collected for analysis of POM at several depths at ten of the hydrographic and water profile sampling stations (**Table 2**).

3.4 EDUCATION OUTREACH, AND MEDIA

The project web site (http://naturalsciences.org/education/online-adventures) was set up as a "blog" to allow for easy posting of cruise activity logs. Four background essays and various photographs (from other related projects) were posted prior to this cruise. In addition to the introductory material, 10 blogs authored by various scientific personnel were posted to this site during the cruise. Statistics on the web site indicated that it was visited 1,947 times during the cruise. The site continues to be maintained by the North Carolina Museum of Natural Sciences.

4 FUTURE WORK

Water samples are currently being analyzed for aragonite saturation state and nutrient and POM concentrations. Although much of the cleaning of the multibeam data was done at sea by U.S. Geological Survey (USGS) scientists, these data continue to be cleaned and analyzed by USGS and other scientists involved in the Atlantic Deepwater Canyons project. A presentation on these multibeam data is planned for an upcoming American Geophysical Union meeting. The bathymetry and backscatter data collected during this cruise will be used to help locate potential hard bottom habitats, areas that may support deep-sea corals, and to select areas to explore in upcoming cruises. In addition, we have considerable post-processing of geophysical survey data to complete prior to the first sampling cruise next year.

Future plans for the project include the continuation of historical and archaeological research in support of the sampling cruises over the next two years and for potential National Register of Historic Places nominations. By the end of the project, we anticipate submitting a multiproperty National Register nomination for the Billy Mitchell Project B fleet.

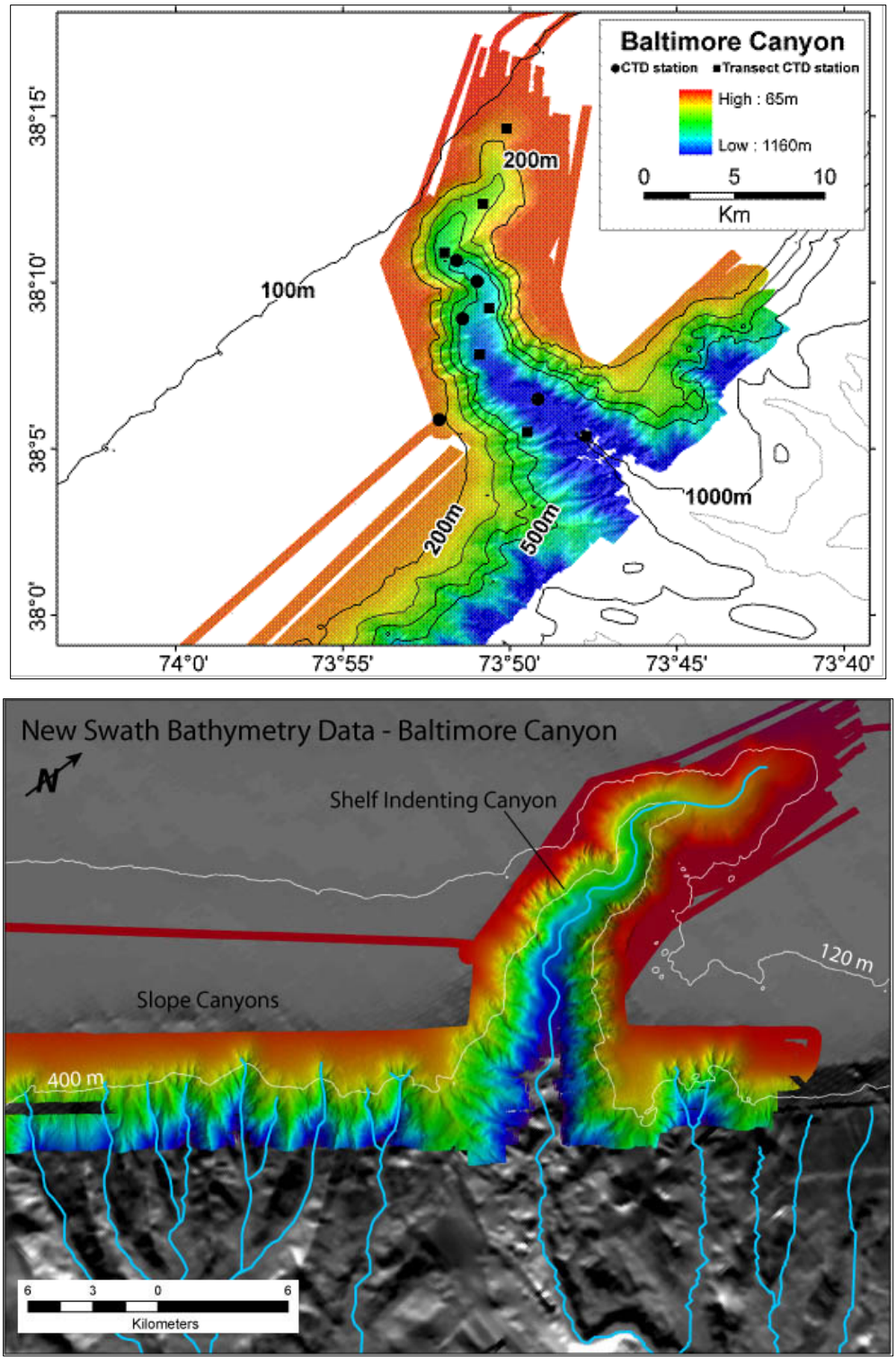

Figure 4. Expanded views of Baltimore Canyon illustrating area mapped with multibeam sonar during the 2011 Mapping Cruise. Hydrographic profile (CTD) stations also are noted (top panel).

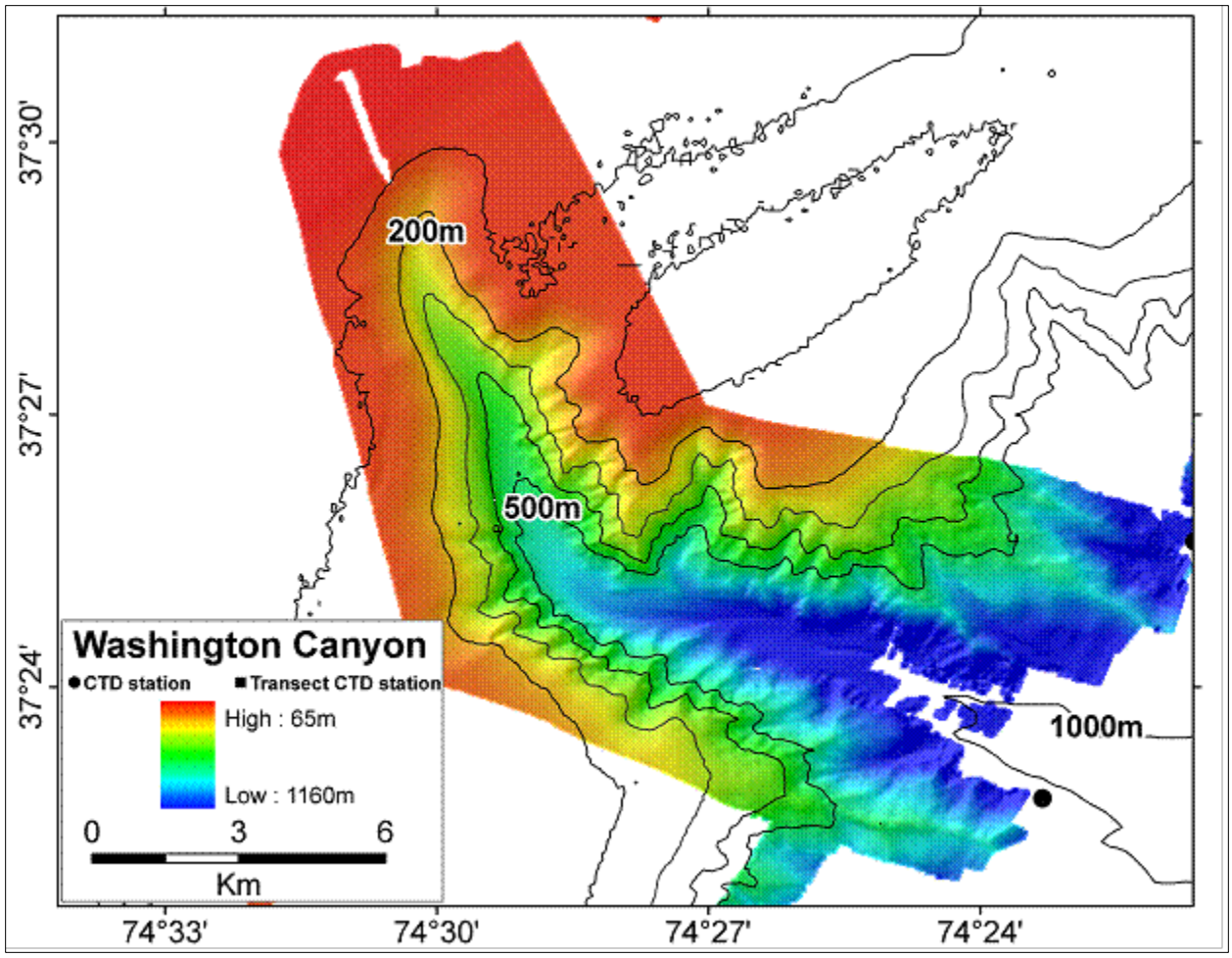

Figure 5. Expanded view of Washington Canyon illustrating area mapped with multibeam sonar during the 2011 Mapping Cruise. Hydrographic profile (CTD) stations also are noted.

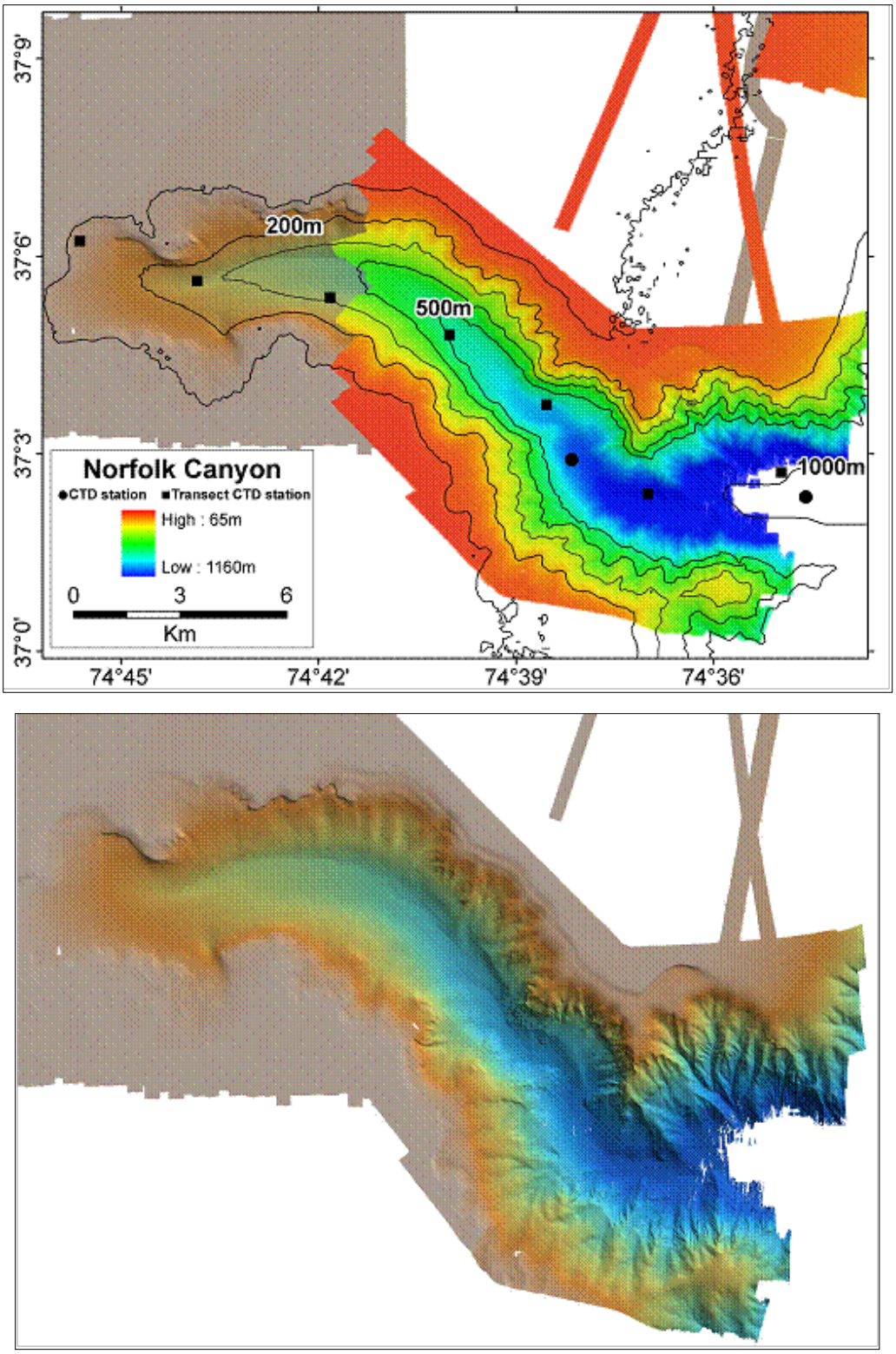

Figure 6. Expanded views of Norfolk Canyon illustrating area mapped with multibeam sonar during the 2011 Mapping Cruise. Hydrographic profile (CTD) stations also are noted (top panel).

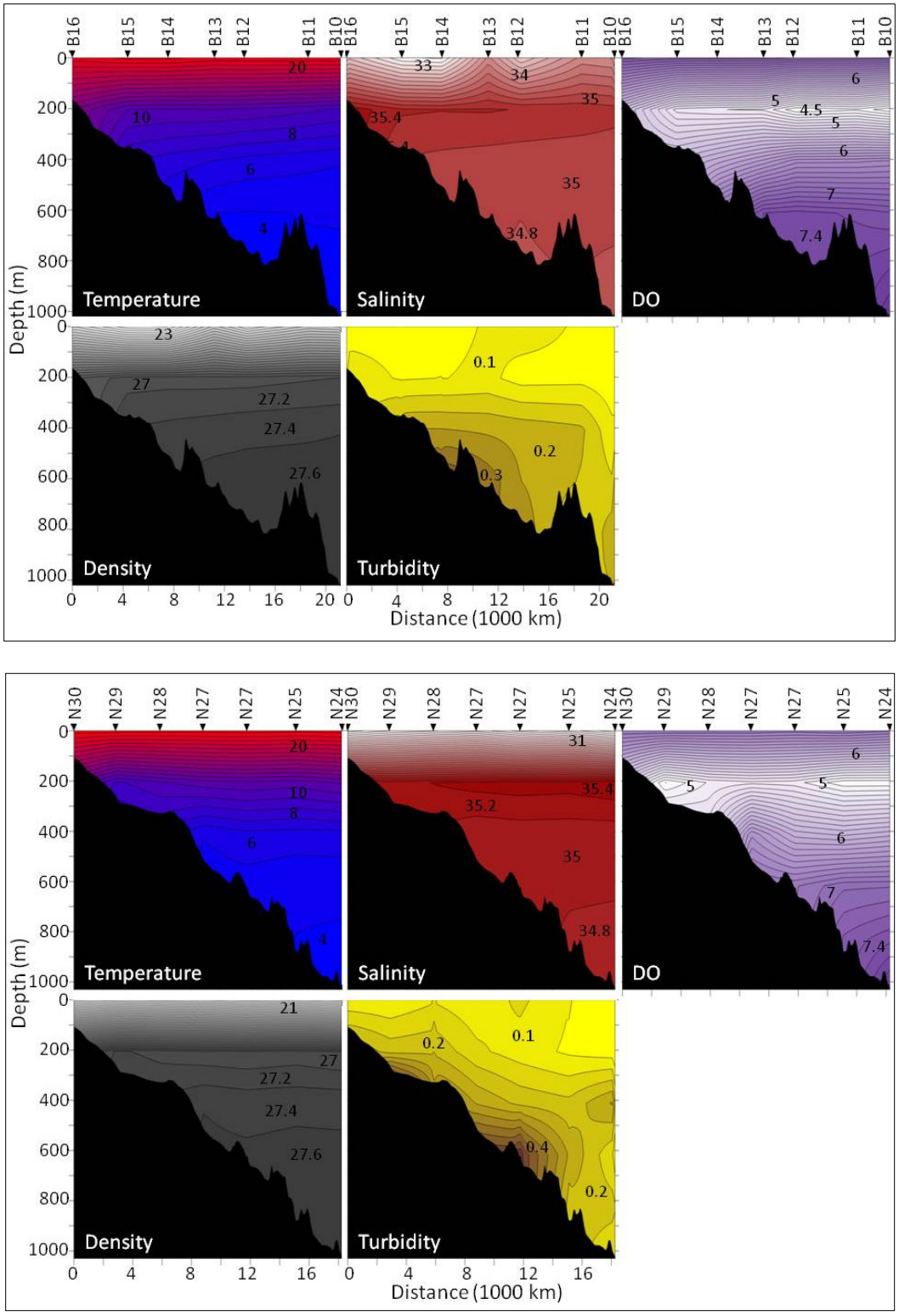

Figure 7. Water column data for hydrographic profile transects conducted down the axes of Baltimore Canyon (top panels) and Norfolk Canyon (bottom panels) during the 2011 Mapping Cruise. Station numbers are across the top. DO = dissolved oxygen.

Table 2. Water column stations sampled in the western North Atlantic (5–14 June 2011) in the region of the Middle Atlantic Canyons.

Station Number	Date	Day/ Night	Total Time (min)	Start Latitude (°N)	Start Longitude (°W)	End Latitude (°N)	End Longitude (°W)	Depth Range (m)
NF-2011-001	5 June 2011	N	22	33°26'11.16"	76°50'26.58"	33°26'20.10	76°50'12.90"	S-220
NF-2011-002	6 June 2011	D	16	37°45'53.10"	74°14'08.22"	37°45'44.04"	74°14'18.78"	S-106
NF-2011-003	6 June 2011	D	18	38°06'29.28"	73°49'09.60"	38°06'24.90"	73°49'14.10"	S-888
NF-2011-004	7 June 2011	N	16	38°08'54.48"	73°51'24.84"	38°08'44.76"	73°51'37.14"	S-468
NF-2011-005	7 June 2011	D	13	38°10'39.84"	73°51'35.58"	38°10'56.70"	73°52'03.06"	S-459
NF-2011-006	7 June 2011	D	12	38°10'01.98"	73°50'58.44"	38°10'04.20"	73°51'11.28"	S-557
NF-2011-007	8 June 2011	N	8	38°05'52.26"	73°52'06.66"	38°05'55.98"	73°52'09.96"	S-149
NF-2011-008*	8 June 2011	D	22	37°56'39.24"	73°52'26.76"	37°56'54.54"	73°52'20.40"	S-1,025
NF-2011-009**	8 June 2011	N	18	37°49'39.48"	74°03'35.04"	37°49'52.32"	73°03'39.48"	S-800
NF-2011-B10*	9 June 2011	D	23	38°05'23.40"	73°47'42.72"	38°05'30.12"	73°47'47.76"	S-1,005
NF-2011-B11**	9 June 2011	D	20	38°05'30.12"	73°49'28.26"	38°06'53.16"	73°49'43.44"	S-872
NF-2011-B12*	9 June 2011	D	15	38°07'49.98"	73°50'53.82"	38°08'04.68"	73°51'10.62"	S-709
NF-2011-B13**	9 June 2011	D	17	38°09'13.56"	73°50'37.26"	38°09'28.80"	73°50'49.26"	S-625
NF-2011-B14*	9 June 2011	D	12	38°10'53.58"	73°51'57.18"	38°10'50.46"	73°51'57.18"	S-495
NF-2011-B15**	9 June 2011	D	10	38°12'21.72"	73°50'47.76"	38°12'22.62"	73°50'46.74"	S-347
NF-2011-B16	9 June 2011	D	6	38°14'37.92"	73°50'05.76"	38°14'38.64"	73°50'06.42"	S-163
NF-2011-017	10 June 2011	D	17	37°50'28.20"	74°04'31.14"	37°50'32.10"	74°04'49.80"	S-571
NF-2011-018**	10 June 2011	D	20	37°25'36.18"	74°21'37.98"	37°25'28.44"	74°21'50.88"	S-984
NF-2011-019**	11 June 2011	D	22	37°22'46.26"	74°23'18.60"	37°22'26.94"	74°23'17.88"	S-740
NF-2011-020	11 June 2011	D	6	37°18'06.12"	74°29'54.54"	37°18'00.06"	74°29'55.74"	S-182
NF-2011-021	12 June 2011	D	6	37°18'34.08"	74°32'01.32"	37°18'19.56"	74°32'07.86"	S-95
NF-2011-022**	12 June 2011	D	25	37°02'20.64"	74°34'36.06"	37°02'45.42"	74°35'08.28"	S-1,085
NF-2011-023	12 June 2011	N	18	37°02'54.48"	74°38'09.24"	37°02'51.12"	74°37'56.76"	S-742
NF-2011-N24*	13 June 2011	D	29	37°02'43.14"	74°34'58.26"	37°02'24.78"	74°35'05.04"	S-1,001
NF-2011-N25**	13 June 2011	D	19	37°02'23.64"	74°36'59.82"	37°02'18.24"	74°37'02.64"	S-751
NF-2011-N26*	13 June 2011	D	17	37°03'4.64"	74°38'2.22"	37°03'8.22"	74°38'7.56"	S-528
NF-2011-N27**	13 June 2011	D	13	37°04'8.54"	74°40'0.48"	37°04'3.86"	74°40'3.86"	S-491
NF-2011-N28*	13 June 2011	D	8	37°05'2.44"	74°41'9.50"	37°05'7.82"	74°41'8.56"	S-294
NF-2011-N29**	13 June 2011	D	8	37°05'7.38"	74°43'0.40"	37°05'6.48"	74°43'4.78"	S-268
NF-2011-N30	13 June 2011	D	7	37°06'3.74"	74°45'7.50"	37°06'0.02"	74°45'2.06"	S-106
NF-2011-031	13 June 2011	D	5	36°54'9.44"	74°49'3.90"	36°54'8.18"	74°49'1.86"	S-52
NF-2011-032*	14 June 2011	D	20	35°32'2.08"	74°46'1.20"	35°32'0.16"	74°45'8.00"	S-943

D = Day (0700–2000 h EST), N = Night (2000–0700 h EST), S = Surface. * = water sample taken for aragonite saturation analysis. ** = Water sample taken for POM analysis.

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Appendix B

2012 Sampling Cruise Report

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OCS Study
BOEM 2017-061

Exploration and Research of Mid-Atlantic Deepwater Hard Bottom Habitats and Shipwrecks with Emphasis on Canyons and Coral Communities: Atlantic Deepwater Canyons Study

2012 Sampling Cruise

March 2013

U.S. Department of the Interior
Bureau of Ocean Energy Management
Atlantic OCS Region

BOEM
Bureau of Ocean Energy Management

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OCS Study
BOEM 2017-061

Exploration and Research of Mid-Atlantic Deepwater Hard Bottom Habitats and Shipwrecks with Emphasis on Canyons and Coral Communities: Atlantic Deepwater Canyons Study

2012 Sampling Cruise

March 2013

Prepared under BOEM Contract M10PC00100 by:

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BOEM
Bureau of Ocean Energy Management

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Appendix B: 2012 Sampling Cruise

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LIST OF ACRONYMS AND ABBREVIATIONS

ALBEX	Autonomous Lander for Biological Experiments (NIOZ lander)
BOBO	Bottom Boundary Layer (lander)
BOEM	Bureau of Ocean Energy Management
CSA	CSA Ocean Sciences Inc.
CTD	conductivity, temperature, depth profiling
IIMR	Institute for International Maritime Research, Inc.
NIOZ	Royal Netherlands Institute for Sea Research
NCMNS	North Carolina Museum of Natural Sciences
NOAA, OER	National Oceanic and Atmospheric Administration, Office of Ocean Exploration and Research
OIMB	Oregon Institute of Marine Biology
MCI	Marine Conservation Institute
POM	particulate organic matter
ROV	remotely operated vehicle
SBE	Sea-Bird Electronics
TAMU	Texas A&M University
UNCW	University of North Carolina, Wilmington
UNOLS	University-National Oceanographic Laboratory System
URI	University of Rhode Island
USGS	U.S. Geological Survey

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1 INTRODUCTION

CSA International, Inc.[1] was contracted to conduct three field sampling efforts (cruises), associated with the Bureau of Ocean Energy Management (BOEM)-funded contract entitled Exploration and Research of Mid-Atlantic Deepwater Hard Bottom Habitats and Shipwrecks with Emphasis on Canyons and Coral Communities, Contract No. M10PC00100. This report describes the first field sampling cruise (2012 Sampling Cruise) of the Canyons project using the National Oceanic and Atmospheric Administration, Office of Ocean Exploration and Research's (NOAA, OER's) ship *Nancy Foster* (August–September 2012).

2 BACKGROUND AND OBJECTIVES

2.1 BACKGROUND

Submarine canyons are dominant features of the outer continental shelf and slope of the U.S. Atlantic coast from Cape Hatteras to the Gulf of Maine. They are important conduits of anthropogenic pollutants, organic carbon, and sediments from shallow to deeper waters and support ecologically important ecosystems, such as cold seeps and hard bottom and coral habitats. The geology of these features has been well studied; however, despite their high productivity, biological data are limited (particularly deeper than 200 m [656 ft]). Much of the biological information on these canyons resides in cruise or project reports, and has not been published as peer reviewed literature. The canyons between Cape Hatteras and Cape Cod are the subject of potential oil and gas exploration, support intensive fisheries, and have been considered in the past for National Marine Sanctuary designation and yet these are poorly understood.

In 2010, BOEM initiated a 4-year multidisciplinary Atlantic Deepwater Canyons study, which focused on ecologically significant habitats (cold seeps, hard bottoms, and shipwrecks) in Norfolk, Washington, and Baltimore canyons. The first activity for this project was a multibeam sonar mapping and water column sampling cruise from Norfolk Canyon to Baltimore Canyon using the NOAA ship *Nancy Foster* (NF-11-04, 4–17 June 2011. Detailed bathymetric maps generated during the 2011 Mapping Cruise (CSA International, Inc. 2011) were used to guide sampling activities during all three legs of the 2012 Sampling Cruise (this report, CSA Ocean Sciences Inc. 2013), which originated and ended in Charleston, South Carolina. The 2012 Sampling Cruise consisted of three legs, with port days between legs in Norfolk, Virginia. During daylight hours, the remotely operated vehicle (ROV) *Kraken 2* (University of Connecticut) was used for ROV surveys and sampling. At night or during times when the ROV could not be used, non-ROV sampling was conducted, including box coring, bottom trawling, benthic lander (four) and mooring (two) deployments, multibeam mapping, and water column conductivity, temperature, depth profiling (CTD) surveys and water sampling. Education and outreach activities were incorporated into the cruise, using National Oceanic and Atmospheric Administration (NOAA) Ocean Explorer, North Carolina Museum of Natural Sciences (NCMNS), and other institutional websites. This cruise was a collaborative effort between BOEM (the major funding source), CSA (the BOEM contractor) and its academic partners, NOAA OER (provider of ship and ROV time), and the U.S. Geological Survey (USGS).

2.2 OBJECTIVES

2.2.1 Leg 1 and 2 Objectives

1. Conduct daily (12 h) ROV operations to survey target canyon habitats and fauna and collect samples in the depth range of approximately 200 to 1,000 m (656 to 3,280 ft).

1 CSA International, Inc. changed its company name to CSA Ocean Sciences Inc. effective 1 January 2013.

2. Deploy two benthic landers and one mooring each in Baltimore Canyon and Norfolk Canyon.
3. Collect replicate benthic box core samples inside and outside of target canyons in the depth range of approximately 100 to 1,500 m (328 to 4,921 ft).
4. Conduct bottom trawl operations (using a 16-ft otter trawl) inside and outside of target canyons in the depth range of 100 to 1,000 m (328 to 3,280 ft).
5. Conduct vertical water column CTD casts to generate environmental profiles and use Niskin bottles to collect water samples for aragonite saturation, particulate organic matter (POM), and other water quality analyses.
6. Process samples and data to support project objectives.
7. Maintain live corals in chilled re-circulating tanks for post-cruise laboratory experiments.
8. Conduct education and outreach activities (regular postings to multiple internet sites, live interview with NCMNS, NOAA OceanAge profiles).
9. Objectives of ROV *Kraken 2*:
   Conduct video transects and photoquadrats or photomosaics over selected areas of different natural habitat types.
10. During each dive, collect fauna from various taxonomic groups in different natural habitats as follows:
    - Collect live corals and other invertebrates from selected sites and transport to surface in insulated bioboxes to maintain alive on board the ship in a chilled deck tank;
    - Make numerous discrete collections of invertebrates (particularly corals) and fishes from multiple sites for various biological studies;
    - Collect large colonies of selected coral species for age, growth, and paleoecology studies; and
    - Collect voucher specimens of selected taxa from each location.
11. Deploy site markers at collection sites as needed.
12. Collect environmental data on depth, oxygen, temperature, salinity, and pH with ROV-mounted instruments.
13. Collect near-bottom water samples with Niskin bottles mounted on the ROV.
14. Collect video and still imagery of deployed benthic landers.
15. Collect push cores for sediment and benthic sampling.

2.2.2 Leg 3 Objectives

2.2.2.1 Archaeology Objectives

Find and identify all eight shipwrecks from the Billy Mitchell-Project B fleet.

- Ground truth other potential shipwreck targets from multibeam sonar mapping data collected from Norfolk Canyon to Baltimore Canyon aboard the NOAA ship *Nancy Foster* (NF-11-04, 4–17 June 2011).
- Conduct multibeam surveys of select areas south of Norfolk Canyon.
- Conduct video transects and photo quadrats or photo-mosaics over selected shipwrecks and other archaeological features.
- Document and image shipwreck and other archaeological sites using high definition video and still photography.
- Assess the condition, threats, and archaeological potential of submerged cultural heritage sites in the vicinity of Norfolk Canyon.

- Assess the potential for paleo-archaeological sites near Norfolk Canyon and the potential for paleo-archaeological landscape reconstruction.

2.2.2.2 Biology and Related Objectives

- Collect dominant epifauna from each shipwreck.
- Collect environmental data including depth, oxygen, temperature, salinity, and pH with ROV-mounted instruments.
- Collect sediment push cores to assess benthic communities near shipwrecks.
- Collect replicate benthic box core samples inside and outside of Norfolk Canyon in the depth range of approximately 100 to 1,500 m (328 to 4,921 ft).
- Conduct bottom trawl operations (using a 16 ft otter trawl) inside and outside of Norfolk Canyon in the depth range of 100 to 1,000 m (328 to 3,280 ft).
- Conduct vertical hydrographic profiles of the water column using a recording CTD probe and collect seawater samples at selected depth levels to analyze aragonite saturation, POM, and other water quality parameters using Niskin-type water sampling bottles.
- Process samples and data to support project objectives.

2.2.3 Educational Outreach Objectives

Education and outreach activities included regularly posting to multiple internet sites, conducting live interviews with the NC Museum of Natural Sciences, and profiling the NOAA OceanAge.

3 METHODS

3.1 FIELD METHODS

This section presents a brief description of field data collection methods for ROV operations, water column sampling, sediment sampling, benthic landers and moorings, bottom trawling, and specimen and data treatment.

3.1.1 ROV Operations

The ROV used in these cruises was the University of Connecticut's ROV *Kraken 2* (**Figure 1**), which is a Max Rover class science-configured vehicle capable of operating to 1,000 m (3,280 ft). The position of *Kraken 2* was continuously recorded using an ORE Trackpoint II ultrashort baseline tracking system combined with a Winfrog integrated navigation system. For each dive, a color-shaded bathymetric geotiff map was provided. These were products of the 2011 Mapping Cruise (CSA International, Inc. 2011) and were useful for guiding the dives. The main science video camera on the ROV was a Kongsberg OE14-502 Hi-Definition video camera. Two parallel lasers mounted 10 cm (4 in.) apart were turned on most of the time when using the video camera. High Definition (HD) video was recorded to a hard drive during the dive, and two copies of the dive video were made onto Apple-formatted, two terabyte hard drives every night after each dive. The main digital still camera (a Kongsberg camera using a Canon G11 Powershot system) was mounted on the same pan and tilt as the above video camera. A down-looking digital still camera was also mounted on the ROV frame and used in both continuous and intervalometer mode. Position data were time-synchronized with all imagery and samples. *Kraken 2* instruments recorded all times as UTM; however, since eventual analyses use local time, local time was recorded on analogue station sheets and on the audio channel. A six-function manipulator arm was used to collect samples. The vehicle had an insulated polypropylene biobox (12 × 36 × 10 in.) mounted in the center of the tool skid, and this was divided into three sections to contain larger biological specimens and those that were to be kept alive after the dive, and archaeological samples. Surrounding the biobox were seven PVC

quivers capped with rubber stoppers which could hold small samples or sediment core tubes (**Figure 1**). Two (occasionally four) push corers were carried on many dives. Additional sampling capacity was provided by a suction sampler which connected to eight separate sample buckets. UNCW provided two 6-L Niskin bottles to collect bottom water samples, and these were mounted vertically to the bow port side of the vehicle (**Figure 1**) and were triggered to close with the manipulator arm. A Sea-Bird Electronics (SBE)19*plus* SeaCAT Profiler (also provided by UNCW) was attached to the ROV to record environmental data during the dive (see CTD section for details).

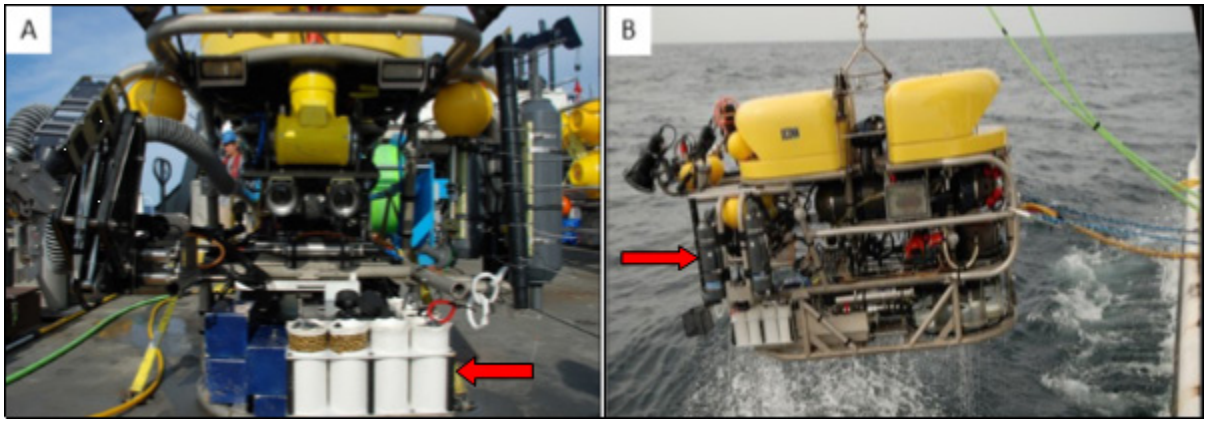

Figure 1. ROV *Kraken 2* showing (A) bow of *Kraken 2* with tube sample containers ('quivers') in the foreground and (B) two Niskin water collection bottles mounted vertically near the bow of the vehicle.

Each ROV dive was scheduled for a 12-hr working day for the ROV crew. The target dive period was from 08:30 h (launch) to 18:30 h (recovery), subject to change as conditions and logistics dictated. During Legs 1 and 2, each dive had multiple objectives, with some tasks given priority on certain dives, but most ROV dives followed a similar pattern, emphasizing bottom transecting, collecting and photographing specimens on or near the bottom. Water collections and tube cores were also taken on selected dives. During Leg 3, most ROV dives followed a similar pattern emphasizing systematic video documentation and photography of shipwrecks and diagnostic features, and the collection and photography of biological specimens on or near the shipwrecks. Tube cores were also taken on selected dives. During each ROV dive, a lead scientist and a second observer were on watch with the ROV crew. The lead scientist directed the dive (course, speed, transect configuration, data collection and sampling), and made audio annotations of dive activities. The second observer recorded events throughout the dive on hard copy and digital event logs. All dives began at the deepest targeted location and worked upslope. During the initial descents we collected water column hydrographic data using the Sea-Bird CTD profiler and took notes and observations of distributions and behaviors of mid-water fauna. Specimen or sample collecting began after the ROV landed on bottom and occurred throughout the dive, including both targeted objectives and fortuitous encounters. Standardized video transects were taken whenever the ROV moved from one location to another. During transects, the video camera was moved to pre-determined pan/tilt position, set on wide angle, and the ROV ran at slow speed close to the bottom. Transects were of variable lengths; some were short as sampling was frequent and interrupted the transects and some were longer, covering wide ranges of habitats. Video transects were taken on every dive since these are the primary means of visual habitat characterization, but the number of transects varied per dive. Except when the ROV was in the water column, video recording and digital still photography were conducted throughout each dive; however, because the science cameras were also used by the pilots to operate the ROV, they were not always collecting useful scientific information. Every collection was documented with video as far as possible (see previous statement). The primary targets were corals (scleractinians and gorgonians) for multiple objectives (reproduction, microbiology, genetics, trophodynamics and paleoecology), and

specimens were collected from multiple locations over a wide depth range. Other specimens were also collected including seep fauna, fish, and other benthic invertebrates. Sediments and water samples were collected for infauna and water chemistry.

During Leg 3, archaeological sampling was undertaken very selectively. During each ROV dive, the lead scientist (Mather) and a second observer were on watch with the ROV crew. The lead scientist directed the dive (course, speed, transect configuration, data collection and sampling), and made audio annotations of dive activities. The second observer recorded events throughout the dive on hard copy and digital event logs. In addition, at least one and usually two archaeologists (Watts or Irion) monitored the dives. All dives were systematic in coverage. Shipwrecks were usually imaged along both the port and starboard side before central longitudinal transects were attempted. In many cases, fishing gear and debris provided significant challenges to ROV operations at shipwreck sites. Biological specimen or sample collecting was usually reserved for the last part of the dive. As far as possible, every collection was documented with video. Except when the ROV was in the water column, video recording and digital still photography were conducted throughout each dive.

3.1.2 Water Column Sampling

The *Nancy Foster*'s CTD (SBE 911*plus* profiler) with a rosette of twelve 5-L Niskin bottles was used to record water column environmental profiles and collect water samples. The CTD measured turbidity (Seapoint probe, formazin turbidity units), dissolved oxygen (ml/L), altitude (m), depth (m), conductivity (Siemens/m), temperature (°C), and salinity. Both single location CTD casts and multilocation transects were accomplished in Baltimore and Norfolk canyons (**Figures 2** and **3**). CTD transects were taken down the axes of and across sections of both canyons. Water samples were collected from specific depths in the water column at selected stations (during the upcast) by selectively triggering (closing) the Niskin bottles. Water samples collected during CTD casts are being processed by various project investigators according to standard protocols for analysis of aragonite saturation state, nutrient concentrations, trace metals, and POM.

The UNCW SBE 19*plus* SeaCAT Profiler was attached to the port side of the ROV *Kraken 2* and measured turbidity (Seapoint probe, formazin turbidity units), dissolved oxygen (ml/L), depth (m), conductivity (Siemens/m), temperature (°C), salinity and pH. The instrument recorded data through the water column as well as on the bottom during each ROV dive.

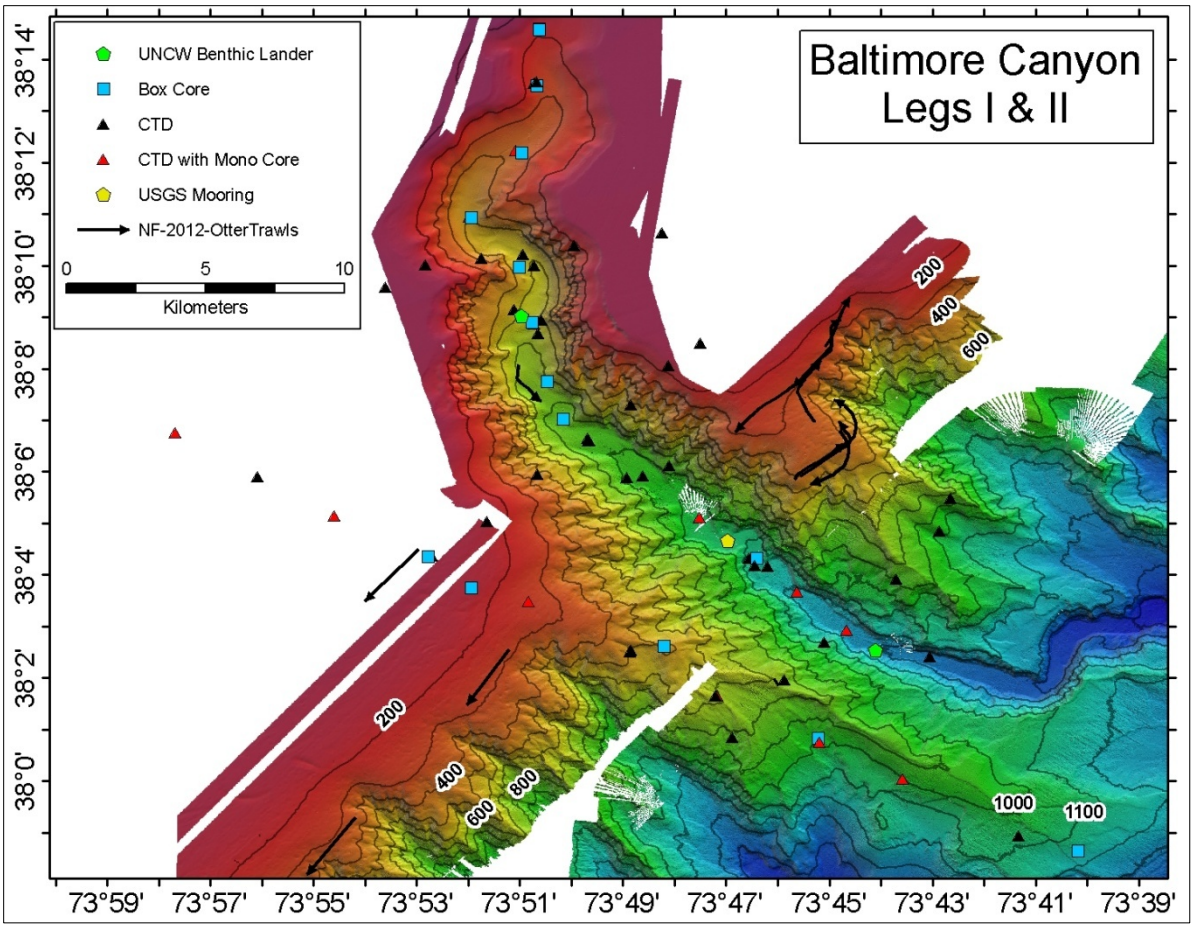

Figure 2. Non-ROV stations sampled in and around Baltimore Canyon during Legs 1 and 2 of the 2012 Sampling Cruise (17 August–14 September 2012).

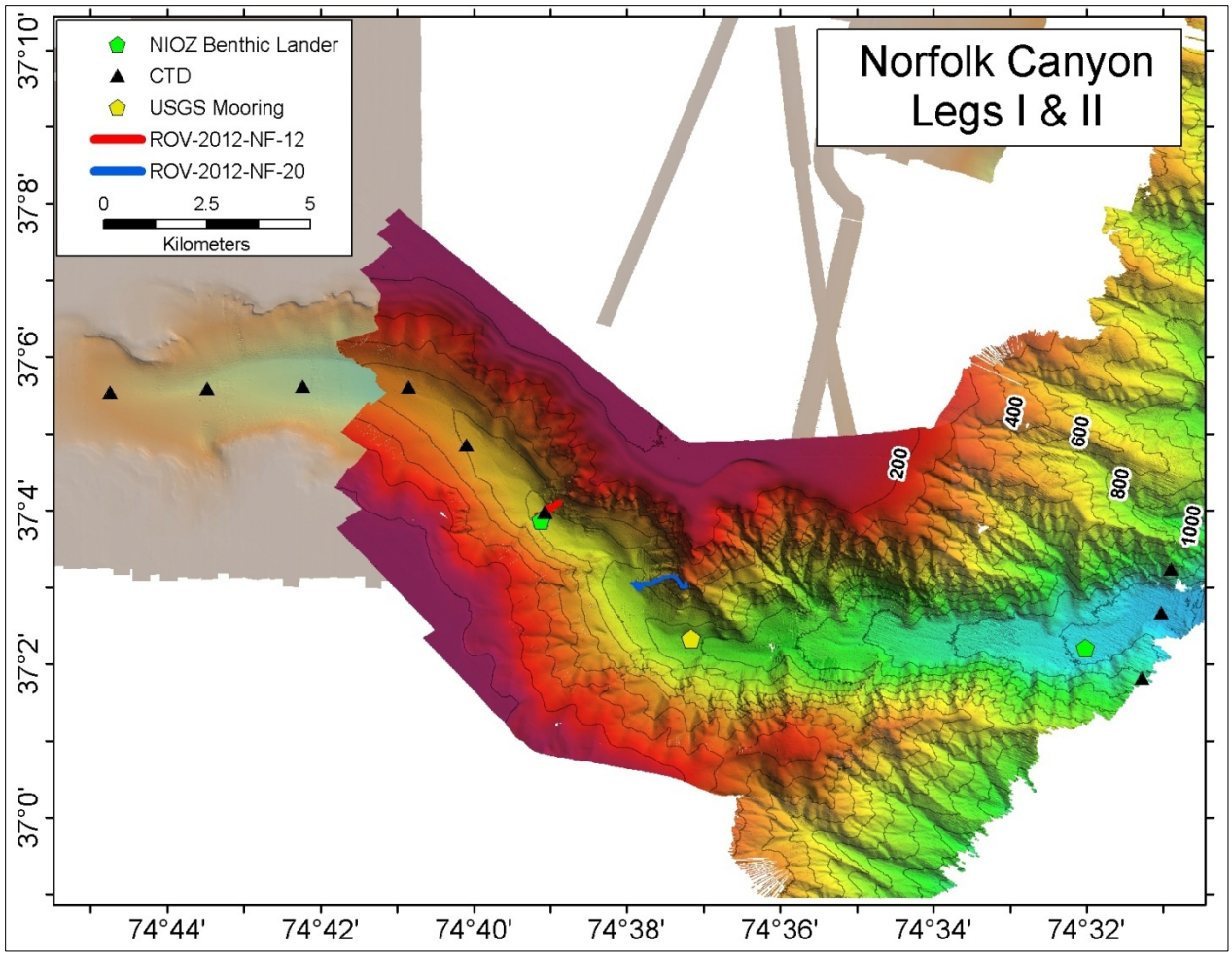

Figure 3. ROV (two dives) and non-ROV stations sampled in and around Norfolk Canyon during Legs 1 and 2 of the 2012 Sampling Cruise (17 August–14 September 2012).

3.1.3 Sediment Sampling

A large box corer (provided by Royal Netherlands Institute for Sea Research [NIOZ]) was used extensively during Legs 1 and 3 (**Figure 4**). As the ship maintained station using dynamic positioning, the box core was lifted through the A-frame by the main winch, was lowered to the bottom until bottom contact was determined (triggering the device to close), and then it was returned to the surface. NIOZ scientists also provided a small monocore (**Figure 4**) which was suspended approximately 10 m (33 ft) beneath the CTD on some casts. This device provided a core sample of the bottom at several locations also sampled with the ship's CTD. Cores will be processed by various investigators for macrofauna, meiofauna, microbes, organic C/N, particle size, δ13C, δ15N, and other parameters.

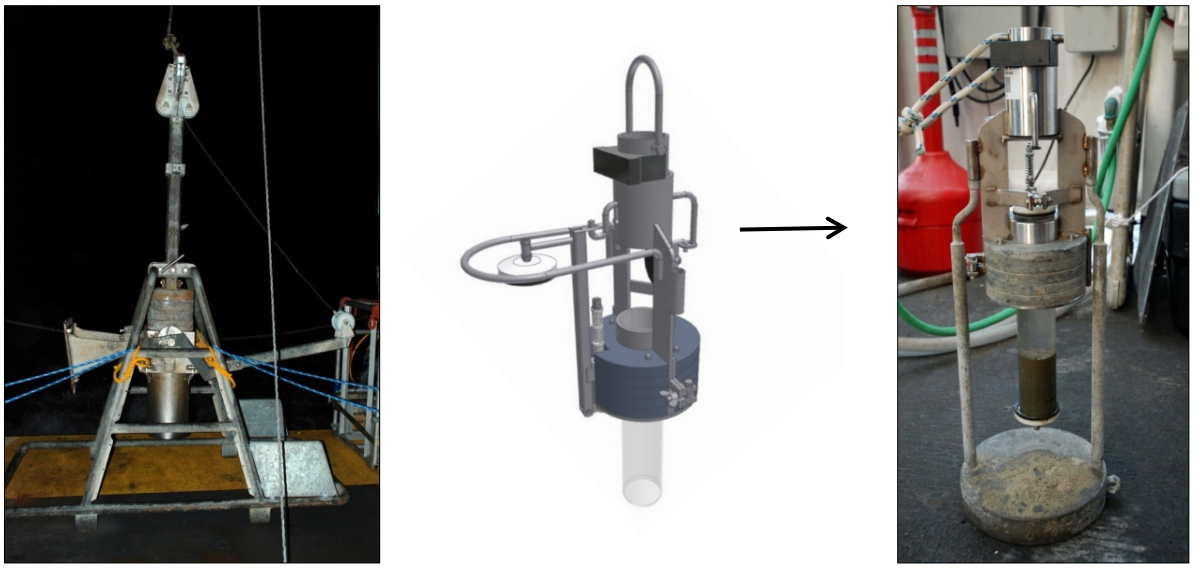

Figure 4. NIOZ box core (left) and NIOZ monocore (center and right) used during the 2012 Sampling Cruise. The monocore was suspended approximately 10 m below the CTD carousel. The photo on the right shows a successful core.

3.1.4 Benthic Landers and Moorings

Two NIOZ and two UNCW landers (**Figure 5**) were each configured with a Sarl Technicap PPS 4/3 sediment trap programmed to rotate a sample bottle (250 ml) at 30-day intervals, delivering a total of 12 samples during the 1-year deployment. Both NIOZ landers (ALBEX and BOBO) deployed in Norfolk Canyon have instruments to record salinity, temperature, turbidity, and fluorescence. In addition, the BOBO lander (deployed at 1,364 m [4,475 ft]) has an upward-looking ADCP current meter mounted approximately 2 m (6.5 ft) off the bottom, and the ALBEX lander (deployed at 917 m [3,000 ft]) has a Nortek Aquadopp current meter mounted approximately 1.5 m off the bottom to measure bottom currents. Each of the two UNCW landers has an Aanderaa RCM string logger with instruments to measure temperature, salinity, turbidity, dissolved oxygen, and bottom currents. All RCM probes were approximately 1.5 m (5 ft) off bottom except the current meter which was approximately 2 m (6.5 ft) off bottom. The UNCW lander placed in the head of Baltimore Canyon also carried three live coral experiments. Three acrylic chambers (designed by Brooke and Ross) were used to deploy a growth and survival experiment using live corals. The chambers were placed on the lower frame of the lander approximately 0.5 m (1.6 ft) off the bottom. Each chamber contained three small fragments of "bubblegum" coral (*Paragorgia arborea*), which were measured and photographed prior to deployment. All four landers carried settlement plate microbiology experiments for USGS (C. Kellogg). The two UNCW landers carried additional settlement plate arrays and two multisubstrate settlement units as part of an international cooperation with the InDeep/Serpent Deep Ocean Colonization Project. The two USGS moorings (**Figure 6**) each held a Honjo Parflux sediment trap with 13 500-ml bottles. Each mooring also held a 300 kHz ADCP and a Sea-Bird Microcat 37 recording temperature and conductivity at 300-second intervals.

All landers and moorings will be retrieved in approximately one year during the next project cruise. If possible, these platforms may be redeployed for a second year of data if there is a plan for retrieval.

Figure 5. Top: UNCW benthic landers; bottom left: NIOZ ALBEX lander; and right: NIOZ BOBO lander being deployed over Norfolk Canyon during the 2012 Sampling Cruise. (ALBEX = Autonomous Lander for Biological Experiments; BOBO = Bottom Boundary Layer (lander); NIOZ = Royal Netherlands Institute for Sea Research; UNCW = University of North Carolina, Wilmington.)

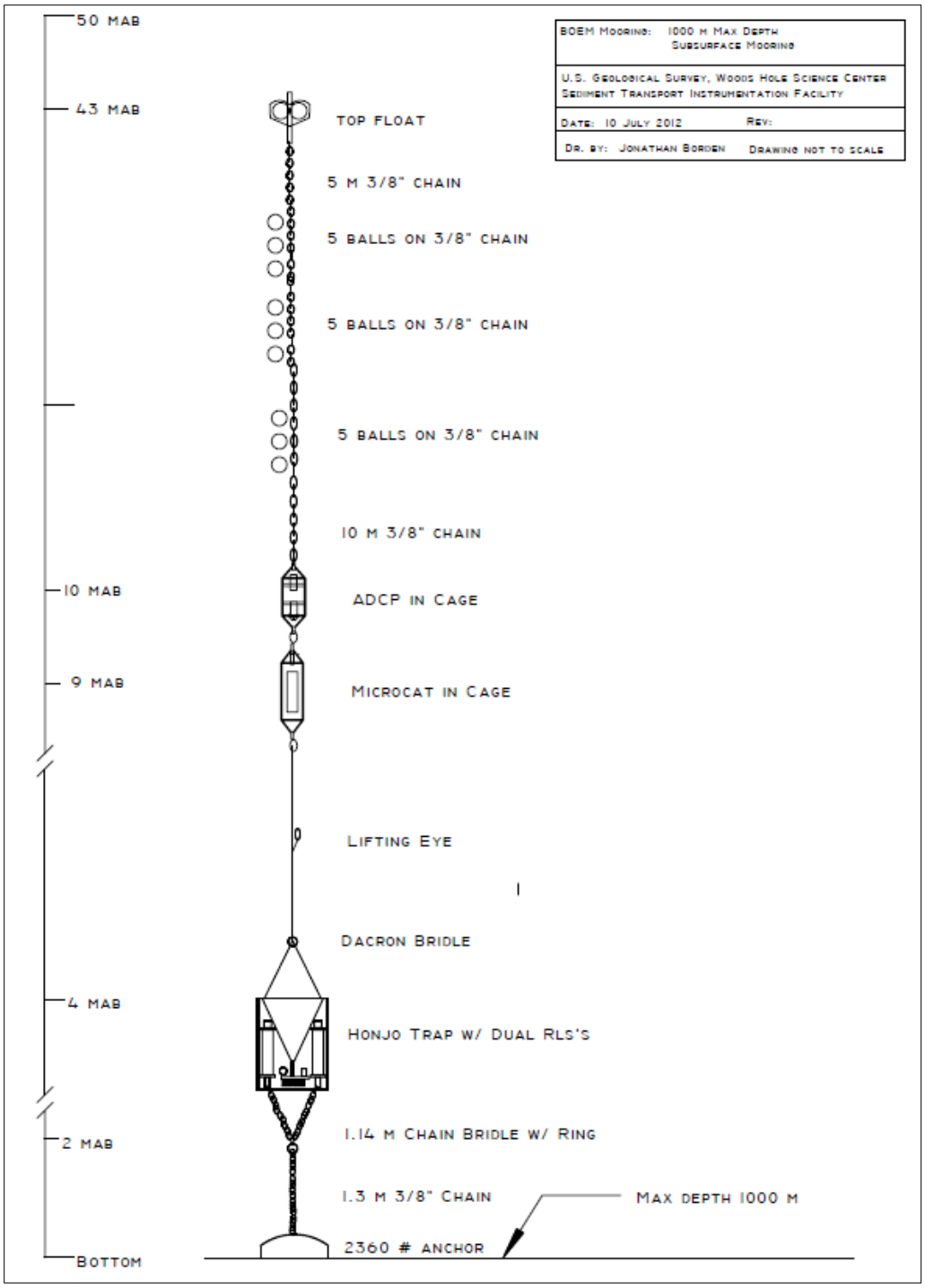

Figure 6. Schematic of moorings provided by the U.S. Geological Survey. One mooring was deployed each in the middle area of Norfolk Canyon and Baltimore canyon.

3.1.5 Bottom Trawling

Bottom trawling of selected areas was accomplished using a 4.9-m (16-ft) headrope otter trawl. The net body was constructed with a mesh size of 38.1 mm and the cod end liner with a mesh size of 3 mm. Trawling was conducted over a depth range of approximately 150 to 800 m (492 to 2,625 ft) off the stern using the ship's main winch spooled with ½" 6 × 19 wire. This winch was provided by NOAA OER which procured it from the University-National Oceanographic Laboratory System (UNOLS) fleet. Trawls generally averaged approximately a 2.5:1 wire scope and, once the net was on bottom, were towed for a duration of 30 min at a ground speed of approximately 2 knots (3.7 km/h).

3.1.6 General Specimen and Data Treatment

Samples from all collections were processed at sea according to various scientific objectives. Fishes and invertebrates that were collected by trawling and voucher specimens from the ROV were immediately preserved in 10% formalin (seawater-buffered solution), to be transferred to 70% ethanol or 50% isopropanol (depending on taxa needs) after the cruise. Samples for genetics were preserved in nondenatured ethanol, in RNA-later or on FTA cards. Before preservation, sub-samples were taken from selected samples for stable isotope analyses. These sub-samples were then dried and stored for further processing after the cruise. Isotope samples were also taken from water and sediment collections. Samples of selected corals (*Paragorgia* sp.*, Desmophyllum dianthus* and *Lophelia pertusa*) and seep mussels that were brought to the surface in the ROV insulated bioboxes were sub-sampled for genetics, reproduction, paleoecology, and isotopic analysis. Remaining specimens were transferred to live tanks, that were large insulated containers that were cooled to 6 to 7° C using a portable chiller. At the end of each leg, these samples were shipped to holding systems at Oregon Institute of Marine Biology (OIMB) where they will be used for physiology experiments. All genetic samples, and representatives of most other species were set aside for on-board photography, using a light table under daylight balanced strobes or daylight balanced fluorescent lights.

4 FIELD RESULTS

The field survey was conducted between 15 August and 2 October 2012. Vessel mobilization and demobilization occurred at locations indicated in **Table** 1.

Table 1. Vessel mobilization and demobilization locations for the 2012 Sampling Cruise.

Cruise Leg	Mobilization	Demobilization
1	NOAA Charleston Marine Support Facility, Charleston, South Carolina	NOAA Marine Operations Center, Norfolk, Virginia
2	NOAA Marine Operations Center, Norfolk, Virginia	NOAA Marine Operations Center, Norfolk, Virginia
3	NOAA Marine Operations Center, Norfolk, Virginia	NOAA Charleston Marine Support Facility, Charleston, South Carolina

NOAA = National Oceanic and Atmospheric Administration.

4.1 SURVEY PERSONNEL

Participants for the survey are presented in **Table 2**. Survey operations were conducted on a 24-hour basis; therefore, the scientific crew was divided into a day and a night watch.

Table 2. Affiliation of science personnel for the 2012 Sampling Cruise and roles for Legs 1–3. Individuals assigned to night watch operations are noted with an asterisk (*).

Cruise Leg	Name	Affiliation	Role
1	Steve W. Ross	UNCW	Chief Scientist–fishes and landers
	Sandra Brooke	OIMB	Co-Chief Scientist–coral and seep biology
	Mike Rhode*	UNCW	Night Watch Chief, Data Manager
	Gerard Duineveld*	NIOZ	Scientist–biology and landers
	Furu Mienis*	NIOZ	Scientist–geology and landers
	Craig Robertson*	Bangor University (UK)	Student–modeling and benthic ecology
	Brendan Roark	TAMU	Scientist–paleoecology
	Eric Hanneman	NCMNS	Education and Outreach
	Katharine Coykendall	USGS	Scientist–genetics
	Chris Kellogg	USGS	Scientist–microbiology
	Amanda Demopoulos*	USGS	Scientist–benthic ecology
2	Sandra Brooke	OIMB	Co-Chief Scientist–coral and seep biology
	Steve W. Ross	UNCW	Co-Chief Scientist–fishes and landers
	Mike Rhode*	UNCW	Night Watch Chief, Data Manager
	Andy Miller*	UNCW	Technician
	William McBurney*	UNCW	Student–general assistance
	Scott France	University of Louisiana, Lafayette	Scientist–coral genetics
	Liz Baird	NCMNS	Education and Outreach
	Art Howard	ArtWork, Inc.	Video and photography
	Jennie McClain-Counts*	USGS	Technician–isotope sampling
	Nancy Prouty	USGS	Scientist–paleoecology
	Chris Kellogg	USGS	Scientist–microbiology
3	Rod Mather	URI	Chief Scientist–archaeology
	Stephen Viada	CSA	Co-Chief Scientist–biology
	Mike Rhode*	UNCW	Night Watch Chief, Data Manager
	Amanda Demopoulos*	USGS	Scientist–benthic ecology
	Gordon Watts	IIMR	Scientist–archaeology
	Jack Irion	BOEM	Contract Inspector and Scientist–archaeology
	Terry Connell	NOAA	NOAA Representative
	Megan Chesser	NCMNS	Education and Outreach
	Esprit Saucier-Heestand	University of Louisiana, Lafayette	Student–biology
	Kirstin Meyer	OIMB	Student–biology
	James Hill	UNCW	Student–biology

BOEM = Bureau of Ocean Energy Management; CSA = CSA Ocean Sciences Inc.; IIMR = Institute for International Maritime Research, Inc.; NCMNS = North Carolina Museum of Natural Sciences; NIOZ = Royal Netherlands Institute for Sea Research; NOAA = National Oceanic and Atmospheric Administration; OIMB = Oregon Institute of Marine Biology; TAMU = Texas A&M University; UNCW = University of North Carolina, Wilmington; URI = University of Rhode Island; USGS = U.S. Geological Survey.

4.2 SURVEY CHRONOLOGY

4.2.1 Leg 1

15 August 2012–The *Nancy Foster* departed Charleston, South Carolina at approximately 10:30 h. The first target destination was the deep benthic lander deployment site in Norfolk Canyon.

16 August 2012–In transit to the lander site, the vessel stopped just north of Cape Lookout, North Carolina to fill the coral holding tanks with Gulf Stream water and to test the ship's CTD and the NIOZ monocore.

17 August 2012–The vessel arrived at the lander site early in the morning. The two NIOZ benthic landers were deployed at the head and mouth of Norfolk Canyon, and a mooring was deployed in mid-canyon. An ROV dive in Norfolk Canyon was originally planned after the lander and mooring deployments; however, there was not enough time for this activity; therefore, several CTD stations were conducted before the ship departed for Baltimore Canyon.

18 August 2012–The ship arrived in Baltimore Canyon the early morning of 18 August and conducted CTD and monocore stations until the ROV dive. After this first ROV dive, a mooring (identical to the one in Norfolk Canyon) was deployed in the middle of Baltimore Canyon.

19 to 30 August 2012–Operational plans followed the same routine each day with ROV dives (launch 08:30 h and recover 18:30 h) and night sampling (box coring and CTD transects), although technical difficulties and weather occasionally shifted these scheduled activities. Due to an unforeseen personnel emergency the ship left station the evening of 19 August to take one of the science crew to shore. The ship arrived back on station in Baltimore Canyon by mid-afternoon of 20 August, but this was too late for an ROV dive. On 25 August an ROV dive was attempted but was aborted due to deteriorating weather and ROV difficulties; operations switched to CTD sampling. Field operations for Leg 1 ended in Baltimore Canyon approximately 17:30 h on 30 August after the eleventh ROV dive, and the vessel steamed for port in Norfolk, Virginia.

4.2.2 Leg 2

31 August to 2 September 2012–The *Nancy Foster* docked in Norfolk in the early afternoon. Live specimens from ROV dives in Leg 1 were shipped to OIMB, and science crews and gear were exchanged to begin Leg 2.

3 September 2012–The *Nancy Foster* departed Norfolk in the morning; however, instead of steaming to the study site in Baltimore Canyon, the vessel had to conduct generator repairs while underway. This repair required most of the day, and the ship could not dock that night to offload the shore engineer.

4 September 2012–The shore engineer was offloaded in the morning, followed by a man overboard call (false alarm) to monitor a drifting kayak observed as the ship steamed offshore. In order to salvage scientific objectives, the target ROV dive site was changed from Baltimore Canyon to the head of Norfolk Canyon. The ROV was launched at 17:30 h.

5 September 2012–The ROV was recovered at 03:30 h. The *Nancy Foster* then steamed to the head of Baltimore Canyon, but because of the late arrival time and high winds an ROV dive was not attempted, and CTD operations were conducted instead. One UNCW benthic lander was deployed in the mouth of Baltimore Canyon during the evening.

6 to 12 September 2012–ROV operations were conducted in Baltimore Canyon, followed by the deployment of another benthic lander in the head of the canyon. Coral growth experiments were attached to the shallower lander at the head of the canyon. For this cruise leg, bottom trawling around the canyon periphery was emphasized and CTD sampling was accomplished as a lower priority. Alternating ROV

dives (day) and trawl and/or CTD sampling (night) was conducted until the vessel moved back to Norfolk Canyon in late evening of 12 September.

13 to 14 September 2012–The final ROV dive of Leg 2 was conducted in the head of Norfolk Canyon and was followed by CTD transects until early morning of 14 September when the vessel began steaming back to Norfolk. The *Nancy Foster* docked in Norfolk around 13:00 h on 14 September. As at the end of Leg 1, live specimens were shipped to OIMB for future experiments.

4.2.3 Leg 3

17 September 2012–The *Nancy Foster* departed Norfolk, Virginia at approximately 13:00 h. This was later than originally scheduled, since it was decided to wait for a replacement Konigsburg camera for the ROV *Kraken 2* to be delivered. The first destination for the leg was Multibeam Area 1, located near the head of Norfolk Canyon. The vessel arrived on site during the early evening and started multibeam operations at 21:00.

18 September 2012–An ROV dive was planned for the morning, but it was postponed due to weather conditions. Instead, four additional multibeam survey lines were completed in Multibeam Area 1 before suspending all operations due to the worsening sea state. The *Nancy Foster* then headed inshore. At 22:00 the vessel anchored in Lynnhaven Bay for the night.

19 September 2012–The vessel departed anchorage at Lynnhaven Bay at 12:00 and headed back to Norfolk Canyon, arriving at 20:00. During the night, box core samples were collected at Stations 159-163, and CTD casts at Stations 165 and 166.

20 September 2012–A problem with the hydraulic system on the *Nancy Foster's* bow thruster delayed ROV operations for the morning. Later that day, however, the first ROV dive (ROV-2012-NF-21) was completed at TGT-ROV_VA2008_1. The ROV was launched at 13:47 and recovered at 19:43. During the night, one trawl at 580 m (Station 167) was conducted inside the southern face of Norfolk Canyon. During a second trawl, however, the net became caught and could only be freed by backing down over the snag. Since there were also problems with the winch, vessel operations shifted back to multibeam operations for the rest of the night. Four lines in Multibeam Area 3 were completed before morning.

21 September 2012–At 07:54 in the morning, an attempt was made to launch the ROV. This was at TGT-MB VA2006_3. During the launch, however, the ROV umbilical became pinched in the *Nancy Foster's* A-frame. A temporary field repair was not successful, and it was determined that the ROV end of the umbilical would have to be cut and the individual wires and fiber optic line reconnected to the fitting (re-terminated). For the rest of the day, vessel operations shifted to multibeam survey, completing Multibeam Area 3 and running two lines in Multibeam Area 4. At 18:00, a box core (Station 169) was attempted, but continuing problems with the winch, specifically the level-wind mechanism, prevented the box core apparatus from being raised completely out of the water. The solution was to retrieve the box core with the ship's crane, and to cut approximately 40 m (130 ft) of cable from the winch drum. The vessel shifted to CTD casts (Stations 170 and 171) and then box cores (Stations 172-174) once the winch had been repaired.

22 September 2012–The second ROV dive for the leg was completed at ROV-2012-NF-22. An archaeological reconnaissance investigation of two shipwrecks TGT-MB VA2006_3 (the same target as the aborted dive from the day before) and TGT-MB VA2006_2 was completed. Launch was at 07:54 and recovery at 18:35. Night operations consisted of five bottom trawls between 389 and 510 m (Stations 175–179).

23 September 2012–An ROV dive (Dive 3 for the leg [ROV-2012-NF-23]) was conducted on a shipwreck identified as TGT-MB VA2011_2. The launch was at 08:30; the recovery at 19:10. During the evening, a trawl was attempted at 390 m (Station 180), but at 21:21 the gear contacted a snag and was lost along

with 400 m of cable. We attempted to collect five box core samples, four of which were successful (Stations 181–185).

24 September 2012–An ROV dive (Dive 4 for the Leg [ROV-2012-NF-24]) was conducted at TGT-MB VA2011_3. The launch was at 08:15; the recovery at 17:15. During this dive, two chained cat sharks (*Scyliorhinus retifer*) became entrained in an ROV thruster, causing the electric motor to burn out. Nevertheless, the dive was successfully completed. In the evening and throughout the night, three trawls were conducted, the first between 105–120 m (Station 186), the second between 402–480 m (Station 187), and the third between 403–408 m (Station 188).

25 September 2012–The ROV was launched at 07:30, but recovered shortly thereafter due to thruster failure. As a result, the vessel shifted operations to multibeam mapping for approximately 90 minutes in Multibeam Area 2, before reattempting the ROV dive for the second time (Dive 5 for the leg; ROV-2012-NF-25). The dive was at the site of a box core along the southern edge of Norfolk Canyon taken at 02:35 on 24 September (Station 183 in 550 m), which had resulted in the recovery of a smooth round river stone considered to have some archaeological potential. The ROV was launched at 11:55 and recovered at 19:07, after which the vessel shifted to night operations, consisting of multibeam surveys in Multibeam Areas 4 and 2.

26 September 2012–Two ROV dives were conducted to examine three shipwrecks. The first dive (Dive 6 for the leg; ROV-2012-NF-26) was at TGT-MB VA2011_6. The vehicle was launched at 07:40 and recovered at 11:35, and reconnaissance operations were conducted on one shipwreck. The second dive (Dive 7 for the leg; ROV-2012-NF-27) comprised reconnaissance operations on two shipwrecks with an on-bottom transit between the two. These were TGT-MB VA2011_4 and TGT-MB VA2011_5. Launch was at 13:13 and recovery at 19:23. At night, a trawl was conducted in 460-500 m on the edge of the OCS (Station 189). Following the completion of this trawl, vessel operations shifted to multibeam mapping operations (Multibeam Area 2).

27 September 2012–An ROV "archaeological prospecting" dive in was conducted in Multibeam Area 3, which had showed interesting geological features possibly conducive for paleo-archaeological sites of human habitation. This was Dive 8 for the leg (ROV-2012-NF-28). Launch was at 08:07 and recovery was at 13:35. A second ROV dive for the day was then conducted (Dive 9 for the leg; ROV-2012-NF-29). This was at a shipwreck identified as TGT-MB VA2011_1. Launch was at 14:57 and recovery at 19:26. During the evening and through the night (including the early hours of 28 September), four box cores (Stations 190–193) were attempted, the last three of which were successful. The first two cores were in 810 m and the second two were in 1,133 and 1,135 m, respectively.

28 to *29 September 2012*–Following box core operations, an ROV dive was conducted (Dive 10 for the leg; ROV-2012-NF-30). The vehicle was launched at 07:58 and conducted archaeological reconnaissance operations on shipwreck TGT–MB VA2006_1. The plan was to recover the vehicle at 11:00 and transit to a second ROV dive location in the afternoon. During recovery, however, the ROV tether became entangled in the *Nancy Foster's* z-drive and was severed. Unexpectedly, as the ROV drifted away from the vessel it lost buoyancy and gradually sunk. From 28 September through 29 September, the vessel was engaged in Z-drive repair and ROV recovery operations.

30 September 2012–ROV recovery operations were completed early in the morning. Full interviews were conducted between NOAA officers, science crew members, and ROV crew involved with ROV operations. Reports on the loss and recovery of the ROV have been submitted separately to NOAA. At 08:00, the vessel departed the work area, enroute for Charleston, South Carolina.

1 October 2012–Transit to Charleston, South Carolina.

2 October 2012–The vessel arrived in port at 09:00. Plans for a scheduled ROV dive off Cape Lookout to recover a UNCW lander were abandoned, due to the time expended to recover the ROV *Kraken 2*.

4.3 SURVEY RESULTS

4.3.1 Legs 1 and 2

Legs 1 and 2 of this cruise were successful. All objectives were accomplished and in some cases, such as the box cores and CTDs, expectations were exceeded. The weather was generally good and contributed to cruise success with only a small amount of sampling lost due to poor weather. Overall, 166 non-ROV stations were completed (**Table 3**). All station data sheets were scanned on board ship and electronic pdfs were provided to project investigators. Data were also entered into an Access database, checked for errors, and archived at UNCW (Ross lab). Of the 23 ROV dives scheduled for Legs 1 and 2, 20 dives were accomplished; 18 in Baltimore and 2 in Norfolk Canyon (**Figures 7**–**9** and **10**, respectively). During over 159 h of bottom time (**Table 3**) a substantial amount of canyon habitat was covered (**Figures 7**–**10**), and many samples (mostly corals and other invertebrates) were collected. Twenty bottom water samples were collected using Niskin bottles attached to the ROV and CTD data were collected during each dive. During one dive in Norfolk Canyon the ALBEX benthic lander was located, photographed, and found to be in good condition. Examples of bottom habitats and fauna are provided in **Figure 11**.

Seventy-two CTD stations were sampled during the first two legs of this cruise (**Table 3**). Examples of environmental profiles (temperature, salinity, dissolved oxygen, and turbidity) taken from along-axis transects of Baltimore Canyon are shown in **Figure 12**. Water samples were collected for analysis of aragonite saturation state and nutrient levels (using the CTD array Niskin bottles) at three depths (100, 500, and 930 m) in the center of Baltimore Canyon. Water samples were also collected for analysis of POM, trace metals and/or nutrient levels at multiple depths during 23 CTD stations.

Box-coring was one of the most successful activities of Cruise Leg 1. The cruise plan outlined an optimal sampling plan of 32 box cores in Baltimore Canyon; however, a total of 65 cores were attempted during Leg 1, with 52 being successful. In addition to the large box-core, the small monocore was attached to the ship's CTD array during 15 of the stations, each producing a single bottom core sample.

Bottom trawling was emphasized in Cruise Leg 2 because it provided many samples for several project objectives. Fourteen 30-min bottom trawls were accomplished during Leg 2, with one trawl of marginal quality (**Table 3**). Trawls were mostly restricted to the upper, flatter sides of the canyons (**Figure 2**) to minimize potential for snagging hard substrate.

The combined sampling approaches (ROV, trawling) provided a large diversity and quantity of samples for multiple research objectives (**Table 4**). The specimens collected during the cruise may include new species or range extensions, but many of the ROV samples and most of those from trawling operations have not yet been inventoried or identified. Representatives of many of the specimens were photographed at sea for scientific documentation and for posting on the cruise internet sites.

For stable isotope analyses, 1,341 individual samples were collected (1,010 invertebrates and 331 fish) from a wide range of taxa. Most samples were dried on the ship and will later be processed for analysis of δ13C and δ15N as part of a study on the trophodynamics of canyon ecosystems. At least five different species of coral were subsampled for coral genetic studies, producing 277 tissue samples. Some species (the scleractinian *Lophelia pertusa*) will contribute to existing studies of connectivity among deep Atlantic ecosystems, whereas others will be used specifically for population genetic analysis for our study canyons (the octocoral *Paramuricea* sp.). Eleven coral taxa (189 samples) and two invertebrate taxa were subsampled to analyze reproductive condition (53 samples). Most coral samples consisted of octocorals such as *Paragorgia* sp.*,* and *Primnoa* sp.*,* but other important species also were observed (the reef-building [hermatypic] scleractinian *L. pertusa,*and one species of solitary scleractinian [*Desmophyllum cristigalli*]). Four species of octocorals (30 samples) were subsampled to analyze microbial communities and 7 species of scleractinian corals (48 samples) were taken for paleoecology objectives.

Table 3. Stations sampled in the Middle Atlantic Bight off the U.S. east coast in and around Baltimore and Norfolk canyons during Legs 1 and 2 of the 2012 Sampling Cruise (17 August–14 September 2012).

Station Number	Gear	Date	Day[1]/Night[2]	Total Time (min)	Start Latitude (°N)	Start Longitude (°W)	End Latitude (°N)	End Longitude (°W)	Depth Range (m)
LEG 1									
ROV-2012-NF-01	ROV	18 Aug 2012	Day	382	38°08'49.56"	73°50'36.24"	38°08'56.64"	73°50'16.92"	450–634
ROV-2012-NF-02	ROV	19 Aug 2012	Day	451	38°08'54.06"	73°50'19.98"	38°08'41.34"	73°50'01.86"	402–530
ROV-2012-NF-03	ROV	21 Aug 2012	Day	542	38°06'25.38"	73°48'30.60"	38°07'36.06"	73°48'11.28"	303–827
ROV-2012-NF-04	ROV	22 Aug 2012	Day	498	38°05'07.98"	73°47'03.78"	38°06'09.90"	73°47'01.86"	537–1,001
ROV-2012-NF-05	ROV	23 Aug 2012	Day	346	38°08'16.56"	73°50'09.30"	38°08'14.70"	73°49'59.82"	400–540
ROV-2012-NF-06	ROV	24 Aug 2012	Day	571	38°08'22.62"	73°50'08.64"	38°08'49.20"	73°49'58.14"	234–530
ROV-2012-NF-07	ROV	26 Aug 2012	Day	369	38°02'31.44"	73°49'51.90"	38°02'35.34"	73°49'28.80"	412–444
ROV-2012-NF-08	ROV	27 Aug 2012	Day	552	38°03'02.22"	73°49'12.00"	38°03'04.08"	73°49'18.78"	412–454
ROV-2012-NF-09	ROV	28 Aug 2012	Day	534	38°09'07.74"	73°50'29.58"	38°09'10.56"	73°50'01.32"	313–574
ROV-2012-NF-10	ROV	29 Aug 2012	Day	523	38°10'06.66"	73°51'08.64"	38°09'40.50"	73°51'31.56"	425–574
ROV-2012-NF-11	ROV	30 Aug 2012	Day	429	38°05'35.22"	73°48'23.70"	38°05'18.48"	73°49'49.08"	446–938
NF-2012-001	CTD	17 Aug 2012	Night	39	37°03'14.16"	74°30'53.70"	37°03'06.24"	74°30'41.64"	S–1,452
NF-2012-002	CTD	17 Aug 2012	Night	24	37°02'40.20"	74°31'01.20"	37°02'31.20"	74°30'56.40"	S–1,387
NF-2012-004	CTD	17 Aug 2012	Day	25	37°01'49.20"	74°31'16.20"	37°01'55.20"	74°31'00.60"	S–1,270
NF-2012-006	CTD	17 Aug 2012	Day	16	37°03'52.80"	74°39'06.84"	37°03'52.68"	74°39'06.84"	S–632
NF-2012-009	CTD	18 Aug 2012	Night	20	38°05'53.52"	73°48'54.72"	38°06'01.86"	73°49'03.72"	S–888
NF-2012-010	CTD	18 Aug 2012	Night	10	38°06'07.44"	73°48'05.04"	38°06'10.20"	73°48'00.72"	S–832
NF-2012-011	CTD	18 Aug 2012	Night	12	38°08'56.16"	73°50'34.44"	38°09'00.48"	73°50'31.56"	S–561
NF-2012-013	CTD	19 Aug 2012	Night	05	38°09'34.92"	73°53'35.82"	38°09'27.12"	73°53'31.68"	S–105
NF-2012-014	CTD	19 Aug 2012	Night	05	38°10'00.42"	73°52'49.38"	38°10'00.24"	73°52'52.92"	S–152
NF-2012-015	CTD	19 Aug 2012	Night	09	38°10'08.40"	73°51'44.04"	38°10'08.40"	73°51'43.20"	S–401
NF-2012-016	CTD	19 Aug 2012	Night	13	38°10'12.84"	73°50'55.80"	38°10'12.84"	73°50'55.80"	S–591
NF-2012-017	CTD	19 Aug 2012	Night	07	38°10'22.68"	73°49'56.16"	38°10'22.74"	73°49'56.22"	S–233
NF-2012-018	CTD	19 Aug 2012	Night	05	38°10'37.50"	73°48'13.38"	38°10'37.56"	73°48'13.44"	S–107
NF-2012-022	CTD	20 Aug 2012	Day	08	38°05'01.74"	73°51'37.08"	38°05'01.38"	73°51'36.72"	S–168
NF-2012-023	CTD	20 Aug 2012	Day	12	38°05'56.82"	73°50'38.40"	38°05'55.02"	73°50'35.52"	S–462
NF-2012-024	CTD	20 Aug 2012	Day	20	38°06'38.40"	73°49'40.08"	38°06'33.48"	73°49'30.72"	S–930
NF-2012-025	CTD	20 Aug 2012	Day	12	38°07'18.12"	73°48'50.40"	38°07'13.74"	73°48'41.76"	S–556
NF-2012-026	CTD	20 Aug 2012	Day	06	38°08'03.54"	73°48'06.12"	38°08'02.82"	73°48'04.68"	S–168
NF-2012-027	CTD	20 Aug 2012	Day	05	38°08'29.10"	73°47'28.68"	38°08'23.16"	73°47'30.48"	S–139
NF-2012-036	CTD	21 Aug 2012	Night	07	38°13'31.86"	73°50'42.84"	38°13'31.92"	73°50'42.96"	S–267
NF-2012-037	CTD	21 Aug 2012	Night	09	38°12'13.08"	73°51'03.48"	38°12'13.26"	73°51'03.48"	S–363
NF-2012-038	CTD	21 Aug 2012	Night	11	38°10'56.34"	73°51'58.20"	38°10'56.34"	73°51'58.26"	S–514

Table 3. (Continued).

Station Number	Gear	Date	Day[1]/Night[2]	Total Time (min)	Start Latitude (°N)	Start Longitude (°W)	End Latitude (°N)	End Longitude (°W)	Depth Range (m)
NF-2012-039	CTD	22 Aug 2012	Night	14	38°09'59.46"	73°50'42.84"	38°10'01.62"	73°50'42.84"	S–600
NF-2012-040	CTD	22 Aug 2012	Night	15	38°08'53.88"	73°50'43.20"	38°08'51.78"	73°50'42.60"	S–631
NF-2012-041	CTD	22 Aug 2012	Night	16	38°07'44.76"	73°50'26.40"	38°07'44.76"	73°50'26.40"	S–726
NF-2012-042	CTD	22 Aug 2012	Night	21	38°06'35.94"	73°49'39.24"	38°06'35.94"	73°49'39.00"	S–855
NF-2012-043	CTD	22 Aug 2012	Night	19	38°05'55.32"	73°48'36.30"	38°05'55.02"	73°48'36.00"	S–927
NF-2012-044	CTD	22 Aug 2012	Night	21	38°05'07.14"	73°47'29.82"	38°05'07.14"	73°47'29.82"	S–1,041
NF-2012-051	CTD	23 Aug 2012	Night	26	38°04'19.68"	73°46'25.02"	38°04'13.20"	73°46'32.04"	S–1,145
NF-2012-052	CTD	23 Aug 2012	Night	25	38°03'41.70"	73°45'37.80"	38°03'40.08"	73°45'36.66"	S–1,205
NF-2012-057	CTD	24 Aug 2012	Night	18	38°00'50.76"	73°46'51.96"	38°00'47.16"	73°47'06.30"	S–844
NF-2012-058	CTD	24 Aug 2012	Night	15	38°01'58.02"	73°45'51.42"	38°01'58.74"	73°45'51.54"	S–738
NF-2012-059	CTD	24 Aug 2012	Night	23	38°02'40.14"	73°45'04.98"	38°02'35.88"	73°45'02.88"	S–1,057
NF-2012-060	CTD	24 Aug 2012	Night	28	38°03'07.32"	73°44'27.96"	38°02'55.74"	73°44'38.88"	S–1,270
NF-2012-061	CTD	24 Aug 2012	Night	22	38°03'54.60"	73°43'41.46"	38°03'37.20"	73°43'45.42"	S–922
NF-2012-073	CTD	25 Aug 2012	Day	31	38°02'24.96"	73°43'02.28"	38°02'25.98"	73°43'01.92"	S–1,260
NF-2012-074	CTD	25 Aug 2012	Day	22	38°04'51.36"	73°42'50.76"	38°04'41.82"	73°43'05.88"	S–936
NF-2012-075	CTD	25 Aug 2012	Day	19	38°05'29.52"	73°42'38.16"	38°05'19.68"	73°42'47.88"	S–876
NF-2012-096	CTD	27 Aug 2012	Night	04	38°06'44.34"	73°57'40.92"	38°06'45.78"	73°57'39.84"	S–103
NF-2012-097	CTD	27 Aug 2012	Night	04	38°05'54.00"	73°56'04.08"	38°05'54.12"	73°56'03.42"	S–107
NF-2012-098	CTD	27 Aug 2012	Night	04	38°05'09.90"	73°54'33.12"	38°05'09.00"	73°54'34.80"	S–115
NF-2012-099	CTD	27 Aug 2012	Night	04	38°04'22.14"	73°52'41.58"	38°04'23.22"	73°52'43.08"	S–129
NF-2012-100	CTD	27 Aug 2012	Night	07	38°03'26.94"	73°50'46.08"	38°03'28.74"	73°50'48.72"	S–252
NF-2012-101	CTD	28 Aug 2012	Night	11	38°02'30.36"	73°48'50.70"	38°02'32.40"	73°48'55.02"	S–490
NF-2012-102	CTD	28 Aug 2012	Night	16	38°01'39.24"	73°47'09.66"	38°01'39.12"	73°47'09.96"	S–680
NF-2012-103	CTD	28 Aug 2012	Night	23	38°00'46.20"	73°45'11.82"	38°00'44.88"	73°45'10.44"	S–988
NF-2012-104	CTD	28 Aug 2012	Night	22	37°59'52.86"	73°43'19.92"	38°00'02.94"	73°43'33.66"	S–987
NF-2012-105	CTD	28 Aug 2012	Night	25	37°58'56.52"	73°41'18.84"	37°58'56.34"	73°41'18.96"	S–1,066
NF-2012-119	CTD	29 Aug 2012	Night	18	38°06'36.30"	73°49'39.00"	38°06'36.24"	73°49'39.00"	S–854
NF-2012-120	CTD	30 Aug 2012	Night	18	38°06'36.24"	73°49'39.00"	38°06'36.30"	73°49'39.00"	S–854
NF-2012-121	CTD	30 Aug 2012	Night	18	38°06'36.30"	73°49'39.00"	38°06'36.30"	73°49'39.00"	S–853
NF-2012-122	CTD	30 Aug 2012	Night	17	38°06'36.30"	73°49'39.06"	38°06'36.36"	73°49'39.00"	S–852
NF-2012-123	CTD	30 Aug 2012	Night	18	38°06'36.30"	73°49'39.00"	38°06'36.30"	73°49'39.12"	S–851
NF-2012-124	CTD	30 Aug 2012	Night	18	38°06'36.30"	73°49'39.12"	38°06'36.30"	73°49'39.12"	S–852
NF-2012-125	CTD	30 Aug 2012	Night	18	38°06'36.06"	73°49'38.70"	38°06'36.06"	73°49'38.76"	S–854
NF-2012-126	CTD	30 Aug 2012	Night	18	38°06'36.06"	73°49'38.76"	38°06'36.06"	73°49'38.70"	S–859
NF-2012-007	MC	17 Aug 2012	Day	n/a	37°03'52.80"	74°39'06.84"	n/a	n/a	632
NF-2012-019	BC	19 Aug 2012	Night	n/a	38°14'35.58"	73°50'36.96"	n/a	n/a	189
NF-2012-020	BC	19 Aug 2012	Night	n/a	38°14'35.46"	73°50'36.72"	n/a	n/a	189

Table 3. (Continued).

Station Number	Gear	Date	Day[1]/Night[2]	Total Time (min)	Start Latitude (°N)	Start Longitude (°W)	End Latitude (°N)	End Longitude (°W)	Depth Range (m)
NF-2012-021	BC	19 Aug 2012	Night	n/a	38°14'35.40"	73°50'36.72"	n/a	n/a	189
NF-2012-028	BC	20 Aug 2012	Night	n/a	38°14'34.14"	73°50'36.60"	n/a	n/a	191
NF-2012-029	BC	20 Aug 2012	Night	n/a	38°14'34.20"	73°50'36.66"	n/a	n/a	191
NF-2012-030	BC	20 Aug 2012	Night	n/a	38°09'57.96"	73°51'00.66"	n/a	n/a	561
NF-2012-031	BC	20 Aug 2012	Night	n/a	38°09'58.20"	73°51'00.36"	n/a	n/a	563
NF-2012-032	BC	21 Aug 2012	Night	n/a	38°09'58.26"	73°51'00.36"	n/a	n/a	563
NF-2012-033	BC	21 Aug 2012	Night	n/a	38°09'58.26"	73°51'00.24"	n/a	n/a	564
NF-2012-034	BC	21 Aug 2012	Night	n/a	38°09'58.38"	73°51'00.00"	n/a	n/a	565
NF-2012-035	BC	21 Aug 2012	Night	n/a	38°09'58.56"	73°50'59.94"	n/a	n/a	567
NF-2012-045	BC	22 Aug 2012	Night	n/a	38°07'01.32"	73°50'09.00"	n/a	n/a	840
NF-2012-046	BC	22 Aug 2012	Night	n/a	38°07'01.98"	73°50'07.14"	n/a	n/a	841
NF-2012-047	BC	22 Aug 2012	Night	n/a	38°07'02.70"	73°50'05.28"	n/a	n/a	848
NF-2012-048	BC	23 Aug 2012	Night	n/a	38°07'03.06"	73°50'04.32"	n/a	n/a	844
NF-2012-049	BC	23 Aug 2012	Night	n/a	38°07'03.06"	73°50'04.32"	n/a	n/a	844
NF-2012-050	BC	23 Aug 2012	Night	n/a	38°07'03.06"	73°50'04.32"	n/a	n/a	844
NF-2012-053*	BC	23 Aug 2012	Day	n/a	38°04'15.30"	73°46'41.82"	n/a	n/a	1,120
NF-2012-054	BC	23 Aug 2012	Night	n/a	38°04'20.64"	73°46'23.82"	n/a	n/a	1,180
NF-2012-055	BC	23 Aug 2012	Night	n/a	38°04'20.76"	73°46'23.64"	n/a	n/a	1,179
NF-2012-056	BC	23 Aug 2012	Night	n/a	38°04'20.76"	73°46'23.52"	n/a	n/a	1,179
NF-2012-062	BC	24 Aug 2012	Night	n/a	38°04'19.56"	73°46'24.00"	n/a	n/a	1,180
NF-2012-063	BC	24 Aug 2012	Night	n/a	38°04'19.80"	73°46'24.12"	n/a	n/a	1,180
NF-2012-064	BC	24 Aug 2012	Night	n/a	38°03'45.00"	73°51'56.04"	n/a	n/a	168
NF-2012-065	BC	25 Aug 2012	Night	n/a	38°03'45.00"	73°51'56.10"	n/a	n/a	170
NF-2012-066	BC	25 Aug 2012	Night	n/a	38°03'45.00"	73°51'56.04"	n/a	n/a	170
NF-2012-067	BC	25 Aug 2012	Night	n/a	38°03'45.12"	73°51'56.22"	n/a	n/a	168
NF-2012-068*	BC	25 Aug 2012	Night	n/a	38°03'45.30"	73°51'56.22"	n/a	n/a	169
NF-2012-069	BC	25 Aug 2012	Night	n/a	38°03'45.30"	73°51'56.22"	n/a	n/a	169
NF-2012-070	BC	25 Aug 2012	Night	n/a	38°02'36.66"	73°48'12.48"	n/a	n/a	515
NF-2012-071	BC	25 Aug 2012	Night	n/a	38°02'36.54"	73°48'12.36"	n/a	n/a	513
NF-2012-072	BC	25 Aug 2012	Night	n/a	38°02'36.48"	73°48'12.36"	n/a	n/a	514
NF-2012-076	BC	25 Aug 2012	Night	n/a	38°02'36.48"	73°48'12.30"	n/a	n/a	510
NF-2012-077*	BC	25 Aug 2012	Night	n/a	38°02'36.48"	73°48'15.72"	n/a	n/a	510
NF-2012-078*	BC	25 Aug 2012	Night	n/a	38°02'36.30"	73°48'18.06"	n/a	n/a	510
NF-2012-079*	BC	25 Aug 2012	Night	n/a	38°02'36.48"	73°48'20.76"	n/a	n/a	518
NF-2012-080*	BC	25 Aug 2012	Night	n/a	38°02'36.48"	73°48'20.58"	n/a	n/a	518
NF-2012-081*	BC	26 Aug 2012	Night	n/a	38°02'35.94"	73°48'09.42"	n/a	n/a	502
NF-2012-082	BC	26 Aug 2012	Night	n/a	38°00'49.80"	73°45'12.48"	n/a	n/a	990

Table 3. (Continued).

Station Number	Gear	Date	Day[1]/Night[2]	Total Time (min)	Start Latitude (°N)	Start Longitude (°W)	End Latitude (°N)	End Longitude (°W)	Depth Range (m)
NF-2012-083*	BC	26 Aug 2012	Night	n/a	38°00'49.98"	73°45'12.24"	n/a	n/a	990
NF-2012-084	BC	26 Aug 2012	Night	n/a	38°00'49.98"	73°45'12.24"	n/a	n/a	990
NF-2012-085	BC	26 Aug 2012	Night	n/a	38°00'49.92"	73°45'12.24"	n/a	n/a	991
NF-2012-086*	BC	26 Aug 2012	Night	n/a	38°00'49.92"	73°45'12.24"	n/a	n/a	991
NF-2012-087	BC	26 Aug 2012	Night	n/a	38°00'49.92"	73°45'12.24"	n/a	n/a	991
NF-2012-088	BC	26 Aug 2012	Night	n/a	38°02'36.96"	73°48'11.52"	n/a	n/a	502
NF-2012-089	BC	26 Aug 2012	Night	n/a	38°00'40.38"	73°45'15.60"	n/a	n/a	1,030
NF-2012-090	BC	27 Aug 2012	Night	n/a	37°58'38.58"	73°40'09.78"	n/a	n/a	1,185
NF-2012-091	BC	27 Aug 2012	Night	n/a	37°58'38.58"	73°40'09.78"	n/a	n/a	1,186
NF-2012-092	BC	27 Aug 2012	Night	n/a	37°58'38.52"	73°40'09.78"	n/a	n/a	1,187
NF-2012-093	BC	27 Aug 2012	Night	n/a	37°58'38.58"	73°40'09.78"	n/a	n/a	1,186
NF-2012-094*	BC	27 Aug 2012	Night	n/a	37°58'38.58"	73°40'09.78"	n/a	n/a	1,186
NF-2012-095	BC	27 Aug 2012	Night	n/a	37°58'38.70"	73°40'09.84"	n/a	n/a	1,186
NF-2012-106	BC	28 Aug 2012	Night	n/a	38°13'29.22"	73°50'40.20"	n/a	n/a	280
NF-2012-107	BC	28 Aug 2012	Night	n/a	38°13'29.04"	73°50'40.26"	n/a	n/a	283
NF-2012-108	BC	28 Aug 2012	Night	n/a	38°12'10.74"	73°50'57.90"	n/a	n/a	360
NF-2012-109	BC	28 Aug 2012	Night	n/a	38°12'10.56"	73°50'57.96"	n/a	n/a	360
NF-2012-110	BC	28 Aug 2012	Night	n/a	38°10'55.20"	73°51'55.86"	n/a	n/a	518
NF-2012-111	BC	29 Aug 2012	Night	n/a	38°10'55.14"	73°51'55.86"	n/a	n/a	517
NF-2012-112	BC	29 Aug 2012	Night	n/a	38°08'53.16"	73°50'44.94"	n/a	n/a	652
NF-2012-113*	BC	29 Aug 2012	Night	n/a	38°08'53.16"	73°50'44.94"	n/a	n/a	652
NF-2012-114	BC	29 Aug 2012	Night	n/a	38°08'53.28"	73°50'44.52"	n/a	n/a	652
NF-2012-115*	BC	29 Aug 2012	Night	n/a	38°07'45.90"	73°50'27.30"	n/a	n/a	734
NF-2012-116*	BC	29 Aug 2012	Night	n/a	38°07'45.84"	73°50'27.30"	n/a	n/a	734
NF-2012-117	BC	29 Aug 2012	Night	n/a	38°07'44.46"	73°50'28.32"	n/a	n/a	754
NF-2012-118	BC	29 Aug 2012	Night	n/a	38°04'20.76"	73°52'46.56"	n/a	n/a	139
NF-2012-037MC	MC	21 Aug 2012	Night	n/a	38°12'13.26"	73°51'03.48"	n/a	n/a	363
NF-2012-038MC	MC	21 Aug 2012	Night	n/a	38°10'56.34"	73°51'58.26"	n/a	n/a	514
NF-2012-040MC	MC	22 Aug 2012	Night	n/a	38°08'51.78"	73°50'42.60"	n/a	n/a	644
NF-2012-041MC	MC	22 Aug 2012	Night	n/a	38°07'44.76"	73°50'26.40"	n/a	n/a	730
NF-2012-042MC	MC	22 Aug 2012	Night	n/a	38°06'35.94"	73°49'39.00"	n/a	n/a	867
NF-2012-044MC	MC	22 Aug 2012	Night	n/a	38°05'07.14"	73°47'29.82"	n/a	n/a	1,068
NF-2012-052MC	MC	23 Aug 2012	Night	n/a	38°03'40.08"	73°45'36.66"	n/a	n/a	1,209
NF-2012-060MC	MC	24 Aug 2012	Night	n/a	38°02'55.74"	73°44'38.88"	n/a	n/a	1,278
NF-2012-096MC	MC	27 Aug 2012	Night	n/a	38°06'45.78"	73°57'39.84"	n/a	n/a	113
NF-2012-098MC	MC	27 Aug 2012	Night	n/a	38°05'09.00"	73°54'34.80"	n/a	n/a	125
NF-2012-100MC	MC	27 Aug 2012	Night	n/a	38°03'28.74"	73°50'48.72"	n/a	n/a	262

Table 3. (Continued).

Station Number	Gear	Date	Day[1]/Night[2]	Total Time (min)	Start Latitude (°N)	Start Longitude (°W)	End Latitude (°N)	End Longitude (°W)	Depth Range (m)
NF-2012-102MC	MC	28 Aug 2012	Night	n/a	38°01'39.12"	73°47'09.96"	n/a	n/a	692
NF-2012-103MC	MC	28 Aug 2012	Night	n/a	38°00'44.88"	73°45'10.44"	n/a	n/a	1,000
NF-2012-104MC*	MC	28 Aug 2012	Night	n/a	37°00'02.94"	73°43'33.66"	n/a	n/a	998
NF-2012-003	BOBO Lander	17 Aug 2012	Day	n/a	37°02'13.02"	74°32'01.20"	n/a	n/a	1,364
NF-2012-005	Mooring	17 Aug 2012	Day	n/a	37°02'19.80"	74°37'09.48"	n/a	n/a	917
NF-2012-008	ALBEX Lander	17 Aug 2012	Day	n/a	37°03'52.56"	74°39'07.14"	n/a	n/a	630
NF-2012-012	Mooring	18 Aug 2012	Night	n/a	38°04'39.42"	73°46'57.42"	n/a	n/a	1,082
LEG 2									
ROV-2012-NF-12	ROV	04 Sept 2012	Day	360	37°03'57.18"	74°39'10.68"	37°04'05.82"	74°38'52.86"	512–638
ROV-2012-NF-13	ROV	06 Sept 2012	Day	533	38°09'34.32"	73°51'20.46"	38°09'23.82"	73°51'54.18"	404–478
ROV-2012-NF-14	ROV	07 Sept 2012	Day	574	38°02'36.12"	73°48'53.94"	38°02'57.06"	73°49'19.56"	407–507
ROV-2012-NF-15	ROV	08 Sept 2012	Day	441	38°10'15.78"	73°50'40.32"	38°10'41.16"	73°50'26.94"	276–577
ROV-2012-NF-16	ROV	09 Sept 2012	Day	509	38°10'37.62"	73°51'39.96"	38°11'20.94"	73°51'22.68"	343–551
ROV-2012-NF-17	ROV	10 Sept 2012	Day	294	38°07'01.20"	73°50'28.74"	38°07'06.84"	73°50'52.02"	569–830
ROV-2012-NF-18	ROV	11 Sept 2012	Day	552	38°07'01.32"	73°50'44.28"	38°06'55.86"	73°51'00.06"	521–748
ROV-2012-NF-19	ROV	12 Sept 2012	Day	559	38°09'19.02"	73°50'26.16"	38°09'05.94"	73°50'07.08"	302–608
ROV-2012-NF-20	ROV	13 Sept 2012	Day	543	37°03'03.48"	74°37'56.34"	37°03'02.28"	74°37'11.88"	385–766
NF-2012-127	CTD	05 Sept 2012	Day	28	38°09'08.52"	73°51'05.34"	38°09'30.48"	73°50'33.78"	S–606
NF-2012-128	CTD	05 Sept 2012	Day	17	38°08'40.38"	73°50'37.62"	38°08'43.02"	73°50'40.26"	S–644
NF-2012-129	CTD	05 Sept 2012	Day	25	38°04'09.42"	73°46'11.40"	38°04'13.02"	73°46'15.48"	S–1,155
NF-2012-130	CTD	05 Sept 2012	Day	24	38°04'10.86"	73°46'25.62"	38°04'11.40"	73°46'26.76"	S–1,140
NF-2012-136	CTD	07 Sept 2012	Night	12	38°02'32.22"	73°48'50.46"	38°02'32.22"	73°48'50.46"	S–500
NF-2012-137	CTD	07 Sept 2012	Day	08	38°13'33.72"	73°50'39.36"	38°13'33.72"	73°50'39.24"	S–260
NF-2012-138	CTD	07 Sept 2012	Night	07	38°13'33.66"	73°50'39.36"	38°13'33.84"	73°50'39.24"	S–261
NF-2012-148	CTD	11 Sept 2012	Night	14	38°01'38.88"	73°47'11.52"	38°01'38.88"	73°47'11.52"	S–671
NF-2012-149	CTD	11 Sept 2012	Night	15	38°01'38.88"	73°47'11.52"	38°01'38.88"	73°47'11.52"	S–668
NF-2012-152	CTD	13 Sept 2012	Night	05	37°05'32.22"	74°44'44.10"	37°05'26.82"	74°44'42.30"	S–182
NF-2012-153	CTD	13 Sept 2012	Night	07	37°05'35.40"	74°43'28.68"	37°05'30.18"	74°43'29.58"	S–270
NF-2012-154	CTD	13 Sept 2012	Night	08	37°05'37.44"	74°42'13.20"	37°05'31.26"	74°42'17.16"	S–328
NF-2012-155	CTD	13 Sept 2012	Night	11	37°05'36.18"	74°40'50.40"	37°05'26.76"	74°40'57.96"	S–428
NF-2012-156	CTD	13 Sept 2012	Night	13	37°04'51.24"	74°40'03.06"	37°04'46.26"	74°40'05.46"	S–498
NF-2012-157	CTD	14 Sept 2012	Night	14	37°03'58.98"	74°39'04.08"	37°03'58.98"	74°39'04.08"	S–621
NF-2012-158	CTD	14 Sept 2012	Night	13	37°03'58.62"	74°39'04.02"	37°03'58.68"	74°39'04.08"	S–621
NF-2012-131	UNCW Lander	05 Sept 2012	Night	n/a	38°02'32.58"	73°44'09.18"	n/a	n/a	1,318

Table 3. (Continued).

Station Number	Gear	Date	Day[1]/Night[2]	Total Time (min)	Start Latitude (°N)	Start Longitude (°W)	End Latitude (°N)	End Longitude (°W)	Depth Range (m)
NF-2012-132	UNCW Lander	06 Sept 2012	Night	n/a	38°09'01.44"	73°50'57.24"	n/a	n/a	603
NF-2012-133	OT	06 Sept 2012	Night	30	38°04'30.48"	73°52'57.60"	38°03'29.76"	73°54'00.30"	136–140
NF-2012-134	OT	07 Sept 2012	Night	30	38°02'33.78"	73°51'12.24"	38°01'29.40"	73°52'01.26"	278–282
NF-2012-135	OT	07 Sept 2012	Night	30	37°59'19.08"	73°54'11.16"	37°58'11.58"	73°55'07.74"	360–380
NF-2012-139	OT	07 Sept 2012	Night	30	38°08'25.44"	73°45'05.10"	38°09'23.10"	73°44'36.24"	214–270
NF-2012-140	OT	08 Sept 2012	Night	30	38°07'50.82"	73°45'30.18"	38°08'57.54"	73°44'46.62"	290–300
NF-2012-141	OT	08 Sept 2012	Night	30	38°08'33.30"	73°44'58.68"	38°07'38.88"	73°45'42.06"	300
NF-2012-142	OT	08 Sept 2012	Night	30	38°06'58.26"	73°45'17.28"	38°08'10.68"	73°45'09.84"	300–360
NF-2012-143	OT	09 Sept 2012	Night	30	38°05'51.36"	73°45'40.26"	38°06'32.64"	73°44'40.08"	405–420
NF-2012-144	OT	09 Sept 2012	Night	30	38°06'47.28"	73°44'47.34"	38°05'46.02"	73°45'21.30"	400–481
NF-2012-145	OT	10 Sept 2012	Night	30	38°06'18.30"	73°45'00.42"	38°07'24.30"	73°44'54.18"	418–540
NF-2012-146	OT	10 Sept 2012	Night	30	38°05'55.08"	73°45'33.48"	38°06'53.88"	73°44'48.60"	412–422
NF-2012-147	OT	10 Sept 2012	Night	30	38°07'40.86"	73°45'41.64"	38°06'46.56"	73°46'48.84"	294–300
NF-2012-150*	OT	12 Sept 2012	Night	n/a	38°01'59.10"	73°46'03.60"	n/a	n/a	~700
NF-2012-151	OT	12 Sept 2012	Night	30	38°08'04.80"	73°51'01.20"	38°07'22.14"	73°50'35.46"	700–800

[1] Day (0800 to 2000 h EST)
[2] Night (2000 to 0800 h EST).
* Poor quality or no sample, gear issue; n/a = not applicable, sediment sample and lander deployment locations are represented as a single point.
CTD = SBE 911*plus* profiler; BC =IOZ box core; MC =IOZ monocore; OT = 3.5 m otter trawl; ROV = *Kraken II* (ROV depth range and location data are only for the period when the ROV was on the bottom).

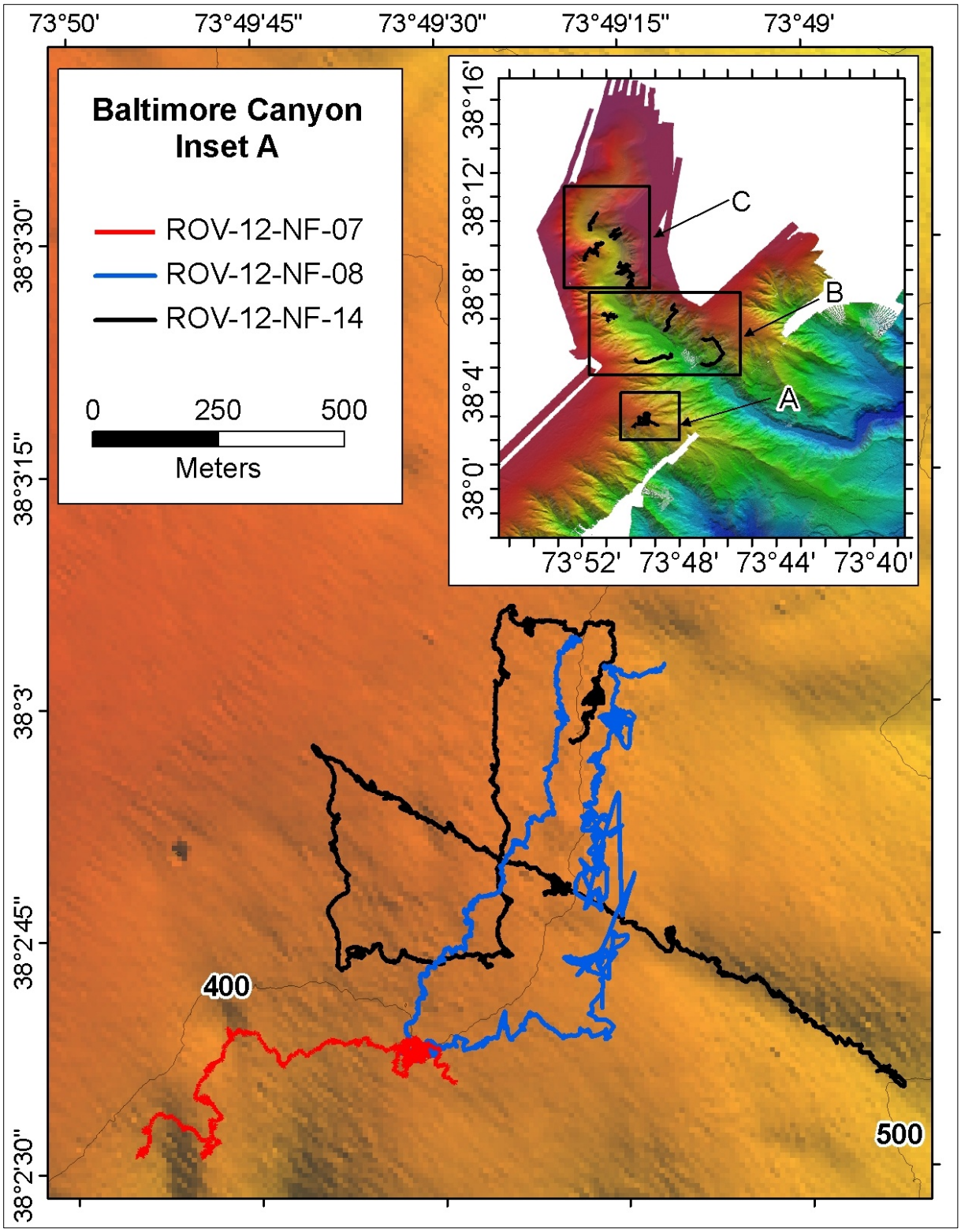

Figure 7. ROV station tracks in the cold seep area along the southwest flank of Baltimore Canyon during the 2012 Sampling Cruise. See **Table 3** for additional data. Expanded views of insets B and C are shown in **Figures 8** and **9**, respectively.

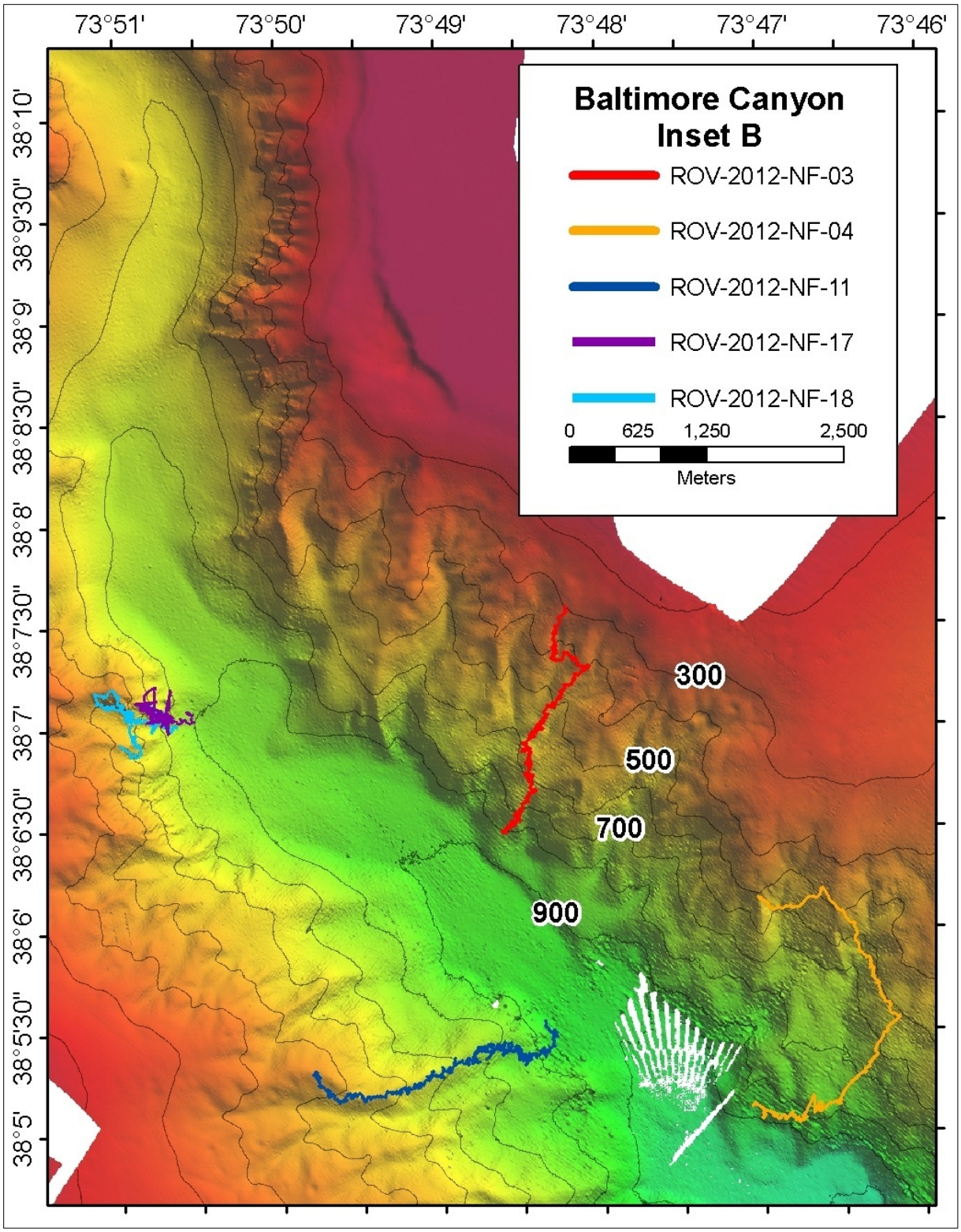

Figure 8. ROV station tracks in the middle area of Baltimore Canyon during the 2012 Sampling Cruise. See **Table 3** for additional data. The inset B location is shown in **Figure 7**.

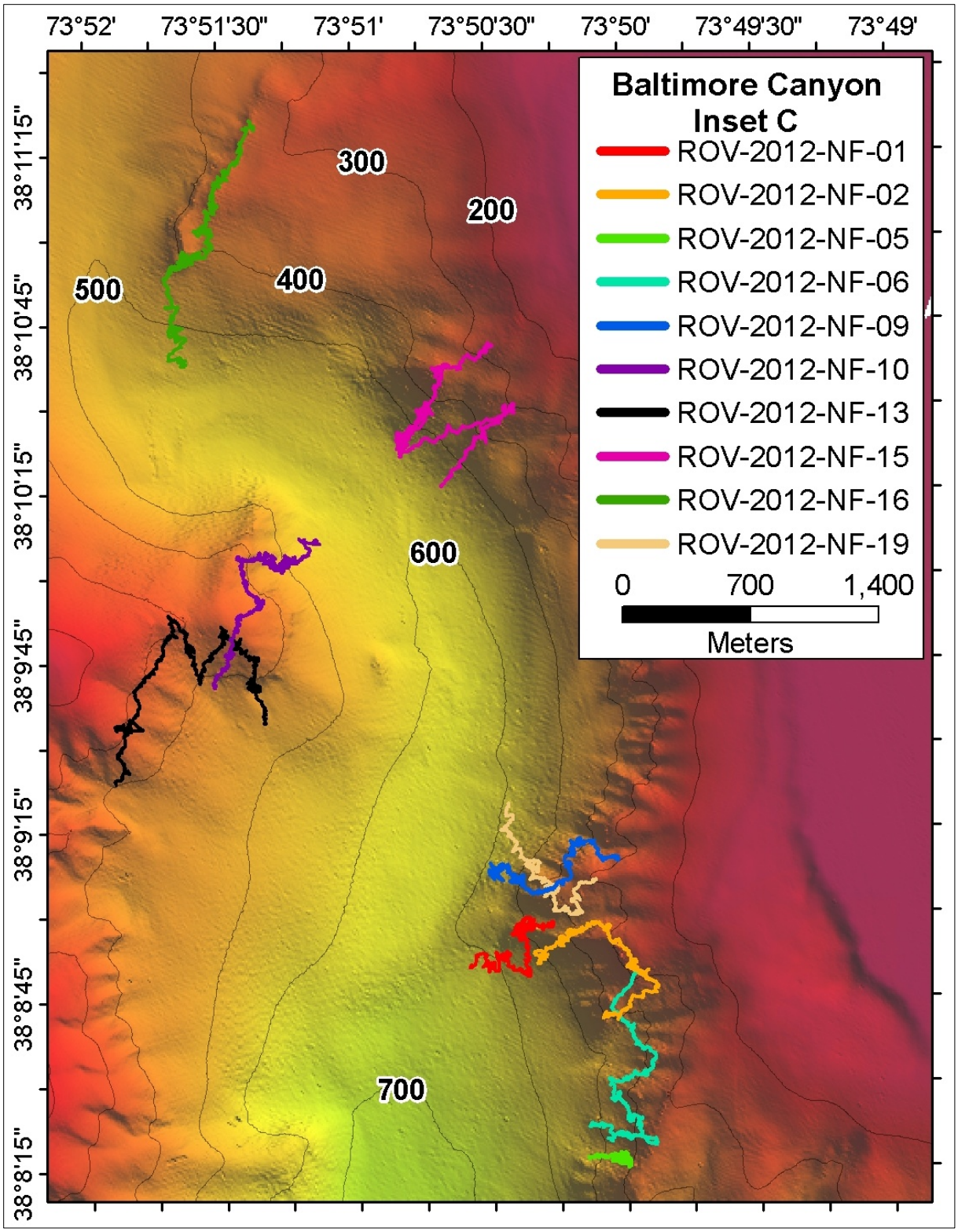

Figure 9. ROV station tracks at the head of Baltimore Canyon during the 2012 Sampling Cruise. See **Table 3** for additional data. Inset C location is shown in **Figure 7**.

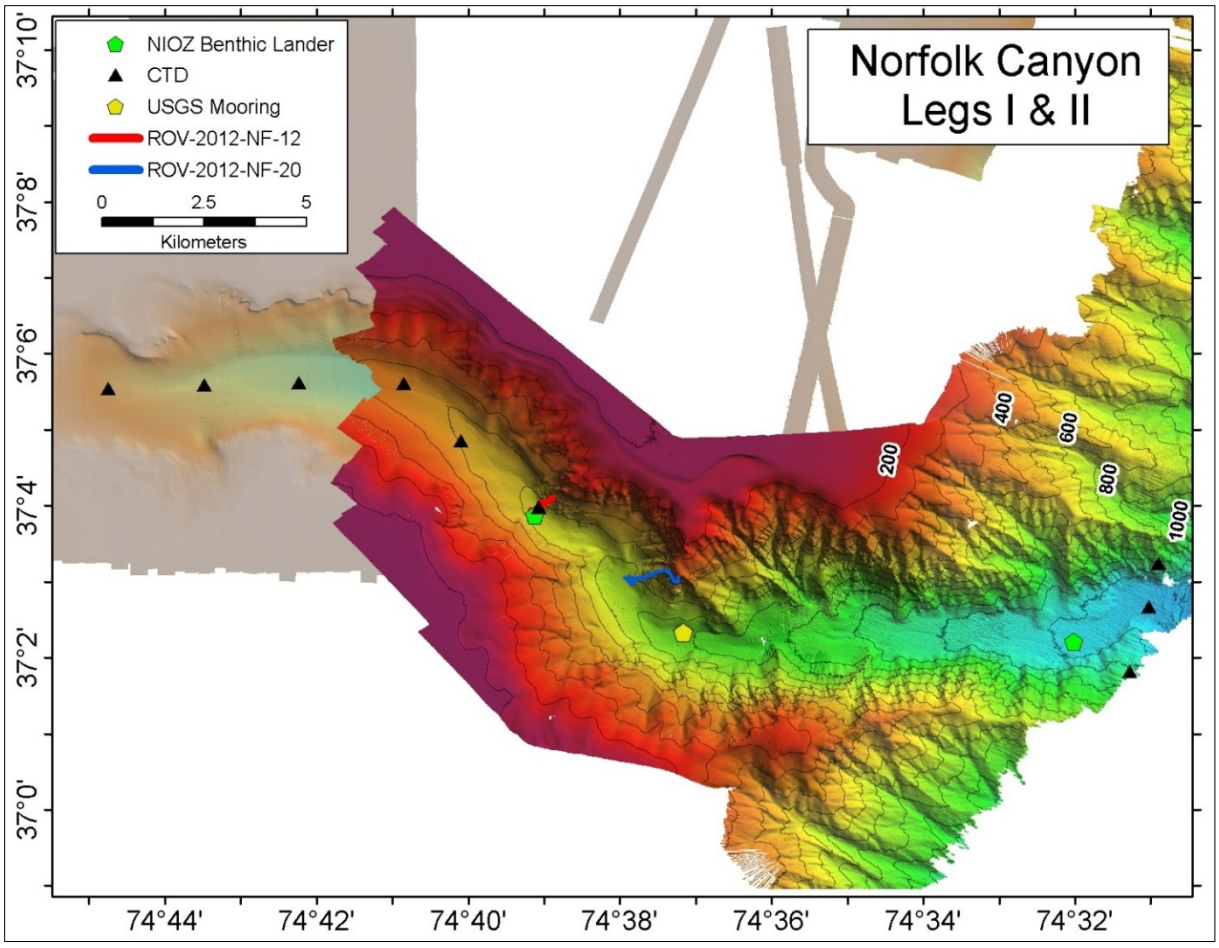

Figure 10. ROV (two dives) and non-ROV stations sampled in and around Norfolk Canyon during Legs 1 and 2 of the 2012 Sampling Cruise.

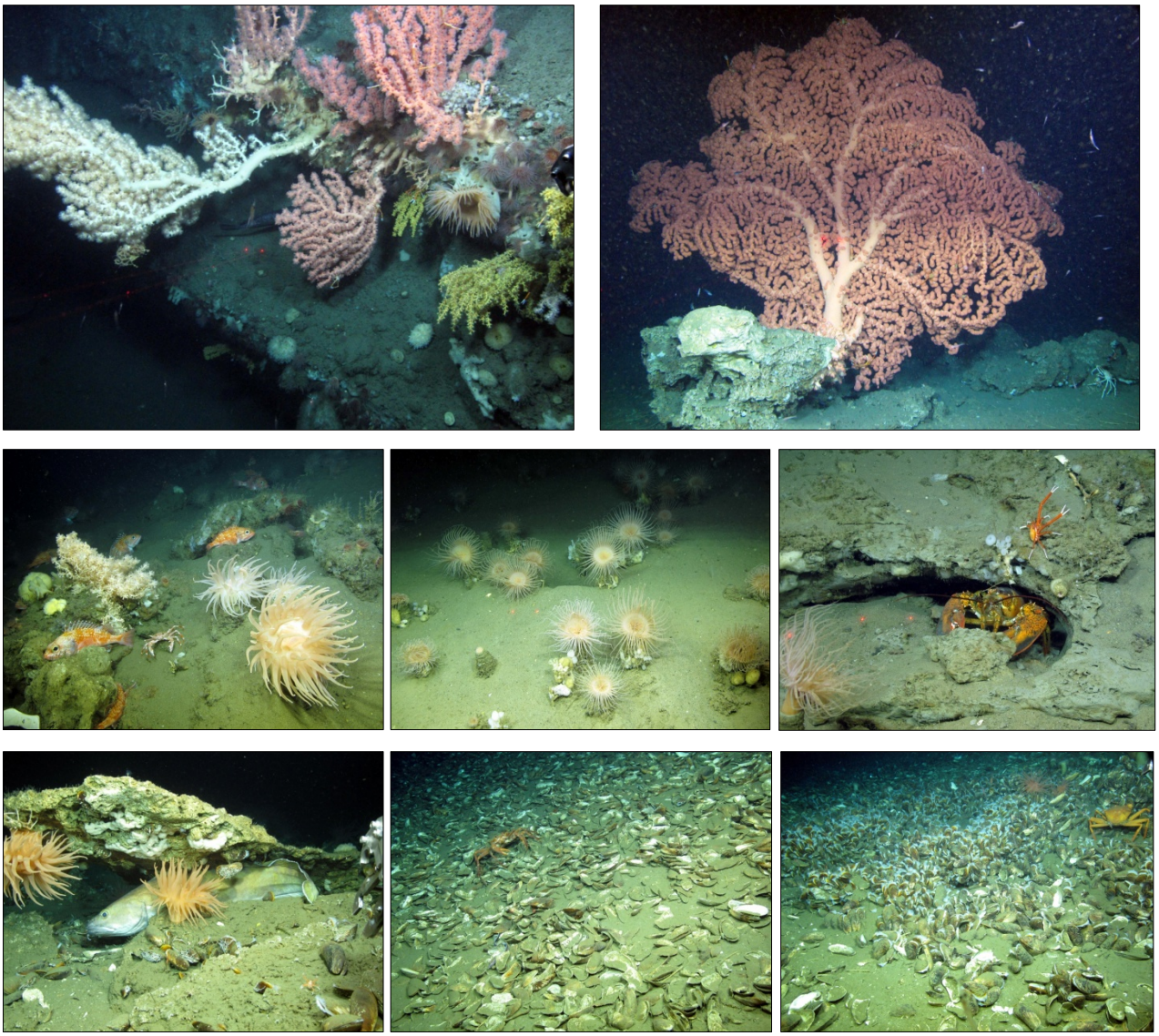

Figure 11. Selected images of bottom habitats and fauna in Baltimore Canyon. Top left: hite and pink bubble gum coral (*Paragorgia arborea*); anemones and sponges cling to a vertical consolidated sediment wall. Top right: *P. arborea* colonizes individual boulders. Center left: blackbelly rosefish (*Helicolenus dactylopterus*) and a variety of invertebrates on boulder habitat. Center: middle: cerianthid anemones on sand bottom. Center right: American lobster (*Homarus americanus*) and squat lobster (*Eumunida picta*) on consolidated mud. Bottom left: cusk (*Brosme brosme*) under a rock slab at the cold seep site. Bottom middle: mostly dead mussels (*Bathymodiolus* sp.) and a red crab (*Geryon quinquedens*) at the seep site. Bottom right: dense bed of live mussels and red crabs at the seep site.

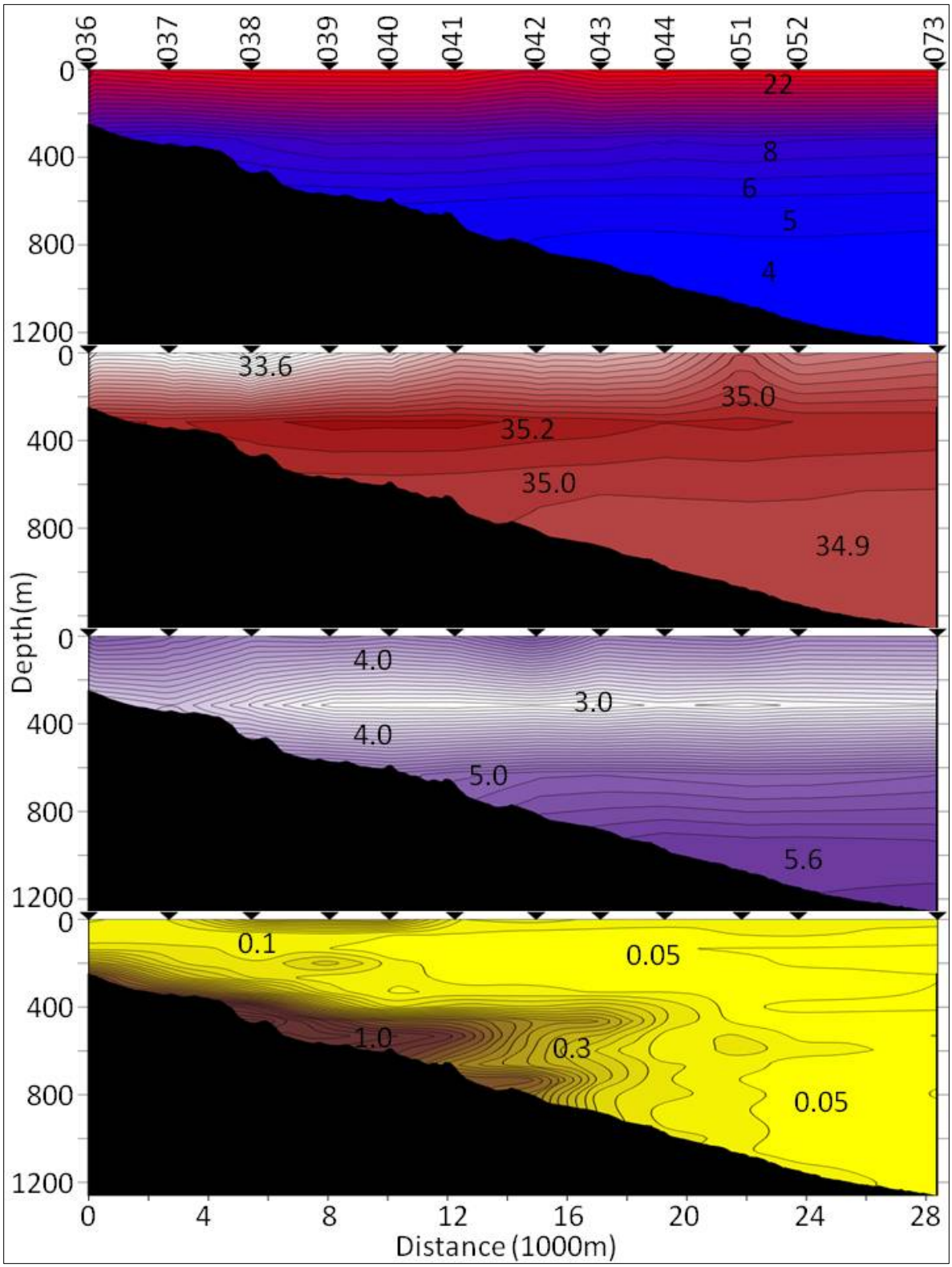

Figure 12. Water column data for CTD transect conducted down the axis of Baltimore Canyon during the 2012 Sampling Cruise. From top to bottom are temperature (°C), salinity, dissolved oxygen (ml/L), and turbidity (formazin turbidity units). Station numbers are across the top. See **Table 3** and **Figure 2** for additional CTD station data.

Table 4. Summary of purpose and fate of samples collected during Legs 1 and 2 of the 2012 Sampling Cruise. This table does not include large numbers of invertebrates and fishes that were collected in the trawls, which were not yet inventoried at the time of this report, but account for several thousand specimens. n/a = not applicable.

Sample Type		Custodian	Number of Taxa	Number of Samples
Vouchers (ROV samples)	Invertebrates	Brooke	Unknown	154
	Invertebrates	Demopoulos	11	11
Isotopes	Invertebrates	Demopoulos	Unknown	1,010
	Fishes	Ross/Demopoulos	~50	331
Reproduction	Invertebrates	Brooke	11	189
Genetics	Invertebrates	France	5	185
	Invertebrates	Morrison (USGS)/Coykendall	7	92
Paleoecology	Invertebrates	Roark/Prouty	7	48
Microbiology	Invertebrates	Kellogg	4	30
	Sediment	Kellogg	n/a	32
Infauna	Cores (box and tube)	Demopoulos/Robertson	Unknown	65
Sediment	Cores	Mienis/Duineveld/Demopoulos	n/a	67
Water	Aragonite/nutrients	Brooke/Ross	n/a	40
	Other	Roark/Prouty	n/a	~220

4.3.2 Preliminary Observations–Legs 1 and 2

Preliminary observations made during Legs 1 and 2 are as follows:

- The most rugged habitats, mostly walls, boulders, and slabs of consolidated sediments, occurred near the heads of the canyons.
- Biodiversity was extremely high on canyon hard substrata.
- Potential food resources in the form of amphipods and small shrimps were very abundant in some locations.
- The octocoral *Paragorgia arborea* was the most common coral species encountered, frequently observed attached to canyon walls and boulders.
- Scleractinian corals were rare and were represented by several species of cup or solitary corals and isolated colonies of the colonial hermatypic species *Lophelia pertusa*. The solitary coral *Desmophyllum cristigalli* occurred only in the deeper parts of the canyons (>600 m [2,000 ft]) and was attached to the underside of overhanging hard substrata. The *L. pertusa* observations may be the first from the middle Atlantic region, and this species occurred on steep walls at approximately 400 m [1,300 ft].
- Sea pen octocorals (Order Pennatulacea) were not observed on the canyon walls and only rarely in sandy areas along the canyon rims.
- Red crabs (*Geryon quinquedens*) were probably the most common mobile macroinvertebrate.
- Fishes were abundant during all dives, and several commercially important species were common.
- Strong reversing currents were observed in the canyons, and a dense nephloid layer was apparent in the middle of the canyons. Bottom visibility was poor during most dives due to suspended particulates.

- A cold seep discovered by Barbara Hecker in 1980 was rediscovered (original navigation was inaccurate) and was much larger than reported by Hecker. It contained dense aggregations of mussels and exhibited active gas (probably methane) bubbling as well as bacterial mats.
- On most dives there was substantial evidence of human impacts in the form of abundant trash (mostly plastics) and lost fishing gear (nets, traps, lines). Commercial and recreational vessels were observed fishing in the area on most days.
- Pilot whales (*Globicephala macrorhynchus* and/or *G. melas*) were observed around the ship in large numbers on most days, particularly when the seas were calm. This may have been due to the presence of squid observed on many dives.

4.3.3 Leg 3

Leg 3 was successful and most of the stated objectives were attained. This was despite the fact that a considerable amount of time was lost at the beginning of the cruise due to bad weather and also at the end of the cruise with the loss of the ROV and subsequent efforts to recover it. All data collection was centered on Norfolk Canyon. Overall, 35 non-ROV stations were completed comprising 19 box cores, 4 CTDs and 12 trawls. Ten ROV dives were completed, capturing 61 hours, 21 minutes and 45 seconds of video footage; 8,646 still images with the downward camera; 3,546 still images with the pan and tilt camera; and 19 sonar images (**Table 5**). In addition, 85.38 km^2 of sea floor were surveyed with the Kongsberg EM1002 multibeam sonar aboard the *Nancy Foster*. All station data sheets were scanned on board ship and electronic pdfs were provided to project investigators. Data were also entered into an Access database, checked for errors, and archived at UNCW (Ross lab).

Table 5. Stations sampled in the Middle Atlantic Bight off the U.S. east coast around and in Norfolk Canyon during Leg 3 of the 2012 Sampling Cruise (19 September–2 October 2012).

Station Number	Date	Good	Gear	Latitude (°N)	Longitude (°W)	Depth (m)	Day/Night
NF-2012-159	19 Sept 2012	Yes	Box core	37°05'39.84"	74°44'49.92"	196	Night
NF-2012-160	19 Sept 2012	No	Box core	37°05'39.48"	74°44'49.92"	196	Night
NF-2012-161	19 Sept 2012	Yes	Box core	37°05'39.84"	74°44'50.28"	197	Night
NF-2012-162	19 Sept 2012	Yes	Box core	37°04'33.60"	74°39'40.32"	573	Night
NF-2012-163	19 Sept 2012	Yes	Box core	37°04'33.60"	74°39'40.32"	572	Night
NF-2012-164	20 Sept 2012	Yes	Box core	37°02'34.44"	74°37'45.12"	819	Night
NF-2012-169	21 Sept 2012	No	Box core	37°02'34.08"	74°37'45.12"	852	Night
NF-2012-172	22 Sept 2012	No	Box core	37°02'18.96"	74°34'40.80"	1,146	Night
NF-2012-173	22 Sept 2012	No	Box core	37°02'18.96"	74°34'40.80"	1,148	Night
NF-2012-174	22 Sept 2012	No	Box core	37°02'18.96"	74°34'40.80"	1,146	Night
NF-2012-181	24 Sept 2012	Yes	Box core	37°01'24.24"	74°38'42.72"	188	Night
NF-2012-182	24 Sept 2012	Yes	Box core	37°01'24.24"	74°38'42.72"	188	Night
NF-2012-183	24 Sept 2012	Yes	Box core	37°00'56.16"	74°34'42.96"	550	Night
NF-2012-184	24 Sept 2012	No	Box core	37°00'56.16"	74°34'42.60"	550	Night
NF-2012-185	24 Sept 2012	Yes	Box core	37°00'56.16"	74°34'42.60"	550	Night
NF-2012-190	27 Sept 2012	No	Box core	37°02'34.80"	74°37'46.20"	810	Night
NF-2012-191	27 Sept 2012	Yes	Box core	37°02'33.72"	74°37'45.12"	810	Night
NF-2012-192	28 Sept 2012	Yes	Box core	37°02'19.32"	74°34'47.64"	1,133	Night
NF-2012-193	28 Sept 2012	Yes	Box core	37°02'19.32"	74°34'47.64"	1,135	Night
NF-2012-167	20 Sept 2012	Yes	Otter trawl	37°03'01.44"	74°38'25.44"	450–580	Night
NF-2012-168	21 Sept 2012	No	Otter trawl	37°02'51.00"	74°38'16.80"	650	Night
NF-2012-175	22 Sept 2012	Yes	Otter trawl	37°05'32.64"	74°41'17.16"	405–510	Night
NF-2012-176	22 Sept 2012	Yes	Otter trawl	37°04'35.76"	74°40'17.04"	400–423	Night
NF-2012-177	23 Sept 2012	Yes	Otter trawl	37°05'08.88"	74°40'50.16"	389–402	Night
NF-2012-178	23 Sept 2012	Yes	Otter trawl	37°03'49.32"	74°39'41.76"	400–401	Night
NF-2012-179	23 Sept 2012	Yes	Otter trawl	37°04'59.16"	74°40'35.76"	395—400	Night
NF-2012-180	23 Sept 2012	Yes	Otter trawl	37°04'27.12"	74°40'12.72"	390	Night
NF-2012-186	24 Sept 2012	Yes	Otter trawl	37°03'27.00"	74°40'34.32"	105–120	Night
NF-2012-187	24 Sept 2012	Yes	Otter trawl	37°04'57.72"	74°40'33.96"	402–480	Night
NF-2012-188	25 Sept 2012	Yes	Otter trawl	37°05'32.28"	74°41'18.96"	403–408	Night
NF-2012-189	26 Sept 2012	Yes	Otter trawl	37°13'08.76"	74°29'50.28"	460–500	Night
ROV-2012-NF-21	20 Sept 2012	Yes	ROV	37°10'54.12"	74°56'14.28"		Day
ROV-2012-NF-22	22 Sept 2012	Yes	ROV	37°09'26.28"	74°45'15.84"		Day
ROV-2012-NF-23	23 Sept 2012	Yes	ROV	37°09'22.32"	74°34'33.96"		Day
ROV-2012-NF-24	24 Sept 2012	Yes	ROV	37°13'55.92"	74°33'02.16"		Day
ROV-2012-NF-25	25 Sept 2012	Yes	ROV	37°00'56.52"	74°34'43.32"		Day
ROV-2012-NF-26	26 Sept 2012	Yes	ROV	37°11'31.92"	74°34'26.76"		Day
ROV-2012-NF-27	26 Sept 2012	Yes	ROV	37°16'55.92"	74°32'08.52"		Day
ROV-2012-NF-28	27 Sept 2012	Yes	ROV	37°01'03.72"	74°39'15.48"		Day
ROV-2012-NF-29	27 Sept 2012	Yes	ROV	36°54'47.16"	74°42'21.24"		Day
ROV-2012-NF-30	28 Sept 2012	Yes*	ROV	37°11'57.12"	74°45'26.28"		Day
NF-2012-165	20 Sept 2012	Yes	CTD	37°02'18.24"	74°37'22.44"	888	Night
NF-2012-166	20 Sept 2012	Yes	CTD	37°03'14.04"	74°38'07.08"	740	Night
NF-2012-170	21 Sept 2012	Yes	CTD	37°02'15.36"	74°36'01.80"	988	Night
NF-2012-171	21 Sept 2012	Yes	CTD	37°02'18.96"	74°34'41.16"	1,146	Night

* = ROV was lost during the recovery.

Of the 11 ROV dives scheduled for Leg 3, ten were accomplished (**Figure 13**). The ROV was lost at the end of the 10th dive, but was eventually recovered along with the data. Because of the time lost at the beginning of the cruise, the investigation of each actual or potential archaeological site was shortened in favor of investigating multiple sites in a single day. This ensured that some data would be collected for each of the planned sites. As a result, the identities of all eight of the Billy Mitchell-Project B shipwrecks were confirmed, as well as one other vessel (**Figures 14** to **16**). A site of potential paleo-archaeological interest was investigated, as well as a site which emerged as a potential archaeological site as the result of data from one of the box cores. Unfortunately, one of the shipwrecks identified during the multibeam survey was not investigated.

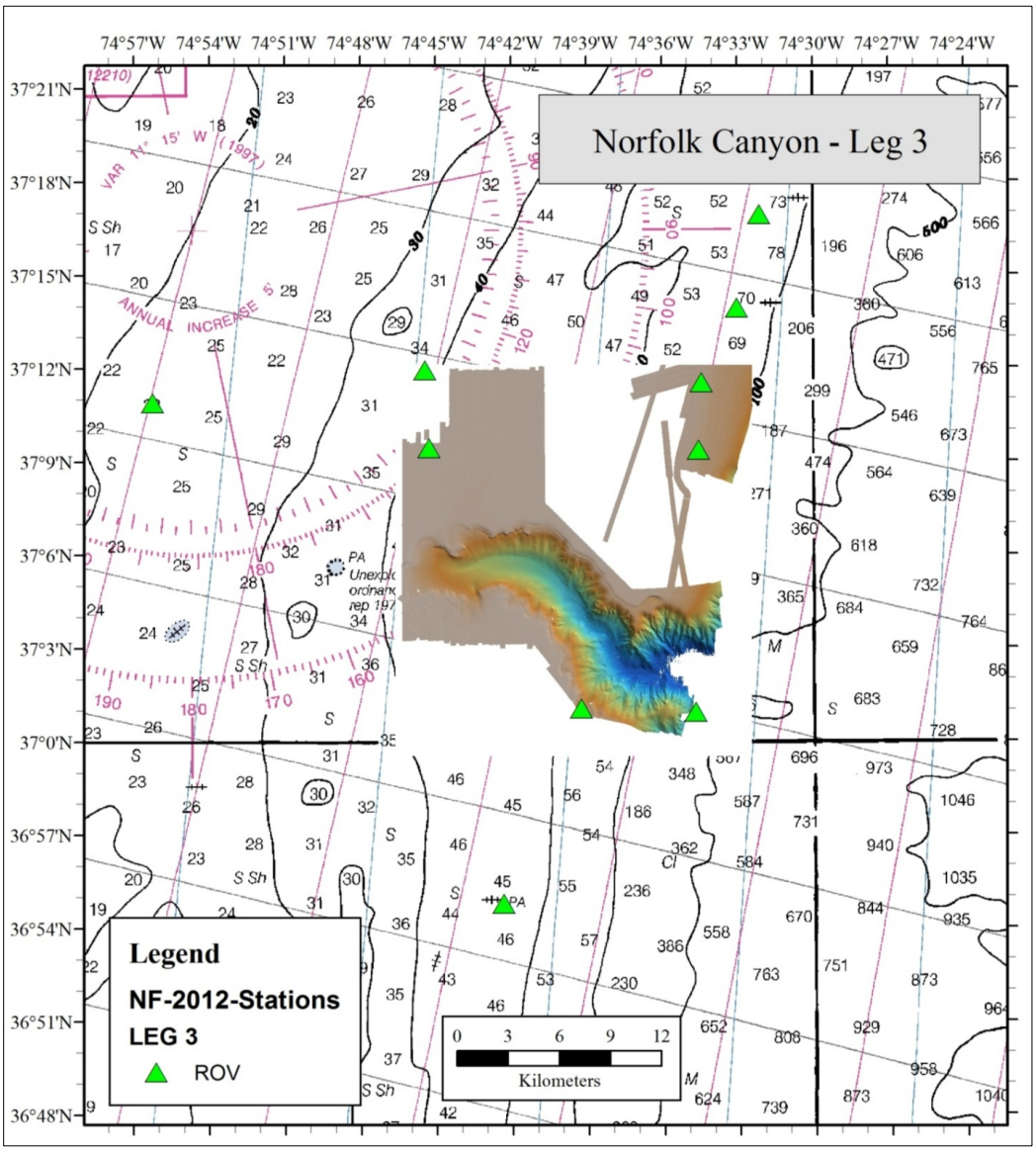

Figure 13. ROV dive locations during Leg 3 of the 2012 Sampling Cruise.

Figure 14. Damage from fishing gear to a destroyer from the Billy Mitchell-Project B fleet.

Figure 15. Ballast from a destroyer from the Billy Mitchell-Project B fleet.

Figure 16. One of the cruiser *Frankfurt*'s 150 mm guns with the gun turret lying on its side in the background.

Data collection at night centered on the biological objectives of the project. Nineteen box core stations (12 of which provided good samples) and four CTD stations (**Figure 17**) were sampled. The latter represented the completion of the CTD transects undertaken in Legs 1 and 2. Bottom trawling was also emphasized for night-time operations during Leg 3. Twelve, 30-minute bottom trawls were attempted during Leg 3, ten of which were successful, one marginally successful, and one (NF-2012-168) was a failure resulting in the loss of the trawl net and 400 m (1,300 ft) of cable. Trawls were mostly restricted to the upper, flatter sides of the canyons (**Figure 18**) to minimize potential for snagging hard substrate in depth ranges centered on 300 to 500 m (984 to 1,640 ft).

Seven areas were identified for multibeam mapping, although without the expectation that all would be completed (**Figure 19**). Because of the cruise, four of the seven survey areas were completed or partially completed, totaling 85.38 km^2 of mapped seafloor.

A limited number of archaeological samples and artifacts were collected during ROV dives on Leg 3. Researchers collected these as part of the archaeological identification and assessment process. All samples were photographed and cataloged and are currently being stored at the University of Rhode Island. Collections of benthic organisms were made from visited shipwrecks, box cores, and from an ROV dive to search for paleo-archaeological sites (**Table 6**). Voucher samples of representative dominant benthic organisms from shipwreck location were collected to facilitate their identifications in video data.

4.3.4 Preliminary Observations–Leg 3

Preliminary observations made during Leg 3 are as follows:

- All eight shipwrecks from the Billy Mitchell-Project B fleet were found and identified, including the *Ostfriesland*, *Frankfurt*, *G-102*, *V-43*, *S-132*, U-*140*, *UB-148*, and U-*117*.
- The battleship, USS *Washington*, was also found and identified.
- All shipwrecks have suffered significant damage from fishing gear, in some cases the damage is extensive (**Figure 14**).
- Damage to shipwrecks from recreational divers and salvage, however, is minimal.
- All shipwrecks were sitting upright on the ocean floor, except for the battleships *Ostfriesland* and USS *Washington*, which had capsized during the wrecking process.
- Damage to the wrecks from the bombing missions in 1921 could be identified and separated from other site formation processes.
- The wrecks were found to be serving as artificial reefs and hosting extensive biological communities.
- Elements of the submerged military landscape associated with the Southern Drill Grounds are identifiable including ships and ammunition.
- Shipwrecks in similar environments sunk at the same time have experienced different rates of degradation and site formation.
- Conditions observed at shipwreck locations are suitable for select photomosaic efforts.
- Paleo-archaeological landscape features (including ancient riverbeds) appear to be identifiable. Rounded river stones were observed and collected at one site.

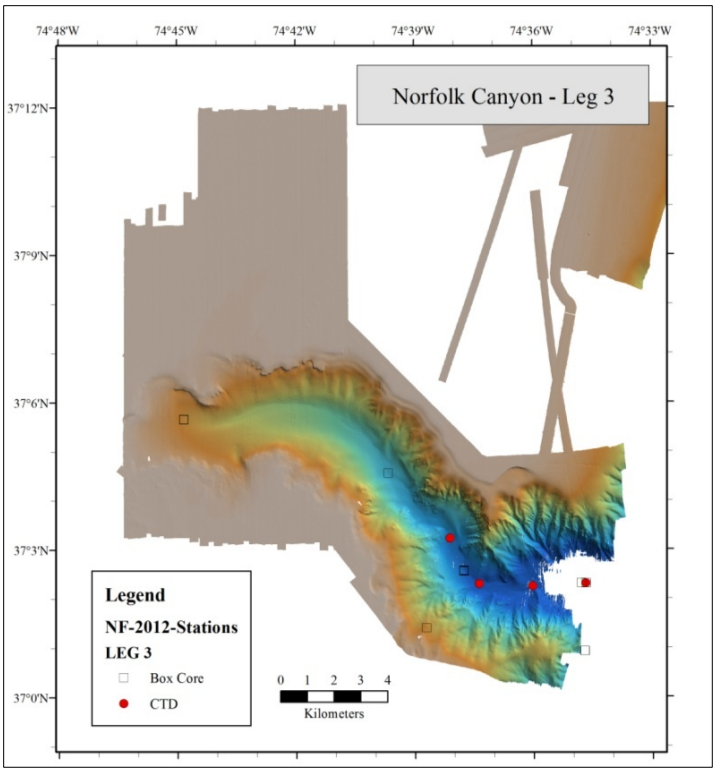

Figure 17. Box core and CTD station locations, Leg 3.

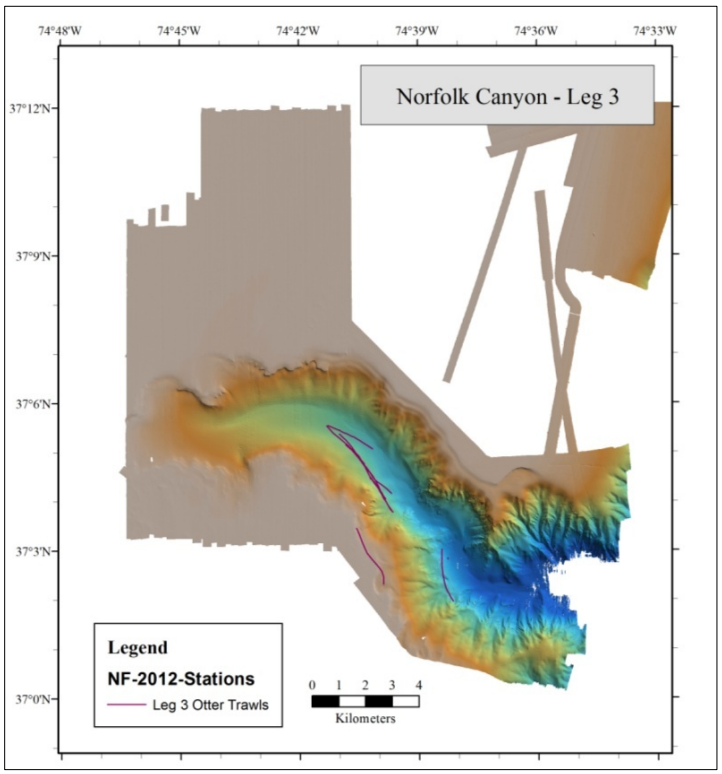

Figure 18. Otter trawl tracks, Leg 3.

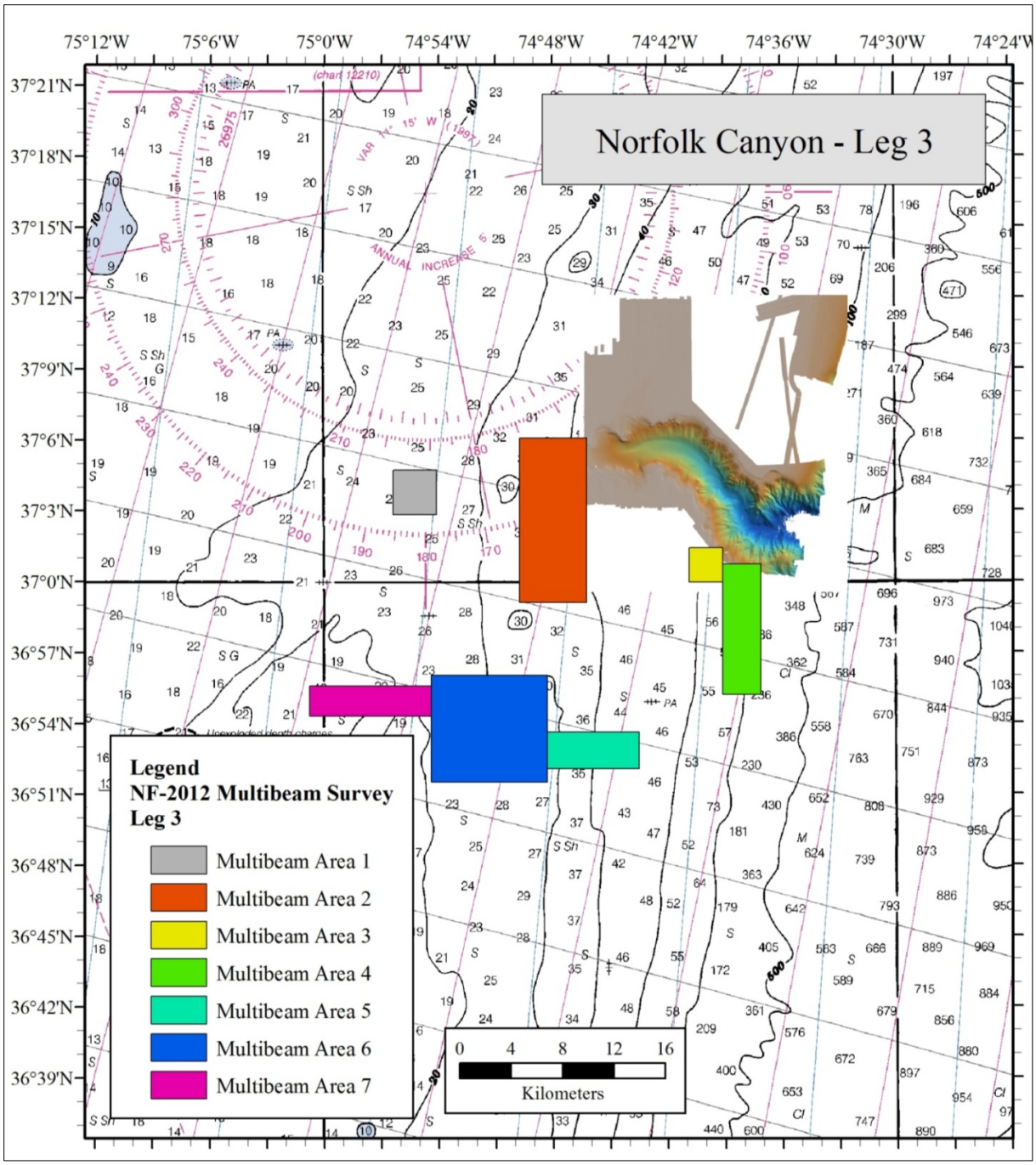

Figure 19. Multibeam survey areas, Leg 3.

Table 6. Biological samples collected during Leg 3 of the 2012 Sampling Cruise (19 September–2 October 2012).

Sample Number	Date	Station Number	Container	Species	Depth (m)	Comments
V66	22 Sept 2012	ROV-2012-NF-22	Bucket 1	Asteroidea	77.78	Found on and around shipwreck, one individual on "brown hydroid"
V67			Biobox	"Brown hydroid"	77.55	Found all over wreck, lots of fauna living in and on
V68			Biobox	Polychaete #1	77.55	Found living in "brown hydroid" on shipwreck
V69			Biobox	Polychaete #2	77.55	Found living in "brown hydroid" on shipwreck
V70			Biobox	Polychaete #3	77.55	Found living in "brown hydroid" on shipwreck
V71			Biobox	Crustacean	77.55	Found living in "brown hydroid" on shipwreck
V72			Biobox	Ophiuroid	77.55	Found living in "brown hydroid" on shipwreck
V73			Biobox	Polychaete #4	77.55	Found in/around "brown hydroid"
V74			Biobox	Polychaete #5	77.55	Found in/around "brown hydroid"
V75			Bucket 2	Zoanthid	76.98	Found on shipwreck
V76			Biobox	Shrimp #1	77.55	Two gravid females found in/around "brown hydroid"
V77			Biobox	Shrimp #2	77.55	Found in/around "brown hydroid"
V78			Biobox	Shrimp #3	77.55	Exoskeleton found in/around "brown hydroid"
V79	23 Sept 2012	ROV-2012-NF-23	Aft biobox	Asteroidea	113.89	Found on rubber tire-like structure
V80			Biobox	Asteroidea	113.89	One found on rubber tire
V81			Bow biobox	Pencil urchin 1	114.63	Found on/near shipwreck
V82			Bow biobox	Pencil urchin 2	114.63	Found on/near shipwreck
V83			Bow biobox	Red-and-white urchin	109.17	Found on/near shipwreck
V84			Mid biobox	Catfish shark embryos	114.63	Found on/near shipwreck
V85			Biobox	Ophiuroid	113.89	Some found on tire structure, others independently (could have fallen off)
V86			Mid biobox	Catfish shark egg casings (empty)	114.63	Found on/near shipwreck
V87			Bucket 3	Shell cluster with epifauna, eggs, bryozoan?	113.75	Anemones removed by Esprit Saucier, University of Louisiana
V88			Biobox	Polychaete	113.89	Found living on asteroid (V79)
V89	23 Sept 2012	ROV-2012-NF-23	Biobox	Pycnogonid	114.63	Found living on pencil urchin 1 (V81)
V90			Mid biobox	Anemones	114.63	Found living on shark egg casings (V84+V86)
V91			Biobox	Crustacea-Decapoda	94-112	Found living on/near shipwreck
V92			Biobox	Gastropoda	94-112	Found living on/near shipwreck
V93			Biobox	Anemone	94-112	Living on worm tube?
V94			Biobox	Asteroidea	94-112	Found living on/near shipwreck
V95			Biobox	Asteroidea	94-112	Found living on/near shipwreck

Table 6. (Continued).

Sample Number	Date	Station Number	Container	Species	Depth (m)	Comments
V96	(Cont'd.) 23 Sept 2012	ROV-2012-NF-23	Biobox	Polychaete	94-112	I wrote on the label "Possibly tube builder because empty tubes found, but no worms in tubes found," but on second look, the "tubes" were just strands from the shark egg casings
V97			Biobox	Asteroidea	113.89	Found on tire structure and shark egg casings (V84+V86)
V98			Biobox	Anemone	113.89	Found living on tire structure
V99			Biobox	Asteroidea	113.89	Found living on tire structure
V100			Biobox	Anemones	113.89	Found living on tire structure
V101			Bucket 8	Hydroids	94-112	Found living on/near shipwreck
V102			Bucket 3	Decapod and Gastropod	113.75	Found living on/near shipwreck
V103			Bucket 7	Various	94-112	Found living on/near shipwreck
V104	24 Sept 2012	ROV-2012-NF-24	Thruster	Dogfish	118-125	Caught in the thrusters of the ROV
V105			Mid biobox	Spider crab	118-125	Found living on/near shipwreck
V106			Mid biobox	Porifera?	118-125	Found living on spider crab (V105)
V107			Box 8	Shark egg casing with anemones	118-125	Found living on/near shipwreck
V108	25 Sept 2012	ROV-2012-NF-25	Box 1	Polychaete	548.25	Found near iron cable
V109			Box 1+8	Rotator shrimp	555.68	Found near iron cable, observed to swim in circles in lab
V110			Box 1+8	Shrimpy shrimp	555.68	Found near iron cable, also ejected from stomach of "Red anemone" (V115)
V111			Box 8	Polychaete	555.68	Found near iron cable
V112			Box 8	Myctophid fish	555.68	Found near iron cable
V113			Box 1	Chiton	548.25	Found near iron cable
V114			Box 1	Polychaete	548.25	Found near iron cable
V115			Biobox	Red anemone	574.08	Found living on soft sediment, cobble
V116			Biobox	Polychaete	574.08	Found living on Red anemone (V115)
V117			Biobox	Acanthogorgia	562.26	
V118			Biobox	Polychaete	562.26	Found living on Acanthogorgia (V117)
V119			Biobox	Ophiuroid	562.26	Found living on Acanthogorgia (V117)
V120			Biobox	Shrimp	562.26	Found living on Acanthogorgia (V117)
V121			Biobox	Unknown worm	562.26	Found living on Acanthogorgia (V117)
V122			Biobox	Sponge	562.26	Found living on Acanthogorgia (V117)

Table 6. (Continued).

Sample Number	Date	Station Number	Container	Species	Depth (m)	Comments
V123	(Cont'd.) 25 Sept 2012	ROV-2012-NF-25	Biobox	Mermaid purse strands (?) and scallop	562.26	Found living on Acanthogorgia (V117)
V124	26 Sept 2012	ROV-2012-NF-26	Box 8	Cup coral	118.23	
V125	26 Sept 2012	ROV-2012-NF-27	Box 1	Green-brain shrimp	118.65	
V126			Biobox	Orange superstar	118.23	Found near brick
V127			Biobox	Rotator shrimp	118.23	Collected with brick, but can't be ruled out that they were still in the box from yesterday's dive
V128			Biobox	Shrimpy shrimp	118.23	Collected with brick, but can't be ruled out that they were still in the box from yesterday's dive
V129			Box 8	Hydroids	118.23	Attached to part of the wreck - iron?
V130	27 Sept 2012	ROV-2012-NF-28	Biobox	Sun star	117.58	
V131			Biobox	Yellow hydroid	117.58	
V132			Biobox	Gastropoda	117.58	Found living on yellow hydroid (V131)
V133			unknown	Polychaete		Found living among pebbles
V134			unknown	Stalks		Found among pebbles, sediment
V135			Biobox	Cup corals	117.58	
V136			unknown	Stones with epifauna		
V137			Box 1	Cup coral	117.25	
V138			Box 1	Gastropoda	117.25	
V139	27 Sept 2012	ROV-2012-NF-29	Box 3	Porifera	79.32	Found living on wreck
V140			Box 3	Hydrozoa	79.32	Found living on wreck
V141			Box 3	Polychaete	79.32	Found living on wreck, possibly within hydrozoan colony
V142			Box 3	Porifera	79.32	Found living on wreck
V143			Box 3	Ophiuroid	79.32	Found living on wreck, possibly within hydrozoan colony
V144			Box 3	Anemone	79.32	Found living on wreck, on catshark egg casings, and it fluoresces under black light!
V145			Box 3	Green-brain shrimp	79.32	Found living on wreck, possibly within hydrozoan colony
V146			Box 3	Mini spider crab	79.32	Found living on wreck, possibly within hydrozoan colony
V147			Box 3	Decapoda	79.32	Found living on wreck, possibly within hydrozoan colony
V148			Box 3	Mini polychaete	79.32	Found living on wreck, possibly within hydrozoan colony

Table 6. (Continued).

Sample Number	Date	Station Number	Container	Species	Depth (m)	Comments
V149	(Cont'd.) 27 Sept 2012	ROV-2012-NF-29	Box 8	Gastropoda	83.15	Found in sediment
V150			Box 2	Limpet	84.88	Found in/on catshark egg casings on wreck
V151			Box 2	Crab	84.88	Found in/on catshark egg casings on wreck
V152			Box 2	Polychaete	84.88	Found in/on catshark egg casings on wreck
V153			Box 2	Anemones	84.88	Found in/on catshark egg casings on wreck, and they fluoresce under black light!
V154			Box 2	Bivalve	84.88	Found on shipwreck, was covered in anemones (V144 and 153)

5 EDUCATION, OUTREACH, AND MEDIA

Two internet sites documented progress and facilitated public awareness of the project during all cruise legs. One site (http://oceanexplorer.noaa.gov/explorations/12midatlantic/welcome.html) was managed by the NOAA Office of Ocean Exploration as a Signature Expedition site. The NCMNS site (http://deepwatercanyons.wordpress.com/ or http://naturalsciences.org/education/onlineadventures) was set up as a "blog" to allow for easy posting of cruise activity logs. Background essays, daily logs and various photographs were posted to both sites prior to and during the cruise. Scientific personnel wrote blogs and recorded daily logs while at sea. During Cruise Leg 1, Drs. Brooke and Ross participated in a Skype real time phone interview which was broadcast on the large screen of the North Carolina Museum's new building. During Leg 2, Steve Ross, Sandra Brooke, Chris Kellogg, Jennie McClain-Counts, and Holly Jablonski (Captain,*Nancy Foster*) answered a questionnaire and were interviewed on video for the OceanAge section of the NOAA Ocean Explorer web site. During Leg 3, Rod Mather, Stephen Viada, Amanda Demopoulos, Jack Irion, Terry Connell, Kirstin Meyer, and Esprit Saucier-Heestand posted mission logs to them NOAA Ocean Explorer web site, while Megan Chesser maintained a second set of mission logs, updates, and blogs through the NCMNS website. She also conducted live Skype sessions with the Museum updating visitors as to the progress and findings of the mission. During August through early October, the NCMNS web site for this project was viewed 6,700 times (highest number of views in one day = 185) spread across 69 countries, and the site has been viewed 15,058 times since last year. Statistics indicate that this site is used as a resource even when we are not at sea. Videographer Art Howard and Liz Baird will continue working on film and education projects related to this project through the coming year. UNCW and Marine Conservation Institute - Seattle, Washington, (MCI) jointly sent out a press release concerning this cruise to a variety of media contacts on 9 October 2012.

6 REFERENCES

CSA International, Inc. 2011. Exploration and Research of Mid-Atlantic Deepwater Hard Bottom Habitats and Shipwrecks with Emphasis on Canyons and Coral Communities: 2011 Mapping Cruise. BOEM Contract M10PC00100.

CSA Ocean Sciences Inc. 2013. Exploration and Research of Mid-Atlantic Deepwater Hard Bottom Habitats and Shipwrecks with Emphasis on Canyons and Coral Communities: 2012 Sampling Cruise. BOEM Contract M10PC00100.

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Appendix C

2013 Sampling Cruise Report

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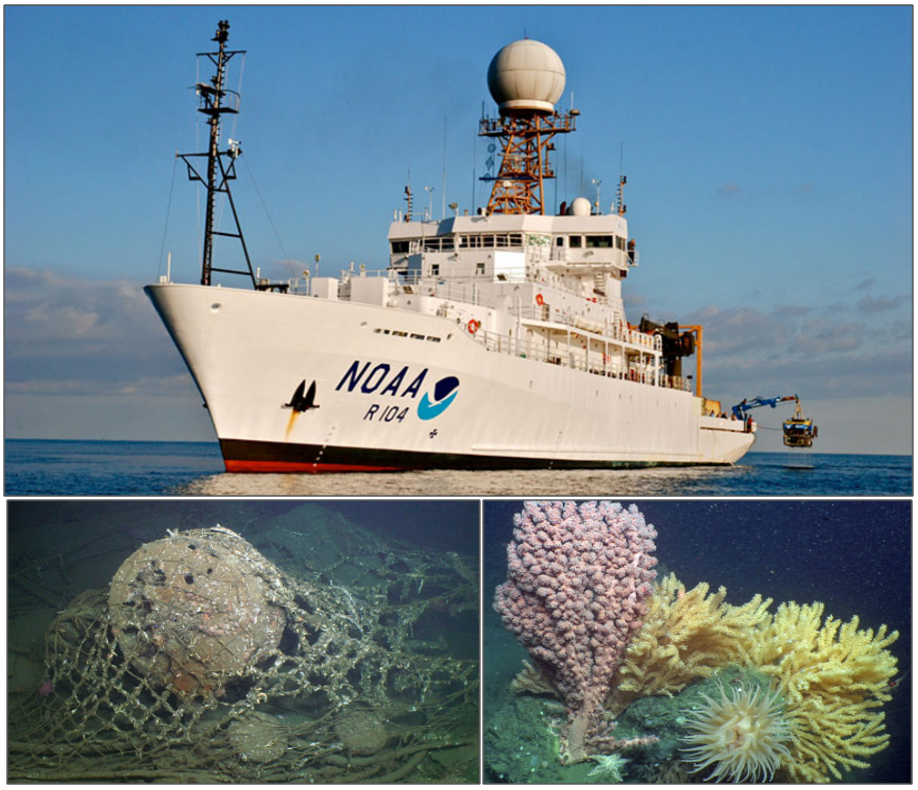
OCS Study
BOEM 2017-061

Exploration and Research of Mid-Atlantic Deepwater Hard Bottom Habitats and Shipwrecks with Emphasis on Canyons and Coral Communities: Atlantic Deepwater Canyons Study

2013 Sampling Cruise

April 2014



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Atlantic OCS Region

BOEM
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OCS Study
BOEM 2017-061

Exploration and Research of Mid-Atlantic Deepwater Hard Bottom Habitats and Shipwrecks with Emphasis on Canyons and Coral Communities: Atlantic Deepwater Canyons Study

2013 Sampling Cruise

April 2014

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Funding for this cruise was largely supplied by the Bureau of Ocean Energy Management (BOEM) contract with CSA Ocean Sciences Inc. (CSA). We thank Greg Boland of BOEM and Stephen Viada of CSA for support during the development of this cruise. The ship *Ronald H. Brown* and ROV *Jason II* were provided by the National Oceanic and Atmospheric Administration (NOAA) Office of Exploration and Research. The U.S. Geological Survey contributed towards funding for personnel. We thank all cruise personnel for their hard work and dedication while at sea and in dealing with logistics and data before and after the cruise. We thank Art Howard and Liz Baird (North Carolina Museum of Natural Sciences) for shoreside support for outreach and web-related activities. Mike Rhode (University of North Carolina - Wilmington) organized and archived multibeam data, produced maps and conductivity-temperature-depth plots, and led the night watch during the cruise. We thank the crew of the ROV *Jason II* for their long hours and determination to successfully complete operations in a safe and efficient manner. Finally, we thank the ship- and shore-based personnel who operated the *Ronald H. Brown* for exemplary service during the mission. At all times, the ship's personnel were dedicated to accomplishing the many objectives of this complex operation.

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Appendix C: 2013 Sampling Cruise

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LIST OF ACRONYMS AND ABBREVIATIONS

BOEM	Bureau of Ocean Energy Management
C/N	carbon/nitrogen
CSA	CSA Ocean Sciences Inc.
EDT	eastern daylight time
EST	eastern standard time
GMT	Greenwich mean time
IIMR	Institute for International Maritime Research, Inc.
MCI	Marine Conservation Institute
NCMNS	North Carolina Museum of Natural Sciences
NIOZ	Royal Netherlands Institute for Sea Research
NOAA, OER	National Oceanic and Atmospheric Administration, Office of Ocean Exploration and Research
OCS	Outer Continental Shelf
OIMB	Oregon Institute of Marine Biology
POM	particulate organic matter
ROV	remotely operated vehicle
SBE	Sea-Bird Electronics, Inc.
TAMU	Texas A&M University
UNCW	University of North Carolina – Wilmington
UNOLS	University-National Oceanographic Laboratory System
URI	University of Rhode Island
USGS	U.S. Geological Survey
WHOI	Woods Hole Oceanographic Institution

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1 INTRODUCTION

CSA Ocean Sciences Inc.1 (CSA) was contracted to conduct three field sampling efforts, or cruises, associated with the Bureau of Ocean Energy Management (BOEM)-funded contract Exploration and Research of Mid-Atlantic Deepwater Hard Bottom Habitats and Shipwrecks with Emphasis on Canyons and Coral Communities (also referred to as the Atlantic Deepwater Canyons project) Contract No. M10PC00100. This report describes the third field sampling effort (April to May 2013) using the National Oceanic and Atmospheric Administration, Office of Ocean Exploration and Research (NOAA, OER) ship *Ronald H. Brown* and the Woods Hole Oceanographic Institution (WHOI) remotely operated vehicle (ROV) *Jason II.*

2 BACKGROUND AND OBJECTIVES

2.1 BACKGROUND

Submarine canyons are dominant features of the Outer Continental Shelf (OCS) and slope of the U.S. Atlantic coast from Cape Hatteras to the Gulf of Maine. They are important conduits of anthropogenic pollutants, organic carbon, and sediments from shallow to deeper waters and support ecologically important ecosystems such as cold seeps and hard bottom and coral habitats. The geology of these features has been well studied; however, despite their high productivity, biological data are limited (particularly in waters deeper than 200 m). Much of the biological information on these canyons resides in cruise or project reports and has not been published as peer-reviewed literature. The canyons between Cape Hatteras and Cape Cod are the subject of potential oil and gas exploration and support intensive fisheries. The canyons in this area have been considered for designation as a National Marine Sanctuary. These canyons are therefore potentially ecologically important ecosystems that may be vulnerable to human activities.

In 2010, BOEM initiated a 4-year multidisciplinary study, which focused on ecologically significant habitats (cold seeps, hard bottoms, and shipwrecks) in submarine canyons and surrounding seafloor areas within the mid-Atlantic OCS Planning Area. Submarine canyons selected for this study included Norfolk, Washington, and Baltimore Canyons.

The first activity for this project was a multibeam sonar mapping and water column sampling cruise from Norfolk Canyon to Baltimore Canyon using the NOAA ship *Nancy Foster* (NF-11-04) from 4 to 17 June 2011, with Co-Chief Scientists Sandra Brooke and Steve W. Ross (2011 Mapping Cruise). Details of this cruise are described in a report prepared for BOEM by CSA International, Inc. (2011).

Detailed bathymetric maps generated during the 2011 Mapping Cruise were used to guide sampling activities during subsequent research cruises in 2012 and 2013. The 2012 Sampling Cruise originated and ended in Charleston, South Carolina, from 14 August to 1 October, and was broken into three legs. Legs 1 and 2 focused on biological objectives and Leg 3 focused on archaeology (Co-Chief Scientists on Legs 1 and 2 were Sandra Brooke and Steve W. Ross, and on Leg 3 were Rod Mather and Stephen Viada). Details of this cruise are available in a report prepared for BOEM in March 2013 (CSA Ocean Sciences Inc., 2013).

For the 2013 Sampling Cruise, the ship *Ronald H. Brown* and the ROV *Jason II* were used. The cruise was split into two legs: Leg 1 (30 April to 19 May) focused on objectives associated with natural substrata and Leg 2 (20 to 27 May) addressed archaeological objectives. Operations were conducted on a 24-h basis to meet project requirements. The ROV was scheduled for launch at 06:00 and recovery at 19:00, for a total deployment period of approximately 13 h; however, dives were often delayed or shortened because of equipment malfunction, bad weather, or poor visibility. Non-ROV operations

1 CSA International, Inc. changed its company name to CSA Ocean Sciences Inc. effective 1 January 2013.

included box coring, bottom trawling, benthic lander recovery (two), multibeam mapping, water column conductivity-temperature-depth (CTD) surveys, and water sampling. Education and outreach activities were incorporated into the cruise using websites of the NOAA Ocean Explorer, North Carolina Museum of Natural Sciences, and other relevant institutions. This cruise was a collaborative effort between BOEM (the major funding source), CSA (the prime contractor) and academic partners, NOAA OER (OER was the provider of ship and ROV time), and the U.S. Geological Survey (USGS).

This report describes Leg 1 and Leg 2 of the 2013 Sampling Cruise for the Atlantic Deepwater Canyons project. Both survey legs focused primarily on Norfolk Canyon, with some biological sampling in Baltimore Canyon (**Figure 1**).

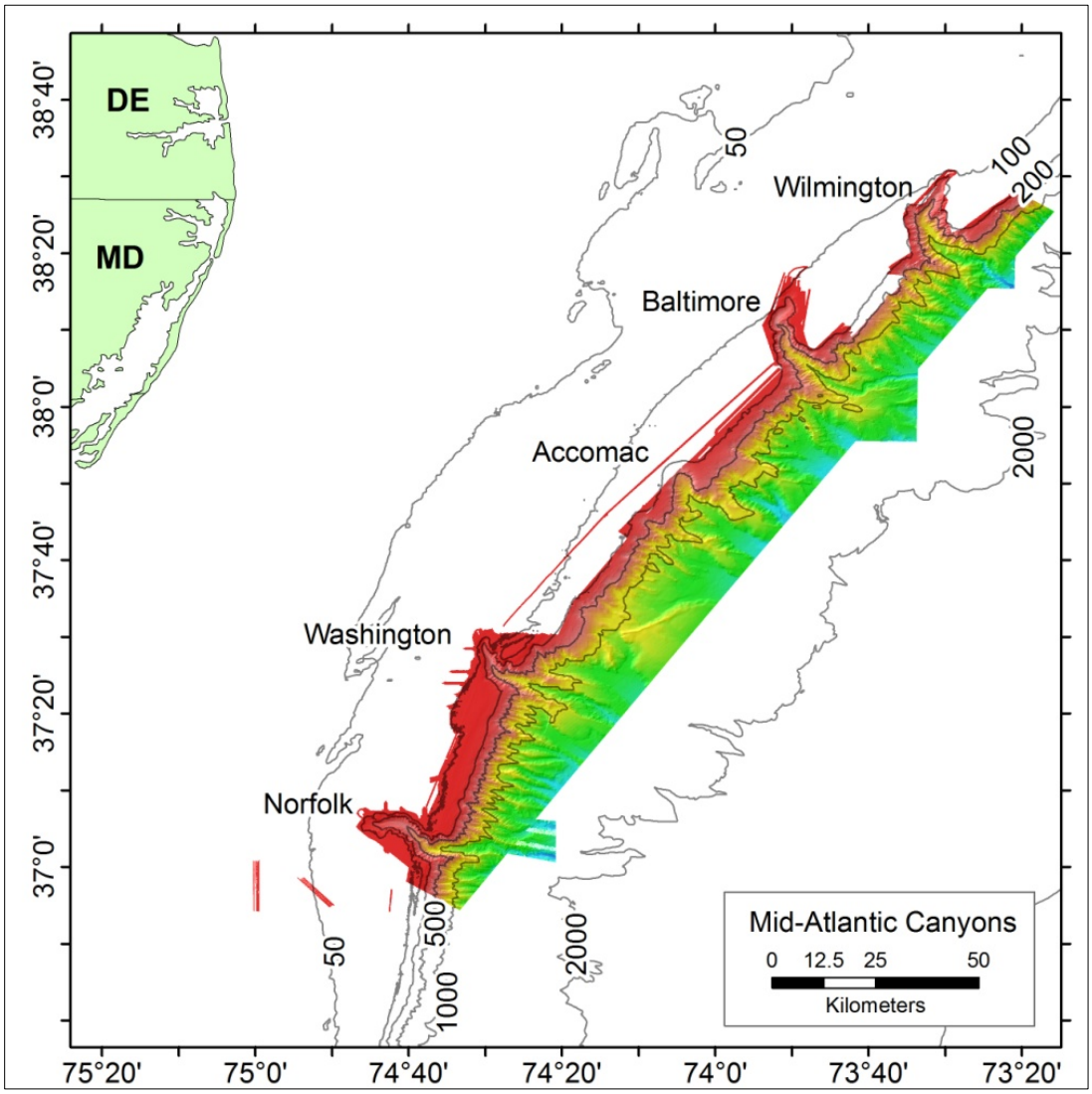


Figure 1 Study area for the Atlantic Deepwater Canyons project. Color-shaded areas represent the total area mapped with multibeam sonar during the 2011 Mapping Cruise and the U.S. Geological Survey cruises.

2.2 OBJECTIVES

2.2.1 Leg 1 Objectives

1. Retrieve two benthic landers deployed in Baltimore Canyon; service and redeploy them in the same locations as soon as possible.
2. Conduct replicate bottom trawl (16-ft otter trawl) operations inside and outside of target canyons in the depth range of 100 to 1,600 m.
3. Collect replicate benthic box core samples inside and outside of target canyons in the depth range of 100 to 1,600 m.
4. Conduct multibeam sonar mapping in selected parts of target mid-Atlantic canyons and surrounding areas. Take appropriate sound velocity measurements in support of multibeam sonar using the ship's CTD profiler.
5. Conduct vertical water column casts using the ship's CTD to generate profiles of environmental conditions. On selected CTD casts, use Niskin bottles to collect water samples for aragonite saturation, particulate organic matter (POM), and other water quality analyses. During some deployments, attach a small coring device (a monocore) under the CTD to collect a single sediment core.
6. Keep live deepsea animals on board in a small recirculating system with chiller.
7. Conduct other activities (e.g., sample or data processing) to support all objectives.
8. Conduct education and outreach activities (internet postings, essays, teacher-at-sea, video clips, live Skype call with the North Carolina Museum of Natural Sciences).
9. Objectives of the ROV *Jason II* included the following:

    - Survey target canyon habitats and collect samples and environmental data in the depth range of 100 to 1,600 m.
    - Conduct video transects over different natural habitat types; collect digital still images to facilitate identifying fauna.
    - During each dive, collect fauna from various taxonomic groups in different natural habitat types as follows:

        - Place stony corals and other selected invertebrates into insulated bio-boxes to transport to the surface and maintain alive on board ship;
        - Make numerous discrete collections of invertebrates (particularly corals) and fishes from multiple sites for various biological studies;
        - Collect large (~1 m tall) colonies of selected coral species for age, growth, and paleoecology studies;
        - Take images and collect voucher specimens of selected taxa from each location;
        - Deploy site markers at sites in locations of interest;
        - Collect environmental data (depth, oxygen, temperature, salinity, pH) using ROV-mounted instruments;
        - Collect near-bottom water samples using 6-L Niskin bottles mounted on the ROV; and
        - Collect push cores for analysis of sediment and infauna.

2.2.2 Leg 2 Objectives

2.2.2.1 Archaeology Objectives

1. Billy Mitchell-Project B fleet (Norfolk Canyon) – Conduct ROV operations on at least four of the Billy Mitchell Fleet wrecks (*Ostfriesland, Frankfurt, G-102,* and *U-140)* and preferably a fifth wreck, the *Washington*. This would provide important archaeological site information on a battleship, a cruiser, a destroyer, and a submarine. Capabilities of the ROV *Jason II* were far superior than those of the *Kraken 2*, which was used in 2012 Sampling Cruise. The purpose of onsite investigations in 2013 was to generate high-quality photomosaics that would be part of the application for nomination to the National Register of Historic Places, which is a required deliverable for the project. All work was within the vicinity of Norfolk Canyon.
2. *San Demetrio* (35 mi east of Norfolk Canyon) – Conduct a multibeam survey and ROV dive on the potential location of the *San Demetrio*. The vessel was central to the archaeological part of the proposal to BOEM. It was estimated that the site was in approximately 2,500 m of water and located 35 mi east of Norfolk Canyon.
3. Prehistoric Site Investigations (Norfolk Canyon) – Conduct at least one prehistoric site reconnaissance dive on the several locations identified in the vicinity of Norfolk Canyon.
4. *Ocean Venture* (Norfolk Canyon) – Conduct an ROV dive on a shipwreck believed to be the *Ocean Venture*. The vessel was sunk by a German submarine in 1942. The potential site was found during the multibeam survey work on the *Nancy Foster* in 2012, but was not investigated during the survey. The *USS Virginia* and *USS New Jersey*, as a contingency plan, conducted ROV dive operations on the sites of these two warships. Their remains are off the coast of North Carolina and outside the initial area of interest for this study; however, they are vessels that were sunk as part of the experiments in airpower in the 1920s and could be included in a National Register of Historic Places nomination for the Billy Mitchell-Project B fleet.

2.2.2.2 Biology and Related Objectives

1. Collect dominant epifauna from each shipwreck.
2. Collect environmental data including depth, oxygen, temperature, salinity, and pH with ROV-mounted instruments.
3. Collect sediment push cores to assess benthic communities near shipwrecks.
4. Collect replicate benthic box core samples inside and outside of Norfolk Canyon in the depth range of approximately 100 to 1,500 m (328 to 4,921 ft).
5. Conduct bottom trawl operations (using a 16-ft otter trawl) inside and outside of Norfolk Canyon in the depth range of 100 to 1,000 m (328 to 3,280 ft).
6. Conduct vertical hydrographic profiles of the water column using a recording CTD probe and collect seawater samples at selected depth levels for aragonite saturation, POM, and other water quality analyses using Niskin-type water sampling bottles.
7. Conduct sample and data processing to support project objectives.

2.2.3 Educational Outreach Objectives

Conduct education and outreach activities (regular postings to multiple internet sites, live interview with North Carolina Museum of Natural Sciences, NOAA OceanAge career profiles).

3 FIELD METHODS

This section presents a brief description of field data collection methods for ROV operations, water column sampling, sediment sampling, benthic landers and moorings, bottom trawling, and specimen and data treatment.

3.1 ROV OPERATIONS

The ROV *Jason II* (**Figure 2**) is owned and operated by the Deep Submergence Laboratory at Woods Hole Oceanographic Institution and is capable of diving to depths up to 6,500 m.

The ROV system is composed of two units: the ROV (*Jason II*) and an active tethering unit (*Medea*), which reduces the load on the umbilical and helps buffer movement between the surface and the ROV. Color-shaded bathymetric geotiff images (products of the 2011 multibeam mapping cruise [CSA International, Inc., 2011]) were provided to the ROV crew prior to each dive. The ROV navigation system was a Sonardyne Ranger ultrashort baseline (USBL), which recorded the position of the vehicle every few seconds and allowed the pilots and scientists to observe the relative location and track of the ROV in near real-time. This provided a useful tool for guiding the dive, particularly when overlaid on the topographic seafloor map.

An Insite Mini Zeus high-definition video camera was used as the primary science camera on the ROV. Two parallel lasers mounted 10 cm apart projected onto the subject of the video image and provided a size reference for measuring objects on the seafloor. The video was recorded directly to external hard drives and DVDs during the dive, and a high-resolution copy of the dive was uploaded onto external hard drives as a backup every night. Two digital still cameras were used for the cruise: a 3-MB Nikon CoolPix controlled by the ROV dive science leader and an Insite Super Scorpio operated by the ROV crew.

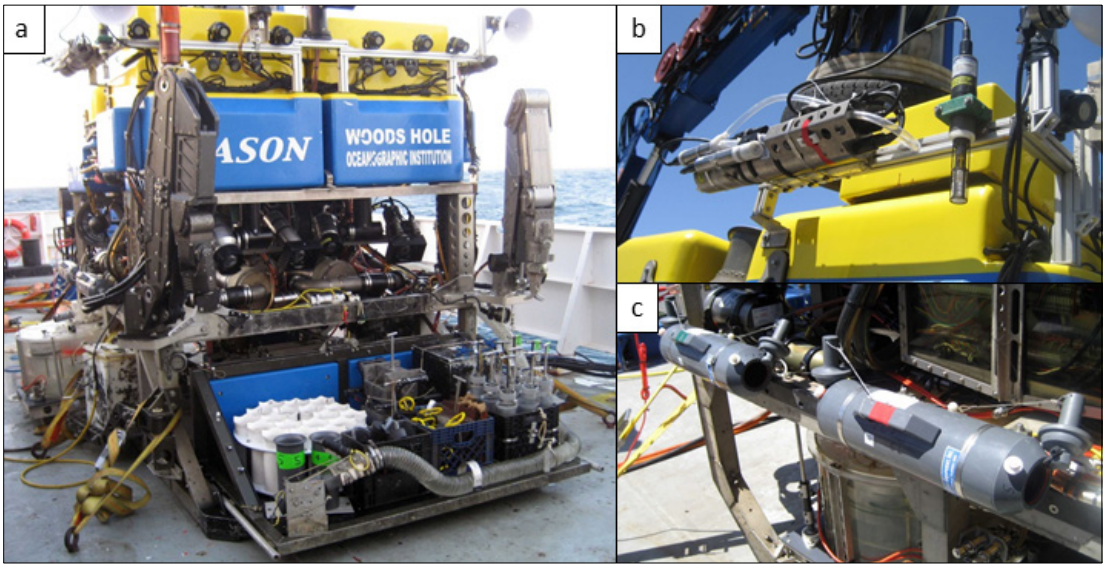


Figure 2 ROV *Jason II* (a) on deck before a dive with various sampling devices attached to the basket on the ROV, (b) with SBE 19+ profiler for collecting environmental data, and (c) with two Niskin bottles mounted horizontally on the lower right side of the vehicle.

Two seven-function hydraulic manipulator arms (a Schilling Titan 4 and a Kraft Predator II) were used to collect samples. A large retractable sled mounted on the front of the ROV was equipped with different sampling devices including an insulated polypropylene biobox, an array of 18 PVC quivers (3" diameter), a set of 4-9 pushcores, and an Ekman box core. Two additional insulated bioboxes were

mounted on retractable arms on either side of the sled and a 5-bucket suction sampling system located at the back of the vehicle. Two 6-L Niskin bottles mounted on the starboard side of the vehicle were used to collect bottom water samples when triggered with a manipulator arm. A SeaBird Electronics, Inc. (SBE) 19*plus* CTD profiler (provided by University of North Carolina – Wilmington [UNCW]) was attached to the ROV to record environmental data during the dive (see **Section 3.2.1**. for CTD details).

The cruise plan was scheduled to accommodate 16-h dives; however, this was reduced to 13 h after adjusting for rest and meal time for the ROV crew. The ROV plan was to launch at 06:00 and be back on deck at 19:00, but this schedule was subject to change as conditions and logistics dictated. Each dive had multiple objectives, with some tasks given priority on certain dives. Most ROV dives followed a similar pattern, emphasizing bottom transects and collecting and photographing specimens on or near the seafloor. Water collections, push cores (sediment sampling), and an Ekman box core were also taken on selected dives. ROV navigation data were time-synchronized with all imagery and samples and the "Virtual Van") was used to record data on observations and collections as well as images and environmental data throughout the dive. The WHOI Virtual Van is a data acquisition system that automatically captures information in the control van during ROV operations, including up to four simultaneous video sources, vehicle data, scientific instrument data, and event data. Time was recorded in Greenwich mean time (GMT); however, since local time is more biologically relevant, station sheets and audio logs were recorded in eastern standard time (EST).

During each ROV dive, the lead scientist and two other observers were on watch in the ROV control van. The lead scientist directed the dive (course, speed, transect configuration, data collection, and sampling) and made audio annotations of dive activities. The second observer recorded events on hard copy throughout the dive and logged events in the Virtual Van. The third observer was responsible for keeping track of the media recordings, and switching and labeling the drives and discs.

All dives began at the deepest part of the target location and worked upslope. During the initial descent, water column data were collected with the CTD profiler. Notes and observations of the distribution and behavior of midwater fauna also were recorded. Samples were collected after the ROV landed on the seafloor and occurred throughout the dive. Standardized video transects were taken whenever the ROV moved from one location to another. During transects, the video camera was moved to a predetermined pan and tilt position, set on wide angle, and the ROV ran at slow speeds (~0.25 kn) close to the seafloor. Transects were of variable lengths; some were short as sampling was frequent and interrupted the transects while others were longer, covering wide ranges of habitats.

Video transects and digital still images were taken throughout each dive because they were the primary means of visually characterizing the habitat. Every collection also was documented with video and digital images to the extent possible. The primary targets were corals (scleractinians and gorgonians) for analysis of reproduction, microbiology, genetics, trophodynamics, and paleoecology. Specimens were collected from multiple locations over a wide depth range. Collected specimens included seep fauna, fishes, and benthic invertebrates. Sediments and water samples were collected for analysis of infaunal communities and water chemistry.

3.2 HYDROGRAPHIC PROFILE DATA AND SEAWATER SAMPLES

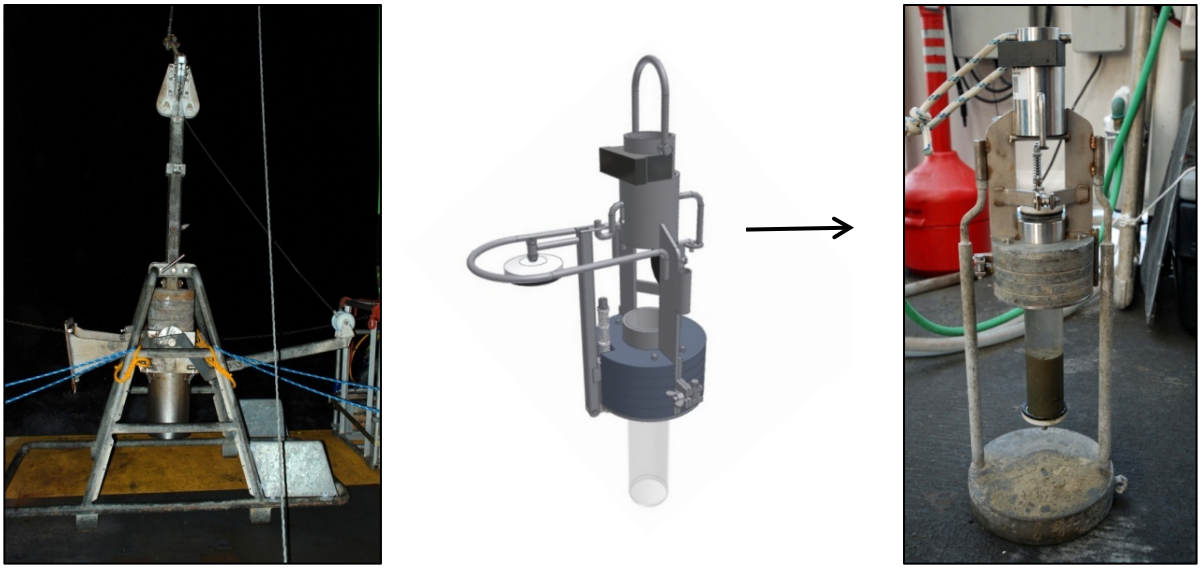
An SBE 9*plus* CTD profiler was mounted on a frame with a rosette of 12, 10-L Niskin bottles to record water column parameters and collect water samples. The CTD profiler measured turbidity (Seapoint probe, formazin turbidity units), dissolved oxygen (mL/L), altitude (m), depth (m), conductivity (Siemens/m), temperature (°C), pH, and fluorescence (**Figure 3**). Single CTD casts and two transects were conducted in Norfolk Canyon. During these casts, the CTD-Niskin array was lowered from the surface to as close to the bottom as possible and water samples were collected by triggering the Niskin bottles at specific depths at selected stations. The samples are currently being processed for analysis of aragonite saturation state, nutrient concentrations, trace metals, and POM.

Figure 3 Water collection rosette with 10-L Niskin bottles and CTD profiler used during the 2013 Sampling Cruise aboard the *Ronald H. Brown*. Photograph courtesy of NOAA (2013).

An SBE 19*plu*s CTD profiler (provided by UNCW) was attached to the starboard side of the ROV to record hydrographic parameter dta through the water column (during deployment and recovery) as well as on the seafloor duringeach ROV dive. The profiler measured turbidity (Seapoint probe, formazin turbidity units), dissolved oxygen (mL/L), depth (m), conductivity (Siemens/m), temperature (˚C), salinity, and pH. **Figure 2b** shows the SBE 19*plus* CTD profiler in the field.

3.3 BOX CORE AND MONOCORE

A box core was used to collect large intact samples of sediment and fauna (**Figure 4**). The box core was provided by the Royal Netherlands Institute for Sea Research (NIOZ.)



(a) (b) (c)

Figure 4 Photographs of a (a) box core, (b) monocore, and (c) successful core taken from a monocore suspended 10 m below the CTD carousel. (All instruments provided by the Royal Netherlands Institute for Sea Research.)

As the ship maintained its location using dynamic positioning, the box core was lifted through the A-frame by the main winch, lowered to the bottom until bottom contact was determined (triggering the device to close), and then returned to the surface. The small monocore was suspended approximately 10 m beneath the CTD on selected casts. The device provided a core sample of the bottom at a number of locations as well as collected environmental data. Cores will be processed by various investigators for macrofauna, meiofauna, microbiology, organic carbon/nitrogen (C/N), particle size, $\delta^{13}C$, $\delta^{15}N$, and other parameters.

3.4 Benthic Lander Retrieval and Redeployment

The two UNCW landers in Baltimore Canyon were recovered to replace a potentially problematic release mechanism while the ROV was available for rescue if necessary. After data download and servicing, the two landers were redeployed in the same locations. However, the sediment trap was removed from the lander at the head of Baltimore Canyon because it had been inundated by mud, and the coral mesocosms were removed from the deep lander because the experiment was terminated.

3.5 Bottom Trawling

During the first week of Leg 1, bottom trawling was the priority for night operations. The otter trawl consisted of 4.9-m headrope, 38.1-mm body mesh, and 3-mm cod end liner mesh. Trawling was conducted over a depth range of approximately 160 to 1,700 m off the stern using the ship's main winch. A wire rope scope of approximately 2.5:1 was used for each trawl. Once it was determined that the net was on the bottom, it was pulled for 30 min at a ground speed of approximately 2 kn (3.7 km/h).

3.6 General Specimen and Data Treatment

Samples from all collections were processed at sea according to various scientific objectives. Fishes and invertebrates that were collected by trawling and voucher specimens from the ROV were preserved in

10% formalin (seawater-buffered solution) on board the ship, to be transferred to 70% ethanol or 50% isopropanol (depending on taxa) after the cruise. Samples for genetic analyses were preserved in nondenatured ethanol, in RNA-later or on FTA cards. Before preservation, subsamples were taken from selected specimens for stable isotope analyses. The subsamples were then dried and stored for further processing after the cruise. Isotope samples also were taken from collected water and sediment samples. Samples of selected corals (*Paragorgia* sp*., Desmophyllum dianthus,* and *Lophelia pertusa*) and seep mussels that were brought to the surface in ROV-insulated bioboxes were subsampled for genetics, reproduction, paleoecology, and isotopic analysis. The remaining specimens were then transferred to the live tanks. The tanks consisted of large insulated containers that were cooled to 6°C to 7°C with a portable chiller. At the end of each leg, the samples were shipped to holding systems at Florida State University where they will be used for physiology experiments. All genetic samples, and representatives of most other species, were set aside for on-board photography, using a light table under daylight-balanced strobes or daylight-balanced fluorescent lights.

4 FIELD RESULTS

4.1 SURVEY PERSONNEL

The international team of scientists came from many different academic, nonprofit and governmental institutions. Participants for the survey are presented in **Table 1**. Personnel boarded the ship in Charleston, South Carolina for Leg 1 on 30 April 2013. On 19 May, there was an at-sea transfer of personnel off Norfolk, Virginia. Most of the science crew from Leg 1 were exchanged with those participating in Leg 2, which terminated at Charleston, South Carolina on 27 May. Operations were conducted on a 24-h schedule, and the scientific crew was divided into a day and a night watch. Night shift personnel were on watch from 20:00 to 08:00, but day shift watches varied according to the ROV dive schedule.

Table 1 Names, titles (roles), and affiliations of science personnel for the Atlantic Deepwater Canyons project 2013 Sampling Cruise Legs 1 and 2.

Cruise Leg		Name (Last, First)	Title	Affiliation
1	2			
•		Baird, Liz	Educator	NCMNS
•	•	Borden, Lisa	ROV crew	WHOI
•		Bourque, Jill	Technician	USGS
•		Brooke, Sandra	Co-chief scientist	FSU
	•	Cantelas, Frank	NOAA archaeologist	NOAA
	•	Cantwell, Kasey	NOAA representative	NOAA
•	•	Collasuis, Tito	ROV crew chief	WHOI
•		Connors, Jimmy	NOAA website representative	NOAA
•		Coykendall, Katharine	Scientist	USGS
	•	Dahlheim, Tony	Multibeam sonar technician	Kongsberg Inc.
•	•	Demopoulos, Amanda	Scientist	USGS
•	•	Denton, Frederick	ROV crew	WHOI
•	•	Dow, Edward	ROV crew	WHOI
•		Gray, Mike	Scientist	USGS
	•	Gurley, Walt	Educator	NCMNS

Table 1 (Continued).

Cruise Leg		Name (Last, First)	Title	Affiliation
1	2			
•	•	Hansen, Scott	ROV crew	WHOI
•	•	Heestand-Saucier, Esprit	Graduate student	University of Louisiana
•	•	Hood, Jeffrey	ROV crew	WHOI
	•	Howard, Art	Photographer	ArtWork, Inc.
•	•	Hutchinson, Baxter	ROV crew	WHOI
•	•	Kevis-Stirling, Nile	ROV crew	WHOI
•		Lavaleye, Marc	Scientist	NIOZ
	•	Mather, Rod	Co-chief scientist	URI
•	•	McClain-Counts, Jennie	Technician	USGS
•		Meyer, Kirstin	Graduate student	OIMB
	•	Moore, James	BOEM representative	BOEM
•		Morrison, Cheryl	Scientist	USGS
•	•	Pelowski, James	ROV crew	WHOI
•		Prouty, Nancy	Scientist	USGS
•	•	Rhode, Mike	Lead technician	UNCW
•	•	Roark, Brendan	Scientist	TAMU
•		Robertson, Craig	Graduate student	Bangor University (UK)
•		Ross, Steve	Co-chief scientist	UNCW
•		Tomczuk, John	NOAA representative	NOAA
	•	VanGraafeiland, Keith	Data manager	CSA
•	•	Verhein, Korey	ROV crew	WHOI
	•	Viada, Stephen	Co-chief scientist	CSA
	•	Watts, Gordon	Scientist	IIMR
	•	Wolf-Watts, Maya	Graduate student	OIMB

BOEM = Bureau of Ocean Energy Management; CSA = CSA Ocean Sciences Inc.; FSU = Florida State University; IIMR = Institute for International Maritime Research, Inc.; NCMNS = North Carolina Museum of Natural Sciences; NIOZ = Royal Netherlands Institute for Sea Research; NOAA = National Oceanic and Atmospheric Administration; OIMB = Oregon Institute of Marine Biology; TAMU = Texas A&M University; UNCW = University of North Carolina – Wilmington; URI = University of Rhode Island; USGS = U.S. Geological Survey; WHOI = Woods Hole Oceanographic Institution.

4.2 SURVEY CHRONOLOGY

4.2.1 Leg 1: 30 April–18 May 2013

Survey Date	Activity
30 April	The *Ronald H. Brown* departed Charleston, South Carolina, at approximately 10:00. The vessel stopped to test dive the ROV then headed to Norfolk Canyon to the first dive target.
2 May	The vessel arrived on station and launched the ROV at 13:48 eastern daylight time (EDT). The first dive was aborted early because of low visibility and fishing gear; the ROV was recovered at 19:30. Otter trawls were conducted during the night shift at a depth of approximately 400 m (note: the first otter trawl deployment was at 01:38 on 3 May).

Survey Date	Activity
3 May	The ROV dive was cancelled because of a malfunction of the manipulator arm so CTD casts were conducted during the day, with the monocore attached to selected casts.
4 May	The ROV dive was cancelled due to weather, and CTD casts were once more conducted during the scheduled dive time, with otter trawl operations during the night shift.
5 May	ROV operations were conducted during the day in Norfolk Canyon (dive time 8 h 35 min, depth 422 to 642 m) with otter trawling during the night shift.
6 May	ROV operations were conducted during the day in Norfolk Canyon (dive time 10 h, depth 412 to 616 m) with otter trawling during the night shift.
7 May	ROV dive was cancelled. CTD casts were carried out during the day with otter trawling during the night shift.
8 May	ROV operations were conducted during the day in Norfolk Canyon (dive time 11 h 24 min, depth 1,519 to 1,612 m) with CTD casts conducted during the night shift.
9 May	ROV operations were conducted during the day in Norfolk Canyon (dive time 11 h 40 min, depth 1,421 to 1,564 m) with box core operations conducted during the night shift.
10 May	ROV operations were conducted during the day in Norfolk Canyon (dive time 12 h 48 min, depth 320 to 611 m) with box core and CTD operations conducted during the night shift.
11 May	The ROV was deployed at 12:15 in Norfolk Canyon. ROV operations were conducted until 18:00 the following day (dive time 27 h 30 min, depth 1,421 to 1,564 m). The decision was made to keep the ROV in the water rather than risking not being able to deploy the next day because of building seas.
12 May	ROV dive continued from May 11. Box core operations were conducted during the night shift.
13 May	ROV operations were conducted during the day in Norfolk Canyon (dive time 12 h 17 min, depth 387 to 622 m) with box core and CTD operations conducted during the night shift.
14 May	ROV operations were conducted during the day in Norfolk Canyon (dive time 12 h 53 min, depth 383 to 715 m) with box core and CTD operations conducted during the night shift.
15 May	ROV operations were conducted during the day in Norfolk Canyon (dive time 6 h 11 min, depth 326 to 561 m) with box core and CTD operations conducted during the night shift. After the ROV dive, the vessel transited overnight to Baltimore Canyon to recover the UNCW benthic landers.
16 May	The deep lander was recovered before the ROV dive in Baltimore Canyon (dive time 9 h 2 min, depth 353 to 441 m). The lander was redeployed that night after downloading data and replacing faulty acoustic release parts.
17 May	The shallow lander was recovered before the ROV dive in Baltimore Canyon (dive time 7 h 45 min, depth 288 to 388 m). The shallow lander was redeployed after the dive but the sediment trap was removed as the unit had become clogged with mud. The vessel transited back to Norfolk Canyon during the night.
18 May	The final ROV dive of Leg 1 was in Norfolk Canyon (dive time 11 h 2 min, depth 377 to 521 m). After the ROV was recovered, box coring operations were conducted until it was time to meet the transfer vessel to exchange the participants for Legs 1 and 2.

4.2.2 Leg 2: 19–27 May 2013

Survey Date	Activity
19 May	Transfer of personnel took place mid-morning through the services of Cape Henry Launch. Steve Nash of the Washington Post accompanied the science team out, spent some time on the *Ronald H. Brown*, and then returned to shore with the departing scientists. The ship arrived at the first ROV dive location at 17:00. ROV operations were conducted at a shipwreck site (MB VA2011_6) from 18:10 to 23:45 (EDT) (dive time 5 h 35 min, depth 105 m). CTD casts during the remainder of the night.
20 May	ROV operations were conducted at a shipwreck site (MB VA2011_2). The vehicle was deployed at 08:03 and recovered at 23:11 (15 h 8 min, depth 111 to 118 m). CTD casts and a trawl were conducted during the night.
21 May	ROV operations were conducted at a shipwreck site (MB VA2011_3). The vehicle was deployed at 08:07 and recovered at 23:55 (15 h 48 min, depth 111 to 118 m). CTD casts and a trawl were conducted during the night. Started transitioning to site 35 mi east of Norfolk Canyon to survey for deepwater shipwrecks, but problems with the ship's multibeam caused a change in plans. The vessel transited to meet the *Okeanos Explorer* to pick up a replacement circuit board for the multibeam and then continued multibeam survey in a 100-mi^2 deepwater quadrant. During the night and early morning, the vessel transitioned to another ROV dive site
22 May	ROV operations were conducted at a shipwreck site (MB VA2001_4). The vehicle was deployed at 11:45 and recovered at 21:50 (9 h 5 min, depth 119 to 122 m).
23 May	Multibeam survey in deepwater area and then ROV operations at a shipwreck (MB VA2011_2). This was a repeat dive on this site. The vehicle was deployed at 20:15 and recovered at 00:40 (4 h 25 min, depth 120 m). The vehicle was recovered early due to worsening sea conditions. Weather and environmental conditions impacted the remainder of the cruise. Transited to multibeam survey area and began survey.
24 May	Multibeam survey of deepwater area. No wrecks positively identified. Worsening sea conditions prompted a decision to head south to wreck sites off Hatteras.
25 May	Arrived at first shipwreck location off Hatteras at 10:20. Current at the site was greater than 2 kn and ROV operations were cancelled. Transited to second shipwreck location off Hatteras. Currents at this site were greater than 2.8 kn. Moved to Steve Ross's lander location off Cape Fear where an attempt was made to locate the lost lander. Attempts were also made to find other shipwrecks in the vicinity.
26 May	Returned to the lost lander site to check surface currents, but they were too strong for ROV operations. Departed for port in Charleston, South Carolina.
27 May	Arrived in Charleston, South Carolina, at approximately 12:00.

4.3 SURVEY RESULTS

4.3.1 Leg 1

Leg 1 of the cruise successfully accomplished all the objectives outlined in the cruise instructions, despite some bad weather and poor bottom visibility. Three ROV dives were cancelled due to weather and technical difficulties and five additional dives were terminated early. In addition to the ROV dives, 84 non-ROV sampling stations were logged during the survey leg. The non-ROV stations comprised 31 CTD casts (5 with water collections and 26 with monocores), 38 box cores, and 15 otter trawls. All station data

sheets were scanned on board the ship and electronic copies were provided to the Principal Investigators. Data were entered into an Access database, checked for errors, and archived at UNCW. Refer to **Appendix Table C-1** for details on the stations visited during Leg 1 of the cruise.

Thirteen of the 17 ROV dives scheduled in the cruise instructions for Leg 1 were accomplished; one was an extended dive of 27 h, which replaced the dive scheduled for the following day. In total, we accomplished 145 h of dive time with average dive duration of 11.2 h. Nine dives were in Norfolk Canyon, two were on a deep methane seep to the south of Norfolk Canyon, and two were in Baltimore Canyon. During the dives, a substantial amount of canyon habitat was covered (**Figures 5** through **8**), and a large number of invertebrates (mostly corals) and some fishes were collected. Six water samples were collected with Niskin bottles attached to the ROV and environmental data were collected during each dive with the SBE 19*plus* profiler. Replicate (two to four) sediment cores were taken on 9 of the 13 dives, and sediment/benthic fauna were collected by the suction sampler and Ekman box core. Examples of bottom habitats and fauna are provided in **Figure 9**.

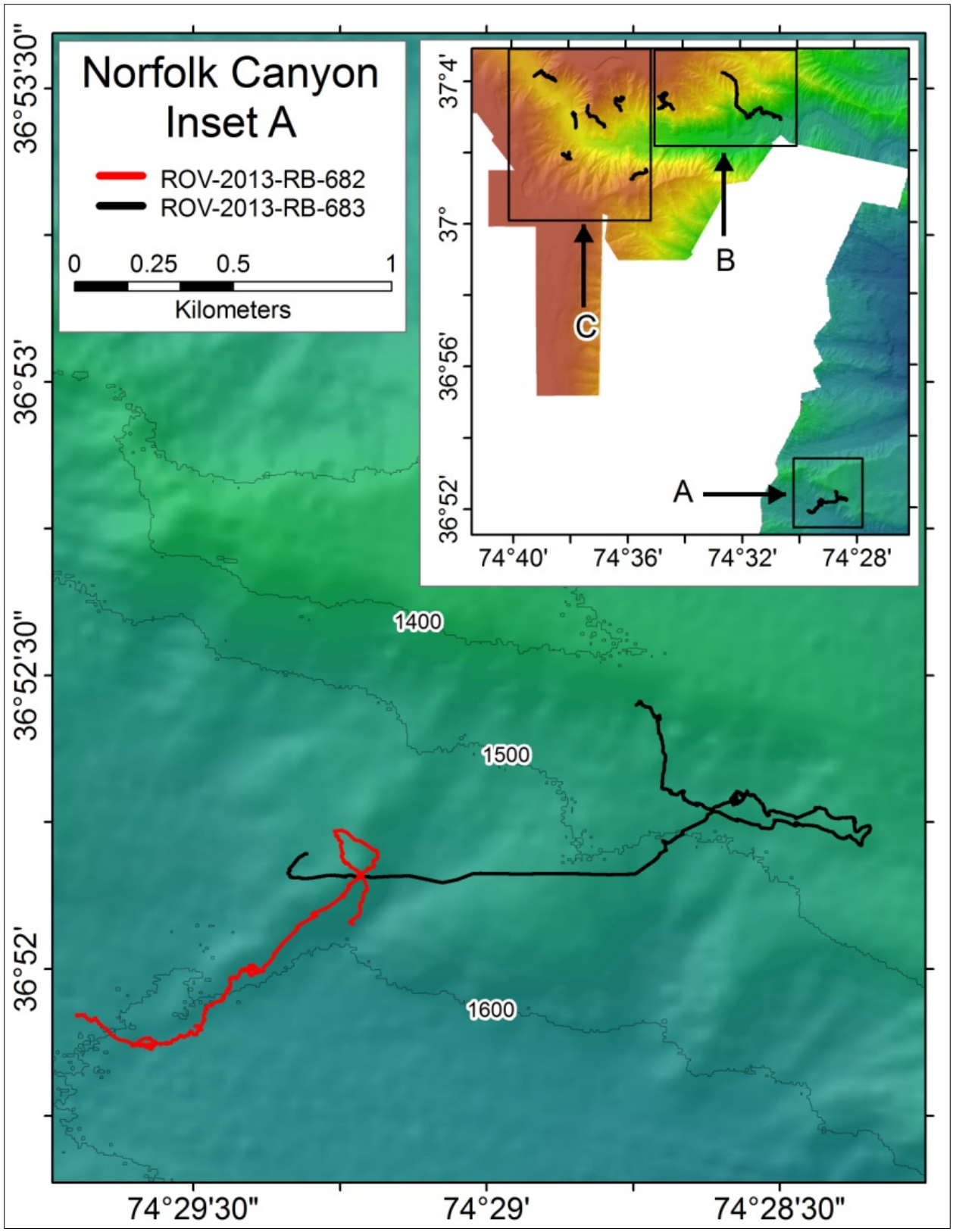


Figure 5 Plots of ROV track lines for dives conducted within Norfolk Canyon (inset area A) during Leg 1 of the 2013 Sampling Cruise.

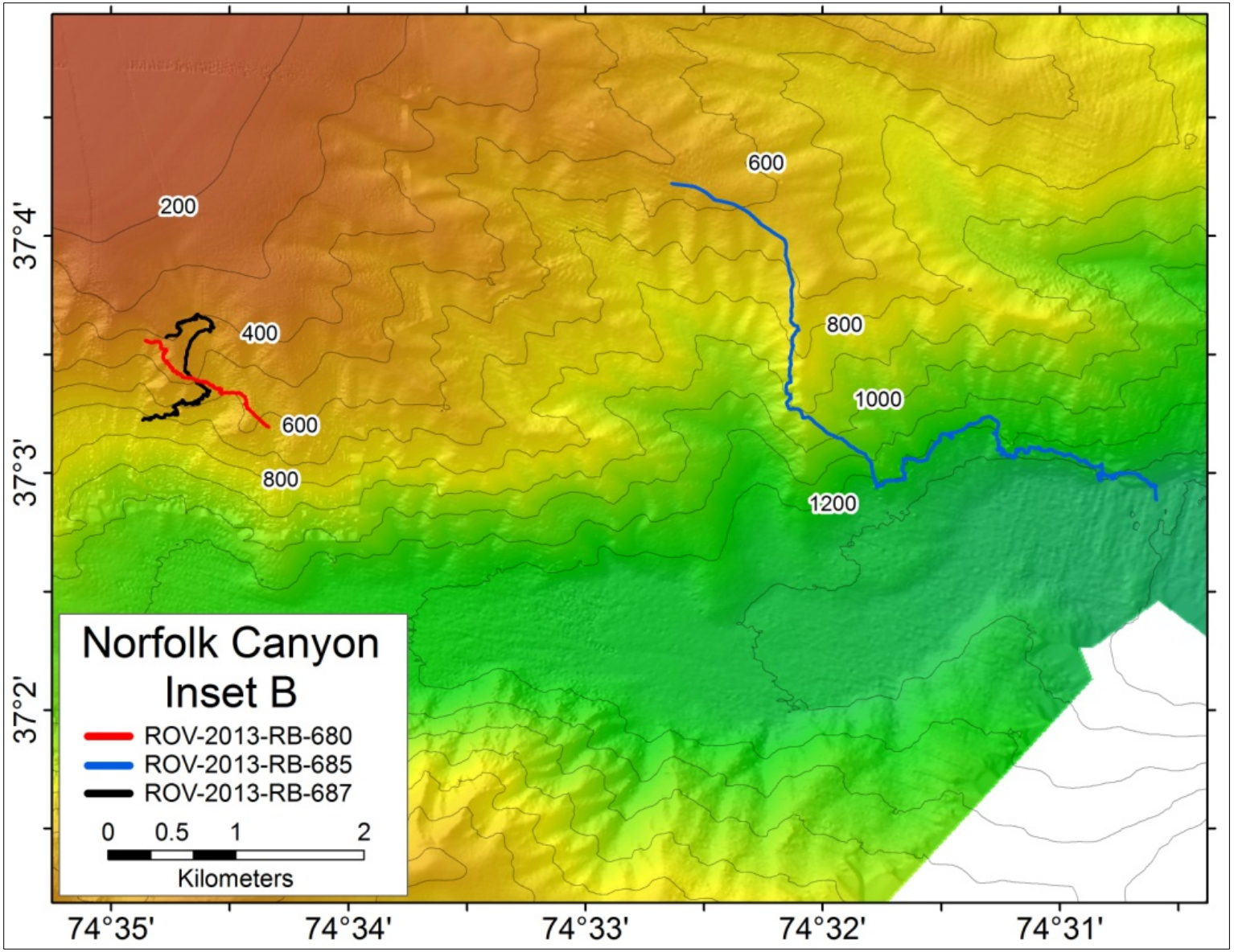


Figure 6 Plots of ROV track lines for dives conducted within Norfolk Canyon (inset area B) during Leg 1 of the 2013 Sampling Cruise.

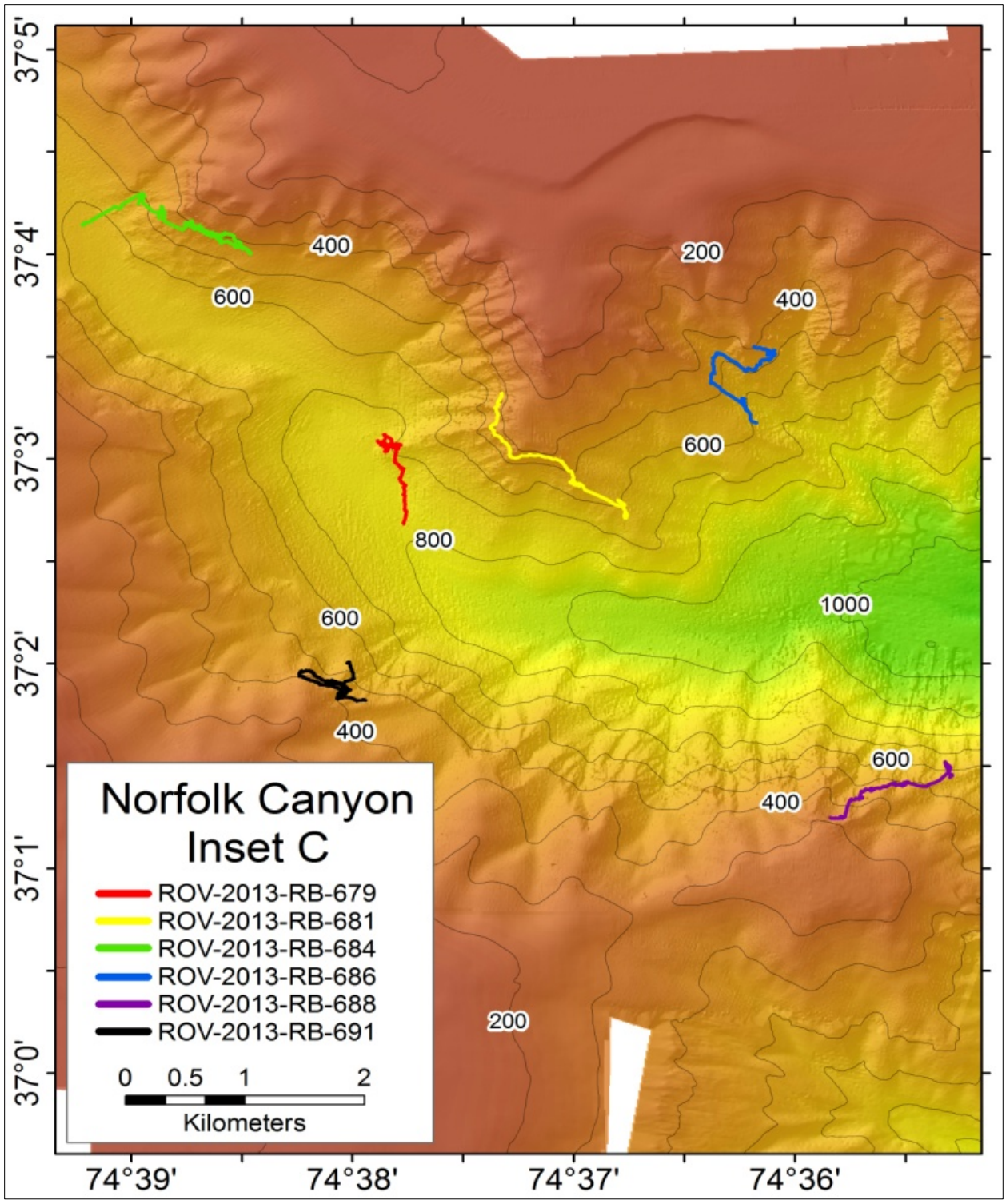


Figure 7 Plots of ROV track lines for dives conducted within Norfolk Canyon (inset area C) during Leg 1 of the 2013 Sampling Cruise.

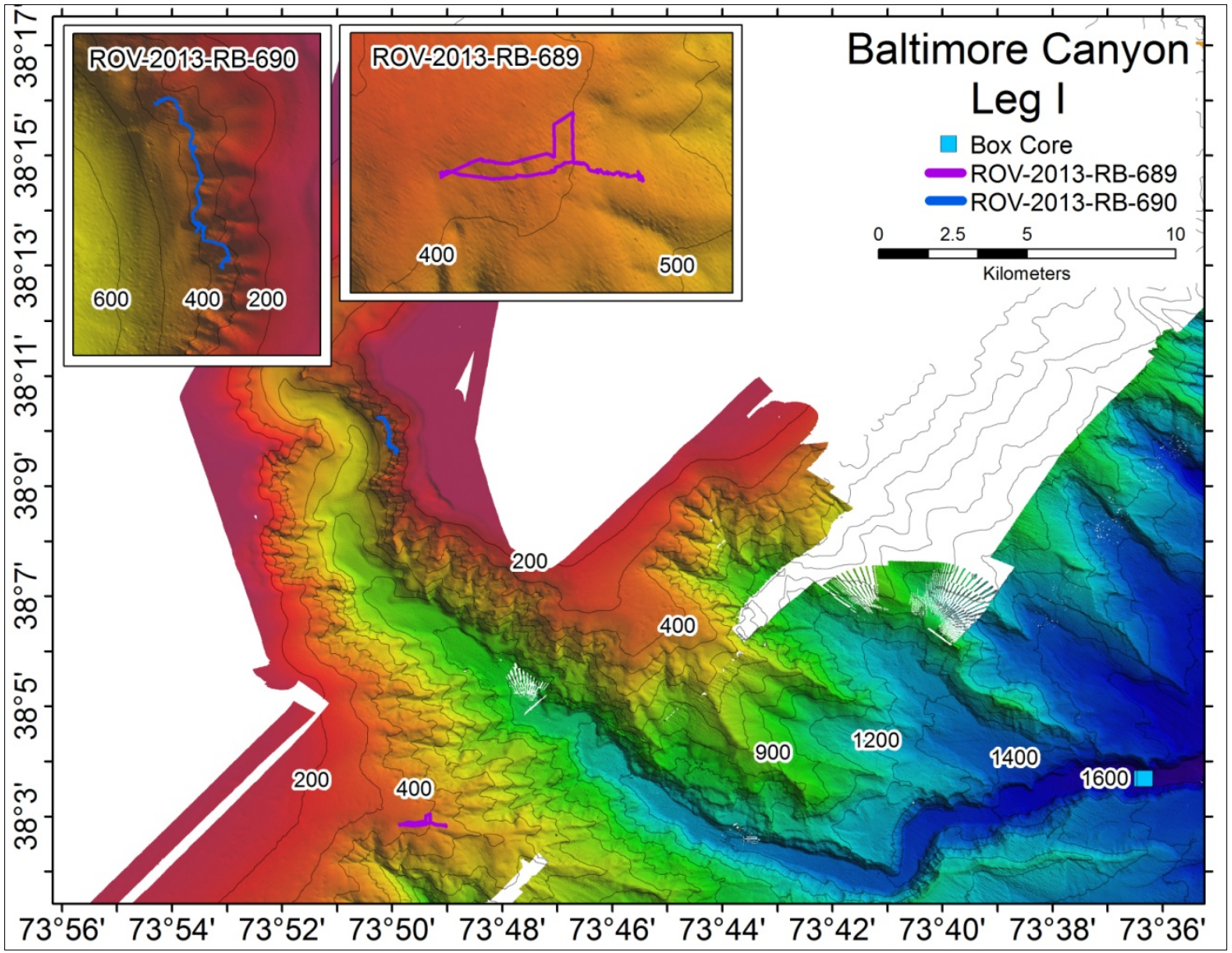


Figure 8 Plots of ROV track lines for dives conducted at the cold seep site within Baltimore Canyon during Leg 1 of the 2013 Sampling Cruise.

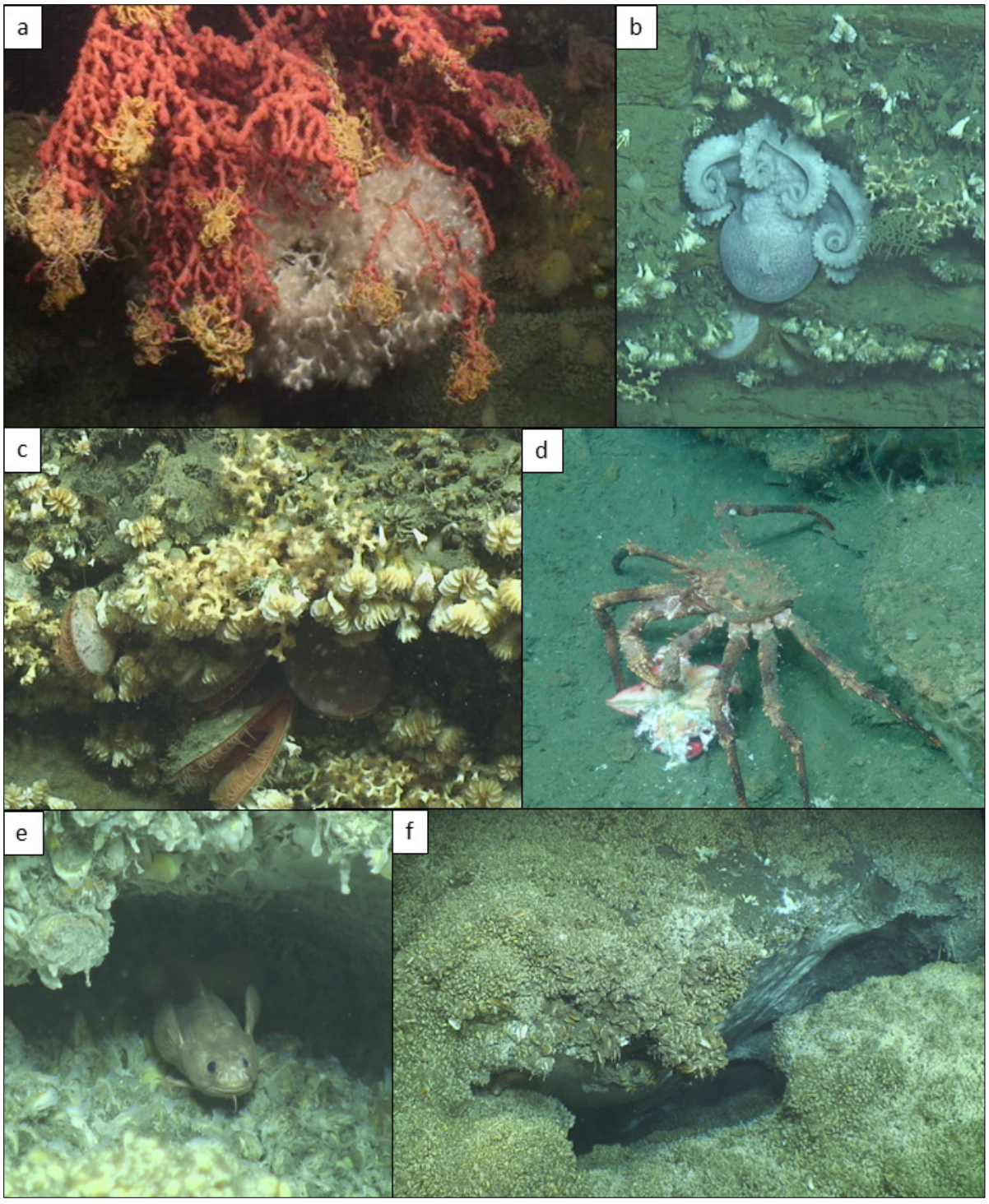


Figure 9 Selected images of fauna from Norfolk Canyon observed during Leg 1 of the 2013 Sampling Cruise. a) *Lophelia pertusa* and *Paragorgia arborea* on the wall of Norfolk Canyon; b) octopus *Graneldone cf verrucosa* commonly observed on hard substrate; c) patch of dense corals (*Desmophyllum dianthus* and *Solenosmillia variabilis*) with large fileshells (*Acesta* sp.); d) Spider crab consuming dead starfish; e) *Gaidropsaurus* sp. sheltering in a cave at newly discovered cold seep off Norfolk Canyon; and f) rugged habitat and vast fields of chemoautotrophic mussels (*Bathymodiolus childressi*) at Norfolk Canyon cold seep.

Thirty one CTD casts were conducted during the first leg of this cruise, providing water column data along two transects; one inside the axis of Norfolk Canyon and another just outside the canyon along the southern edge. Examples of environmental profiles (temperature, salinity, dissolved oxygen and turbidity) taken from the along-axis transect are shown in **Figure 10**.

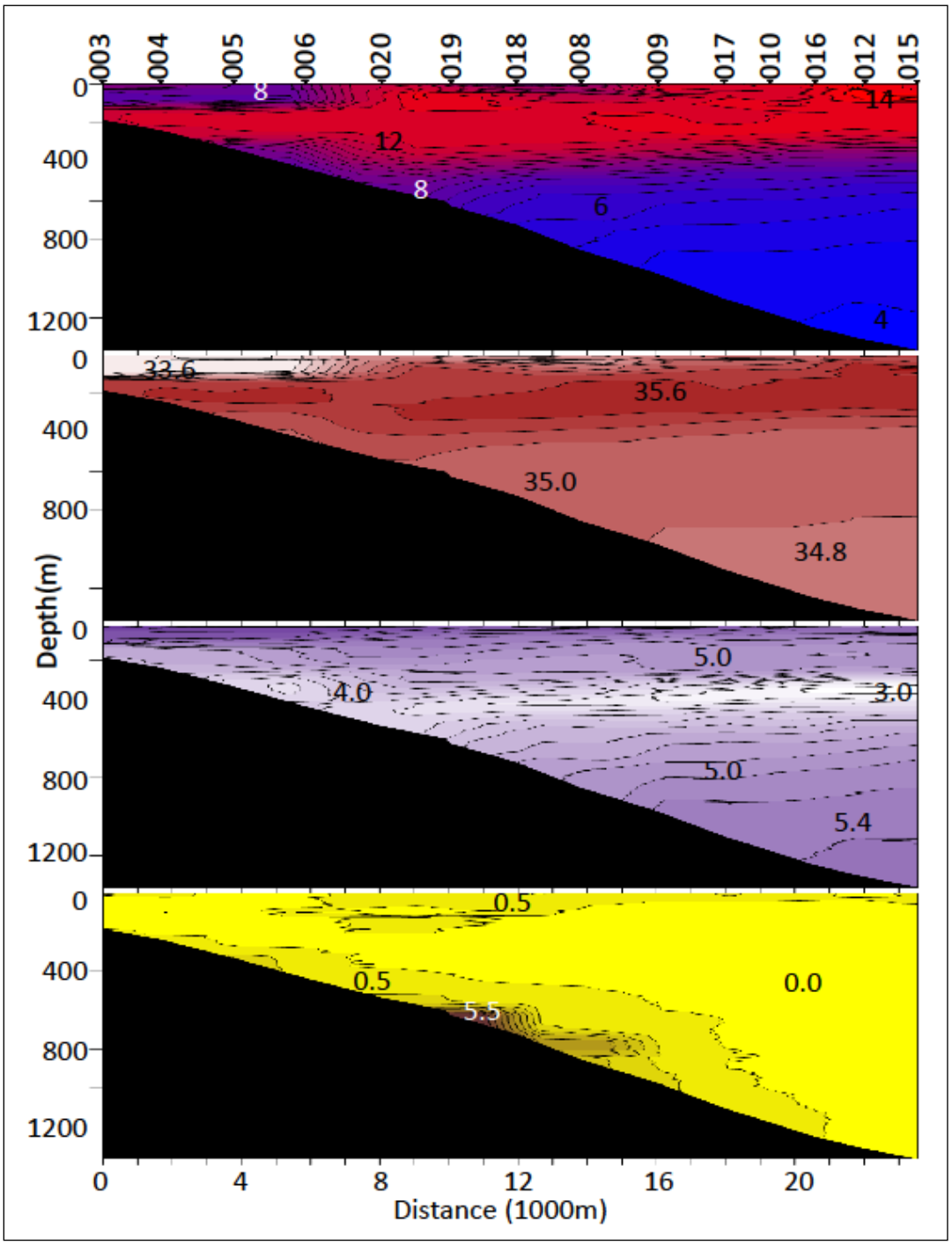


Figure 10 Water column data for CTD transect conducted down the axis of Norfolk Canyon during Leg 1 of the 2013 Sampling Cruise. From top to bottom are temperature (°C), salinity, dissolved oxygen (mL/L), and turbidity (formazin turbidity units). Station numbers are across the top.

Water samples were collected for analysis of nutrients, POM, dissolved organic carbon (^{12}C and ^{14}C), chlorophyll and trace metals (neodymium) in multiple depths at five CTD stations. For 26 casts, the small monocore was attached to the ship's CTD array, each producing a single bottom core sample. Thirty five box cores were taken in Norfolk Canyon, along the same transect lines as the CTD casts, and an additional three were taken near the mouth of Baltimore Canyon (**Figure 8**).

Fifteen 30-min bottom trawls were completed during Leg 1, providing a large number of samples for several project objectives. All of these stations were in Norfolk Canyon, as bottom trawling was emphasized in Baltimore Canyon during the 2012 cruise aboard the NOAA ship *Nancy Foster*. Trawls were restricted mostly to the upper, flatter sides of the canyons and areas near the mouth (**Figure 11**) to minimize potential for snagging on rough substrate. Even so, the gear was considerably damaged.

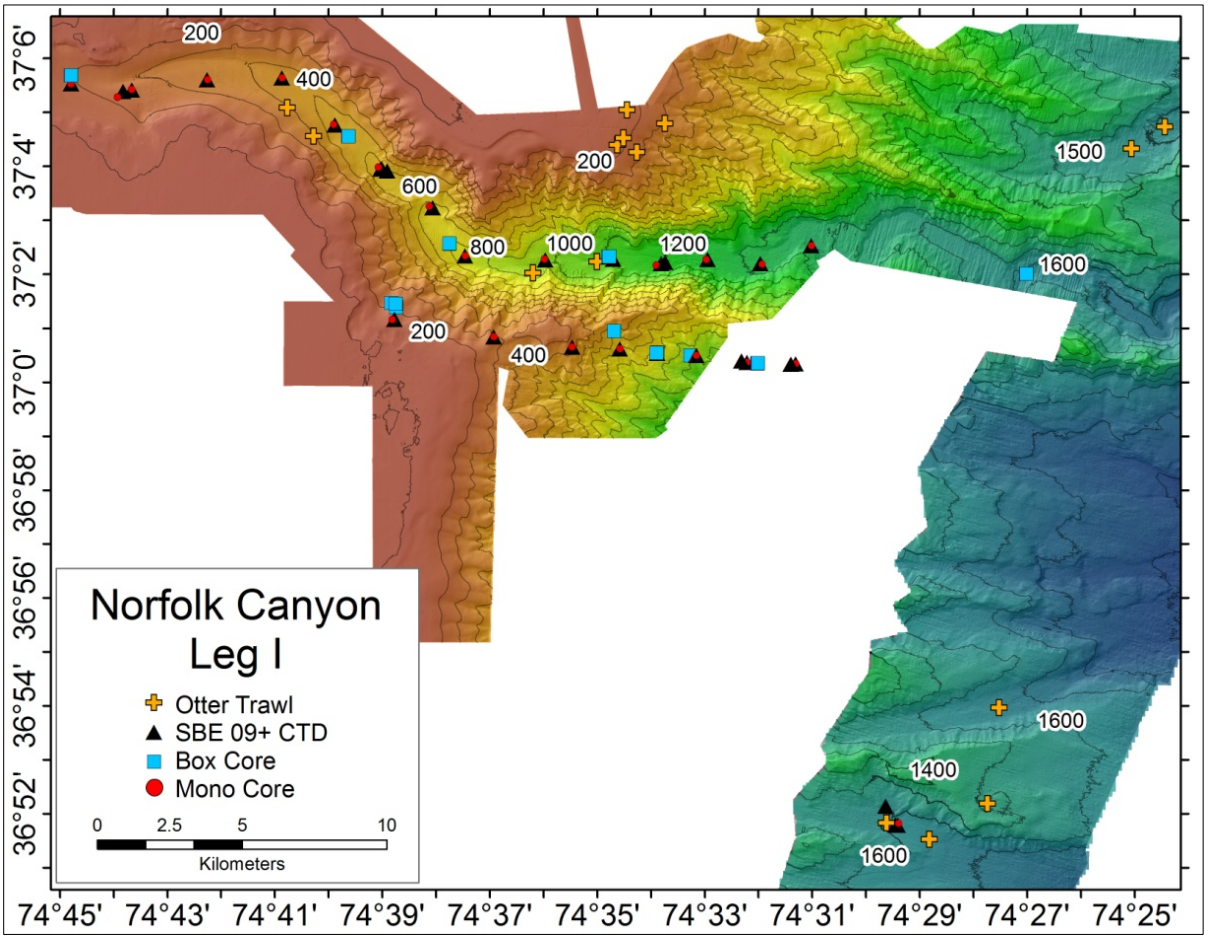


Figure 11 Non-ROV stations sampled in and around Norfolk Canyon during Leg 1 of the 2013 Sampling Cruise.

The combined sampling approaches (ROV, trawling, box coring, and water collections) provided a large diversity and quantity of samples for multiple research objectives (**Table 2**). The specimens collected during the cruise may include new species or range extensions, but many of the samples from the ROV and trawling operations have not yet been identified. Representatives of many specimens were photographed at sea for scientific documentation and for posting on the cruise internet sites.

For stable isotope analyses, 1,697 samples were collected from a wide range of invertebrate and fish taxa. Most samples were dried on the ship and will be processed at a later time for analysis of $\delta^{13}C$ and $\delta^{15}N$ as part of a study on the trophodynamics of canyon ecosystems. At least 13 different species of coral

were subsampled for coral genetic studies, producing more than 300 tissue samples. Some species (e.g., *Lophelia pertusa*) will contribute to existing studies of connectivity among deep Atlantic ecosystems, whereas others (e.g., *Primnoa resedaeformis*) will be used specifically for analysis of population genetics in the canyons studied for this project. Ten coral taxa and six invertebrate taxa (seep mussels, and other dominant invertebrates) were subsampled for analysis of reproductive condition (379 samples in total). Most coral samples were octocorals (*Paragorgia arborea, P. resedaeformis, Acanthogorgia armata, Anthothela* sp.*, Acanella* sp.*, Stylatula* sp.), but there also were four scleractinians (*L. pertusa, Desmophyllum dianthus, Solenosmillia variabilis, Flabellum* sp.). Four species of octocorals (31 samples) plus cold seep microbial mats were subsampled for analysis of microbial communities and 7 species of corals (105 samples) were taken for paleoecology objectives. In addition to the biological samples, sediment cores and water samples were taken for other science objectives. Samples and disposition are summarized in **Table 2**.

Table 2 Summary of purpose and fate of samples collected during Leg 1 of the 2013 Sampling Cruise. Table 2 does not include large numbers of invertebrates that were collected in the trawls; these have not yet been inventoried, but account for several thousand specimens.

Sample Type		Custodian	No. of Taxa	No. of Samples
Vouchers (ROV samples)	Invertebrates	Brooke	~37	~200
Isotopes	Invertebrates and fishes	Demopoulos and Ross	Unknown	1,697
Reproduction	Invertebrates	Brooke	16	379
Genetics	Invertebrates	France	13	312
	Invertebrates	Morrison and Coykendall	23	394
Paleoecology	Invertebrates	Roark and Prouty	7	105
Microbiology	Invertebrates	Chris Kellogg (USGS)	4	31
	Sediment	Chris Kellogg	n/a	30
Fish communities, trophics	Fishes	Ross and Rhode	~55	~850
Infauna	Cores (box and tube)	Demopoulos and Robertson	Unknown	82
Sediment	Cores	Mienis, Gerard Duineveld (NIOZ) , and Demopoulos	n/a	44
Water	Aragonite/nutrients	Brooke and Ross	n/a	6
	Other	Roark and Prouty	n/a	181

n/a = not applicable.

Both UNCW benthic landers were recovered from Baltimore Canyon and redeployed in the same location within 12 h resulting in minimal data loss. The lander deployed at the deep site was recovered first and was in good condition. The sediment trap had nine successful sediment samples, which were removed and taken back to UNCW pending further processing. The sediment trap and remaining three bottles were redeployed with the lander. The three sets of settlement plates (UNCW, USGS, InDeep) were removed and preserved. The release mechanism was replaced and the datalogger was downloaded and serviced prior to redeployment. The lander from the shallow site had been damaged by sediment. The mesocosms and sediment trap were full of sediment, and only three sediment samples could be salvaged so all the equipment was removed. The settlement plates were also affected by sediment but were removed and preserved. As for the lander from the deep site, the release was replaced, the datalogger was downloaded and serviced, and the lander was redeployed.

4.3.2 Leg 2

During Leg 2 of the cruise, five ROV dives were completed for a total of 50 h 01 min bottom time and 120 mi^2 of multibeam mapping; three CTD casts and one otter trawl were conducted (see **Figures 12** and **13**; **Appendix Table C-2**). Initial post-processing of multibeam data was achieved on board the ship and a list of targets identified; however, none of the targets proved sufficiently promising to warrant an ROV dive. All station data sheets were scanned on board ship and electronic copies were provided to the PIs. Data were entered into an Access database, checked for errors, and archived at UNCW, URI, and CSA. **Appendix Table C-2** contains details on the stations sampled during Leg 2 of the cruise.

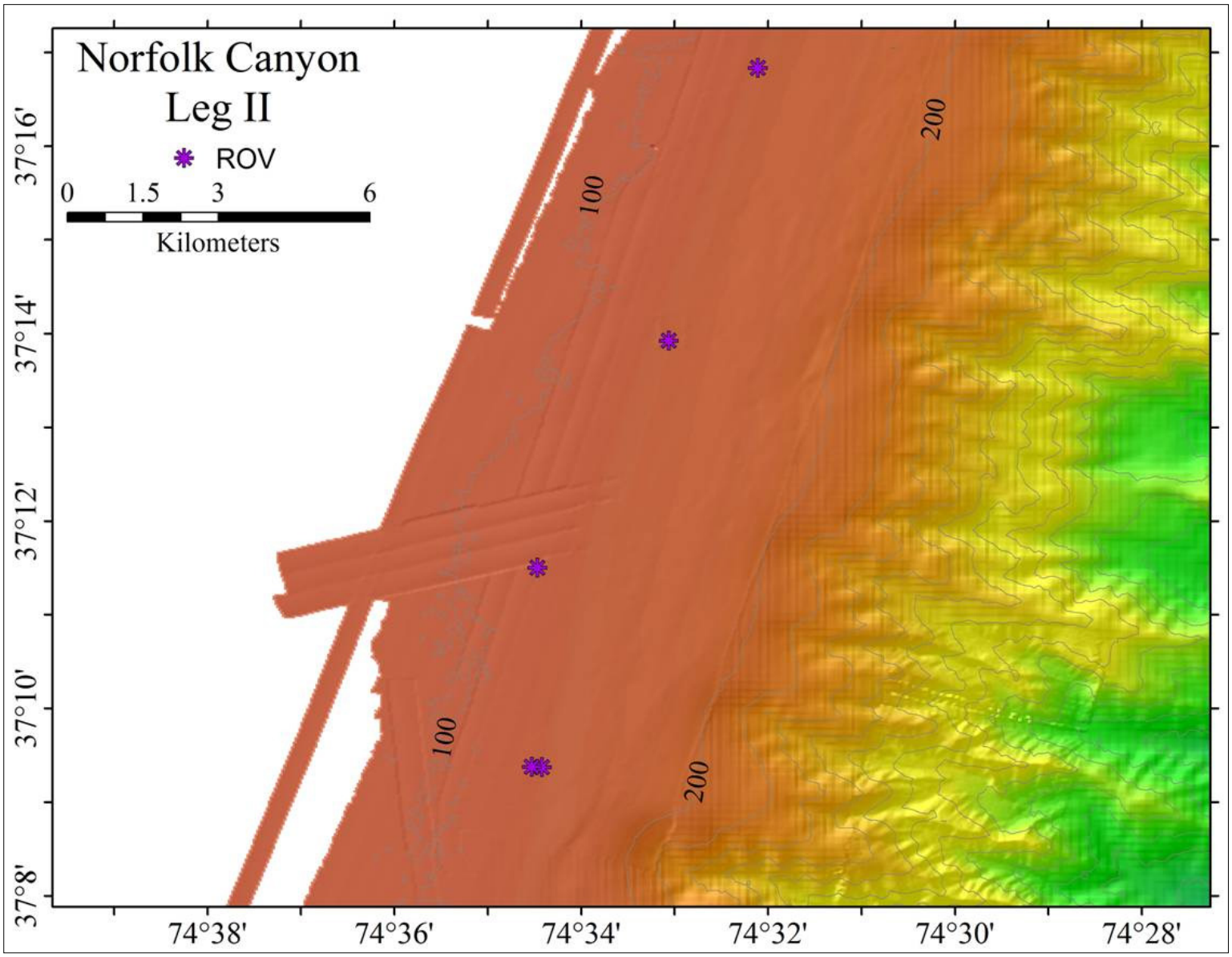


Figure 12 ROV stations investigated in and around Norfolk Canyon during Leg 2 of the 2013 Sampling Cruise.

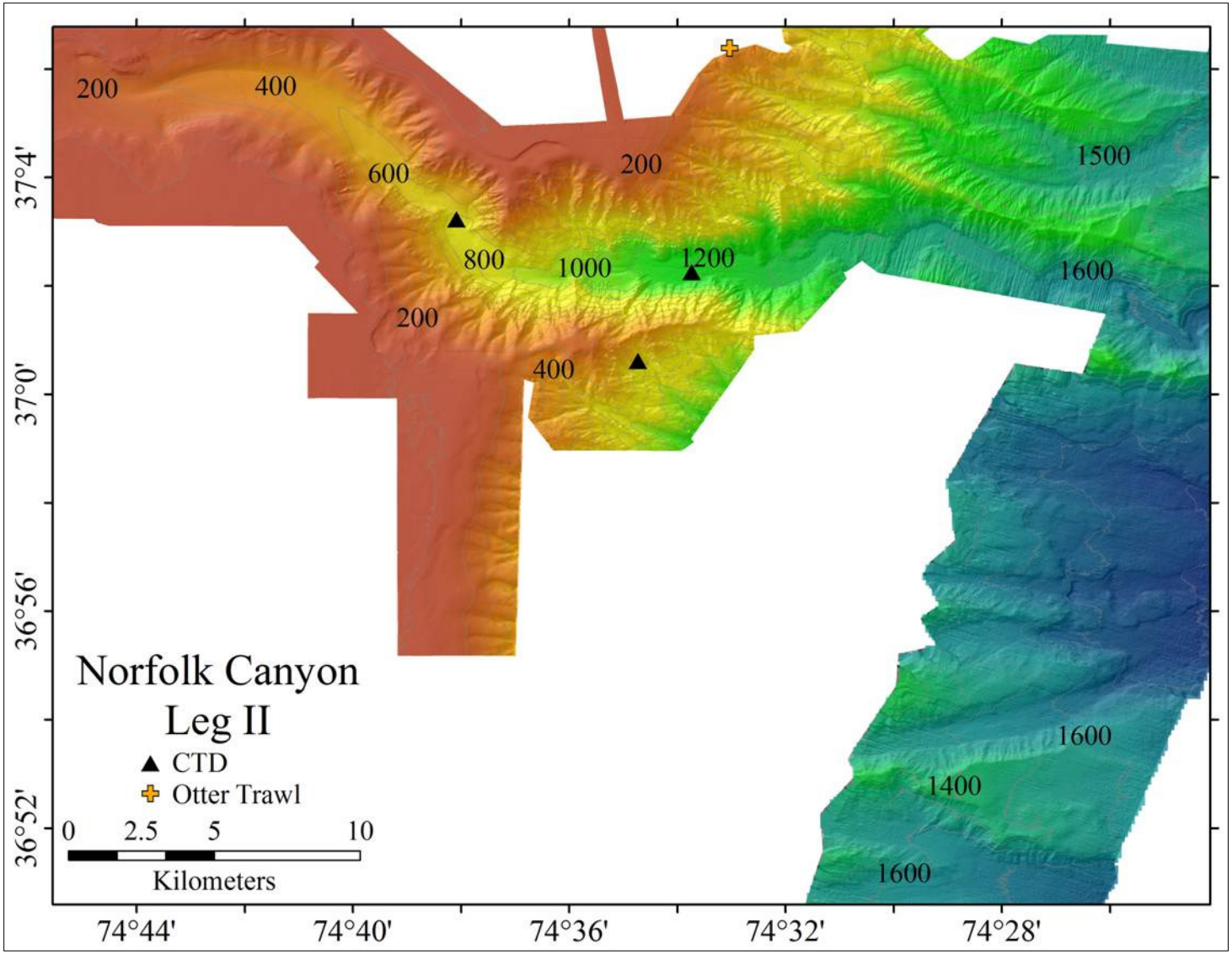


Figure 13 Conductivity-temperature-depth (CTD) and otter trawl stations sampled in and around Norfolk Canyon during Leg 2 of the 2013 Sampling Cruise.

Despite the overall success of the cruise, a series of technical and weather-related issues prevented the completion all objectives. Most of the archaeological sites were only just deep enough for the ROV *Jason II* to safely operate, and some were too shallow. This meant that it was not possible to dive on the suspected wreck of the *Ocean Venture*. In addition, three wreck sites had water currents approaching or in excess of 2 kn. The ROV team judged these conditions to be unsafe for *Jason II* operations. The *Ronald H. Brown's* EM 122 multibeam system worked well, thanks in large part to the dedication of the crew and the presence of a Kongsberg technician on board. However, some time was lost getting a replacement circuit board (generously provided at sea by the *Okeanos Explorer*). Unfortunately, water depths in the deepwater survey area exceeded the capacity of the Kongsberg EM 122 to resolve objects size of shipwrecks. This may have contributed to the unsuccessful search for the *San Demetrio*, but it could also be the case that historical evidence for the location of the wreck was inaccurate. The weather conditions and sea state toward the end of the cruise impacted operations significantly. During the evening of 24 May, conditions were sufficiently adverse to prevent any science operations.

4.3.3 Preliminary Observations

4.3.3.1 Leg 1

- The most rugged habitats, mostly walls, boulders, and slabs of consolidated sediments, occurred near the heads of both sides of the canyons but were also found in some deep locations near the mouth of Norfolk Canyon.
- A massive cold seep was discovered at 1,600 m depth just south of the mouth of Norfolk Canyon. This is probably the largest continuous methane seep in the North Atlantic Ocean. Several species of fishes and invertebrates were collected for identification and for biological objectives. The seep mussel has been confirmed as *Bathymodiolus childressi*.
- Biodiversity was high on hard substrata at all depths in the canyons. Potential food resources in the form of amphipods and small shrimps were very abundant in some locations.
- Octocorals were the most common taxa of structure-forming cnidarians, with *Paragorgia arborea* being the largest and most abundant octocoral species found. Octocorals were frequently observed attached to canyon walls and boulders.
- Scleractinian corals were rare but two additional species were observed this year, compared to last year's cruise. These were *Solenosmillia* cf *variabilis* on the deep hard wall along the north slope of Norfolk Canyon, and *Flabellum* sp. on the soft sediment near the canyon rim and outer shelf. The solitary coral *Desmophyllum cristigalli* was most abundant in the deeper parts of the canyons (>1,000 m) but was also found at shallower sites (~450 m and deeper). Eighteen individual colonies of *L. pertusa* were observed from five different locations in Norfolk Canyon. This supplements observations from the 2012 research cruise, during which the first observations of *L. pertusa* from the Middle Atlantic Bight were documented. These observations were published by Brooke and Ross in Deep Sea Research II Special Canyons Issue.
- Red crabs (*Geryon quinquedens*) were probably the most common mobile macroinvertebrate.
- Fishes were abundant during most dives, and several commercial and potential commercial species were observed.
- Some species of fishes and invertebrates exhibited a strong association with corals and complex, rugged substrata.

- Strong currents were observed in the canyons and a persistent dense nepheloid layer was apparent in the middle of the canyons. Visibility was bad at depths greater than 600 m during several dives due to suspended particulates. Some dives were aborted or re-directed because of this problem.
- There was substantial evidence of human impacts in the form of abundant trash (mostly plastics) and lost fishing gear (nets, traps, lines). Commercial and recreational vessels were observed fishing in the area most days.

4.3.3.2 Leg 2

- ROV dives were completed on the *G102*, the *Ostfriesland*, the *Frankfurt,* and what is believed to be the *V43*.
- All wrecks showed signs of damage from anchors and fishing gear, particularly the *V43* (**Figure 14**); however, fishing gear has done less damage to the larger ships, particularly the *Ostfriesland.*
- Some of the damage from ground tackle appeared to be recent as evidenced by extensive fresh corrosion.
- The propellers are missing from all wrecks examined. This is consistent with historical accounts of the removal of the propellers prior to sinking.
- Evidence of bomb damage was discernable on all wrecks examined during this cruise.
- The bridge of the *G102* is still in partially intact with compass binnacle and ship's telegraph still present.
- Very little of the bow of the *G102* still exists, but the stern is well preserved.
- There is a complete break running athwartships toward the stern of the *Ostfriesland*.
- A substantial entanglement of fishing gear is located on the northern side of the *Ostfriesland* toward the stern. It extends approximately 13 m above the wreck.
- The anchor chain is still in place on the port bow of the *Ostfriesland*. It extends from the hawse pipe and runs east (there is one hawse pipe on the starboard bow of the *Ostfriesland* and two on the port).
- The stern of the *Frankfurt* is well-preserved, but there is considerable damage to the bow.
- There were no obvious shipwreck targets in the deepwater multibeam area surveyed during this cruise.
- Shipwrecks in the study area support large populations of fishes, particularly chain catshark (*Scyliorhinus retifer*). Trawl nets cover segments of many shipwrecks visited during the survey and clumps of net webbing appear to provide the catsharks with preferred habitat for attaching their egg cases and for resting.
- Dominant and conspicuous epibiota observed on shipwrecks during the survey included clusters of small white zoanthids and solitary anemones (Actiniaria), sponges, solitary "cup" corals (Scleractinia), hydroids (Hydroidea), and oysters. Motile invertebrates included sea stars (Asteroidea) and sea urchins (Echinoidea).

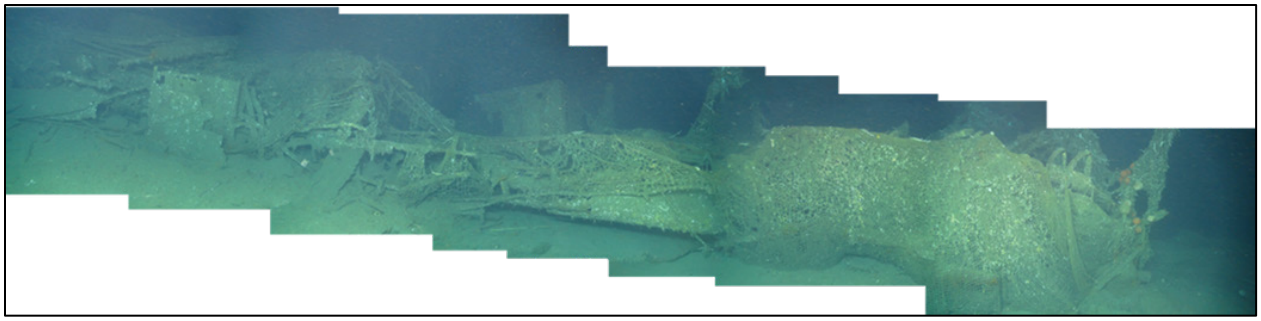


Figure 14 Profile photomosaic of destroyer *V-43* showing extensive damage by and cover of fishing gear.

4.3.4 Ship and ROV Operations

Overall, the crew and equipment of the ROV *Jason II* performed well and were reliable. One dive was cancelled because the second manipulator arm was malfunctioning, but it was decided to proceed with subsequent dives until the arm could be fixed. The digital still camera was of low quality with poor lighting, but an additional camera (Super Scorpio) was installed and produced some high-quality images. The high-definition video imagery was of excellent quality and produced good frame grabs as substitutes for the poor quality digital images. Collection capability met or exceeded our needs and the ROV team was flexible in accommodating different configurations. The ROV crew exhibited skill and dedication in trying to meet the needs of this mission; some pilots were particularly skilled and were able to continue working efficiently in very challenging conditions. The *Ronald H. Brown* crew worked well with the ROV team to maintain stations and facilitate the ROV dives under many different conditions. The ship and crew performed very well and did everything possible to ensure success of the cruises. The crew was flexible and helped with plan changes dictated by changing sea and weather conditions, technical problems, and science needs.

5 EDUCATION, OUTREACH, AND MEDIA

Two internet sites documented progress and facilitated public awareness of the project during all cruise legs. One website was managed by the NOAA Office of Ocean Exploration as a Signature Expedition site (NOAA, 2012, 2014). The North Carolina Museum of Natural Sciences website (2013) was set up as a "blog" to allow for easy posting of cruise activity logs. Background essays, daily logs, and various photographs were posted to both sites prior to and during the cruise. The blogs and daily logs were authored by various scientific personnel while at sea. During cruise Leg 1, Drs. Brooke and Roark participated in a real-time Skype phone interview, which was broadcast on the large screen of the museum's new building. Videographers Art Howard and Liz Baird will continue working on film and education projects related to the Atlantic Deepwater Canyons project in the coming year. Press releases were dispatched jointly to a variety of media contacts after Leg 1 of the cruise. Outreach efforts included an article in the Washington Post (Nash 2013a) and Herald-Tribune (Nash 2013b).

6 REFERENCES

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APPENDIX

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Table C-1 Stations sampled in the Middle Atlantic Bight off the U.S. east coast around Baltimore and Norfolk Canyons during Leg 1 of the 2013 Sampling Cruise. ROV depth range and location data are only for the period when the ROV was on the seafloor.

Station Number	Gear	Date	Day[1]/Night[2]	Total Time (min)	Start Latitude (°N)	Start Longitude (°W)	End Latitude (°N)	End Longitude (°W)	Depth Range (m)
ROV-2013-RB-679	ROV	2 May 2013	D	236	37°02'41.04"	74°37'46.14"	37°03'03.72"	74°37'50.76"	617–789
ROV-2013-RB-680	ROV	5 May 2013	D	515	37°03'11.64"	74°34'20.22"	37°03'33.42"	74°34'51.36"	422–642
ROV-2013-RB-681	ROV	6 May 2013	D	600	37°02'44.34"	74°36'46.20"	37°03'19.32"	74°37'19.62"	412–616
ROV-2013-RB-682	ROV	8 May 2013	D	684	36°51'55.26"	74°29'34.44"	36°52'04.86"	74°29'13.92"	1,519–1,612
ROV-2013-RB-683	ROV	9 May 2013	D	700	36°52'26.94"	74°28'44.70"	36°52'11.76"	74°29'18.48"	1,421–1,564
ROV-2013-RB-684	ROV	10 May 2013	D	768	37°04'08.64"	74°39'13.20"	37°04'09.90"	74°38'43.80"	320–611
ROV-2013-RB-685	ROV	11 May 2013	D	1650	37°02'53.28"	74°30'35.58"	37°04'13.26"	74°32'38.16"	539–1,390
ROV-2013-RB-686	ROV	13 May 2013	D	737	37°03'10.62"	74°36'10.38"	37°03'33.06"	74°36'11.22"	387–622
ROV-2013-RB-687	ROV	14 May 2013	D	773	37°03'13.32"	74°34'52.08"	37°03'34.44"	74°34'46.08"	383–715
ROV-2013-RB-688	ROV	15 May 2013	D	371	37°01'27.60"	74°35'17.70"	37°01'14.88"	74°35'50.46"	326–561
ROV-2013-RB-689	ROV	16 May 2013	D	542	38°02'50.82"	73°49'02.64"	38°02'52.98"	73°49'18.90"	441–353
ROV-2013-RB-690	ROV	17 May 2013	D	465	38°10'13.86"	73°50'15.72"	38°09'36.54"	73°49'57.18"	288–388
ROV-2013-RB-691	ROV	18 May 2013	D	662	37°02'00.24"	74°38'01.50"	37°01'49.26"	74°37'56.46"	377–521
RB-2013-003	CTD	3 May 2013	D	06	37°05'31.56"	74°44'47.40"	37°05'31.50"	74°44'47.76"	0–188
RB-2013-004	CTD	3 May 2013	D	09	37°05'25.02"	74°43'39.72"	37°05'25.14"	74°43'40.08"	0–237
RB-2013-005	CTD	3 May 2013	D	12	37°05'36.12"	74°42'15.84"	37°05'36.18"	74°42'15.48"	0–337
RB-2013-006	CTD	3 May 2013	D	15	37°05'38.28"	74°40'51.96"	37°05'38.16"	74°40'51.96"	0–438
RB-2013-007	CTD	3 May 2013	D	15	37°03'56.88"	74°39'01.80"	37°03'56.94"	74°39'01.80"	0–606
RB-2013-008	CTD	3 May 2013	D	18	37°02'20.16"	74°37'27.84"	37°02'20.28"	74°37'27.84"	0–853
RB-2013-009	CTD	3 May 2013	D	18	37°02'15.96"	74°35'58.20"	37°02'16.68"	74°35'59.28"	0–974
RB-2013-010	CTD	3 May 2013	D	22	37°02'11.52"	74°33'48.60"	37°02'09.60"	74°33'54.36"	0–1,177
RB-2013-011	CTD	3 May 2013	D	07	37°02'13.08"	74°33'44.28"	37°02'11.76"	74°33'42.48"	0–252
RB-2013-012	CTD	3 May 2013	D	25	37°02'11.70"	74°31'57.72"	37°02'10.74"	74°31'56.28"	0–1,311
RB-2013-015	CTD	4 May 2013	D	24	37°02'31.80"	74°31'01.20"	37°02'31.62"	74°31'01.20"	0–1,364
RB-2013-016	CTD	4 May 2013	D	25	37°02'16.14"	74°32'56.76"	37°02'16.20"	74°32'58.92"	0–1,249
RB-2013-017	CTD	4 May 2013	D	20	37°02'16.74"	74°34'42.24"	37°02'17.58"	74°34'44.76"	0–1,101
RB-2013-018	CTD	4 May 2013	D	19	37°03'13.74"	74°38'03.84"	37°03'15.36"	74°38'07.80"	0–726
RB-2013-019	CTD	4 May 2013	D	13	37°03'57.36"	74°39'00.72"	37°03'58.92"	74°39'04.68"	0–628
RB-2013-020	CTD	4 May 2013	D	13	37°04'45.84"	74°39'52.92"	37°04'46.32"	74°39'54.36"	0–534

Table C-1 (Continued).

Station Number	Gear	Date	Day[1]/Night[2]	Total Time (min)	Start Latitude (°N)	Start Longitude (°W)	End Latitude (°N)	End Longitude (°W)	Depth Range (m)
RB-2013-021	CTD	4 May 2013	D	07	37°05’23.34"	74°43’49.44"	37°05’16.56"	74°43’55.92"	0–208
RB-2013-022	CTD	4 May 2013	D	15	37°03’54.66"	74°38’54.60"	37°03’50.82"	74°38’57.48"	0–631
RB-2013-031	CTD	7 May 2013	D	29	36°51’46.80"	74°29’24.72"	36°51’46.74"	74°29’24.72"	0–1,611
RB-2013-034	CTD	8 May 2013	N	29	36°51’47.46"	74°29’26.88"	36°51’48.90"	74°29’23.64"	0–1,611
RB-2013-052	CTD	11 May 2013	D	22	37°00’20.28"	74°31’18.48"	37°00’20.28"	74°31’18.48"	0–1,069
RB-2013-053	CTD	11 May 2013	D	21	37°00’21.90"	74°32’12.84"	37°00’21.96"	74°32’12.84"	0–1,092
RB-2013-061	CTD	13 May 2013	N	21	37°00’19.92"	74°31’23.88"	37°00’20.16"	74°31’23.88"	0–1,052
RB-2013-062	CTD	13 May 2013	N	20	37°00’23.64"	74°32’18.96"	37°00’23.46"	74°32’18.96"	0–1,080
RB-2013-063	CTD	13 May 2013	N	20	37°00’29.40"	74°33’09.36"	37°00’29.46"	74°33’09.72"	0–941
RB-2013-064	CTD	14 May 2013	N	18	37°00’32.10"	74°33’53.28"	37°00’32.10"	74°33’53.28"	0–791
RB-2013-065	CTD	14 May 2013	N	14	37°00’36.96"	74°34’35.04"	37°00’37.02"	74°34’35.04"	0–676
RB-2013-066	CTD	14 May 2013	N	09	37°00’38.76"	74°35’27.96"	37°00’38.82"	74°35’28.32"	0–356
RB-2013-067	CTD	14 May 2013	N	07	37°00’50.16"	74°36’55.80"	37°00’50.16"	74°36’55.80"	0–277
RB-2013-068	CTD	14 May 2013	N	04	37°01’09.48"	74°38’46.32"	37°01’09.12"	74°38’49.20"	0–126
RB-2013-084	CTD	19 May 2013	N	28	36°52’08.28"	74°29’38.04"	36°52’08.34"	74°29’38.04"	0–1,570
RB-2013-036*	BC	9 May 2013	N	n/a	37°02’19.08"	74°34’47.70"	**	**	1,108
RB-2013-037*	BC	9 May 2013	N	n/a	37°02’19.20"	74°34’47.64"	**	**	1,108
RB-2013-038	BC	10 May 2013	N	n/a	37°02’19.08"	74°34’47.52"	**	**	1,110
RB-2013-039	BC	10 May 2013	N	n/a	37°02’19.26"	74°34’47.82"	**	**	1,110
RB-2013-040	BC	10 May 2013	N	n/a	37°02’33.84"	74°37’45.00"	**	**	805
RB-2013-041	BC	10 May 2013	N	n/a	37°02’33.90"	74°37’45.12"	**	**	803
RB-2013-042	BC	10 May 2013	N	n/a	37°02’34.08"	74°37’45.30"	**	**	804
RB-2013-043	BC	11 May 2013	N	n/a	37°04’33.48"	74°39’38.28"	**	**	559
RB-2013-044	BC	11 May 2013	N	n/a	37°04’33.48"	74°39’38.10"	**	**	557
RB-2013-045	BC	11 May 2013	N	n/a	37°04’33.42"	74°39’38.10"	**	**	558
RB-2013-046	BC	11 May 2013	N	n/a	37°05’41.10"	74°44’47.70"	**	**	195
RB-2013-047	BC	11 May 2013	N	n/a	37°05’41.22"	74°44’47.64"	**	**	195
RB-2013-048	BC	11 May 2013	N	n/a	37°05’41.22"	74°44’47.64"	**	**	195
RB-2013-049	BC	11 May 2013	N	n/a	37°01’23.04"	74°38’44.76"	**	**	187
RB-2013-050	BC	11 May 2013	N	n/a	37°01’28.02"	74°38’50.22"	**	**	187
RB-2013-051	BC	11 May 2013	N	n/a	37°01’26.94"	74°38’45.36"	**	**	187
RB-2013-054	BC	12 May 2013	N	n/a	37°00’56.88"	74°34’41.52"	**	**	549

Table C-1 (Continued).

Station Number	Gear	Date	Day[1]/Night[2]	Total Time (min)	Start Latitude (°N)	Start Longitude (°W)	End Latitude (°N)	End Longitude (°W)	Depth Range (m)
RB-2013-055	BC	12 May 2013	N	n/a	37°00'56.88"	74°34'41.34"	**	**	548
RB-2013-056	BC	12 May 2013	N	n/a	37°00'56.88"	74°34'41.40"	**	**	548
RB-2013-057*	BC	12 May 2013	N	n/a	37°00'29.46"	74°33'16.08"	**	**	977
RB-2013-058*	BC	13 May 2013	N	n/a	37°00'32.58"	74°33'53.16"	**	**	791
RB-2013-059	BC	13 May 2013	N	n/a	37°00'32.52"	74°33'53.22"	**	**	790
RB-2013-060	BC	13 May 2013	N	n/a	37°00'32.58"	74°33'52.98"	**	**	790
RB-2013-069	BC	14 May 2013	N	n/a	37°00'32.46"	74°33'53.88"	**	**	804
RB-2013-070	BC	14 May 2013	N	n/a	37°00'32.22"	74°33'53.88"	**	**	805
RB-2013-071	BC	14 May 2013	N	n/a	37°00'20.76"	74°32'01.44"	**	**	1,118
RB-2013-072*	BC	15 May 2013	N	n/a	37°00'20.82"	74°32'01.44"	**	**	1,105
RB-2013-073	BC	15 May 2013	N	n/a	37°00'20.76"	74°32'01.32"	**	**	1,106
RB-2013-074*	BC	15 May 2013	N	n/a	37°00'20.82"	74°32'01.26"	**	**	1,109
RB-2013-075	BC	15 May 2013	D	n/a	37°00'21.18"	74°32'01.14"	**	**	1,103
RB-2013-076	BC	15 May 2013	D	n/a	37°00'20.88"	74°32'00.90"	**	**	1,100
RB-2013-077	BC	15 May 2013	D	n/a	37°02'19.50"	74°34'46.68"	**	**	1,108
RB-2013-078	BC	15 May 2013	D	n/a	37°02'00.48"	74°27'01.38"	**	**	1,622
RB-2013-079	BC	16 May 2013	N	n/a	38°03'40.92"	73°36'22.68"	**	**	1,608
RB-2013-080	BC	17 May 2013	N	n/a	38°03'41.16"	73°36'22.74"	**	**	1,606
RB-2013-081	BC	17 May 2013	N	n/a	38°03'40.80"	73°36'19.32"	**	**	1,608
RB-2013-082	BC	18 May 2013	N	n/a	37°02'00.36"	74°27'01.14"	**	**	1,619
RB-2013-083	BC	18 May 2013	N	n/a	37°02'00.36"	74°27'01.08"	**	**	1,620
RB-2013-003MC	MC	3 May 2013	D	n/a	37°05'31.50"	74°44'47.76"	**	**	190
RB-2013-004MC*	MC	3 May 2013	D	n/a	37°05'25.14"	74°43'40.08"	**	**	247
RB-2013-005MC	MC	3 May 2013	D	n/a	37°05'36.18"	74°42'15.48"	**	**	341
RB-2013-006MC	MC	3 May 2013	D	n/a	37°05'38.16"	74°40'51.96"	**	**	440
RB-2013-007MC*	MC	3 May 2013	D	n/a	37°03'56.94"	74°39'01.80"	**	**	630
RB-2013-008MC	MC	3 May 2013	D	n/a	37°02'20.28"	74°37'27.84"	**	**	855
RB-2013-009MC*	MC	3 May 2013	D	n/a	37°02'16.68"	74°35'59.28"	**	**	974
RB-2013-010MC	MC	3 May 2013	D	n/a	37°02'09.60"	74°33'54.36"	**	**	1,184
RB-2013-012MC	MC	3 May 2013	D	n/a	37°02'10.74"	74°31'56.28"	**	**	1,315
RB-2013-015MC*	MC	4 May 2013	D	n/a	37°02'31.62"	74°31'01.20"	**	**	1,381
RB-2013-016MC	MC	4 May 2013	D	n/a	37°02'16.20"	74°32'58.92"	**	**	1,255

Table C-1 (Continued).

Station Number	Gear	Date	Day[1]/Night[2]	Total Time (min)	Start Latitude (°N)	Start Longitude (°W)	End Latitude (°N)	End Longitude (°W)	Depth Range (m)
RB-2013-017MC	MC	4 May 2013	D	n/a	37°02’17.58"	74°34’44.76"	**	**	1,113
RB-2013-018MC*	MC	4 May 2013	D	n/a	37°03’15.36"	74°38’07.80"	**	**	728
RB-2013-019MC	MC	4 May 2013	D	n/a	37°03’58.92"	74°39’04.68"	**	**	629
RB-2013-020MC	MC	4 May 2013	D	n/a	37°04’46.32"	74°39’54.36"	**	**	537
RB-2013-021MC	MC	4 May 2013	D	n/a	37°05’16.56"	74°43’55.92"	**	**	212
RB-2013-031MC	MC	7 May 2013	D	n/a	36°51’46.74"	74°29’24.72"	**	**	1,616
RB-2013-034MC	MC	8 May 2013	N	n/a	36°51’48.90"	74°29’23.64"	**	**	1,614
RB-2013-052MC*	MC	11 May 2013	D	n/a	37°00’20.28"	74°31’18.48"	**	**	1,076
RB-2013-053MC	MC	11 May 2013	D	n/a	37°00’21.96"	74°32’12.84"	**	**	1,107
RB-2013-063MC*	MC	13 May 2013	N	n/a	37°00’29.46"	74°33’09.72"	**	**	959
RB-2013-064MC	MC	14 May 2013	N	n/a	37°00’32.10"	74°33’53.28"	**	**	800
RB-2013-065MC	MC	14 May 2013	N	n/a	37°00’37.02"	74°34’35.04"	**	**	681
RB-2013-066MC*	MC	14 May 2013	N	n/a	37°00’38.82"	74°35’28.32"	**	**	363
RB-2013-067MC*	MC	14 May 2013	N	n/a	37°00’50.16"	74°36’55.80"	**	**	307
RB-2013-068MC*	MC	14 May 2013	N	n/a	37°01’09.12"	74°38’49.20"	**	**	131
RB-2013-001	OT	3 May 2013	N	30	37°05’04.86"	74°40’46.20"	37°05’42.66"	74°41’39.60"	382–388
RB-2013-002*	OT	3 May 2013	N	30	37°04’33.36"	74°40’17.04"	37°05’18.18"	74°41’08.88"	376–392
RB-2013-013	OT	4 May 2013	N	30	37°02’01.14"	74°36’11.76"	37°02’12.72"	74°35’15.96"	931–1,046
RB-2013-014*	OT	4 May 2013	N	30	37°02’13.80"	74°35’00.36"	37°02’28.86"	74°33’52.62"	1,063–1,183
RB-2013-023	OT	4 May 2013	D	30	37°05’02.46"	74°34’26.70"	37°05’56.94"	74°34’07.86"	160–165
RB-2013-024	OT	4 May 2013	N	30	37°04’23.58"	74°34’37.92"	37°05’18.12"	74°34’09.78"	175–187
RB-2013-025	OT	4 May 2013	N	30	37°04’31.26"	74°34’30.84"	37°05’36.84"	74°34’05.70"	180–185
RB-2013-026	OT	5 May 2013	N	30	37°04’15.36"	74°34’15.72"	37°05’13.38"	74°33’44.10"	255–270
RB-2013-027	OT	5 May 2013	N	30	37°04’47.46"	74°33’44.64"	37°05’52.32"	74°33’22.74"	304–330
RB-2013-028	OT	5 May 2013	N	30	37°04’44.04"	74°24’26.40"	37°05’24.36"	74°23’39.60"	1,614–1,643
RB-2013-029	OT	7 May 2013	N	30	37°04’19.32"	74°25’03.84"	37°05’00.66"	74°24’10.86"	1,576–1,629
RB-2013-030*	OT	7 May 2013	D	30	36°53’57.60"	74°27’31.20"	36°54’05.46"	74°26’18.66"	1,670–1,694
RB-2013-032*	OT	7 May 2013	D	30	36°52’11.10"	74°27’44.16"	36°51’51.42"	74°26’24.66"	1,504–1,550

Table C-1 (Continued).

Station Number	Gear	Date	Day[1]/Night[2]	Total Time (min)	Start Latitude (°N)	Start Longitude (°W)	End Latitude (°N)	End Longitude (°W)	Depth Range (m)
RB-2013-033*	OT	8 May 2013	N	30	36°51’31.32"	74°28’49.14"	36°51’07.74"	74°27’36.96"	1,636–1,712
RB-2013-035*	OT	9 May 2013	N	30	36°51’49.50"	74°29’37.32"	36°51’23.52"	74°28’33.84"	1,608–1,674

[1] Day (06:00 to 20:00 eastern standard time (EST).
[2] Night (20:00 to 06:00 EST).
* Poor quality or no sample; gear issue.
** Boxcore and monocore stations were recorded as single points.
ROV = remotely operated vehicle; CTD = conductivity-temperature-depth profiler; BC = box core; MC = monocore; OT = otter trawl.

Table C-2 Stations sampled in the Middle Atlantic Bight off the U.S. east coast around Baltimore and Norfolk Canyons during Leg 2 of the 2013 Sampling Cruise. ROV depth range and location data are only for the period when the ROV was on the seafloor.

Station Number	Gear	Date	Day[1]/Night[2]	Total Time (min)	Start Latitude (°N)	Start Longitude (°W)	End Latitude (°N)	End Longitude (°W)	Depth Range (m)
ROV-2013-RB-692	ROV	19 May 2013	N	295	37°11'30.00"	74°34'28.14"	37°11'29.94"	74°34'26.64"	91–105
ROV-2013-RB-693	ROV	20 May 2013	D	894	37°09'22.02"	74°34'25.20"	37°09'23.64"	74°34'39.48"	90–116
ROV-2013-RB-694	ROV	21 May 2013	D	861	37°13'55.20"	74°33'03.72"	37°13'59.70"	74°33'07.02"	101–126
ROV-2013-RB-695	ROV	22 May 2013	D	504	37°16'50.10"	74°32'06.48"	37°16'55.80"	74°32'09.24"	106–121
ROV-2013-RB-696	ROV	23 May 2013	D	197	37°09'22.38"	74°34'31.74"	37°09'26.28"	74°34'35.46"	90–114
RB-2013-085	CTD	20 May 2013	N	22	37°02'15.24"	74°33'43.92"	37°02'15.36"	74°33'43.92"	0–1,181
RB-2013-086	OT	21 May 2013	N	30	37°06'23.28"	74°33'01.92"	37°05'29.16"	74°33'25.02"	287–340
RB-2013-087	CTD	21 May 2013	N	14	37°03'13.74"	74°38'04.92"	37°03'13.74"	74°38'04.92"	0–721
RB-2013-088	CTD	21 May 2013	N	12	37°00'37.08"	74°34'43.68"	37°00'37.20"	74°34'43.68"	0–600

[1] Day (06:00 to 20:00 eastern standard time (EST).
[2] Night (20:00 to 06:00 EST).
* Poor quality or no sample; gear issue.

Appendix D

2013 Instrument Retrieval Cruise Report

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OCS Study
BOEM 2017-061

Exploration and Research of Mid-Atlantic Deepwater Hard Bottom Habitats and Shipwrecks with Emphasis on Canyons and Coral Communities: Atlantic Deepwater Canyons Study

2013 Instrument Retrieval Cruise

NF-13-09, Deepwater Canyons (Benthic Landers)
Cruise Report for NOAA Ship *Nancy Foster*
21–27 August 2013

24 September 2013

U.S. Department of the Interior
Bureau of Ocean Energy Management
Atlantic OCS Region

BOEM
Bureau of Ocean Energy Management

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Cruise Report for NOAA Ship *Nancy Foster*
21–27 August 2013

24 September 2013

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Appendix C: 2013 Sampling Cruise

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LIST OF ACRONYMS AND ABBREVIATIONS

BOEM	Bureau of Ocean Energy Management
CFCC	Cape Fear Community Cololege
CTD	conductivity-temperature-depth profiler
CSA	CSA Ocean Sciences Inc.
FSU	Florida State University
NCMNS	North Carolina Museum of Natural Sciences
NIOZ	Royal Netherlands Institute for Sea Research
NOAA, OER	National Oceanic and Atmospheric Administration, Office of Ocean Exploration and Research
POM	particulate organic matter
ROV	remotely operated vehicle
SBE	Sea-Bird Electronics, Inc.
UNCW	University of North Carolina, Wilmington
USGS	U.S. Geological Survey

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1 BACKGROUND AND OBJECTIVES

1.1 BACKGROUND

Submarine canyons are dominant features of the outer continental shelf and slope of the U.S. east coast from Cape Hatteras to the Gulf of Maine. Linking the shelf to the deep sea, these conduits funnel anthropogenic pollutants, organic carbon, and sediments from shallow to deeper waters. Large canyons (Norfolk, Baltimore, Washington, Hudson) occur at regular intervals along the shelf-slope interface (**Figure 1**). The geology of these features has been well studied; however, biological data are limited (particularly deeper than 200 m). Much of the biological data available for these canyons is represented by unpublished reports, unanalyzed datasets, and anecdotal observations. The canyons between Cape Hatteras and Cape Cod are the subject of potential oil exploration, intensive fisheries, and are possible National Marine Sanctuary candidates. This interagency study focuses on the exploration and investigation of deepwater biological communities and shipwreck sites located in and around the deep-sea canyons offshore Virginia and Maryland.

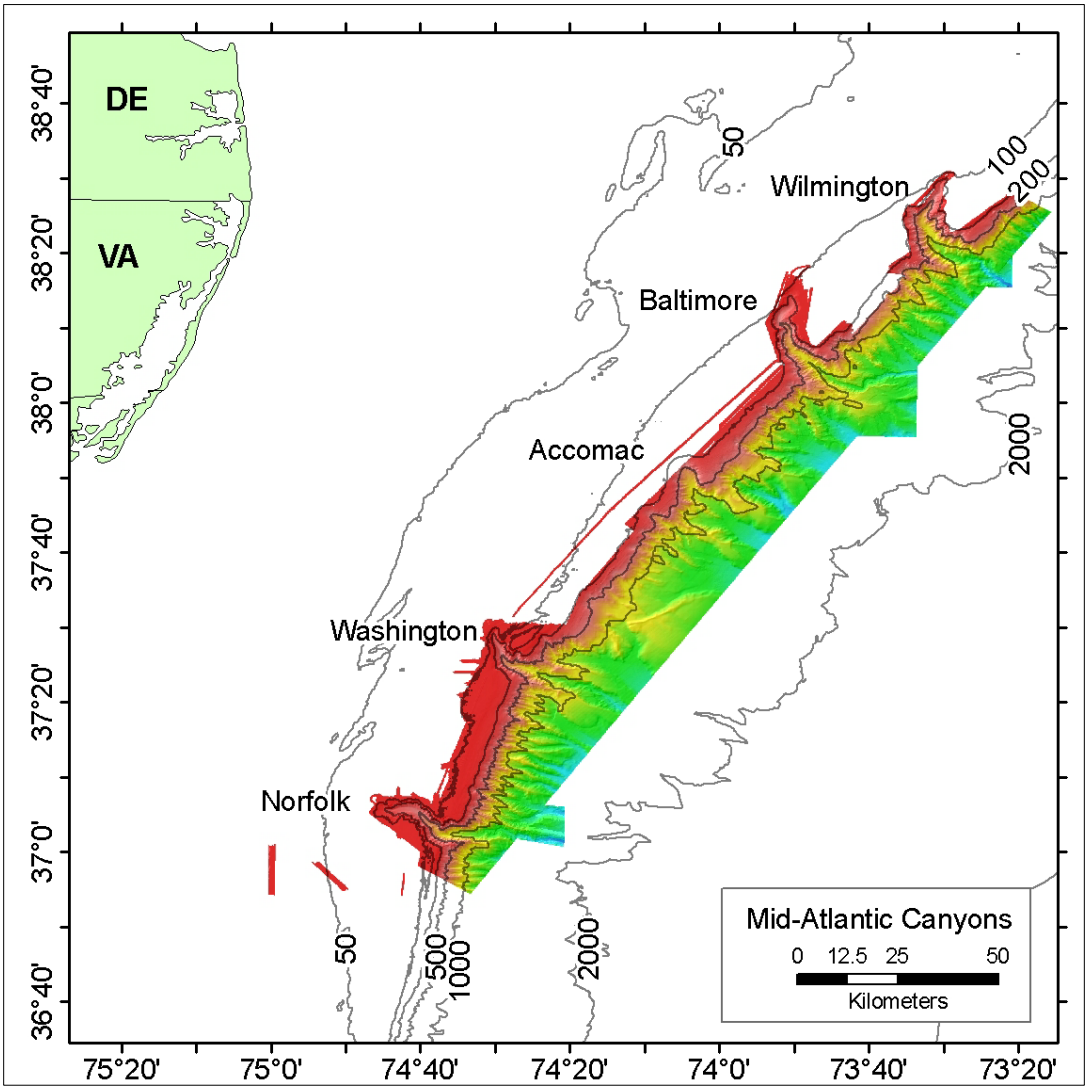

Figure 1. Major middle Atlantic study area canyons. Multibeam sonar data are represented by color shaded areas.

The first activity of this project consisted of multibeam sonar mapping and water column sampling (2011 Mapping Cruise) from Norfolk Canyon to Baltimore Canyon using the National Oceanic and Atmospheric Administration (NOAA) ship *Nancy Foster* (NF-11-04, 4–17 June 2011, Co-Chief Scientists: S.W. Ross and S.D. Brooke). Detailed bathymetric maps generated during this cruise were used to guide sampling activities during the 2012 and 2013 Sampling Cruises. The 2012 Sampling Cruise using the *Nancy Foster* (NF-12-07, 15 Aug - 2 Oct 2012, Co-Chief Scientists: S.W. Ross, S.D. Brooke, R. Mather, and S. Viada, cruise report of 29 Oct 2012) concentrated on geology, biology, and oceanographic sampling during its first two legs in Baltimore Canyon with limited sampling in Norfolk Canyon. Four benthic landers and two moorings were placed in two canyons during this cruise. Leg three of the 2012 cruise conducted archaeological and biological sampling mostly around Norfolk Canyon.

The first 2013 mission, consisted of two legs (30 April–19 May and 19–27 May) and used the NOAA ship *Ronald H. Brown* and the *Jason II* remotely operated vehicle (ROV) (Woods Hole Oceanographic Institution). The *Jason II* was used for video surveys and sampling. Non-ROV sampling included bottom trawling, box coring, retrieval, and re-deployment of two benthic landers, multibeam mapping, and conductivity- temperature-depth (CTD) profiling and water sampling. Education and outreach activities were incorporated into the cruise, through NOAA, North Carolina Museum of Natural Sciences (NCMNS), U.S. Geological Survey (USGS), and other institutional websites.

This second 2013 cruise on the NOAA ship *Nancy Foster* was the final cruise of this project and its primary objective was to retrieve the four benthic landers and two moorings placed in Baltimore and Norfolk canyons during the 2012 cruise. It departed from and returned to North Charleston, South Carolina. Twenty-four-hour operations were conducted, and overall three landers and one mooring were recovered during daylight hours while CTD transects and monocore stations were completed at night.

This cruise was a collaborative effort between the Bureau of Ocean Energy Management (BOEM, the primary funding source), CSA Ocean Sciences, Inc. (the BOEM contractor) and academic partners, NOAA Office of Ocean Exploration and Research (OER, provider of ship time), and USGS. All three federal agencies and their partners have a vested interest in the discovery and characterization of new ocean phenomena and dynamic processes that provide essential information and baseline characterizations to help better understand the nation's ocean resources. Other organizations involved were Univ. of North Carolina at Wilmington (UNCW), Florida State University (FSU), Netherlands Institute of Sea Research (NIOZ), NCMNS, ArtWork, Inc., and Cape Fear Community College (CFCC).

1.2 OBJECTIVES

1. Retrieve one lander from the mouth and one lander from the head of Baltimore Canyon.
2. Retrieve one mooring from the center of Baltimore Canyon.
3. As time allows, conduct CTD casts for hydrographic profiles in Baltimore Canyon. Water samples may be collected, but not on every cast. Monocore samples will be collected on most casts.
4. Retrieve one lander from the mouth and one lander from the head of Norfolk Canyon.
5. Retrieve one mooring from the center of Norfolk Canyon.
6. As time allows, conduct, multibeam mapping, and/or CTD casts (with monocore) in the Norfolk Canyon area.
7. Conduct limited education and outreach activities (internet postings, essays). No special efforts will be required by the ship for this activity. This will consist of posting regular updates via email to web coordinators on shore.

2 METHODS

2.1 STUDY AREAS

The cruise study area included Norfolk and Baltimore canyons as shown in **Figure 1**.

2.2 SCIENCE PERSONNEL

The science crew came from a number of locations and institutions (**Table 1**). Although 24 hour operations were conducted once on site, due to the high percentage of transiting time the scientific crew were not divided into day and night watches, but rather all necessary personnel were available when needed.

Table 1. Affiliation and roles of science personnel for the 2013 Instrument Retrieval Cruise.

Name	Affiliation	Role
Michael Rhode	UNCW	Chief Scientist, landers, data manager
Furu Mienis	NIOZ	Night watch chief, geology and landers
Gerard Duineveld	NIOZ	Scientist, ecologist and landers
Art Howard	ArtWork, Inc.	Video and photography
Jonathan Borden	USGS	Scientist and moorings
Mike Gray	USGS	Scientist and microbiologist
Olivia Cheriton	USGS	Scientist and moorings
Dacia Harris	NCMNS	Teacher at sea
Liz Baird	NCMNS	Education and outreach
Sarah Nall	CFCC	Student/marine technician
Kelly Bryant	CFCC	Student/marine technician
Colby Witt	CFCC	Student/marine technician
Gabriella Hogue	NCMNS	Scientist and educator

CFCC = Cape Fear Community College; NCMNS = North Carolina Museum of Natural Sciences; NIOZ = Royal Netherlands Institute for Sea Research; UNCW = University of North Carolina, Wilmington; USGS = U.S. Geological Survey.

2.3 FIELD METHODS

The *Nancy Foster* departed Charleston, South Carolina, on 21 August 2013 at approximately 10:00 h. We transited directly from Charleston to Norfolk Canyon, which took approximately 41 h. The ship arrived at the mouth of Norfolk Canyon on the morning of 23 August. In the remaining time before dawn CTD casts with the monocore were conducted until there was sufficient light for lander/mooring recovery.

The BOBO lander was successfully retrieved at the canyon mouth, but the ALBEX lander and the Norfolk Canyon USGS mooring were not. Communications were established with both, but neither surfaced. After several hours of searching, two more CTD casts with the monocore were conducted. At the completion of operations in Norfolk Canyon the ship began transiting to Baltimore Canyon (approximately 7 h) to retrieve two more landers and another mooring.

Once the ship arrived at the mouth of Baltimore Canyon, morning of 24 August, a CTD cast was conducted, after which there was sufficient light for lander recovery. Both UNCW landers and the Baltimore Canyon mooring were collected by midday. After these operations were completed a CTD transect over a shallow seep site just south of the mouth of the canyon, and some additional CTDs along the axis of the canyon were conducted. Two monocores were conducted in the canyon axis to compare to monocore samples from the NF-2013 cruise.

Around 04:00 h on 25 August the ship transited back to Norfolk canyon and spent the remainder of the time searching for ALBEX. Again, communications were established with the lander, but a location could not be determined. By 16:00 h on 25 August the search was aborted, and we began transiting to a

site for multibeam mapping. While in route to the site, the ship discovered an issue with the main engine lagging. Given the severity of the ship issue, the decision was made to forego multibeaming and transit back to Charleston. The *Nancy Foster* docked in Charleston around 21:00 h on 27 August.

2.3.1 CTD

The *Nancy Foster*'s CTD (Sea-Bird Electronics, Inc. [SBE] 911*plus*) with a rosette of twelve 5-L Nisken bottles, was used to record water column environmental profiles and collect water samples. The CTD measured turbidity (Seapoint probe, formazin turbidity units), dissolved oxygen (mL/L), altitude (m), depth (m), conductivity (Siemens/m), temperature (°C), salinity, fluorescence (Seapoint probe, µg/L), and pH. Both single location CTD casts and multi-location transects were accomplished in Baltimore and Norfolk canyons (**Figures 2** and **3**). A CTD transect was conducted over the seep site near Baltimore Canyon, and transects were also conducted up the axis of each canyon. Water samples were collected from specific depths in the water column at selected stations (during the upcast) by triggering Niskin bottles. Water samples collected during CTD casts are being processed by various project investigators for pigments and particulate organic matter (POM)

2.3.2 Monocore

NIOZ scientists provided a small monocore (**Figure 4**) which was suspended approximately 10 m beneath the CTD on some casts. This device provided a core sample of the bottom at several locations also sampled with the ship's CTD. Cores will be processed by various investigators for macrofauna, meiofauna, microbes, organic C/N, particle size, $\delta^{13}C$, $\delta^{15}N$, and other parameters.

2.3.3 Benthic Landers and Moorings

The two NIOZ and two UNCW landers (**Figure 5**) were each configured with a Sarl Technicap PPS 4/3 sediment trap programmed to rotate a sample bottle (250 mL) at 30-day intervals, delivering a total of 12 samples during the 1-year deployment. Both NIOZ landers (BOBO and ALBEX) deployed in Norfolk Canyon had instruments to record salinity, temperature, turbidity, and fluorescence. In addition, BOBO (deployed at 1,364 m) had an upward looking acoustic Doppler current profiler (ADCP) mounted approximately 2 m off the bottom, and ALBEX (deployed at 917 m) had a Nortek Aquadopp current meter mounted approximately 1.5 m off the bottom to measure bottom currents. Each of the two UNCW landers had an Aanderaa RCM string logger with instruments to measure temperature, salinity, turbidity, dissolved oxygen, and bottom currents. All RCM probes were approximately 1.5 m off bottom except the current meter which was approximately 2 m off bottom.

The UNCW lander placed in the head of Baltimore Canyon also carried three live coral experiments. Three acrylic chambers (designed by Brooke and Ross) were used to deploy a growth and survival experiment using live corals. The chambers were placed on the lower frame of the lander approximately 0.5 m off the bottom. Each chamber contained three small fragments of bubblegum coral (*Paragorgia arborea*) which were measured and photographed prior to deployment.

All four landers carried settlement plate microbiology experiments for USGS (C. Kellogg). The two UNCW landers carried additional settlement plate arrays and two multisubstrate settlement units as part of an international cooperation with the InDeep/Serpent Deep Ocean Colonization Project.

The two USGS moorings (**Figure 6**) each held a Honjo Parflux sediment trap with fifteen 500 mL-bottles. Each mooring also held a 300 kHz ADCP and a Sea-Bird Microcat 37 recording temperature and conductivity at 300 second intervals.

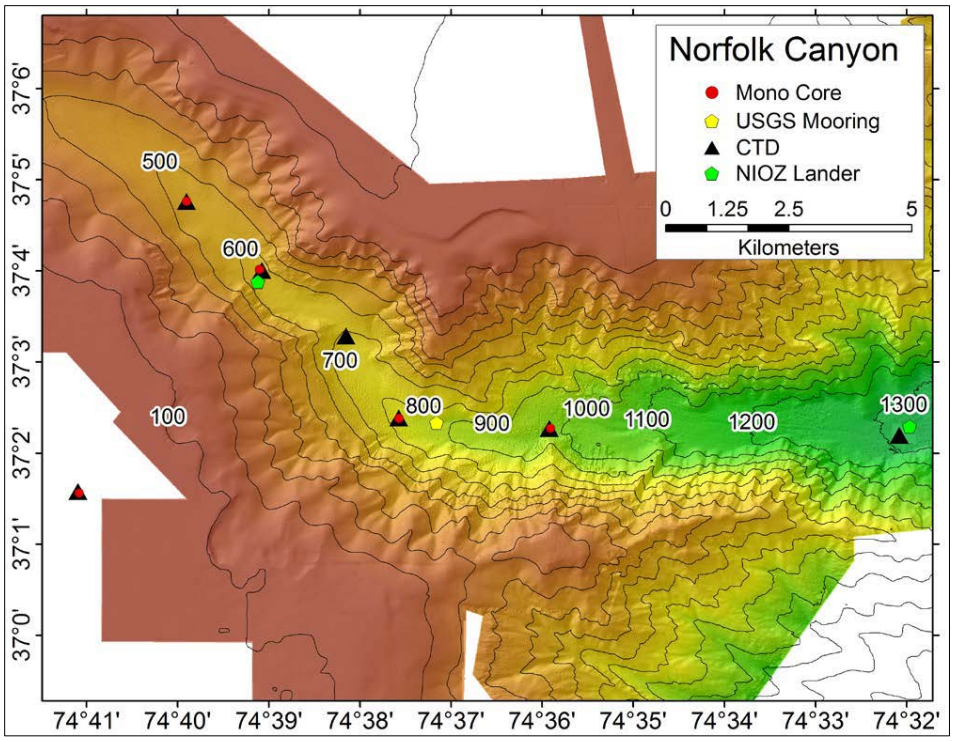

Figure 2. Map shows lander and mooring locations in Norfolk Canyon from the 2012 Sampling Cruise and locations of CTD and monocore stations sampled during the 2013 Instrument Retrieval Cruise.

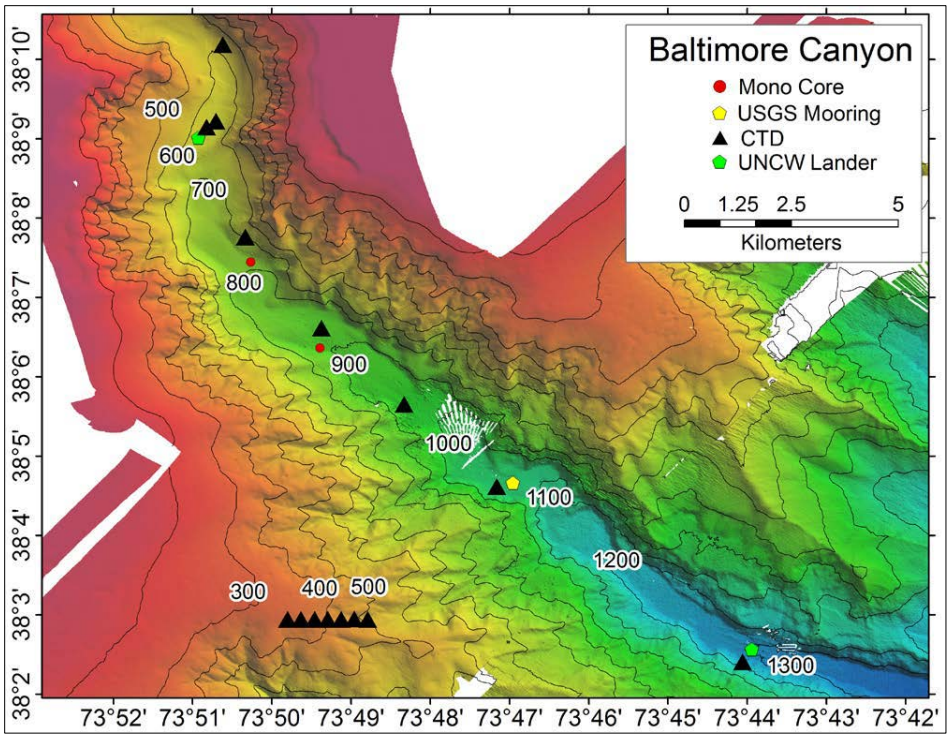

Figure 3. Map shows lander and mooring locations in Baltimore Canyon from the 2012 Sampling Cruise and locations of CTD and monocore stations sampled during the 2013 Instrument Retrieval Cruise.

Figure 4. NIOZ monocore suspended under the CTD carousel by a 10-m line.

Figure 5. UNCW benthic lander (left); NIOZ ALBEX lander (right).

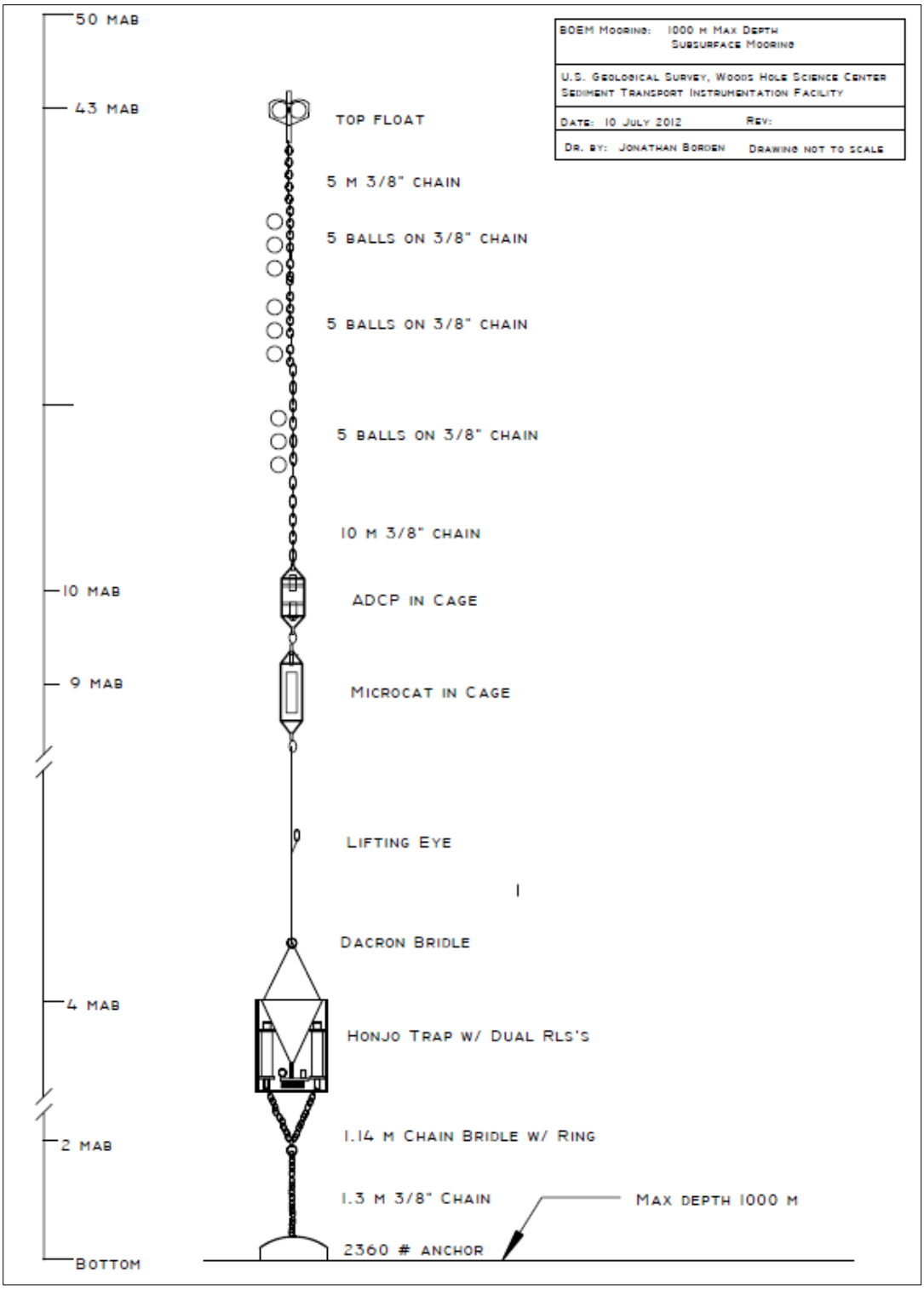

Figure 6. Schematic of the USGS mooring.

The two UNCW landers were recovered during the May 2013 cruise using the NOAA ship *Ronald H. Brown.* During this recovery all settlement plates, coral chambers, and multi-substrate settlement units were removed. In addition, sediment trap bottles 1-8 (bottle # 8 was a partial month sample) were removed from the deep lander, and the entire sediment trap was removed from the shallow lander. Upon recovery of the shallow lander, the sediment trap was completely inundated with mud. The landers were then redeployed until this August 2013 cruise.

2.3.4 General Specimen and Data Treatment

Samples from all collections were processed at sea according to various scientific objectives. Invertebrates that were collected from the landers with forceps were preserved in 70% ethanol. Respective investigators will analyze biological experiments and instrument data.

3 FIELD RESULTS

The weather was generally good and did not limit operations, allowing us to complete the major objectives. Overall, 33 stations were completed (**Table 2**). All station data were recorded on UNCW station data sheets and will be scanned upon completion of QA/QC. Data were also entered into an Access database, checked for errors, and archived at UNCW (Ross lab).

3.1 CTD OBSERVATIONS

Twenty-two CTD stations were sampled during this cruise (**Figures 2** and **3**). An example of the environmental profiles (temperature, salinity, dissolved oxygen, density, turbidity, and fluorescence) is plotted for a cast taken from the head of Norfolk Canyon (**Figure 7**). Water samples were collected during selected CTD casts for analysis of POM and/or nutrient levels at multiple depths (using the CTD array Niskin bottles). At lander and mooring recovery sites water was also collected to be used in splitting the sediment trap samples (**Table 2**).

The small monocore was attached to the ship's CTD array during 7 of the stations (**Figures 2** and **3**), each producing a single bottom core sample.

Not all objectives were accomplished during this cruise. Due to equipment failure, the ALBEX lander and the USGS mooring in Norfolk Canyon were not recovered. We speculated that heavy sedimentation or turbidity flows may have damaged the lander and mooring or partially buried them. It is possible that ALBEX came to the surface and drifted somewhere. The USGS mooring in Norfolk surfaced unexpectedly during the week of 8 September. The NOAA ship *Henry B. Bigelow* recovered the USGS mooring on 13 September.

Although the original cruise plan called for CTD sampling deeper than 1,000 m, we did not find out until the ship was underway that sampling would be limited to <1,000 m. This caused us to lose important comparative data in deeper water. The ship's engineering problem also caused the cruise to end early and the loss of valuable data.

3.2 SHIP OPERATIONS

In general, the *Nancy Foster* crew worked well with the science team to maintain stations and facilitate lander/mooring recoveries under varying conditions. Despite being somewhat hampered by an M/E lagging on the forward end of the M/E muffler, this ship and crew performed very well and did all possible to ensure success of this cruise. Several hours of project time were lost to aid a vessel in distress. The ship's crew was flexible and helped with plan changes dictated by changing sea/weather conditions, technical problems, and science needs. The lack of adequate CTD wire and the engine issue caused some loss of sampling time.

Table 2. Stations sampled in the Middle Atlantic Bight off the U.S. east coast around Baltimore and Norfolk canyons during the 2013 Instrument Retrieval Cruise.

Station No.	Gear	Date	Day/Night	Total Time (min)	Start Latitude (°N)	Start Longitude (°W)	End Latitude (°N)	End Longitude (°W)	Depth Range
NF-2013-001	CTD	23 Aug 2013	N	17	37°02'15.96"	74°35'55.38"	37°02'16.08"	74°35'54.54"	S-991
NF-2013-002	CTD	23 Aug 2013	N	15	37°02'22.86"	74°37'34.56"	37°02'22.80"	74°37'34.32"	S-825
NF-2013-003	CTD	23 Aug 2013	N	18	37°03'16.92"	74°38'09.30"	37°03'16.86"	74°38'09.00"	S-705
NF-2013-004	CTD	23 Aug 2013	N	16	37°04'00.12"	74°39'04.62"	37°04'00.72"	74°39'06.12"	S-620
NF-2013-005	CTD	23 Aug 2013	N	13	37°04'45.54"	74°39'54.36"	37°04'45.72"	74°39'54.36"	S-528
NF-2013-006	CTD	23 Aug 2013	N	4	37°01'34.38"	74°41'05.70"	37°01'33.48"	74°41'04.98"	S-80
NF-2013-007	CTD	23 Aug 2013	N	21	37°02'11.40"	74°32'02.34"	37°02'10.44"	74°32'01.98"	S-992
NF-2013-008	CTD	24 Aug 2013	N	18	38°02'24.00"	73°44'03.60"	38°02'10.08"	73°44'02.70"	S-959
NF-2013-009	CTD	24 Aug 2013	D	21	38°04'36.66"	73°47'09.78"	38°04'24.48"	73°47'07.62"	S-960
NF-2013-010	CTD	24 Aug 2013	D	15	38°09'08.64"	73°50'49.62"	38°08'55.38"	73°50'47.34"	S-630
NF-2013-011	CTD	24 Aug 2013	D	9	38°02'56.16"	73°49'48.36"	38°02'56.22"	73°49'48.36"	S-333
NF-2013-012	CTD	24 Aug 2013	D	10	38°02'56.22"	73°49'38.10"	38°02'56.34"	73°49'38.22"	S-351
NF-2013-013	CTD	24 Aug 2013	D	9	38°02'56.16"	73°49'27.84"	38°02'56.16"	73°49'27.90"	S-366
NF-2013-014	CTD	24 Aug 2013	D	10	38°02'56.34"	73°49'17.76"	38°02'56.28"	73°49'17.76"	S-395
NF-2013-015	CTD	24 Aug 2013	D	10	38°02'56.28"	73°49'07.56"	38°02'56.28"	73°49'07.56"	S-444
NF-2013-016	CTD	24 Aug 2013	N	11	38°02'56.52"	73°48'57.66"	38°02'56.40"	73°48'57.54"	S-472
NF-2013-017	CTD	24 Aug 2013	N	12	38°02'56.16"	73°48'47.52"	38°02'56.16"	73°48'47.52"	S-505
NF-2013-018	CTD	24 Aug 2013	N	20	38°05'38.82"	73°48'19.86"	38°05'27.00"	73°48'19.86"	S-898
NF-2013-019	CTD	24 Aug 2013	N	20	38°06'36.66"	73°49'22.56"	38°06'21.60"	73°49'23.64"	S-888
NF-2013-020	CTD	25 Aug 2013	N	21	38°07'45.36"	73°50'20.28"	38°07'26.76"	73°50'16.08"	S-768
NF-2013-021	CTD	25 Aug 2013	N	20	38°09'13.20"	73°50'42.48"	38°08'48.78"	73°50'43.80"	S-631
NF-2013-022	CTD	25 Aug 2013	N	10	38°10'11.04"	73°50'37.26"	38°09'55.32"	73°50'37.68"	S-336
NF-2013-001MC	MC	23 Aug 2013	N	n/a	37°02'16.08"	74°35'54.54"	37°02'16.08"	74°35'54.54"	1001
NF-2013-002MC	MC	23 Aug 2013	N	n/a	37°02'22.80"	74°37'34.32"	37°02'22.80"	74°37'34.32"	835
NF-2013-004MC	MC	23 Aug 2013	N	n/a	37°04'00.72"	74°39'06.12"	37°04'00.72"	74°39'06.12"	630
NF-2013-005MC	MC	23 Aug 2013	N	n/a	37°04'45.72"	74°39'54.36"	37°04'45.72"	74°39'54.36"	538
NF-2013-006MC	MC	23 Aug 2013	N	n/a	37°01'33.48"	74°41'04.98"	37°01'33.48"	74°41'04.98"	87
NF-2013-019MC	MC	25 Aug 2013	N	n/a	38°06'21.60"	73°49'23.64"	38°06'21.60"	73°49'23.64"	898
NF-2013-020MC	MC	25 Aug 2013	N	n/a	38°07'26.76"	73°50'16.08"	38°07'26.76"	73°50'16.08"	778
NF-2012-003	BOBO lander*	23 Aug 2013	D	534,224	37°02'13.02"	74°32'01.20"	37°02'13.02"	74°32'01.20"	1364
NF-2012-008	ALBEX lander*[1]	—			37°03'52.56"	74°39'07.14"	—	—	630
NF-2012-131	UNCW lander*	24 Aug 2013	D	507,417	38°02'32.58"	73°44'09.18"	38°02'33.60"	73°43'56.52"	1,318
NF-2012-132	UNCW lander*	24 Aug 2013	D	506,241	38°09'01.44"	73°50'57.24"	38°09'00.60"	73°50'55.74"	603
NF-2012-012	USGS mooring* Baltimore	24 Aug 2013	D	533,548	38°04'39.42"	73°46'57.42"	38°04'39.42"	73°46'57.42"	1,082
NF-2012-005	USGS mooring* Norfolk[2]	13 Sept 2013	D	564,526	37°02'19.80"	74°37'09.48"	36°39'00.00"	74°34'48.00"	917

* Landers and mooring were deployed in August and September 2012 (see the 2012 Sampling Cruise report).
[1] The ALBEX lander was not retrieved due to equipment failure.
[2] The Norfolk Canyon USGS mooring was retrieved by another ship after it unexpectedly surfaced.

4 EDUCATION, OUTREACH, AND MEDIA

An internet site documented progress and facilitated public awareness of the project during the cruise and was managed by the NCMNS (see http://deepwatercanyons.wordpress.com/ or http://naturalsciences.org/ education/online-adventures). It was set up as a "blog" to allow for easy posting of cruise activity logs. Background essays, daily logs and various photographs were posted prior to and during the cruise. Scientific personnel and educators wrote the blogs and recorded daily logs while at sea. From 19 August to 1 September, during which the cruise occurred, the NCMNS website for this project was viewed 1,421 times (highest Number of views in one day = 422) spread across 60 countries, and the site has been viewed 33,157 times since the beginning of the project. Statistics indicate that this site is used as a resource even when at sea. Art Howard and Liz Baird will continue working on film and education projects related to this project through the coming year.

5 REFERENCES

CSA International, Inc. 2011. Exploration and Research of Mid-Atlantic Deepwater Hard Bottom Habitats and Shipwrecks with Emphasis on Canyons and Coral Communities: 2011 Mapping Cruise. BOEM contract number M10PC00100.

CSA Ocean Sciences Inc. 2013. Exploration and Research of Mid-Atlantic Deepwater Hard Bottom Habitats and Shipwrecks with Emphasis on Canyons and Coral Communities: 2012 Sampling Cruise. BOEM contract number M10PC00100.

CSA Ocean Sciences Inc. 2014. Exploration and Research of Mid-Atlantic Deepwater Hard Bottom Habitats and Shipwrecks with Emphasis on Canyons and Coral Communities: 2013 Sampling Cruise. BOEM contract number M10PC00100.

Appendix E

Dive Logs from Historical Video Footage

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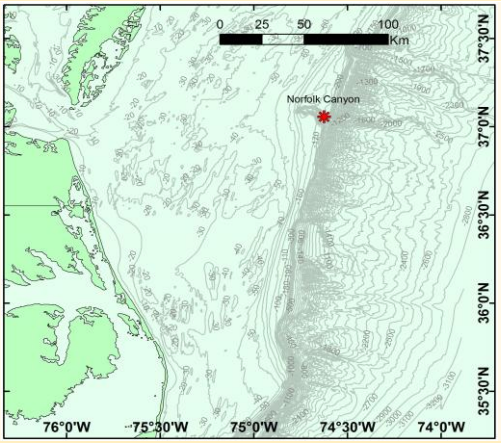
DIVE NUMBER: JSLI-1092 *STUDY AREA: Norfolk Canyon*

STATION OVERVIEW

Project	Canyon and Slope Processes Study
Principal investigators	B Hecker[1]
PI Contact Info[1]	Hecker Environmental Consulting, 26 Mullen Way, Falmouth, MA, 02540
Purpose	Assess and compare canyon and slope habitats in mid-Atlantic canyons
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	E Forde (bow), B Hecker (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	B Hecker, Minerals Management Service
SEADESC Analyst	M Watts
Date Compiled	7/6/2012
PI Station Number	

GENERAL LOCATION



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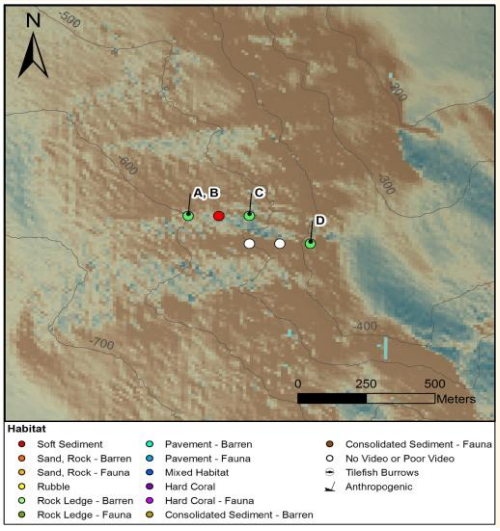


DIVE DATA

Date	06-Aug-81
Minimum Bottom Depth (m)	360
Maximum Bottom Depth (m)	557
Start Bottom Time (EDT)	16:24
End Bottom End (EDT)	18:42
Starting Latitude (N)	37° 03.313'
Starting Longitude (W)	74° 37.573'
Ending Latitude (N)	37° 03.236'
Ending Longitude (W)	74° 37.325'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Rock Ledge - with Attached Fauna
37° 03.313' N, 74° 37.573' W

DIVE NUMBER: JSLI-1092 *STUDY AREA: Norfolk Canyon*

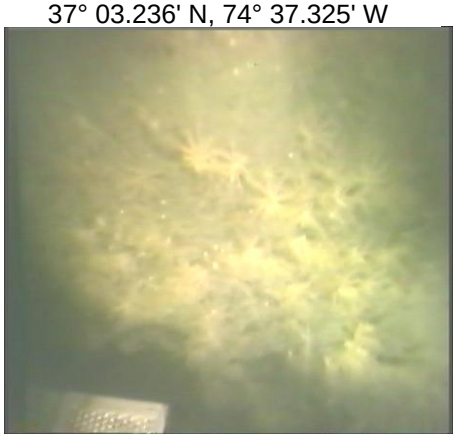
IMAGE GALLERY

*** indicates image position is approximated**

Image B: Rock Ledge - with Attached Fauna
37° 03.313' N, 74° 37.573' W

Image C: Rock Ledge - with Attached Fauna
37° 03.302' N, 74° 37.464' W

Image D: Rock Ledge - with Attached Fauna
37° 03.236' N, 74° 37.325' W



RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Haefner (1977)
Hecker et al. (1980, 1983)
Malahoff et al. (1982)
Forde et al. (1984)
Grimes (1987)
Williams (1988)
Mitchell (2004, 2005)
Schlee and Robb (2010)
Chaytor and Brothers (2011)
Kellog (2011)

BIOLOGICAL ENVIRONMENT

This dive ran upslope along the north wall of central Norfolk Canyon. Soft sediment habitat supported a few light pink anemones and a *Chaceon quinquedens*. Rock ledge habitat supported a diversity of soft corals including orange and pink *Paragorgia* spp., an unidentified light pink "broccoli coral," and anemones, urchins, sea stars, basket stars, spider crabs, and an abundance of crinoids covering vertical walls.

PHYSICAL ENVIRONMENT

This dive covered part of the north central wall of Norfolk Canyon. The submersible moved upslope traversing soft sediment habitat with an occasional boulder before reaching the canyon wall. The canyon wall consisted of rock, ledge habitat comprised of a series of vertical rock walls with attached soft corals and sponges.

ADDITIONAL COMMENTS

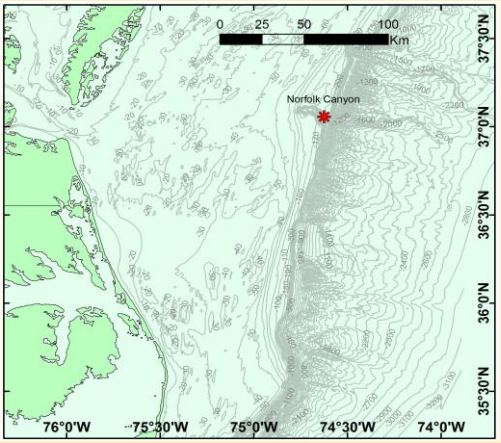
Original dives were likely on several Umatic tapes combined onto a VHS tape, then converted to digital media and stored on an external hard drive. Original Loran C navigation data were converted to latitude and longitude. Video quality was very poor with the entire dive being too out of focus to accurately identify invertebrate and fish taxa to genus and species. Eleven reliable position fixes were taken along the dive, though many had the same coordinates, causing overlap on the map. However, habitat type could only be assigned to four of the fixes as audio cues were necessary to align the time of the fixes with the video as no video overlay was present on the tape. Video footage was not continuous. Collections were taken of a large rock with crinoids and anemones and one of the light pink "broccoli" corals.

DIVE NUMBER: JSLI-1093 *STUDY AREA: Norfolk Canyon*

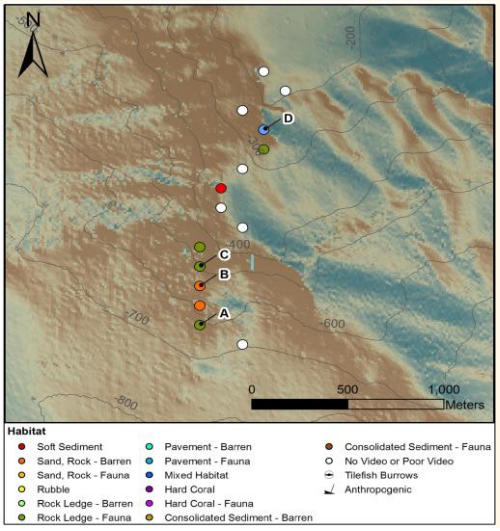
STATION OVERVIEW

Project	Canyon and Slope Processes Study
Principal investigators	B Hecker[1]
PI Contact Info[1]	Hecker Environmental Consulting, 26 Mullen Way, Falmouth, MA, 02540
Purpose	Assess and compare canyon and slope habitats in mid-Atlantic canyons
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	R Embley (bow), B Hecker (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	B Hecker, Minerals Management Service
SEADESC Analyst	M Watts
Date Compiled	7/11/2012
PI Station Number	

GENERAL LOCATION



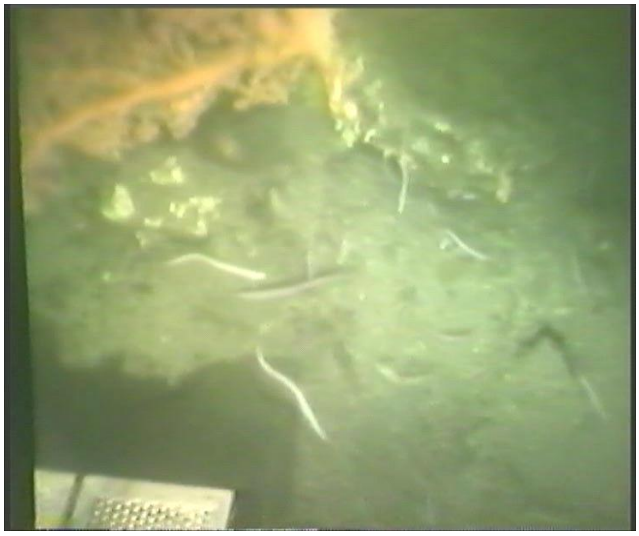
Dive Track:



DIVE DATA

Date	07-Aug-81
Minimum Bottom Depth (m)	162
Maximum Bottom Depth (m)	580
Start Bottom Time (EDT)	9:34
End Bottom End (EDT)	13:05
Starting Latitude (N)	37° 02.758'
Starting Longitude (W)	74° 37.225'
Ending Latitude (N)	37° 03.621'
Ending Longitude (W)	74° 37.137'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Rock Ledge - with Attached Fauna
37° 02.815' N, 74° 37.322' W



DIVE NUMBER: JSLI-1093 *STUDY AREA: Norfolk Canyon*

IMAGE GALLERY *** indicates image position is approximated**

Image B: Sand/Rubble/Rock - Barren
37° 02.938' N, 74° 37.313' W

Image C: Rock Ledge - with Attached Fauna
37° 03.014' N, 74° 37.315' W

Image D: Pavement - with Attached Fauna
37° 03.399' N, 74° 37.137' W

RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Haefner (1977)
Hecker et al. (1980, 1983)
Malahoff et al. (1982)
Forde et al. (1984)
Grimes (1987)
Williams (1988)
Mitchell (2004, 2005)
Schlee and Robb (2010)
Chaytor and Brothers (2011)
Kellog (2011)

BIOLOGICAL ENVIRONMENT

This dive covered part of the north central wall of Norfolk Canyon. Hard rock substrate (including vertical walls, rock slabs/ledges, and rock pavement) supported sessile fauna such as a diversity of soft corals and anemones including very large *Paragorgia* spp., an *Eunephthya florida*, *Primnoa resedaeformis*, *Halcurias pilatus*,*Cerianthus borealis*, *Actinoscyphia* sp., *Bolocera tuediae*, and a diversity of sponges as well as an encrusting polychaete and crinoids attached to vertical rock faces. Mobile fauna included sting rays, galatheid and *Chaceon quinquedens*, a lobster, numerous sea stars, basket stars, large scorpionfish, and a large school of synaphobranchid eels.

PHYSICAL ENVIRONMENT

This dive covered part of the north central wall of Norfolk Canyon. The submersible moved north, upslope, traversing rock ledge habitat consisting of a series vertical rock walls. Separating the vertical walls were areas of low slope with low relief rock slabs and ledges and soft sediment with cobbles, boulders and *Paragorgia* spp. rubble, with and without fauna. The canyon walls were often undercut and ranged from five to over 12 meters high with attached fauna. The submersible reached soft sediment with rock habitat and pavement habitat with dense assemblages of *Halcurias pilatus* and sponges, respectively.

ADDITIONAL COMMENTS

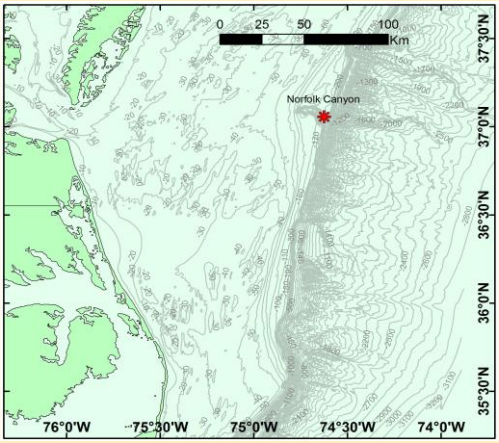
Original dives were likely on several Umatic tapes combined onto a VHS tape, then converted to digital media and stored on an external hard drive. Original Loran C navigation data were converted to latitude and longitude. Video quality was very poor with the entire dive being too out of focus to accurately identify invertebrate and fish taxa to genus and species. Nineteen reliable position fixes were taken along the dive, though many had the same coordinates, causing overlap on the map. Habitat type could only be assigned to eleven of the fixes as audio cues were necessary to align the time of the fixes with the video as no video overlay was present on the tape. Video footage was not continuous. Sediment samples, a large rock with *Halcurias pilatus*, and an *Eunephthya florida* were collected.

DIVE NUMBER: JSLI-1094 *STUDY AREA: Norfolk Canyon*

STATION OVERVIEW

Project	Canyon and Slope Processes Study
Principal investigators	B Hecker[1]
PI Contact Info[1]	Hecker Environmental Consulting, 26 Mullen Way, Falmouth, MA, 02540
Purpose	Assess and compare canyon and slope habitats in mid-Atlantic canyons
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	G Carpenter (bow), P Gibson (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	B Hecker, Minerals Management Service
SEADESC Analyst	M Watts
Date Compiled	7/16/2012
PI Station Number	

GENERAL LOCATION



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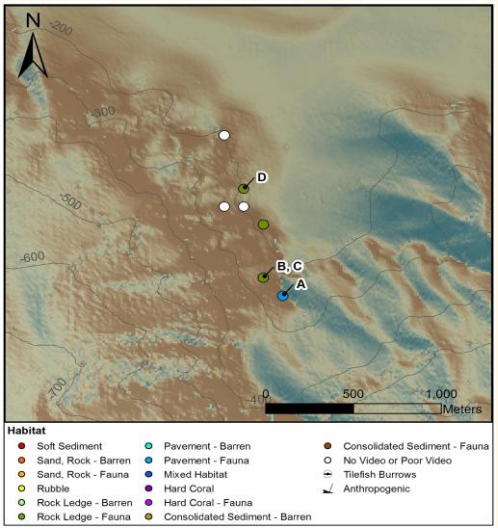
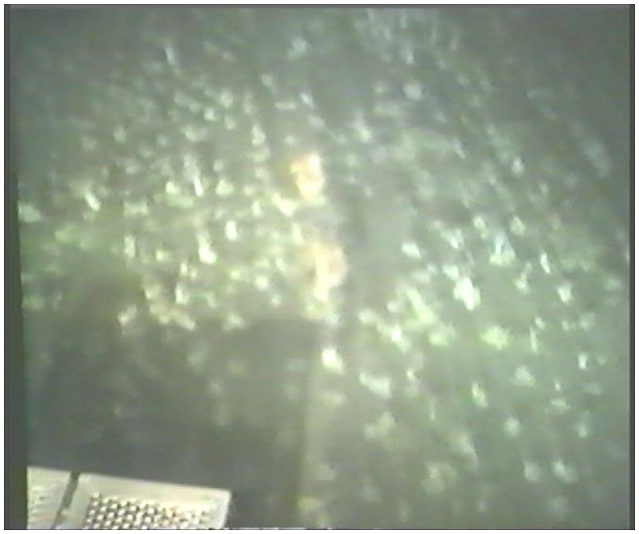


DIVE DATA

Date	07-Aug-81
Minimum Bottom Depth (m)	192
Maximum Bottom Depth (m)	239
Start Bottom Time (EDT)	16:44
End Bottom End (EDT)	19:05
Starting Latitude (N)	37° 03.403'
Starting Longitude (W)	74° 37.148'
Ending Latitude (N)	37° 03.943'
Ending Longitude (W)	74° 37.321'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Pavement - with Attached Fauna
37° 03.403' N, 74° 37.148' W



DIVE NUMBER: JSLI-1094 *STUDY AREA: Norfolk Canyon*

IMAGE GALLERY

*** indicates image position is approximated**

Image B: Rock Ledge - with Attached Fauna
37° 03.457' N, 74° 37.179' W

Image C: Rock Ledge - with Attached Fauna
37° 03.457' N, 74° 37.179' W

Image D: Rock Ledge - with Attached Fauna
37° 03.804' N, 74° 37.245' W

RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Haefner (1977)
Hecker et al. (1980, 1983)
Malahoff et al. (1982)
Forde et al. (1984)
Grimes (1987)
Williams (1988)
Mitchell (2004, 2005)
Schlee and Robb (2010)
Chaytor and Brothers (2011)
Kellog (2011)

BIOLOGICAL ENVIRONMENT

This dive covered part of the north central wall of Norfolk Canyon. Hard rock substrate (including vertical walls, rock slabs/ledges, and rock pavement) supported sessile fauna such as a diversity of soft corals and anemones including very large *Paragorgia* spp., *Primnoa resedaeformis*, fields of the anemone, *Halcurias pilatus*, *Actinoscyphia* sp., and a diversity of sponges as well as crinoids attached to vertical rock faces. Mobile fauna included galatheid crabs and *Chaceon quinquedens* , a lobster, numerous sea stars, large scorpionfish, a batfish, and an enormous conger eel.

PHYSICAL ENVIRONMENT

This dive covered part of the north central wall of Norfolk Canyon. The submersible moved north, upslope, beginning over rock pavement habitat with attached fauna such as dense assemblages of *Halcurias pilatus* and sponges. Pavement habitat transitioned abruptly into rock ledge habitat as the pavement ended and the submersible descended a vertical cliff. Rock ledge habitat consisted of a series vertical rock walls and escarpments with attached fauna and periodic areas of recent rock face collapse. The canyon walls were often undercut and ranged from five to over 40 feet high with attached fauna. Separating the vertical walls were areas of low slope with low relief rock slabs and ledges and soft sediment with cobbles and boulders, with and without fauna. At the end of the dive, the submersible reached soft sediment with cobbles and rock slabs covered in sediment.

ADDITIONAL COMMENTS

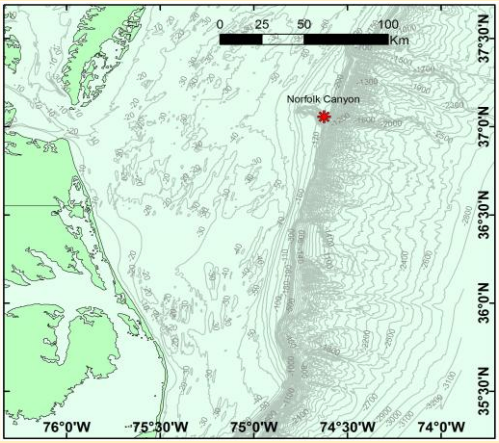
Original dives were likely on several Umatic tapes combined onto a VHS tape, then converted to digital media and stored on an external hard drive. Original Loran C navigation data were converted to latitude and longitude. Video quality was very poor with the entire dive being too out of focus to accurately identify invertebrate and fish taxa to genus and species. Twelve reliable position fixes were taken along the dive, though many had the same coordinates, causing overlap on the map. Habitat type could only be assigned to six of the fixes as audio cues were necessary to align the time of the fixes with the video as no video overlay was present on the tape. Video footage was not continuous. Multiple rocks, some with *Halcurias pilatus*, were collected along with a batfish and several unspecified "biological" samples.

DIVE NUMBER: JSLI-1095 *STUDY AREA: Norfolk Canyon*

STATION OVERVIEW

Project	Canyon and Slope Processes Study
Principal investigators	B Hecker[1]
PI Contact Info[1]	Hecker Environmental Consulting, 26 Mullen Way, Falmouth, MA, 02540
Purpose	Assess and compare canyon and slope habitats in mid-Atlantic canyons
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	R Embley (bow), B Hecker (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	B Hecker, Minerals Management Service
SEADESC Analyst	M Watts
Date Compiled	7/18/2012
PI Station Number	

GENERAL LOCATION



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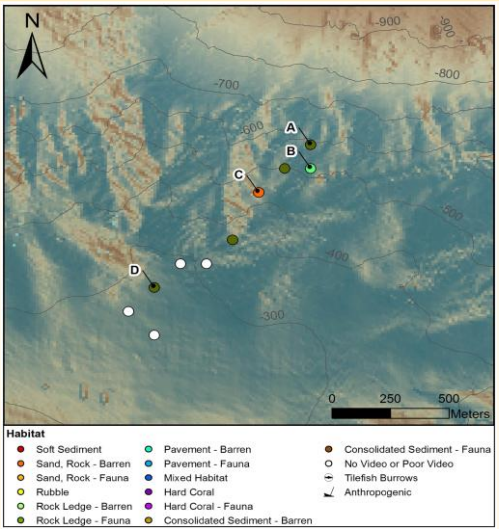
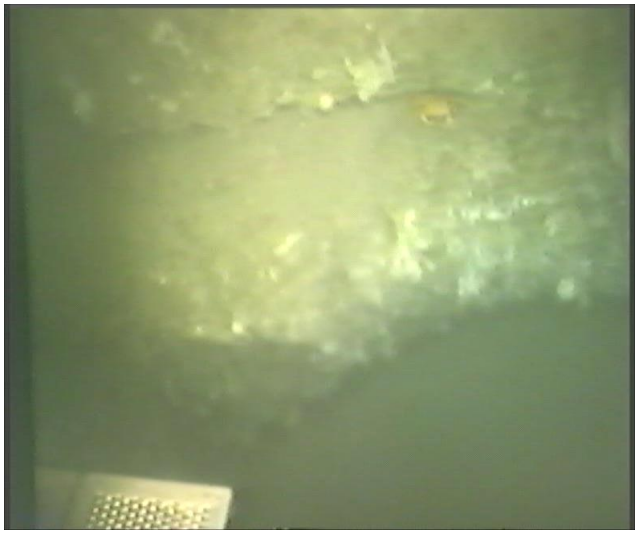


DIVE DATA

Date	08-Aug-81
Minimum Bottom Depth (m)	255
Maximum Bottom Depth (m)	297
Start Bottom Time (EDT)	9:10
End Bottom End (EDT)	12:16
Starting Latitude (N)	37° 01.504'
Starting Longitude (W)	74° 35.513'
Ending Latitude (N)	37° 01.033'
Ending Longitude (W)	74° 35.900'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Rock Ledge - with Attached Fauna
37° 01.490' N, 74° 35.494' W



DIVE NUMBER: JSLI-1095 *STUDY AREA: Norfolk Canyon*

IMAGE GALLERY

*** indicates image position is approximated**

Image B: Rock Ledge - Barren
37° 01.467' N, 74° 35.522' W

Image C: Sand/Rubble/Rock - Barren
37° 01.347' N, 74° 35.635' W

Image D: Rock Ledge - Barren
37° 01.143' N, 74° 35.873' W

RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Haefner (1977)
Hecker et al. (1980, 1983)
Malahoff et al. (1982)
Forde et al. (1984)
Grimes (1987)
Williams (1988)
Mitchell (2004, 2005)
Schlee and Robb (2010)
Chaytor and Brothers (2011)
Kellog (2011)

BIOLOGICAL ENVIRONMENT

This dive covered part of the south central wall of Norfolk Canyon. Hard rock substrate (including vertical walls and rock slabs/ledges) supported some sessile fauna such as a diversity of soft corals and anemones including very large *Paragorgia arborea*, *Acanthogorgia armata, Primnoa resedaeformis, Halcurias pilatus*, *Actinoscyphia* sp., *Bolocera tuediae* and a diversity of sponges as well as crinoids attached to vertical rock faces. Soft sediment supported *Cerianthus borealis.* Mobile fauna included *Chaceon quinquedens*, galatheid, *Cancer* , and hermit crabs, numerous sea stars, large scorpionfish (e.g. blackbelly rosefish), a large hake, and schools of synaphobranchid eels and squid.

PHYSICAL ENVIRONMENT

This dive covered part of the south central wall of Norfolk Canyon. The submersible reached bottom in the center of undercut ledges in a bowl shape. Moving in a downslope, southwest direction, the submersible encountered rock ledge habitat consisting of vertical rock walls and rock with and without attached fauna. The canyon walls were often undercut and ranged from five to over 15 meters high. Separating the vertical walls were areas of low slope with low relief rock slabs and ledges and soft sediment with cobbles and boulders, with and without fauna. The submersible traversed soft sediment with barren cobbles before completing the dive over rock slabs with numerous *Halcurias pilatus*.

ADDITIONAL COMMENTS

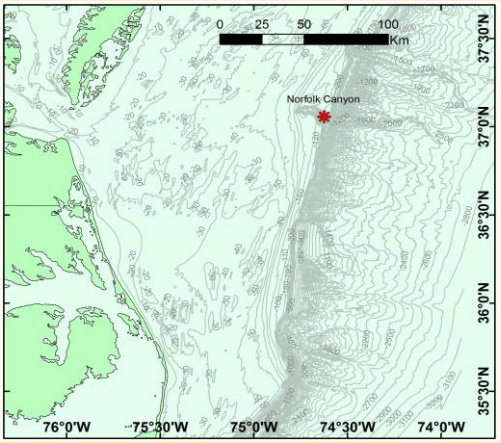
Original dives were likely on several Umatic tapes combined onto a VHS tape, then converted to digital media and stored on an external hard drive. Original Loran C navigation data were converted to latitude and longitude. Video quality was very poor with the entire dive being too out of focus to accurately identify invertebrate and fish taxa to genus and species. Sixteen reliable position fixes were taken along the dive, though many had the same coordinates, causing overlap on the map. Habitat type could only be assigned to ten of the fixes as audio cues were necessary to align the time of the fixes with the video as no video overlay was present on the tape. Video footage was not continuous. Multiple rocks were collected, some with fauna attached, along with two *Acanthogorgia armata*.

DIVE NUMBER: JSLI-1096 *STUDY AREA: Norfolk Canyon*

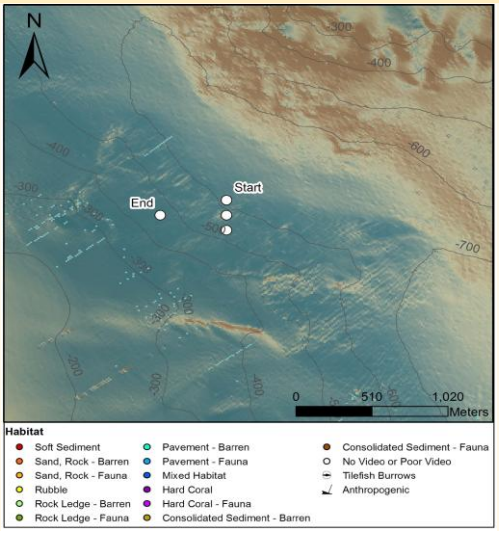
STATION OVERVIEW

Project	Canyon and Slope Processes Study
Principal investigators	B Hecker[1]
PI Contact Info[1]	Hecker Environmental Consulting, 26 Mullen Way, Falmouth, MA, 02540
Purpose	Assess and compare canyon and slope habitats in mid-Atlantic canyons
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	E Forde (bow), D. Logan (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	B Hecker, Minerals Management Service
SEADESC Analyst	M Watts
Date Compiled	7/19/2012
PI Station Number	

GENERAL LOCATION



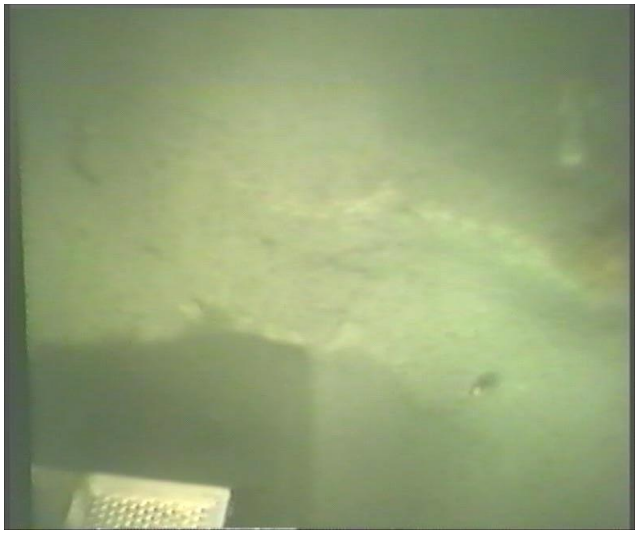
Dive Track:



DIVE DATA

Date	08-Aug-81
Minimum Bottom Depth (m)	472
Maximum Bottom Depth (m)	597
Start Bottom Time (EDT)	16:06
End Bottom End (EDT)	17:27
Starting Latitude (N)	37° 03.539'
Starting Longitude (W)	74° 38.940'
Ending Latitude (N)	37° 03.457'
Ending Longitude (W)	74° 39.162'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Rock Ledge - Barren



DIVE NUMBER: JSLI-1096 *STUDY AREA: Norfolk Canyon*

IMAGE GALLERY *** indicates image position is approximated**

Image B: Sand/Rubble/Rock - Barren

Image C: Sand/Rubble/Rock- with Attached Fauna

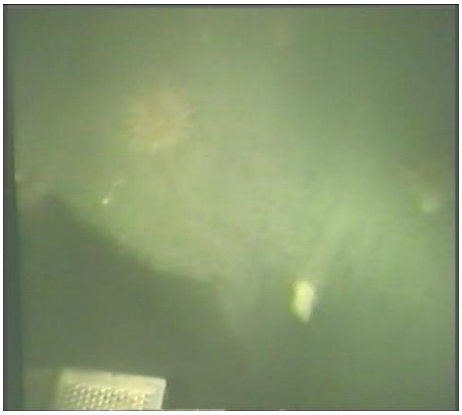
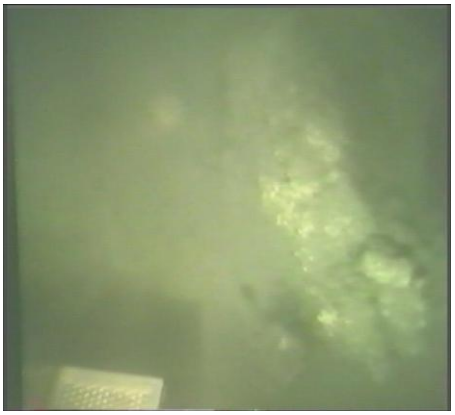


Image D: Rock Ledge - with Attached Fauna



RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Haefner (1977)
Hecker et al. (1980, 1983)
Malahoff et al. (1982)
Forde et al. (1984)
Grimes (1987)
Williams (1988)
Mitchell (2004, 2005)
Schlee and Robb (2010)
Chaytor and Brothers (2011)
Kellog (2011)

BIOLOGICAL ENVIRONMENT

This dive covered part of the southern wall of Norfolk Canyon. Hard rock substrate (including vertical walls and rock slabs/ledges) supported some sessile fauna such as one large *Paragorgia arborea*, *Actinoscyphia* sp., and *Bolocera tuediae*. Soft sediment supported annelid tubes. Mobile fauna included *Chaceon quinquedens*, and hermit crabs, blackbelly rosefish, and a few hakes.

PHYSICAL ENVIRONMENT

This dive covered part of the southern wall of western Norfolk Canyon. The submersible traversed a least one vertical rock wall (not visible on the video but discussed on the audio output) and several small rock slab outcrops. Though little was visible on the video, these rock ledge habitats seemed typically barren with occasional sparse attached fauna. As the submersible moved upslope, it reached soft sediment with rock, rubble, and shell hash habitat with and without fauna.

ADDITIONAL COMMENTS

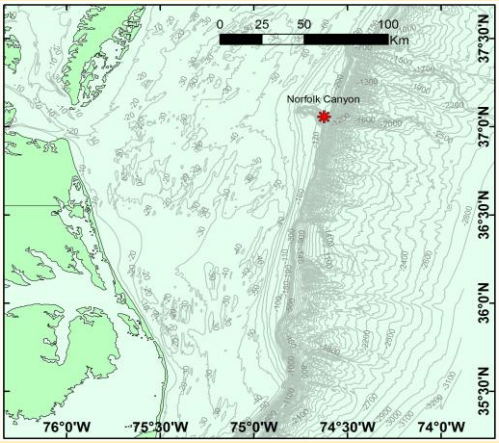
Original dives were likely on several Umatic tapes combined onto a VHS tape, then converted to digital media and stored on an external hard drive. Original Loran C navigation data were converted to latitude and longitude. Video quality was very poor with the entire dive being too out of focus to accurately identify invertebrate and fish taxa to genus and species. Six reliable position fixes were taken along the dive, though a few had the same coordinates, causing overlap on the map. Habitat type could not be assigned to any of the fixes as audio cues necessary to align the time of the fixes with the video were not recorded and no video overlay was present on the tape. Video footage was not continuous. Therefore, images A-D could not be assigned specific coordinates. Samples were taken though not identified or viewed on the video.

DIVE NUMBER: JSLI-1429 *STUDY AREA: Norfolk Canyon*

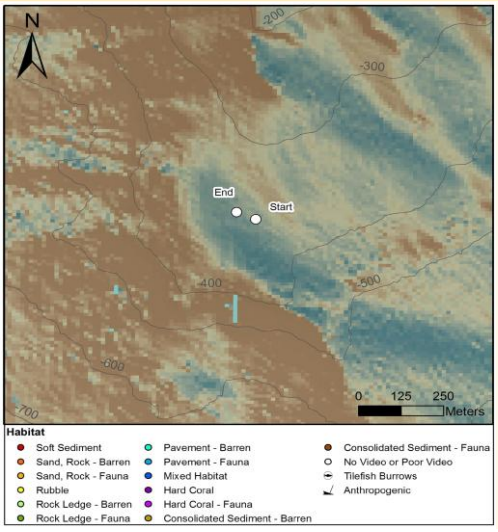
STATION OVERVIEW

Project	Tilefish Assessment
Principal investigators	CB Grimes[1] KW Able, RS Jones, DC Twichell, SC Turner
PI Contact Info[1]	Southwest Fisheries Science Center, Fisheries Ecology Division, 110 Shaffer Rd, Santa Cruz, CA 95060
Purpose	Investigation of tilefish fishery on the middle Atlantic and southern New England continental shelf
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	R Jones (bow), S Turner (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☐
Other	
Acknowledgements	K Able, Mid-Atlantic Fishery Management Council
SEADESC Analyst	M Watts
Date Compiled	7/20/2012
PI Station Number	

GENERAL LOCATION



Dive Track:



DIVE DATA

Date	18-Aug-83
Minimum Bottom Depth (m)	155
Maximum Bottom Depth (m)	292
Start Bottom Time (EDT)	8:33
End Bottom End (EDT)	11:17
Starting Latitude (N)	37° 03.170'
Starting Longitude (W)	74° 37.140'
Ending Latitude (N)	37° 03.190'
Ending Longitude (W)	74° 37.170'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Consolidated Sediment - without Attached Fauna

DIVE NUMBER: JSLI-1429 *STUDY AREA: Norfolk Canyon*

IMAGE GALLERY *** indicates image position is approximated**

Image B: Consolidated Sediment - with Attached Fauna

Image C: Consolidated Sediment - with Attached Fauna

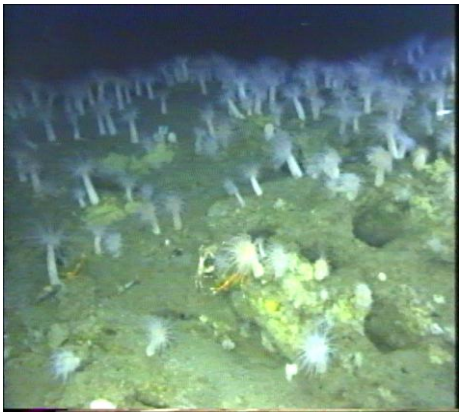


Image D: Consolidated Sediment - with Attached Fauna

RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Haefner (1977)
Hecker et al. (1980, 1983)
Malahoff et al. (1982)
Forde et al. (1984)
Grimes (1987)
Williams (1988)
Mitchell (2004, 2005)
Schlee and Robb (2010)
Chaytor and Brothers (2011)
Kellog (2011)

BIOLOGICAL ENVIRONMENT

This dive covered part of the north central wall of Norfolk Canyon. Consolidated clay habitat supported an abundance of the anemone *Halcurias pilatus*, cerianthids, sponges, galatheid, *Chaceon quinquedens*, and *Cancer* crabs, sea stars, a lobster, hakes, and scorpionfish (e.g. blackbelly rosefish).

PHYSICAL ENVIRONMENT

This dive covered part of the north central wall of Norfolk Canyon. The dive began over low relief consolidated clay bottom covered in small rock and shell hash rubble without attached fauna. As the submersible moved upslope the consolidated clay exhibited greater bioerosion as the substrate transitioned into grotto-like habitats with excavated burrows and attached fauna. At the end of the dive the consolidated clay took on the form of undercut ledges and slabs.

ADDITIONAL COMMENTS

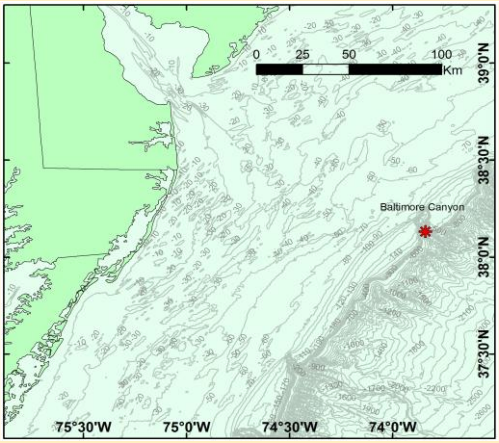
Original dives were on U-matic tapes, then converted to digital media and stored on an external hard drive. Video quality was clear overall. Only two position fixes were taken, at the start and end of the dive. Habitat type could not be assigned to the fixes as no audio cues were recorded for any portion of the dive to align the time of the fixes with the video as no video overlay was present on the tape. Video footage was not continuous. Therefore, images A-D could not be assigned specific coordinates. Collections were not recorded or mentioned on the video.

DIVE NUMBER: JSLI-1083 *STUDY AREA: Baltimore Canyon*

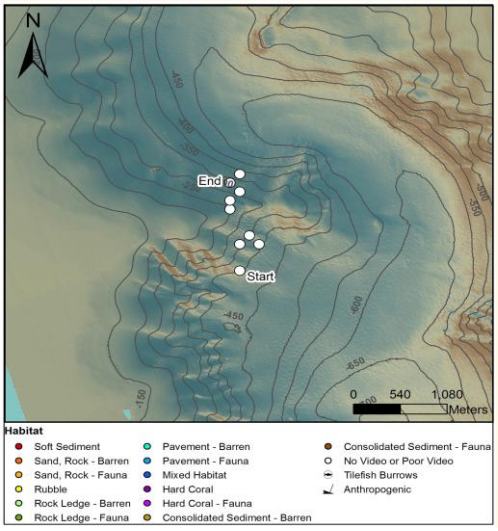
STATION OVERVIEW

Project	Canyon and Slope Processes Study
Principal investigators	B Hecker
PI Contact Info[1]	Hecker Environmental Consulting, 26 Mullen Way, Falmouth, MA, 02540
Purpose	Assess and compare canyon and slope habitats in mid-Atlantic canyons
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	B Hecker (bow), R Embley (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	B Hecker, Minerals Management Service
SEADESC Analyst	M Watts
Date Compiled	4/6/2012
PI Station Number	

GENERAL LOCATION



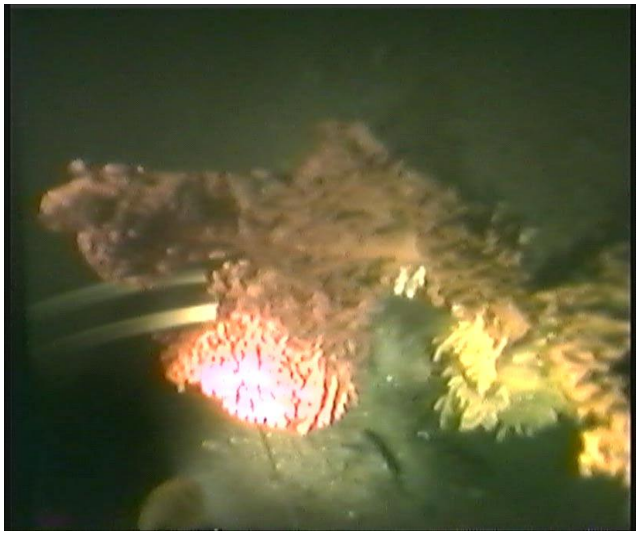
Dive Track:



DIVE DATA

Date	02-Aug-81
Minimum Bottom Depth (m)	381
Maximum Bottom Depth (m)	560
Start Bottom Time (EDT)	8:44
End Bottom End (EDT)	11:45
Starting Latitude (N)	38° 09.420'
Starting Longitude (W)	73° 51.750'
Ending Latitude (N)	38° 09.990'
Ending Longitude (W)	73° 51.860'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Rock Ledge - with Attached Fauna



DIVE NUMBER: JSLI-1083 *STUDY AREA: Baltimore Canyon*

IMAGE GALLERY

*** indicates image position is approximated**

Image B: Rock Ledge - with Attached Fauna

Image C: Rock Ledge - with Attached Fauna

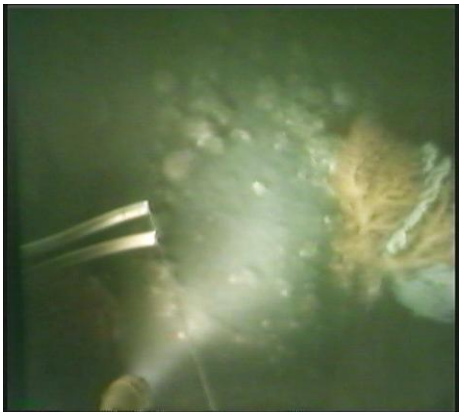


Image D: Consolidated Sediment - with Attached Fauna

RELEVANT WORK AND/OR LITERATURE CITED

Drake et al. (1978)
Hecker et al. (1980, 1983)
Forde et al. (1984)
Grimes (1987)
Maciolek et al. (1987a, b, c)
Williams (1988)
Schlee and Robb (2010)
Twichell and Roberts (2010)
Chaytor and Brothers (2011)
Kellog (2011)

BIOLOGICAL ENVIRONMENT

This dive ran along the west wall of Baltimore Canyon. This dive covered a variety of hard substrate habitat. Vertical rock walls, and large and small rocks provided substrate for a diversity of soft corals (e.g. *Paragorgia* sp.) and an abundant pink anemone (*Hormathia nodosa*) that covered rock surfaces. Consolidated sediment under a thin soft sediment layer provided habitat for extensive fields of the anemone *Halcurias pilatus*. Low relief rock with pocks and depressions supported anemones and soft corals as well as numerous mobile fauna including crabs, sea stars, sea urchins, skates, and other unidentifiable fish.

PHYSICAL ENVIRONMENT

This dive covered a northerly traverse along the west wall of Baltimore Canyon. The submersible reached bottom over soft sediment with shell hash and occasional rocks supporting anemones. The habitat transitioned into rock ledge habitat comprised of vertical rock and large rocks supporting large attached soft corals and low relief rock with pocks and depressions housing abundant attached and mobile fauna. At the end of the dive the terrain flattened into pavement with attached fauna, then to consolidated sediment habitat with a thin soft sediment veneer covered in*Halcurias pilatus*.

ADDITIONAL COMMENTS

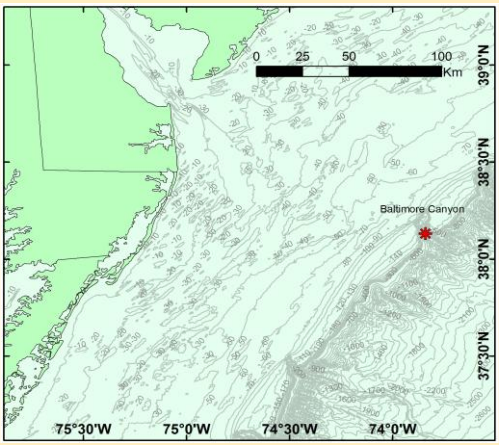
Original dives were likely on several Umatic tapes combined onto a VHS tape, then converted to digital media and stored on an external hard drive. Original Loran C navigation data were converted to latitude and longitude. Video quality was very poor with the entire dive being too out of focus to accurately identify invertebrate and fish taxa to genus and species. Ten reliable position fixes were taken along the dive, though two had the same coordinates, causing overlap on the map. However, habitat type could not be assigned to fixes as audio was not recorded with the video. Audio cues are necessary to align the time of the fixes with the video as no video overlay was present on the tape. Video footage is not continuous in many instances. Therefore, images A-D could not be assigned specific coordinates. Collections were taken of a pink *Paragorgia* sp., sea stars, and a crab.

DIVE NUMBER: JSLI-1084 *STUDY AREA: Baltimore Canyon*

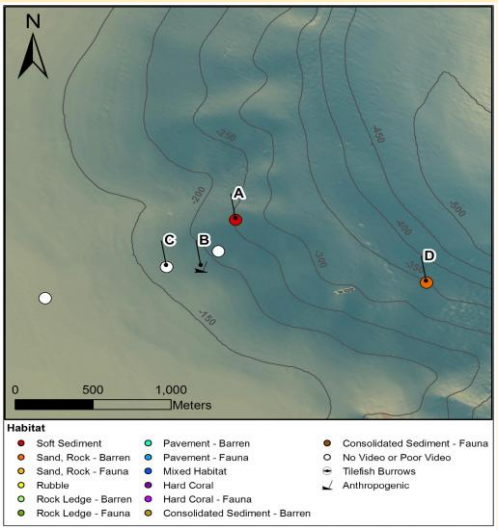
STATION OVERVIEW

Project	Canyon and Slope Processes Study
Principal investigators	B Hecker[1]
PI Contact Info[1]	Hecker Environmental Consulting, 26 Mullen Way, Falmouth, MA, 02540
Purpose	Assess and compare canyon and slope habitats in mid-Atlantic canyons
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	B Hecker (bow), G Carpenter (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	B Hecker, Minerals Management Service
SEADESC Analyst	M Watts
Date Compiled	4/6/2012
PI Station Number	

GENERAL LOCATION



Dive Track:



DIVE DATA

Date	02-Aug-81
Minimum Bottom Depth (m)	127
Maximum Bottom Depth (m)	330
Start Bottom Time (EDT)	15:58
End Bottom End (EDT)	18:16
Starting Latitude (N)	38° 10.400'
Starting Longitude (W)	73° 52.700'
Ending Latitude (N)	38° 10.050'
Ending Longitude (W)	73° 52.360'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Soft Substrate
38° 10.400' N, 73° 52.700' W

DIVE NUMBER: JSLI-1084 *STUDY AREA: Baltimore Canyon*

IMAGE GALLERY

*** indicates image position is approximated**

Image B: Artificial Substrate
38° 10.210' N, 73° 52.820' W

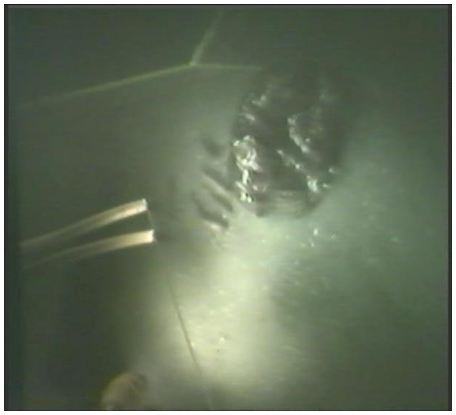


Image C: Sand/Rubble/Rock - Barren
38° 10.180' N, 73° 52.890' W

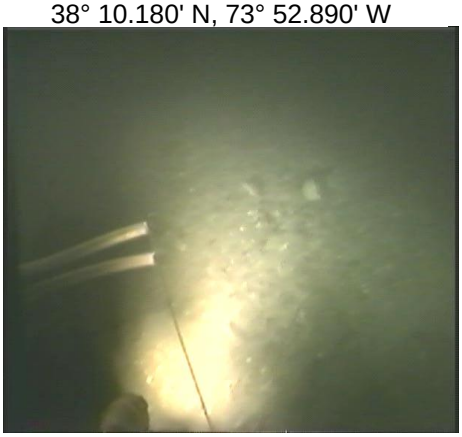
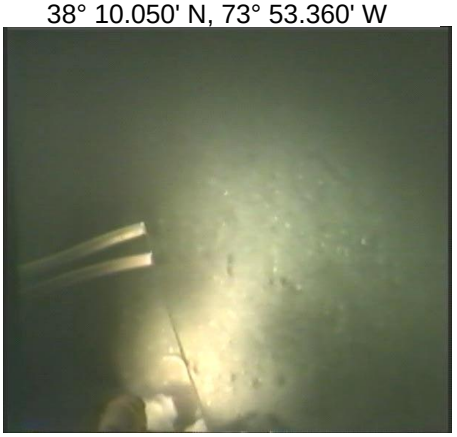


Image D: Sand/Rubble/Rock - Barren
38° 10.050' N, 73° 53.360' W



RELEVANT WORK AND/OR LITERATURE CITED

Drake et al. (1978)
Hecker et al. (1980, 1983)
Forde et al. (1984)
Grimes (1987)
Maciolek et al. (1987a, b, c)
Williams (1988)
Schlee and Robb (2010)
Twichell and Roberts (2010)
Chaytor and Brothers (2011)
Kellog (2011)

BIOLOGICAL ENVIRONMENT

This dive traversed a small area of the northwest corner of Baltimore Canyon. The soft sediment habitat contained regions with bioturbation such as pock marks and medium-sized burrows. Soft sediment habitat and soft sediment mixed with shell hash rubble supported fauna such *Cancer* , galatheid, and hermit crabs, sea stars (i.e. *Astropecten* sp.), an anemone (i.e. *Cerianthus* sp.), hagfish, and a spotted hake.

PHYSICAL ENVIRONMENT

This dive began at the outside margin of the northwest corner of Baltimore Canyon. The submersible reached bottom and conducted a westerly traverse across soft sediment habitat with pock marks and medium sized burrows before habitat type transitioned into soft sediment mixed with shell hash rubble. Depth changed little over the dive, remaining in the 200-250m range. No hard substrate was encountered except for a single crab pot shown in image B.

ADDITIONAL COMMENTS

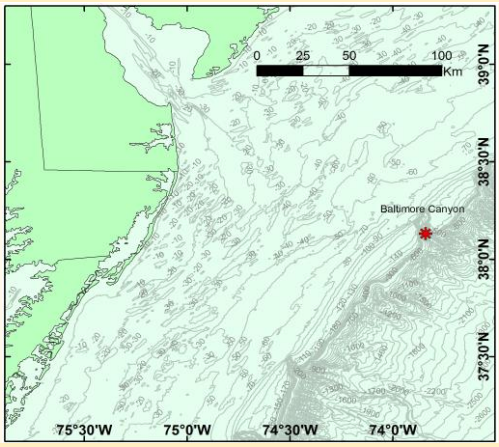
Original dives were likely on several Umatic tapes combined onto a VHS tape, then converted to digital media and stored on an external hard drive. Original Loran C navigation data were converted to latitude and longitude. Video quality was very poor with the entire dive being too out of focus to accurately identify invertebrate and fish taxa to genus and species. Seven reliable position fixes were taken along the dive. However, habitat type could only be assigned to three of the fixes as audio cues were necessary to align the time of the fixes with the video as no video overlay was present on the tape. Video footage is not continuous in many instances. A collection was taken of *Cerianthus* sp, and a sea star.

DIVE NUMBER: JSLI-1085 *STUDY AREA: Baltimore Canyon*

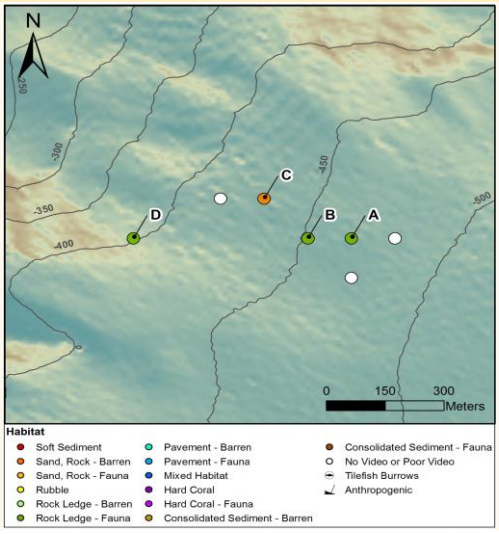
STATION OVERVIEW

Project	Canyon and Slope Processes Study
Principal investigators	B Hecker[1]
PI Contact Info[1]	Hecker Environmental Consulting, 26 Mullen Way, Falmouth, MA, 02540
Purpose	Assess and compare canyon and slope habitats in mid-Atlantic canyons
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	B Hecker (bow), E Forde (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	B Hecker, Minerals Management Service
SEADESC Analyst	M Watts
Date Compiled	4/13/2012
PI Station Number	

GENERAL LOCATION



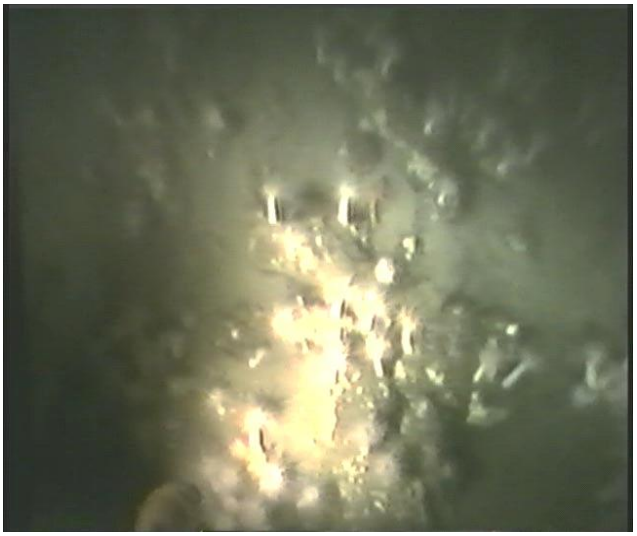
Dive Track:



DIVE DATA

Date	03-Aug-81
Minimum Bottom Depth (m)	195
Maximum Bottom Depth (m)	271
Start Bottom Time (EDT)	8:45
End Bottom End (EDT)	12:40
Starting Latitude (N)	38° 09.370'
Starting Longitude (W)	73° 51.470'
Ending Latitude (N)	38° 09.390'
Ending Longitude (W)	73° 51.800'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Rock Ledge - with Attached Fauna
38° 09.410' N, 73° 51.490' W



DIVE NUMBER: JSLI-1085 *STUDY AREA: Baltimore Canyon*

IMAGE GALLERY

*** indicates image position is approximated**

Image B: Rock Ledge - with Attached Fauna
38° 09.420' N, 73° 51.560' W

Image C: Sand/Rubble/Rock- with Attached Fauna
38° 09.470' N, 73° 51.590' W

Image D: Rock Ledge - with Attached Fauna
38° 09.400' N, 73° 51.780' W

RELEVANT WORK AND/OR LITERATURE CITED

Drake et al. (1978)
Hecker et al. (1980, 1983)
Forde et al. (1984)
Grimes (1987)
Maciolek et al. (1987a, b, c)
Williams (1988)
Schlee and Robb (2010)
Twichell and Roberts (2010)
Chaytor and Brothers (2011)
Kellog (2011)

BIOLOGICAL ENVIRONMENT

This dive ran upslope along the west wall of Baltimore Canyon. Rock slabs and boulders provided hard habitat for extensive fields of the white anemone, *Halcurias pilatus* interspersed with yellow sponge. Consolidated and unconsolidated sediment on and around the rock slabs provided habitat for numerous tilefish, galatheid crabs and *Bathynectes superba*, a lobster, sea stars, a sea urchin, conger eels, blackbelly rosefish, and huge aggregations of chain catsharks and hakes.

PHYSICAL ENVIRONMENT

This dive began at the central axis and moved to the west wall of Baltimore Canyon. The submersible reached bottom and conducted a westerly traverse upslope over rock and ledge habitat comprised of large rock slabs and small boulders with a layer of soft sediment covered in *Halcurias pilatus*. Undercut rock slabs provided hard habitat for numerous tilefish to burrow under and to which anemones and sponges could attach. Rock slabs appeared to have spilled down from upslope often forming piles of slabs. The peripheral margin of the rock slab/anemone fields was soft sediment habitat with small attached fauna.

ADDITIONAL COMMENTS

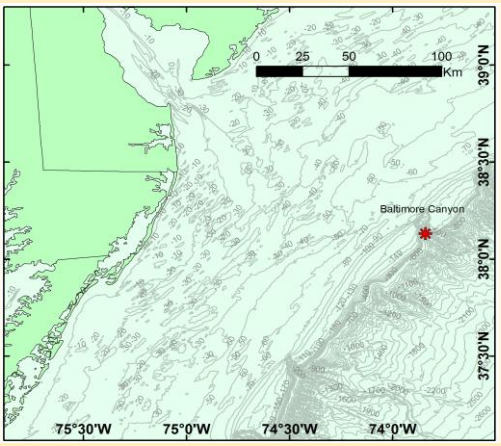
Original dives were likely on several Umatic tapes combined onto a VHS tape, then converted to digital media and stored on an external hard drive. Original Loran C navigation data were converted to latitude and longitude. Video quality was very poor with the entire dive being too out of focus to accurately identify most taxa to genus and species. Ten reliable position fixes were taken, though several had the same coordinates, causing overlap on the map. Habitat type could only be assigned to four of the fixes as audio cues were necessary to align the time of the fixes with the video as no video overlay was present on the tape. Video footage is not continuous in many instances. Collections were taken of *Halcurias pilatus*, three species of sea star and a sea urchin.

DIVE NUMBER: JSLI-1087 *STUDY AREA: Baltimore Canyon*

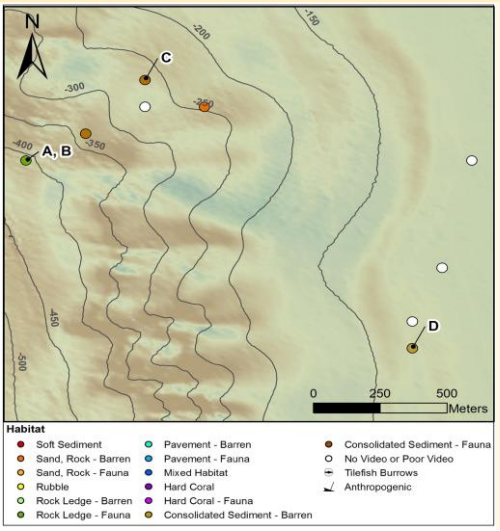
STATION OVERVIEW

Project	Canyon and Slope Processes Study
Principal investigators	B Hecker[1]
PI Contact Info[1]	Hecker Environmental Consulting, 26 Mullen Way, Falmouth, MA, 02540
Purpose	Assess and compare canyon and slope habitats in mid-Atlantic canyons
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	P Gibson (bow), G Carpenter (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	B Hecker, Minerals Management Service
SEADESC Analyst	M Watts
Date Compiled	4/18/2012
PI Station Number	

GENERAL LOCATION



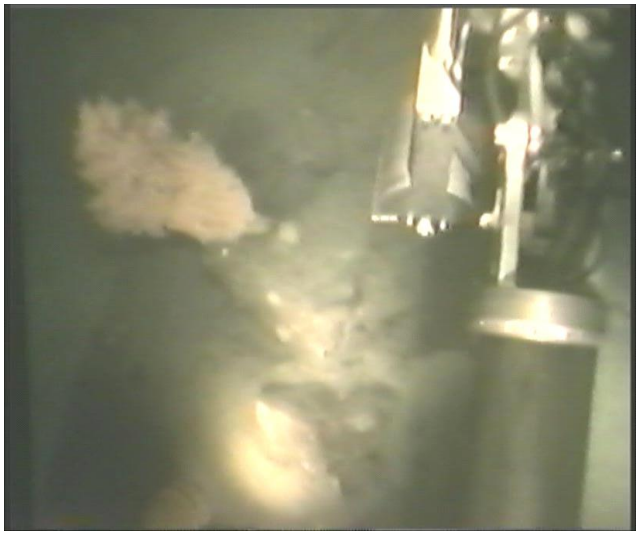
Dive Track:



DIVE DATA

Date	04-Aug-81
Minimum Bottom Depth (m)	192
Maximum Bottom Depth (m)	542
Start Bottom Time (EDT)	9:00
End Bottom End (EDT)	12:00
Starting Latitude (N)	38° 10.120'
Starting Longitude (W)	73° 50.220'
Ending Latitude (N)	38° 09.770'
Ending Longitude (W)	73° 49.460'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Rock Ledge - with Attached Fauna
38° 10.120' N, 73° 50.220' W



DIVE NUMBER: JSLI-1087 *STUDY AREA: Baltimore Canyon*

IMAGE GALLERY

*** indicates image position is approximated**

Image B: Rock Ledge - with Attached Fauna
38° 10.120' N, 73° 50.220' W

Image C: Consolidated Sediment - with Attached Fauna
38° 10.300' N, 73° 49.970' W

Image D: Consolidated Sediment - without Attached Fauna
38° 09.730' N, 73° 49.450' W

RELEVANT WORK AND/OR LITERATURE CITED

Drake et al. (1978)
Hecker et al. (1980, 1983)
Forde et al. (1984)
Grimes (1987)
Maciolek et al. (1987a, b, c)
Williams (1988)
Schlee and Robb (2010)
Twichell and Roberts (2010)
Chaytor and Brothers (2011)
Kellog (2011)

BIOLOGICAL ENVIRONMENT

This dive ran along northern Baltimore Canyon. Rock slabs and talus boulders provided hard habitat for a diversity of soft corals including multiple *Paragorgia* spp., *Acanthogorgia* sp., *Primnoa resedaeformis* and anemones such as *Halcurias pilatus*, *Actinoscyphia* sp., and sponges. Soft sediment habitat supported cerianthids, skates, hake, and a few *Cancer* crabs. Consolidated sediment with a thin veneer of soft sediment provided habitat for abundant *Halcurias pilatus*, cerianthids, galatheid crabs, *Cancer* crabs, a lobster, sea stars, an octopus, blackbelly rosefish, and rattail fish.

PHYSICAL ENVIRONMENT

This dive began at the northern extent of Baltimore Canyon in relatively shallow waters. The submersible reached bottom in rock, ledge habitat comprised of a wall of rock and small boulders with attached soft corals and anemones. The submersible progressed upslope past the rock ledge habitat into soft sediment with shell hash and occasional rocks with fauna before reaching consolidated sediment habitat covered with a thin layer of soft sediment with attached fauna such as *Halcurias pilatus*. As the submersible headed south, fauna became very sparse on the consolidated sediment and overlying sediment appeared as fine rock rubble.

ADDITIONAL COMMENTS

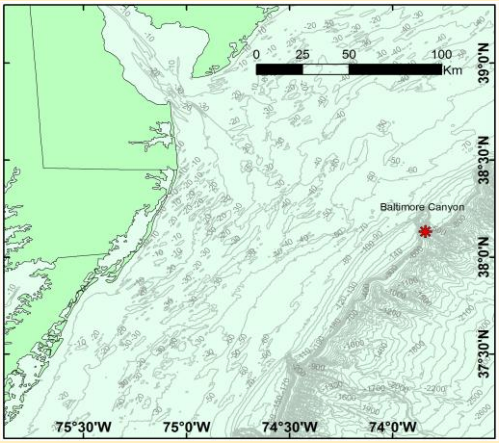
Original dives were likely on several Umatic tapes combined onto a VHS tape, then converted to digital media and stored on an external hard drive. Original Loran C navigation data were converted to latitude and longitude. Video quality was very poor with the entire dive being too out of focus to accurately identify invertebrate and fish taxa to genus and species. Eleven reliable position fixes were taken, though a few had the same coordinates, causing overlap on the map. Habitat type could only be assigned to five of the fixes as audio cues were necessary to align the time of the fixes with the video as no video overlay was present on the tape. Video footage is often not continuous. Collections were taken of a *Primnoa resedaeformis*, cerianthids, and a talus rock.

DIVE NUMBER: JSLI-1089 *STUDY AREA: Baltimore Canyon*

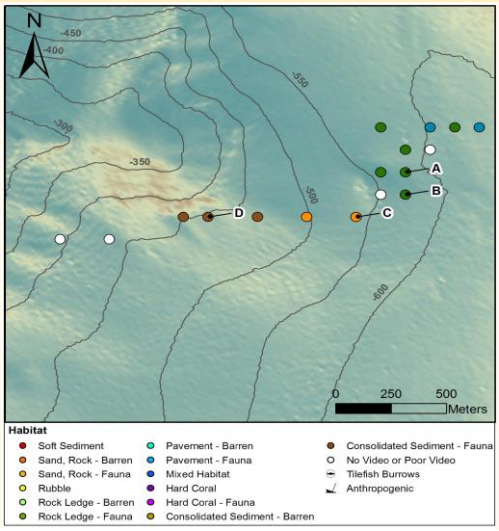
STATION OVERVIEW

Project	Canyon and Slope Processes Study
Principal investigators	B Hecker[1]
PI Contact Info[1]	Hecker Environmental Consulting, 26 Mullen Way, Falmouth, MA, 02540
Purpose	Assess and compare canyon and slope habitats in mid-Atlantic canyons
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	B Hecker (bow), R Embley (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	B Hecker, Minerals Management Service
SEADESC Analyst	M Watts
Date Compiled	4/25/2012
PI Station Number	

GENERAL LOCATION



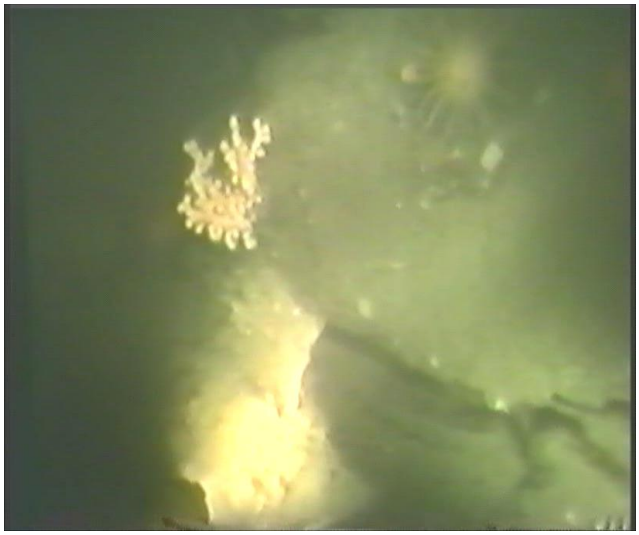
Dive Track:



DIVE DATA

Date	05-Aug-81
Minimum Bottom Depth (m)	195
Maximum Bottom Depth (m)	570
Start Bottom Time (EDT)	8:46
End Bottom End (EDT)	12:25
Starting Latitude (N)	38° 09.840'
Starting Longitude (W)	73° 50.780'
Ending Latitude (N)	38° 09.610'
Ending Longitude (W)	73° 51.630'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Rock Ledge - with Attached Fauna
38° 09.790' N, 73° 50.820' W



DIVE NUMBER: JSLI-1089 *STUDY AREA: Baltimore Canyon*

IMAGE GALLERY

*** indicates image position is approximated**

Image B: Rock Ledge - with Attached Fauna
38° 09.700' N, 73° 50.820' W

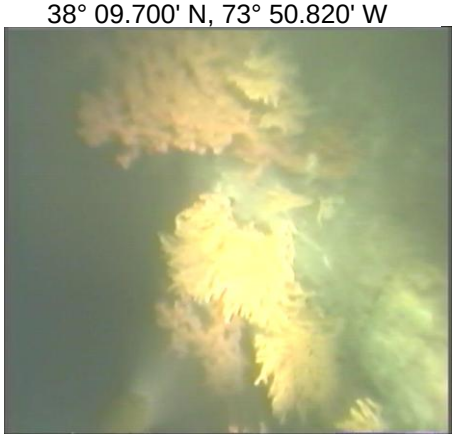


Image C: Sand/Rubble/Rock- with Attached Fauna
38° 09.680' N, 73° 50.950' W

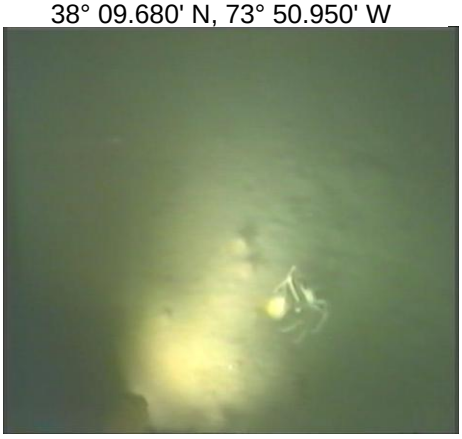


Image D: Consolidated Sediment - with Attached Fauna
38° 09.640' N, 73° 51.310' W

RELEVANT WORK AND/OR LITERATURE CITED

Drake et al. (1978)
Hecker et al. (1980, 1983)
Forde et al. (1984)
Grimes (1987)
Maciolek et al. (1987a, b, c)
Williams (1988)
Schlee and Robb (2010)
Twichell and Roberts (2010)
Chaytor and Brothers (2011)
Kellog (2011)

BIOLOGICAL ENVIRONMENT

This dive ran upslope from the center of Baltimore Canyon to the west slope. Hard rock substrate, consolidated, and unconsolidated sediment supported sessile fauna such as a diversity of soft corals and anemones including very large multiple *Paragorgia* spp., a *Eunephthya florida,* and *Primnoa resedaeformis*,, fields of the anemone, *Halcurias pilatus* , and tube-dwelling anemones (*Cerianthus borealis*), *Actinoscyphia* sp., *Bolocera tuediae*, and sponges as well as an encrusting polychaete attached to vertical rock faces. Mobile fauna included sting rays, hakes, hermit, galatheid, cancer, *Chaceon quinquedens*, and portunid (*Bathynectes longispina*) and lithodid crabs, a lobster, shrimp, numerous sea stars, a sea urchin, crinoids, basket stars, large scorpionfish, and a rattail fish.

PHYSICAL ENVIRONMENT

This dive began at the central axis of Baltimore Canyon in relatively shallow waters. The submersible reached bottom in pavement habitat of pocked/creviced rock with attached fauna. As the submersible moved westward rock pavement was interspersed with the dominant rock ledge habitat comprised of large boulders, cobbles, slabs, and walls of rock with attached soft corals and anemones. As the submersible moved upslope it traversed several rock walls and outcrops separated by regions of soft sediment with small cobble rocks, rubble, and shell hash with periodic large rocks and slabs. The habitat at the end of the dive consisted of consolidated sediment habitat, both low relief with burrows and vertical walls often with attached fauna such as anemones.

ADDITIONAL COMMENTS

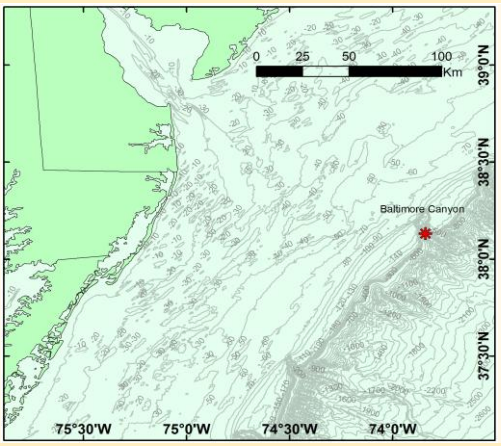
Original dives were likely on several Umatic tapes combined onto a VHS tape, then converted to digital media and stored on an external hard drive. Original Loran C navigation data were converted to latitude and longitude. Video quality was very poor with the entire dive being too out of focus to accurately identify invertebrate and fish taxa to genus and species. Twenty-one reliable position fixes were taken along the dive, though a few had the same coordinates, causing overlap on the map. Habitat type could only be assigned to seventeen of the fixes as audio cues were necessary to align the time of the fixes with the video as no video overlay was present on the tape. Video footage is not continuous in many instances. Collections were taken of rock samples and consolidated clay with a few attached anemones, seastars, a crinoid, a spider crab, and an *Eunephthya florida*.

DIVE NUMBER: JSLI-1090 *STUDY AREA: Baltimore Canyon*

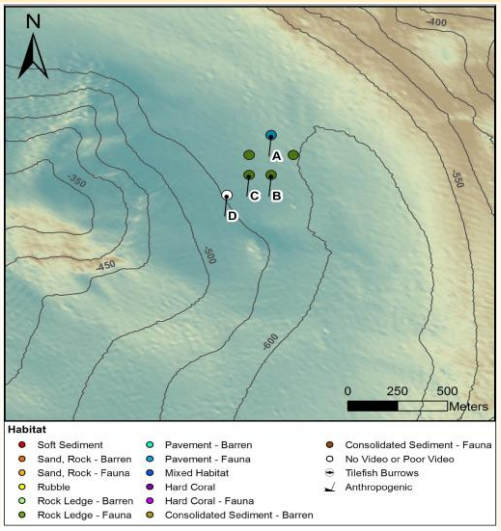
STATION OVERVIEW

Project	Canyon and Slope Processes Study
Principal investigators	B Hecker[1]
PI Contact Info[1]	Hecker Environmental Consulting, 26 Mullen Way, Falmouth, MA, 02540
Purpose	Assess and compare canyon and slope habitats in mid-Atlantic canyons
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	D Logan (bow), G Carpenter (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	B Hecker, Minerals Management Service
SEADESC Analyst	M Watts
Date Compiled	4/26/2012
PI Station Number	

GENERAL LOCATION



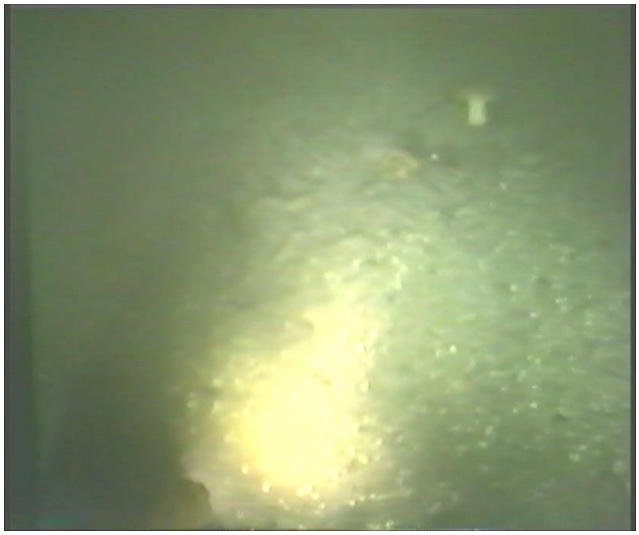
Dive Track:



DIVE DATA

Date	05-Aug-81
Minimum Bottom Depth (m)	403
Maximum Bottom Depth (m)	583
Start Bottom Time (EDT)	16:48
End Bottom End (EDT)	18:45
Starting Latitude (N)	38° 10.070'
Starting Longitude (W)	73° 50.860'
Ending Latitude (N)	38° 09.910'
Ending Longitude (W)	73° 50.980'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Pavement - Fauna
38° 10.070' N, 73° 50.860' W



DIVE NUMBER: JSLI-1090 *STUDY AREA: Baltimore Canyon*

IMAGE GALLERY

*** indicates image position is approximated**

Image B: Rock Ledge - with Attached Fauna
38° 09.940' N, 73° 50.900' W

Image C: Rock Ledge - with Attached Fauna
38° 09.930' N, 73° 50.940' W

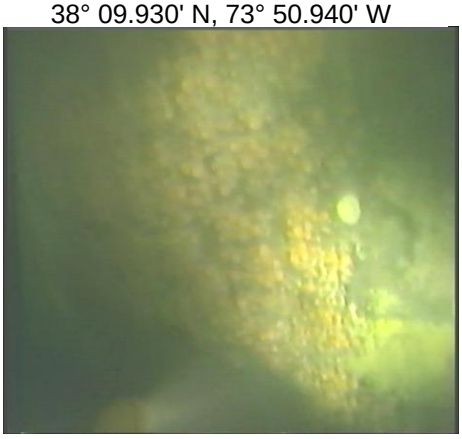


Image D: Rock Ledge - with Attached Fauna
38° 09.910' N, 73° 50.980' W

RELEVANT WORK AND/OR LITERATURE CITED

Drake et al. (1978)
Hecker et al. (1980, 1983)
Forde et al. (1984)
Grimes (1987)
Maciolek et al. (1987a, b, c)
Williams (1988)
Schlee and Robb (2010)
Twichell and Roberts (2010)
Chaytor and Brothers (2011)
Kellog (2011)

BIOLOGICAL ENVIRONMENT

This dive traversed the west wall of Baltimore Canyon in a long continuous transect. Hard rock substrate of the canyon wall supported sessile fauna such as a diversity of soft corals and anemones including the most dominate and very large *Paragorgia* spp., *Acanthogorgia* sp., *Primnoa resedaeformis*, abundant anemones such as *Bolocera tuediae*, *Actinoscyphia* sp., and *Hormathia nodosa* and an encrusting sponge covering a vertical rock face. Mobile fauna included sting rays, very large hakes, hermit and *Chaceon quinquedens*, shrimp, numerous sea stars, and a sea urchin.

PHYSICAL ENVIRONMENT

This dive began at the base of the west wall of Baltimore Canyon. The submersible reached bottom in pavement habitat of pocked/creviced rock with shell hash and attached fauna. The entire dive consisted of a long traverse upslope along the west wall of the canyon. The habitat was rock ledge habitat comprised of a cascade of large boulders, cobbles, slabs, and vertical walls of rock with abundant attached fauna such as soft corals and anemones. Additionally, the piles of rock contained large chunks of dead soft coral rubble, discernible as sediment covered horizontal coral stalks.

ADDITIONAL COMMENTS

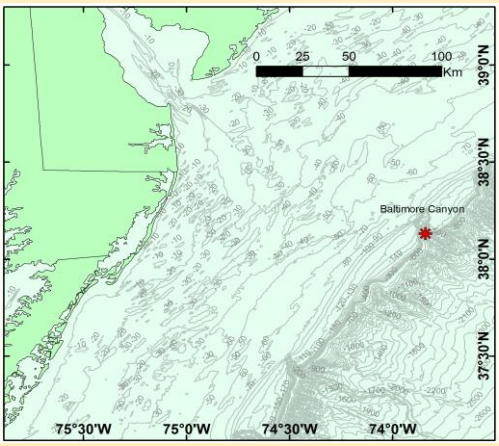
Original dives were likely on several Umatic tapes combined onto a VHS tape, then converted to digital media and stored on an external hard drive. Original Loran C navigation data were converted to latitude and longitude. Video quality was very poor with the entire dive being too out of focus to accurately identify invertebrate and fish taxa to genus and species. Nine reliable position fixes were taken along the dive, though a few had the same coordinates, causing overlap on the map. Habitat type could only be assigned to eight of the fixes as audio cues were necessary to align the time of the fixes with the video as no video overlay was present on the tape. Video footage is not continuous in many instances. Collections were taken of multiple rock samples, red and white *Paragorgia* spp., *Primnoa resedaeformis*, a *Acanthogorgia* sp., a sea star, and a sea urchin.

DIVE NUMBER: JSLI-1427 *STUDY AREA: Baltimore Canyon*

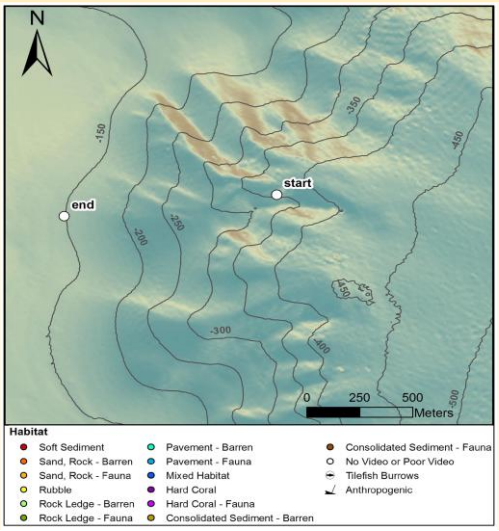
STATION OVERVIEW

Project	Tilefish Assessment
Principal investigators	CB Grimes[1] KW Able, RS Jones, DC Twichell, SC Turner
PI Contact Info[1]	Southwest Fisheries Science Center, Fisheries Ecology Division, 110 Shaffer Rd, Santa Cruz, CA 95060
Purpose	Investigation of tilefish fishery on the middle Atlantic and southern New England continental shelf
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	C Grimes (bow), M Crawford (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	K Able, Mid-Atlantic Fishery Management Council
SEADESC Analyst	M Watts
Date Compiled	6/28/2012
PI Station Number	

GENERAL LOCATION



Dive Track:



DIVE DATA

Date	17-Aug-83
Minimum Bottom Depth (m)	114
Maximum Bottom Depth (m)	325
Start Bottom Time (EDT)	8:24
End Bottom End (EDT)	11:25
Starting Latitude (N)	38° 09.310'
Starting Longitude (W)	73° 52.02'
Ending Latitude (N)	38° 09.360'
Ending Longitude (W)	73° 52.56'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Rock Ledge - with Attached Fauna

DIVE NUMBER: JSLI-1427 *STUDY AREA: Baltimore Canyon*

IMAGE GALLERY *** indicates image position is approximated**

Image B: Consolidated Sediment - without Attached Fauna

Image C: Rock Ledge - with Attached Fauna

Image D: Rock Ledge - with Attached Fauna

RELEVANT WORK AND/OR LITERATURE CITED

Drake et al. (1978)
Hecker et al. (1980, 1983)
Forde et al. (1984)
Grimes (1987)
Maciolek et al. (1987a, b, c)
Williams (1988)
Schlee and Robb (2010)
Twichell and Roberts (2010)
Chaytor and Brothers (2011)
Kellog (2011)

BIOLOGICAL ENVIRONMENT

This dive traversed the west side of Baltimore Canyon. Rock ledges and slabs supported extensive fields of the anemone *Halcurias pilatus* and occasional venus flytrap anemones, an abundance of sponge species, and golden tilefish with burrows excavated below rock ledges. Shell hash rubble habitat supported a few brisinigid sea stars. Other mobile fauna included *Bathynectes superba* and galatheid crabs, hakes, scorpionfish (e.g. blackbelly rosefish), chain catsharks, and a hammerhead shark.

PHYSICAL ENVIRONMENT

This dive traversed the west side of Baltimore Canyon moving from the center of the canyon upslope. The submersible first covered low lying talus rock ledge and broken slab habitat with fields of the anemone *Halcurias pilatus,* surrounded by soft sediment. Rock ledges were often undercut with burrow excavations in the soft sediment below. The dive progressed to a heavily burrowed vertical wall that appeared to be consolidated clay. As the submersible moved upslope the habitat transitioned into heavily pocked rock shelves and consolidated mud habitat with significant bioerosion. The end of the dive revealed more rock slabs with anemone fields attached before ending in bivalve shell hash rubble habitat with occasional boulders.

ADDITIONAL COMMENTS

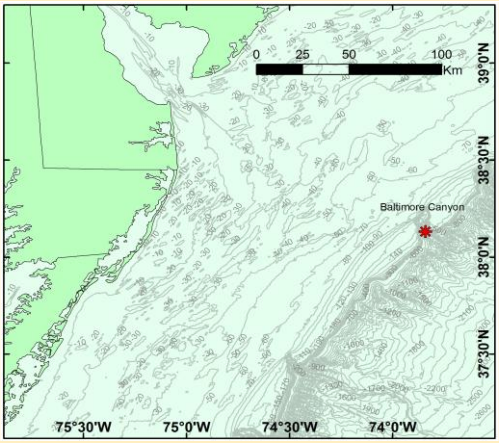
Original dives were on U-matic tapes, then converted to digital media and stored on an external hard drive. Video quality was clear overall. Only two position fixes were taken, at the start and end of the dive. Habitat type could not be assigned to the fixes as no audio cues were recorded for any portion of the dive to align the time of the fixes with the video as no video overlay was present on the tape. Video footage was not continuous. Therefore, images A-D could not be assigned specific coordinates. Collections were not observed on the video footage but the dive logs mention two sediment grabs.

DIVE NUMBER: JSLI-1428 *STUDY AREA: Baltimore Canyon*

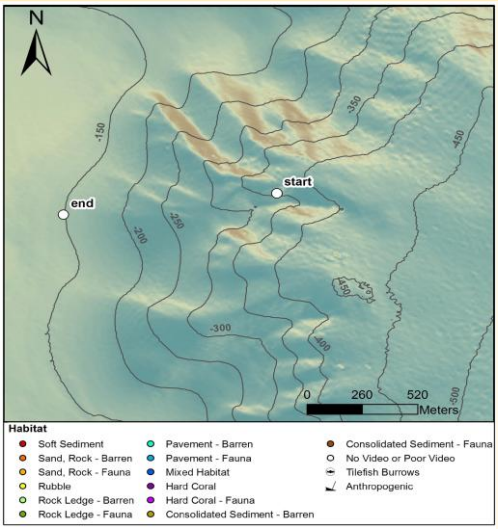
STATION OVERVIEW

Project	Tilefish Assessment
Principal investigators	CB Grimes[1] KW Able, RS Jones, DC Twichell, SC Turner
PI Contact Info[1]	Southwest Fisheries Science Center, Fisheries Ecology Division, 110 Shaffer Rd, Santa Cruz, CA 95060
Purpose	Investigation of tilefish fishery on the middle Atlantic and southern New England continental shelf
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	R Jones (bow), S Turner (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	K Able, Mid-Atlantic Fishery Management Council
SEADESC Analyst	M Watts
Date Compiled	6/28/2012
PI Station Number	

GENERAL LOCATION



Dive Track:



DIVE DATA

Date	17-Aug-83
Minimum Bottom Depth (m)	
Maximum Bottom Depth (m)	
Start Bottom Time (EDT)	16:03
End Bottom End (EDT)	
Starting Latitude (N)	38° 09.300'
Starting Longitude (W)	73° 52.020'
Ending Latitude (N)	38° 09.240'
Ending Longitude (W)	73° 52.560'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Rock Ledge - with Attached Fauna

DIVE NUMBER: JSLI-1428 *STUDY AREA: Baltimore Canyon*

IMAGE GALLERY *** indicates image position is approximated**

Image B: Tilefish Habitat **Image C: Artificial Substrate** **Image D: Soft Substrate**

RELEVANT WORK AND/OR LITERATURE CITED

Drake et al. (1978)
Hecker et al. (1980, 1983)
Forde et al. (1984)
Grimes (1987)
Maciolek et al. (1987a, b, c)
Williams (1988)
Schlee and Robb (2010)
Twichell and Roberts (2010)
Chaytor and Brothers (2011)
Kellog (2011)

BIOLOGICAL ENVIRONMENT

This dive traversed the west side of Baltimore Canyon. Soft sediment habitat supported a golden tilefish burrow, an abundance of *Cancer* crabs, long-antennaed shrimp, hakes, a spotted flounder, and an American lobster. Occasional large rocks supported the anemone *Halcurias pilatus*, sponges and a few cup corals.

PHYSICAL ENVIRONMENT

This dive traversed the west edge of Baltimore Canyon moving from the center of the canyon upslope. The submersible covered primarily soft sediment habitat without attached fauna except for an occasional isolated rock with numerous *Halcurias pilatus.* Only one tilefish burrow was encountered. At the end of the dive, the soft sediment habitat exhibited numerous mounds and depressions.

ADDITIONAL COMMENTS

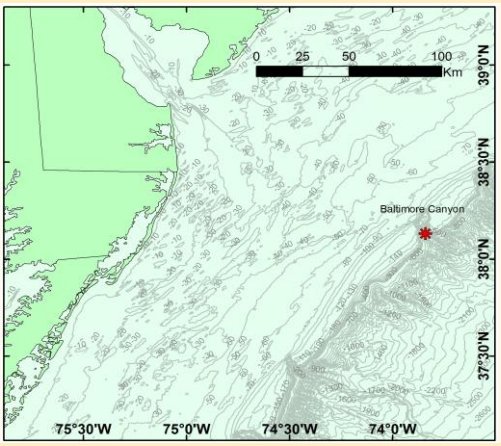
Original dives were on U-matic tapes, then converted to digital media and stored on an external hard drive. Video quality was clear overall. Only two position fixes were taken, at the start and end of the dive. Habitat type could not be assigned to the fixes as no audio cues were recorded for any portion of the dive to align the time of the fixes with the video as no video overlay was present on the tape. Video footage is not continuous. Therefore, images A-D could not be assigned specific coordinates. A sediment sample was taken and the collection of a shrimp was attempted.

DIVE NUMBER: JSLI-1969 *STUDY AREA: Baltimore Canyon*

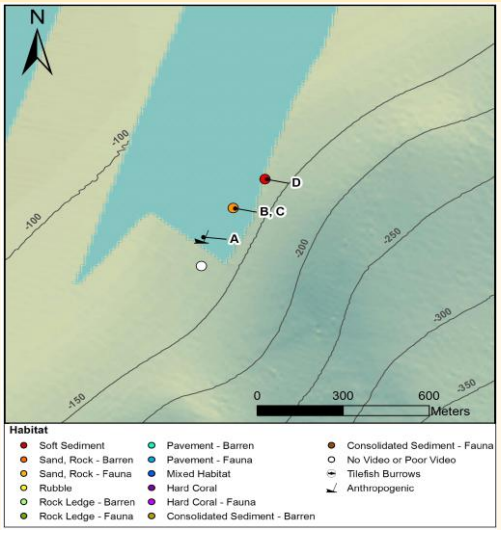
STATION OVERVIEW

Project	Ocean Dumping Impact Assessment
Principal investigators	RA Cooper[1] (deceased)
PI Contact Info[1]	University of Connecticut at Avery Point, Groton, CT 06340
Purpose	Assess the impact of sewage sludge dumping in canyons off New England and Mid-Atlantic Bight States
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	L Stewart (bow), M Feeley (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	R Cooper, I Babb, P Auster, R Cooper, I Babb, P Auster, NURC-UCAP
SEADESC Analyst	M Watts
Date Compiled	5/2/2012
PI Station Number	

GENERAL LOCATION



Dive Track:



DIVE DATA

Date	05-Jun-90
Minimum Bottom Depth (m)	193
Maximum Bottom Depth (m)	214
Start Bottom Time (EDT)	13:18
End Bottom End (EDT)	16:35
Starting Latitude (N)	38° 12.560'
Starting Longitude (W)	73° 52.310'
Ending Latitude (N)	38° 12.690'
Ending Longitude (W)	73° 52.170'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Artificial Substrate
38° 12.580' N, 73° 52.330' W

DIVE NUMBER: JSLI-1969 *STUDY AREA: Baltimore Canyon*

IMAGE GALLERY

*** indicates image position is approximated**

Image B: Sand/Rubble/Rock- without Attached Fauna
38° 12.630' N, 73° 52.280' W

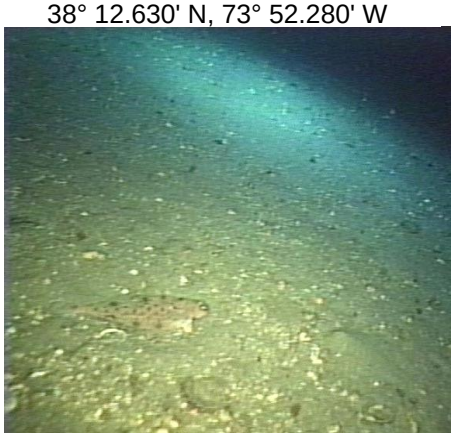


Image C: Sand/Rubble/Rock- with Attached Fauna
38° 12.630' N, 73° 52.280' W

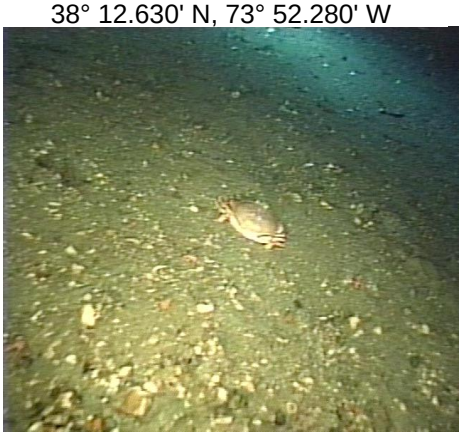


Image D: Soft Substrate
38° 12.690' N, 73° 52.170' W

RELEVANT WORK AND/OR LITERATURE CITED

Drake et al. (1978)
Hecker et al. (1980, 1983)
Forde et al. (1984)
Grimes (1987)
Maciolek et al. (1987a, b, c)
Williams (1988)
Schlee and Robb (2010)
Twichell and Roberts (2010)
Chaytor and Brothers (2011)
Kellog (2011)

BIOLOGICAL ENVIRONMENT

This dive traversed the northwest corner of Baltimore Canyon. Soft substrate with shell hash and pebbles did not support any attached fauna except a single burrowing anemone and a sea pen. Mobile fauna included Torbay soles, *Cancer borealis*, hakes, blackbelly rosefish, small galatheids and hermit crabs, sea stars (including an abundant light pink species), lizardfish, a blenny, and an eel.

PHYSICAL ENVIRONMENT

This dive traversed soft sediment habitat to the northwest extent of Baltimore Canyon. The submersible reached bottom in coarse soft sediment habitat with bivalve shell hash and occasional small rocks and pebbles with no attached fauna. Soft sediment with shell hash was the dominant habitat until the last 5 minutes of the dive when the habitat transitioned into soft sediment without the shell hash and small pebbles. A lobster trap and Tucker trawl net were also found on the dive. No hard substrate was encountered during this dive.

ADDITIONAL COMMENTS

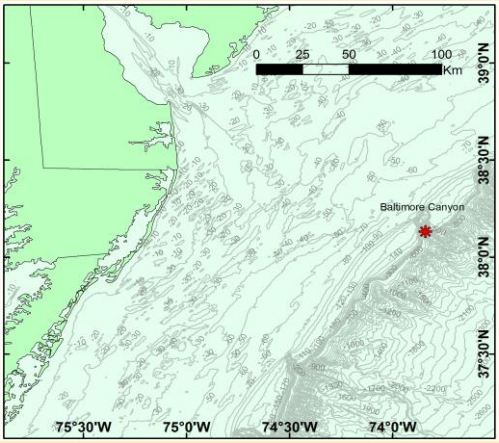
Original dives were on 8mm tapes, then converted to digital media and stored on an external hard drive. Video quality was clear overall. Four reliable position fixes were taken along the dive. Habitat type could be assigned to three of the fixes as audio cues were necessary to align the time of the fixes with the video as no video overlay was present on the tape. Video footage is not continuous in many instances. Suction samples and boxcores were taken for sediment samples but no macrofauna were collected.

DIVE NUMBER: JSLI-1970 *STUDY AREA: Baltimore Canyon*

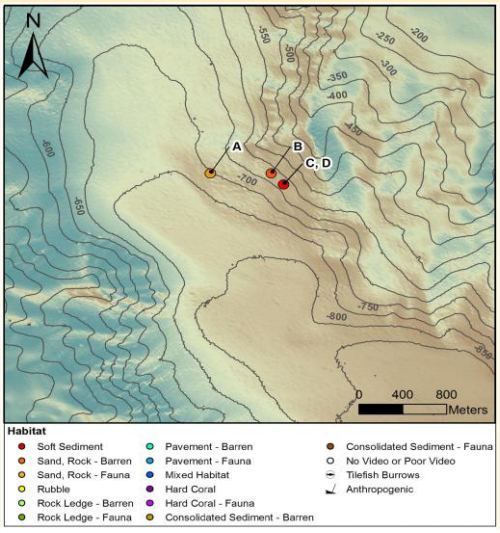
STATION OVERVIEW

Project	Ocean Dumping Impact Assessment
Principal investigators	RA Cooper[1] (deceased)
PI Contact Info[1]	University of Connecticut at Avery Point, Groton, CT 06340
Purpose	Assess the impact of sewage sludge dumping in canyons off New England and Mid-Atlantic Bight States
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	J Baker (bow), K Jessen (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	R Cooper, I Babb, P Auster, R Cooper, I Babb, P Auster, NURC-UCAP
SEADESC Analyst	M Watts
Date Compiled	5/4/2012
PI Station Number	

GENERAL LOCATION



Dive Track:



DIVE DATA

Date	07-Jun-90
Minimum Bottom Depth (m)	534
Maximum Bottom Depth (m)	615
Start Bottom Time (EDT)	13:51
End Bottom End (EDT)	15:55
Starting Latitude (N)	38° 07.780'
Starting Longitude (W)	73° 50.430'
Ending Latitude (N)	38° 07.710'
Ending Longitude (W)	73° 50.090'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Sand/Rubble/Rock- with Attached Fauna

38° 07.780' N, 73° 50.430' W

DIVE NUMBER: JSLI-1970 *STUDY AREA: Baltimore Canyon*

IMAGE GALLERY

*** indicates image position is approximated**

Image B: Sand/Rubble/Rock-without Attached Fauna
38° 07.810' N, 73° 50.130' W

Image C: Soft Substrate
38° 07.710' N, 73° 50.090' W

Image D: Soft Substrate
38° 07.710' N, 73° 50.090' W

RELEVANT WORK AND/OR LITERATURE CITED

Drake et al. (1978)
Hecker et al. (1980, 1983)
Forde et al. (1984)
Grimes (1987)
Maciolek et al. (1987a, b, c)
Williams (1988)
Schlee and Robb (2010)
Twichell and Roberts (2010)
Chaytor and Brothers (2011)
Kellog (2011)

BIOLOGICAL ENVIRONMENT

This dive traversed the northwest corner of Baltimore Canyon. Soft substrate with rock rubble overlaying rocks and slabs did not support any attached fauna except sparse small sea pens and venus flytrap anemones or a rare sponge on an isolated exposed rock. Small tubeworms with white tubes were found in the soft sediment habitat only. *Chaceon quinquedens* burrows and excavations were common in soft sediment below the exposed edges of rocks or slabs. Mobile fauna included abundant swarms of synaphobranchid eels, red crabs, hermit crabs, rattail fish with parasitic isopods, flounder, longfin hakes, a few lizardfish and a blackbelly rosefish.

PHYSICAL ENVIRONMENT

This dive traversed soft sediment habitat from the center of the canyon up the base of the east slope of Baltimore Canyon. The submersible reached bottom in an area with inches of coarse soft sediment habitat with rock rubble overlaying rocks and small slabs. This soft sediment, rubble and rock habitat supported little to no attached fauna. Box cores could not be taken in this habitat due to the rocks below the sediment surface. Occasionally, rocks and slabs were exposed below the sediment from red crab excavations to make small burrows. This habitat continued for the first half of the dive before it transitioned into deep soft sediment habitat without underlying rock that supported only small tubeworms.

ADDITIONAL COMMENTS

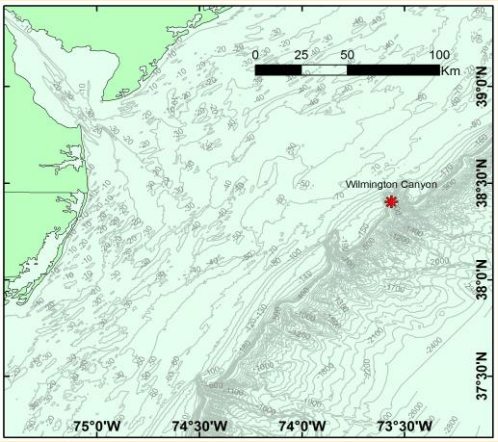
Original dives were on 8-mm tapes, then converted to digital media and stored on an external hard drive. Video quality was clear overall. Three reliable position fixes were taken along the dive. Habitat type could be assigned to all three of the fixes as audio cues were available to align the time of the fixes with the video as no video overlay was present on the tape. Video footage was continuous. Suction samples and boxcores were taken for sediment samples but no macrofauna were collected.

DIVE NUMBER: JSLI-1971 *STUDY AREA: Wilmington Canyon*

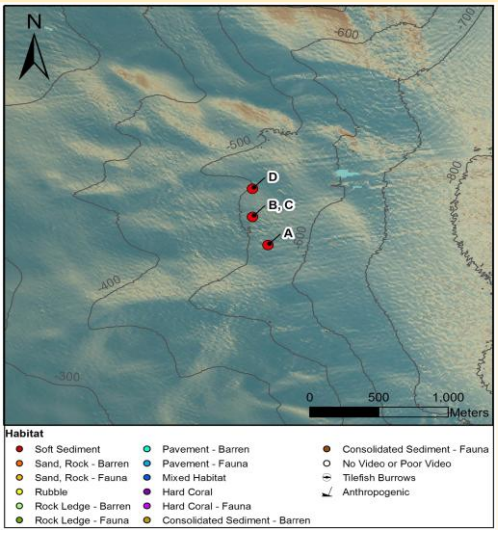
STATION OVERVIEW

Project	Ocean Dumping Impact Assessment
Principal investigators	RA Cooper[1] (deceased)
PI Contact Info[1]	University of Connecticut at Avery Point, Groton, CT 06340
Purpose	Assess the impact of sewage sludge dumping in canyons off New England and Mid-Atlantic Bight States
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	T Sawyer (bow), N Worobey (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	R Cooper, I Babb, P Auster, NURC-UCAP
SEADESC Analyst	M Watts
Date Compiled	7/27/2012
PI Station Number	

GENERAL LOCATION



Dive Track:



DIVE DATA

Date	07-Jun-90
Minimum Bottom Depth (m)	594
Maximum Bottom Depth (m)	538
Start Bottom Time (EDT)	20:14
End Bottom End (EDT)	21:15
Starting Latitude (N)	38° 24.130'
Starting Longitude (W)	73° 33.860'
Ending Latitude (N)	38° 24.370'
Ending Longitude (W)	73° 33.910'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Soft Substrate
38° 24.130' N, 73° 33.860' W

DIVE NUMBER: JSLI-1971 *STUDY AREA: Wilmington Canyon*

IMAGE GALLERY

*** indicates image position is approximated**

Image B: Soft Substrate
38° 24.240' N, 73° 33.870' W

Image C: Soft Substrate
38° 24.240' N, 73° 33.870' W

Image D: Soft Substrate
38° 24.370' N, 73° 33.910' W

RELEVANT WORK AND/OR LITERATURE CITED

Stanley and Fenner (1973)
Church et al. (1984)
Forde et al. (1984)
Grimes (1987)
Michell (2004)
McGregor et al. (2010)
Schlee and Robb (2010)
Stubblefield et al. (2010)
Chaytor and Brothers (2011)

BIOLOGICAL ENVIRONMENT

This dive covered part of the northwest corner of Wilmington Canyon. Soft sediment substrate supported only mobile macrofauna including *Chaceon quinquedens*, red shrimp, pink anemones, *Nezumia* sp., synaphobranchid eels, longfin hake, chain catsharks, and flounders.

PHYSICAL ENVIRONMENT

This dive covered part of the northwest corner of Wilmington Canyon. The submersible traversed soft sediment habitat with occasional evidence of significant bioturbation in the form of burrows and small mounds.

ADDITIONAL COMMENTS

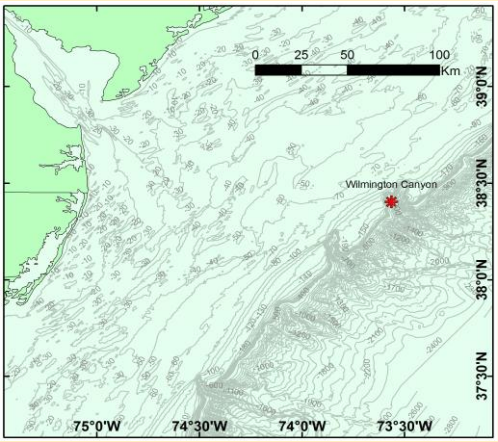
Original dives were on 8-mm tapes, then converted to digital media and stored on an external hard drive. Video quality was clear overall. Three reliable position fixes were taken along the dive. Habitat type could be assigned to all three of the fixes as the bottom time was evident and the video tape continuous. Audio was not recorded on the original 8-mm tapes. No samples were collected during video footage, though the dive log reports the collection of a bivalve, two lanternfish, one amphipod, and worms from a "bag suction."

DIVE NUMBER: JSLI-1983 *STUDY AREA: Wilmington Canyon*

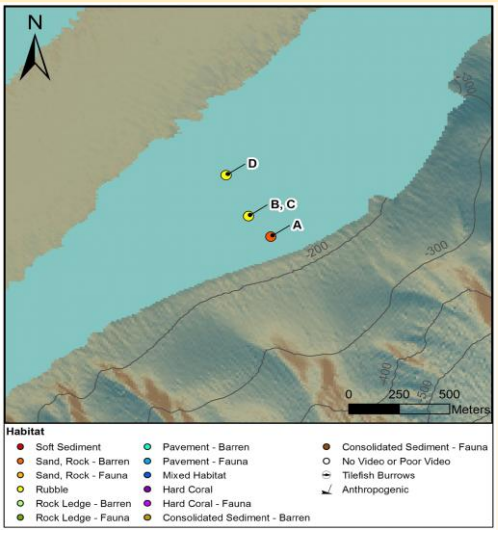
STATION OVERVIEW

Project	Ocean Dumping Impact Assessment
Principal investigators	RA Cooper[1] (deceased)
PI Contact Info[1]	University of Connecticut at Avery Point, Groton, CT 06340
Purpose	Assess the impact of sewage sludge dumping in canyons off New England and Mid-Atlantic Bight States
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	J Gaines (bow), G Small (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	R Cooper, I Babb, P Auster, NURC-UCAP
SEADESC Analyst	M Watts
Date Compiled	8/3/2012
PI Station Number	

GENERAL LOCATION



Dive Track:

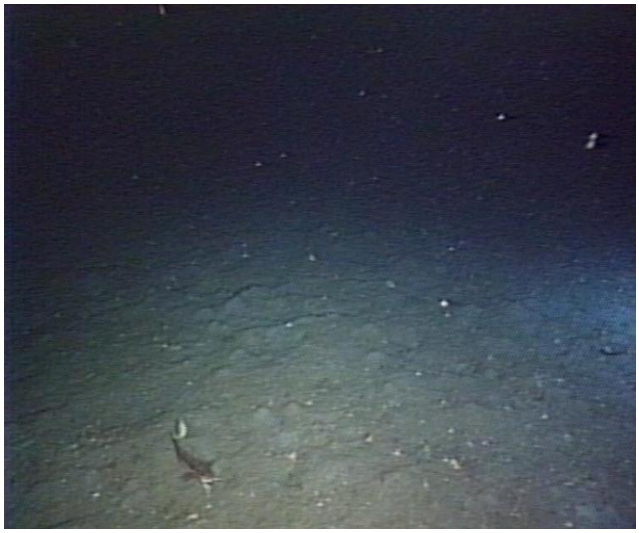


DIVE DATA

Date	12-Jun-90
Minimum Bottom Depth (m)	148
Maximum Bottom Depth (m)	175
Start Bottom Time (EDT)	8:36
End Bottom End (EDT)	10:55
Starting Latitude (N)	38° 26.540'
Starting Longitude (W)	73° 32.940'
Ending Latitude (N)	38° 26.680'
Ending Longitude (W)	73° 33.060'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Sand/Rubble/Rock- without Attached Fauna

38° 26.540' N, 73° 32.940' W



DIVE NUMBER: JSLI-1983 *STUDY AREA: Wilmington Canyon*

IMAGE GALLERY

*** indicates image position is approximated**

Image B: Rubble
38° 26.600' N, 73° 33.010' W

Image C: Rubble
38° 26.600' N, 73° 33.010' W

Image D: Rubble
38° 26.680' N, 73° 33.060' W

RELEVANT WORK AND/OR LITERATURE CITED

Stanley and Fenner (1973)
Church et al. (1984)
Forde et al. (1984)
Grimes (1987)
Michell (2004)
McGregor et al. (2010)
Schlee and Robb (2010)
Stubblefield et al. (2010)
Chaytor and Brothers (2011)

BIOLOGICAL ENVIRONMENT

This dive covered part of the northern slope of Wilmington Canyon. Soft sediment substrate supported only mobile macrofauna including abundant red, long-armed sea stars, longfin hake, and flounder as well as a skate, a synaphobranchid eel, a *Cancer* and a hermit crab, a bat sea star, and an unidentified shark.

PHYSICAL ENVIRONMENT

This dive covered part of the shallow northern slope of Wilmington Canyon. The submersible traversed barren soft sediment with shell hash and small rocks before the habitat transitioned into rubble habitat. Both habitats occasionally showed evidence of bioturbation in the form of burrows or small mounds.

ADDITIONAL COMMENTS

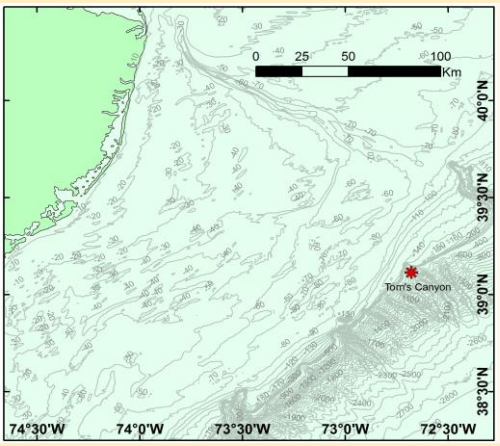
Original dives were on 8-mm tapes, then converted to digital media and stored on an external hard drive. Video quality was clear overall. Three reliable fixes were taken along the dive. Habitat type could be assigned to all three of the fixes as the bottom time was evident and the video tape continuous. Sediment samples were collected.

DIVE NUMBER: JSLI-1972 *STUDY AREA: Tom's Canyon*

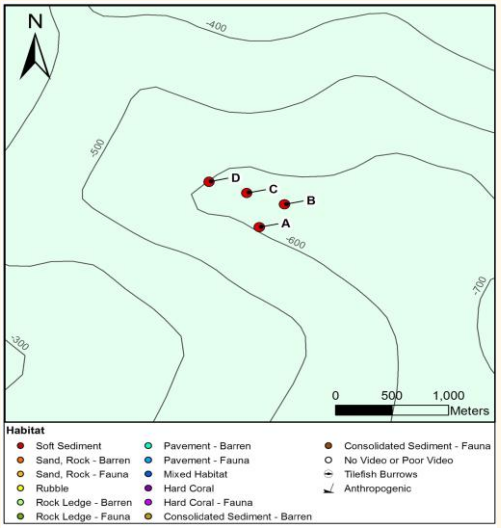
STATION OVERVIEW

Project	Ocean Dumping Impact Assessment
Principal investigators	RA Cooper[1] (deceased)
PI Contact Info[1]	University of Connecticut at Avery Point, Groton, CT 06340
Purpose	Assess the impact of sewage sludge dumping in canyons off New England and Mid-Atlantic Bight States
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	B Bullis (bow), K Harrica (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	R Cooper, I Babb, P Auster, NURC-UCAP
SEADESC Analyst	M Watts
Date Compiled	8/9/2012
PI Station Number	

GENERAL LOCATION



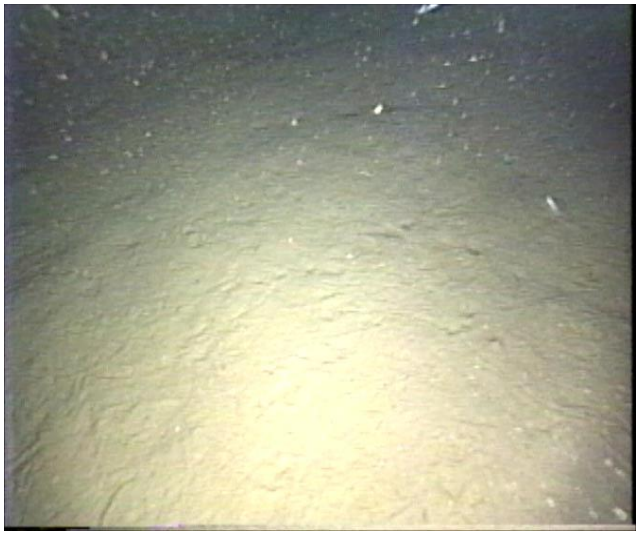
Dive Track:



DIVE DATA

Date	08-Jun-90
Minimum Bottom Depth (m)	664
Maximum Bottom Depth (m)	683
Start Bottom Time (EDT)	8:36
End Bottom End (EDT)	10:32
Starting Latitude (N)	39° 06.580'
Starting Longitude (W)	72° 40.670'
Ending Latitude (N)	39° 06.850'
Ending Longitude (W)	72° 40.930'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Soft Substrate
39° 06.580' N, 72° 40.670' W



DIVE NUMBER: JSLI-1972 *STUDY AREA: Tom's Canyon*

IMAGE GALLERY

*** indicates image position is approximated**

Image B: Soft Substrate
39° 06.690' N, 72° 40.580' W

Image C: Soft Substrate
39° 06.760' N, 72° 40.750' W

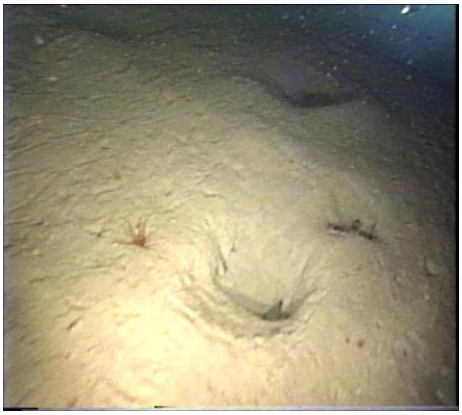


Image D: Soft Substrate
39° 06.850' N, 72° 40.930' W

RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Rowe et al. (1982)
Twitchell and Roberts (1982)
Forde et al. (1984)
Robb and Hampson (1987)
Watling and Auster (2005)

BIOLOGICAL ENVIRONMENT

This dive traversed part of Tom's Canyon. Soft sediment substrate supported only mobile macrofauna including a hermit crab, *Chaceon quinquedens*, *Nezumia* sp., synaphobranchid eels, longfin hakes, chain catsharks, and flounders.

PHYSICAL ENVIRONMENT

This dive covered part of Tom's Canyon. The submersible traversed soft sediment habitat exclusively with evidence of significant bioturbation in the form of burrows and small mounds.

ADDITIONAL COMMENTS

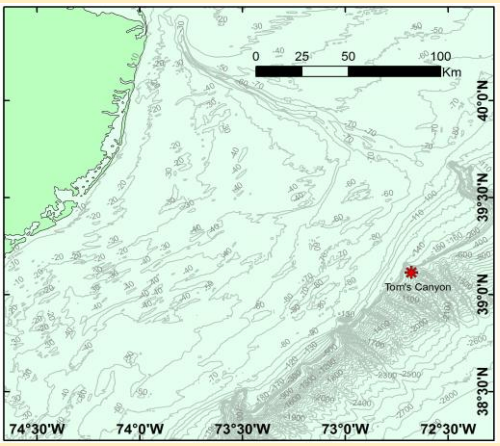
Original dives were on 8-mm tapes, then converted to digital media and stored on an external hard drive. Video quality was clear overall. Four reliable position fixes were taken along the dive. Habitat type could be assigned to all four of the fixes as the bottom time was evident and the video tape continuous. Sediment core samples were taken during video footage.

DIVE NUMBER: JSLI-1974 *STUDY AREA: Tom's Canyon*

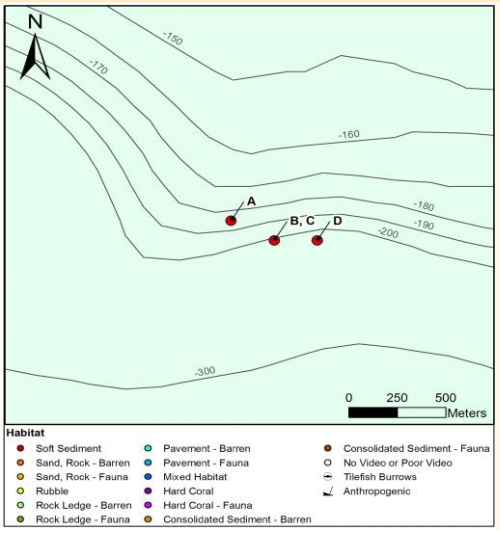
STATION OVERVIEW

Project	Ocean Dumping Impact Assessment
Principal investigators	RA Cooper[1] (deceased)
PI Contact Info[1]	University of Connecticut at Avery Point, Groton, CT 06340
Purpose	Assess the impact of sewage sludge dumping in canyons off New England and Mid-Atlantic Bight States
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	J Gaines (bow), L Rader (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	R Cooper, I Babb, P Auster, NURC-UCAP
SEADESC Analyst	M Watts
Date Compiled	9/20/2012
PI Station Number	

GENERAL LOCATION



Dive Track:



DIVE DATA

Date	08-Jun-90
Minimum Bottom Depth (m)	203
Maximum Bottom Depth (m)	207
Start Bottom Time (EDT)	20:44
End Bottom End (EDT)	21:36
Starting Latitude (N)	39° 08.520'
Starting Longitude (W)	72° 40.680'
Ending Latitude (N)	39° 08.460'
Ending Longitude (W)	72° 40.440'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Soft Substrate
39° 08.520' N, 72° 40.680' W

DIVE NUMBER: JSLI-1974 *STUDY AREA: Tom's Canyon*

IMAGE GALLERY *** indicates image position is approximated**

Image B: Soft Substrate
39° 08.480' N, 72° 40.570' W

Image C: Soft Substrate
39° 08.480' N, 72° 40.570' W

Image D: Soft Substrate
39° 08.460' N, 72° 40.440' W

RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Rowe et al. (1982)
Twitchell and Roberts (1982)
Forde et al. (1984)
Robb and Hampson (1987)
Watling and Auster (2005)

BIOLOGICAL ENVIRONMENT

This dive traversed part of Tom's Canyon. Soft sediment substrate supported an abundance of sea pens, hake, flounder, and a few cerianthid anemones, sea stars, scorpionfish, *Cancer* and galatheid crabs, and a hagfish.

PHYSICAL ENVIRONMENT

This dive covered part of Tom's Canyon. The submersible traversed soft sediment habitat with small shell hash. The sediment showed evidence of significant bioturbation in the form of burrows, depressions, and small mounds that covered the ocean floor.

ADDITIONAL COMMENTS

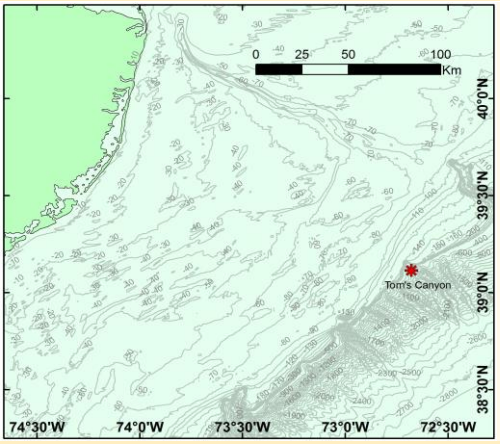
Original dives were on 8-mm tapes, then converted to digital media and stored on an external hard drive. Video quality was clear overall. Three reliable fixes were taken along the dive. Habitat type could be assigned to all three of the fixes as the bottom time was evident and the video tape continuous. Though not visible on the video, suction sediment samples, a sea star, two hermit crabs and three shrimp were collected according to the dive log.

DIVE NUMBER: JSLI-2174 *STUDY AREA: Tom's Canyon*

STATION OVERVIEW

Project	Ocean Dumping Impact Assessment
Principal investigators	RA Cooper[1] (deceased)
PI Contact Info[1]	University of Connecticut at Avery Point, Groton, CT 06340
Purpose	Assess the impact of sewage sludge dumping in canyons off New England and Mid-Atlantic Bight States
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	R Cooper (bow), R Robertson (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	R Cooper, I Babb, P Auster, NURC-UCAP
SEADESC Analyst	M Watts
Date Compiled	9/28/2012
PI Station Number	

GENERAL LOCATION



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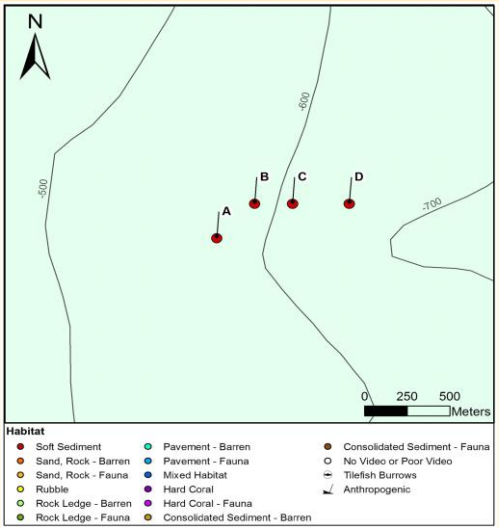


DIVE DATA

Date	16-Jul-91
Minimum Bottom Depth (m)	579
Maximum Bottom Depth (m)	605
Start Bottom Time (EDT)	9:21
End Bottom End (EDT)	11:17
Starting Latitude (N)	39° 04.980'
Starting Longitude (W)	72° 40.380'
Ending Latitude (N)	39° 05.100'
Ending Longitude (W)	72° 39.960'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Soft Substrate
39° 04.980' N, 72° 40.380' W

DIVE NUMBER: JSLI-2174 *STUDY AREA: Tom's Canyon*

IMAGE GALLERY *** indicates image position is approximated**

Image B: Soft Substrate
39° 05.100' N, 72° 40.280' W

Image C: Soft Substrate
39° 05.120' N, 72° 40.130' W

Image D: Soft Substrate
39° 05.100' N, 72° 39.960' W

RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Rowe et al. (1982)
Twitchell and Roberts (1982)
Forde et al. (1984)
Robb and Hampson (1987)
Watling and Auster (2005)

BIOLOGICAL ENVIRONMENT

This dive traversed part of Tom's Canyon. At the start of the dive, the submersible lights attracted a swarm of amphipods and shrimp that obstructed the view of the video camera. Soft sediment substrate supported an abundance of flounder, hake, *Nezumia* sp., *Chaceon quinquedens,* and a few quillworms, *Actinoscyphia* sp., hermit and galatheid crabs, synaphobranchid eels, and a scorpionfish.

PHYSICAL ENVIRONMENT

This dive covered part of Tom's Canyon. The submersible traversed soft sediment habitat with evidence of significant bioturbation in the form of burrows, depressions, and small mounds that covered the ocean floor. An occasional isolated rock supported *Actinoscyphia* sp.

ADDITIONAL COMMENTS

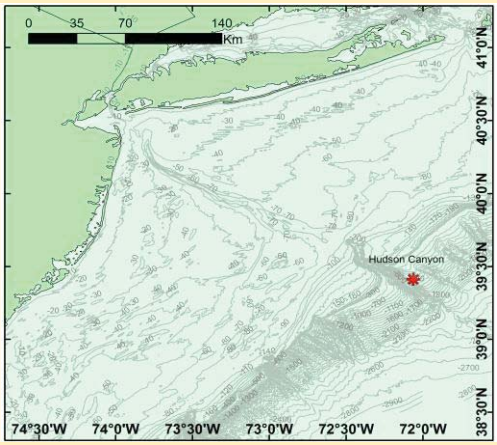
Original dives were on 8-mm tapes, then converted to digital media and stored on an external hard drive. Video quality was clear overall. Four reliable fixes were taken along the dive. Habitat type could be assigned to all four of the fixes as the bottom time was evident and the video tape continuous. A suction sample as well as box and punch cores were taken during the dive.

DIVE NUMBER: JSLI-1234 *STUDY AREA: Hudson Canyon*

STATION OVERVIEW

Project	Tilefish Assessment
Principal investigators	CB Grimes[1] KW Able, RS Jones, DC Twichell, SC Turner
PI Contact Info[1]	Southwest Fisheries Science Center, Fisheries Ecology Division, 110 Shaffer Rd, Santa Cruz, CA 95060
Purpose	Investigation of tilefish fishery on the middle Atlantic and southern New England continental shelf
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	C Grimes (bow), P Hood (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☐
Other	
Acknowledgements	K Able, Mid-Atlantic Fishery Management Council
SEADESC Analyst	M Watts
Date Compiled	10/17/2012
PI Station Number	

GENERAL LOCATION



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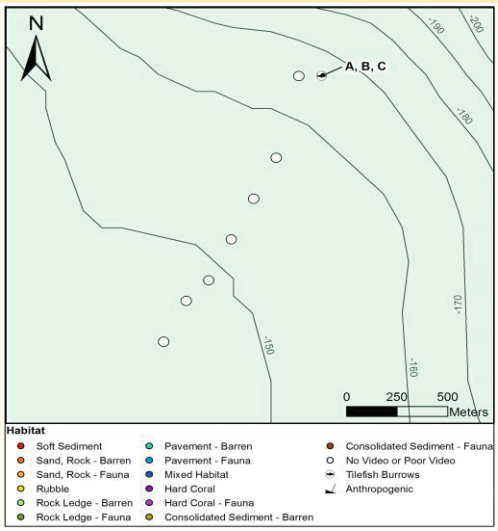


DIVE DATA

Date	23-Jul-82
Minimum Bottom Depth (m)	151
Maximum Bottom Depth (m)	165
Start Bottom Time (EDT)	8:17
End Bottom End (EDT)	10:53
Starting Latitude (N)	39° 27.710'
Starting Longitude (W)	72° 18.570'
Ending Latitude (N)	39° 26.910'
Ending Longitude (W)	72° 18.950'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Tilefish Habitat
39° 27.690' N, 72° 18.540' W

DIVE NUMBER: JSLI-1234 *STUDY AREA: Hudson Canyon*

IMAGE GALLERY

*** indicates image position is approximated**

Image B: Tilefish Habitat
39° 27.690' N, 72° 18.540' W

Image C: Tilefish Habitat
39° 27.690' N, 72° 18.540' W

RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Rowe et al. (1972, 1982)
Twitchell and Roberts (1982)
Forde et al. (1984)
Williams (1988)
Able (2002)
Watling and Auster (2005)

BIOLOGICAL ENVIRONMENT

This dive traversed part of the southwest wall of Hudson Canyon. No fauna were recorded on the video, though the numerous tilefish burrows described in the dive log likely supported the tilefish (*Lopholatilus chamaeleonticeps*).

PHYSICAL ENVIRONMENT

This dive traversed the southwest wall of Hudson Canyon. The dive log reports that the submersible encountered 23 tilefish burrows. However, only one burrow was recorded on the video.

ADDITIONAL COMMENTS

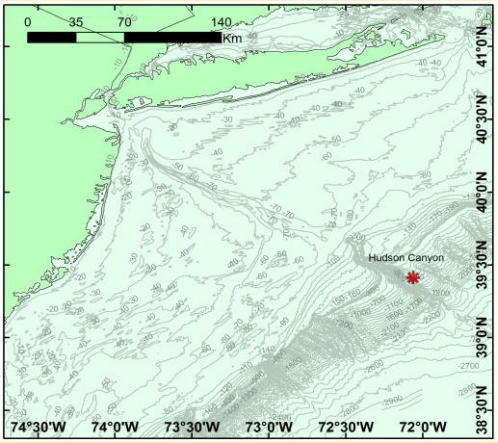
Original dives were on U-matic tapes, then transferred to digital media and stored on an external hard drive. Video quality was generally clear. While nine fixes were taken during the two hour dive, habitat type could only be assigned to one fix position as audio cues are necessary to align fixes with the correct portion of the video. Video footage only lasted 14 minutes and was not continuous but jumped from one tilefish burrow to the next without recording the habitats between burrows. The video only recorded the deployment of a camera next to a tilefish burrow with little footage of the habitat. Therefore, pictures A-C were all of this one burrow.

DIVE NUMBER: JSLI-1235 *STUDY AREA: Hudson Canyon*

STATION OVERVIEW

Project	Tilefish Assessment
Principal investigators	CB Grimes[1] KW Able, RS Jones, DC Twichell, SC Turner
PI Contact Info[1]	Southwest Fisheries Science Center, Fisheries Ecology Division, 110 Shaffer Rd, Santa Cruz, CA 95060
Purpose	Investigation of tilefish fishery on the middle Atlantic and southern New England continental shelf
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	R Jones (bow), S Turner (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☐
Other	
Acknowledgements	K Able, Mid-Atlantic Fishery Management Council
SEADESC Analyst	M Watts
Date Compiled	10/18/2012
PI Station Number	

GENERAL LOCATION



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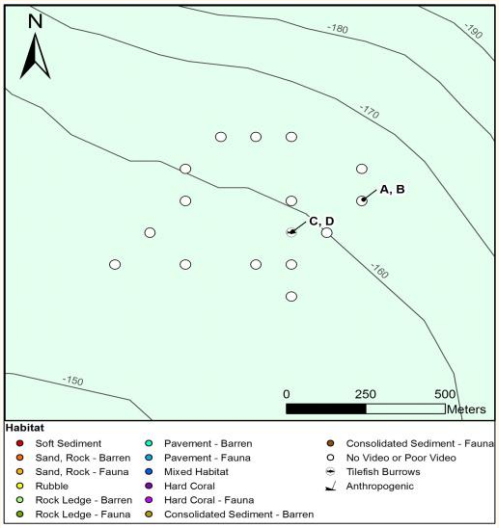


DIVE DATA

Date	24-Jul-82
Minimum Bottom Depth (m)	144
Maximum Bottom Depth (m)	156
Start Bottom Time (EDT)	
End Bottom End (EDT)	
Starting Latitude (N)	39° 27.610'
Starting Longitude (W)	72° 18.460'
Ending Latitude (N)	39° 27.490'
Ending Longitude (W)	72° 18.870'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Tilefish Habitat
39° 27.610' N, 72° 18.460' W

DIVE NUMBER: JSLI-1235 *STUDY AREA: Hudson Canyon*

IMAGE GALLERY

*** indicates image position is approximated**

Image B: Tilefish Habitat
39° 27.610' N, 72° 18.460' W

Image C: Tilefish Habitat
39° 27.540' N, 72° 18.610' W

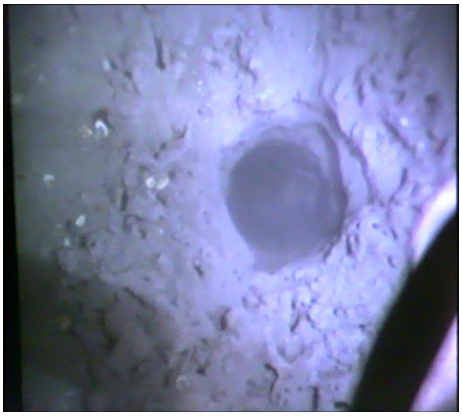


Image D: Tilefish Habitat
39° 27.540' N, 72° 18.610' W

RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Rowe et al. (1972, 1982)
Twitchell and Roberts (1982)
Forde et al. (1984)
Williams (1988)
Able (2002)
Watling and Auster (2005)

BIOLOGICAL ENVIRONMENT

This dive traversed part of the southwest wall of Hudson Canyon. Tilefish habitats supported tilefish (*Lopholatilus chamaeleonticeps*) and a *Cancer* sp. crab.

PHYSICAL ENVIRONMENT

This dive traversed the southwest wall of Hudson Canyon. The dive log reports that the submersible encountered 67 tilefish burrows. However, only four burrows were recorded on the video.

ADDITIONAL COMMENTS

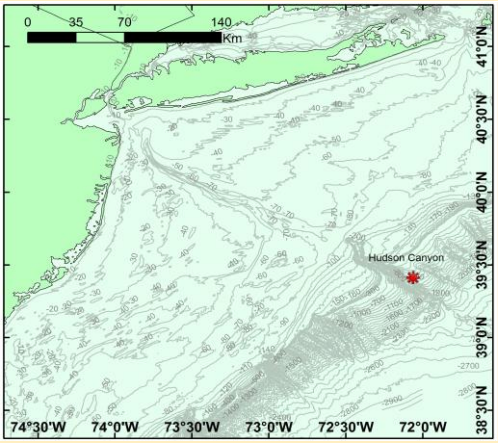
Original dives were on U-matic tapes, then transferred to digital media and stored on an external hard drive. Video quality was generally clear. While seventeen fixes were taken during the two hour dive, habitat type could only be assigned to two fix positions as audio cues are necessary to align fixes with the correct portion of the video. Video footage only lasted 11 minutes and was not continuous but jumped from one tilefish burrow to the next without recording the habitats between burrows.

DIVE NUMBER: JSLI-1237 *STUDY AREA: Hudson Canyon*

STATION OVERVIEW

Project	Tilefish Assessment
Principal investigators	CB Grimes[1] KW Able, RS Jones, DC Twichell, SC Turner
PI Contact Info[1]	Southwest Fisheries Science Center, Fisheries Ecology Division, 110 Shaffer Rd, Santa Cruz, CA 95060
Purpose	Investigation of tilefish fishery on the middle Atlantic and southern New England continental shelf
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	C Grimes (bow), P Hood (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☐
Other	
Acknowledgements	K Able, Mid-Atlantic Fishery Management Council
SEADESC Analyst	M Watts
Date Compiled	10/19/2012
PI Station Number	

GENERAL LOCATION



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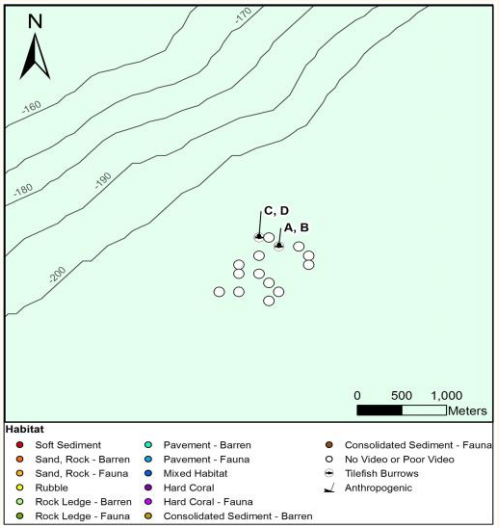


DIVE DATA

Date	25-Jul-82
Minimum Bottom Depth (m)	227
Maximum Bottom Depth (m)	237
Start Bottom Time (EDT)	9:20
End Bottom End (EDT)	13:05
Starting Latitude (N)	39° 31.300'
Starting Longitude (W)	72° 08.950'
Ending Latitude (N)	39° 31.210'
Ending Longitude (W)	72° 08.770'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Tilefish Habitat
39° 31.300' N, 72° 08.950' W

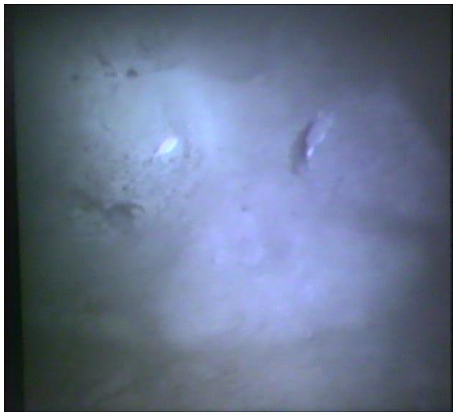
DIVE NUMBER: JSLI-1237 *STUDY AREA: Hudson Canyon*

IMAGE GALLERY *** indicates image position is approximated**

Image B: Tilefish Habitat
39° 31.300' N, 72° 08.950' W

Image C: Tilefish Habitat
39° 31.350' N, 72° 09.040' W

Image D: Tilefish Habitat
39° 31.350' N, 72° 09.040' W



RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Rowe et al. (1972, 1982)
Twitchell and Roberts (1982)
Forde et al. (1984)
Williams (1988)
Able (2002)
Watling and Auster (2005)

BIOLOGICAL ENVIRONMENT

This dive traversed part of the northeast region of Hudson Canyon. Tilefish habitats supported tilefish (*Lopholatilus chamaeleonticeps*) and a cerianthid anemone.

PHYSICAL ENVIRONMENT

This dive traversed northeast Hudson Canyon. The dive log reports that the submersible encountered 63 tilefish burrows. However, only three burrows were recorded on the video.

ADDITIONAL COMMENTS

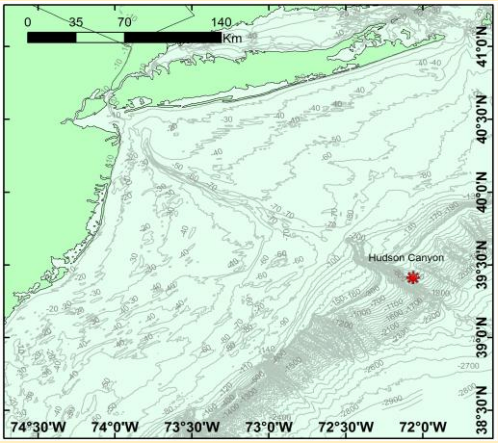
Original dives were on U-matic tapes, then transferred to digital media and stored on an external hard drive. Video quality was generally clear. While seventeen fixes were taken during the two hour dive, habitat type could only be assigned to two fix positions as audio cues are necessary to align fixes with the correct portion of the video. Video footage only lasted 10 minutes and was not continuous but jumped from one tilefish burrow to the next without recording the habitats between burrows.

DIVE NUMBER: JSLI-1238 *STUDY AREA: Hudson Canyon*

STATION OVERVIEW

Project	Tilefish Assessment
Principal investigators	CB Grimes[1] KW Able, RS Jones, DC Twichell, SC Turner
PI Contact Info[1]	Southwest Fisheries Science Center, Fisheries Ecology Division, 110 Shaffer Rd, Santa Cruz, CA 95060
Purpose	Investigation of tilefish fishery on the middle Atlantic and southern New England continental shelf
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	C Grimes (bow), D Twitchell (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	K Able, Mid-Atlantic Fishery Management Council
SEADESC Analyst	M Watts
Date Compiled	10/22/2012
PI Station Number	

GENERAL LOCATION



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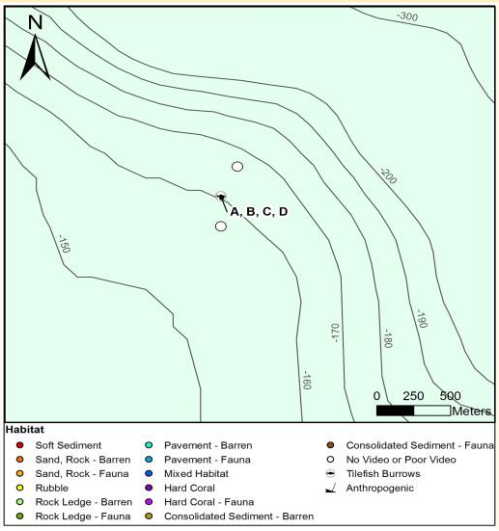


DIVE DATA

Date	25-Jul-82
Minimum Bottom Depth (m)	156
Maximum Bottom Depth (m)	175
Start Bottom Time (EDT)	16:09
End Bottom End (EDT)	18:30
Starting Latitude (N)	39° 27.480'
Starting Longitude (W)	72° 18.600'
Ending Latitude (N)	39° 27.700'
Ending Longitude (W)	72° 18.550'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Tilefish Habitat
39° 27.610' N, 72° 18.610' W

DIVE NUMBER: JSLI-1238 *STUDY AREA: Hudson Canyon*

IMAGE GALLERY *** indicates image position is approximated**

Image B: Tilefish Habitat
39° 27.610' N, 72° 18.610' W

Image C: Tilefish Habitat
39° 27.610' N, 72° 18.610' W

Image D: Tilefish Habitat
39° 27.610' N, 72° 18.610' W

RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Rowe et al. (1972, 1982)
Twitchell and Roberts (1982)
Forde et al. (1984)
Williams (1988)
Able (2002)
Watling and Auster (2005)

BIOLOGICAL ENVIRONMENT

This dive traversed part of the southwest region of Hudson Canyon. Tilefish habitats supported tilefish (*Lopholatilus chamaeleonticeps*), galatheid crabs, a cerianthid anemone, and two conger eels.

PHYSICAL ENVIRONMENT

This dive traversed southwest Hudson Canyon. The submersible encountered three tilefish burrows surrounded by soft and consolidated sediment with significant bioerosion.

ADDITIONAL COMMENTS

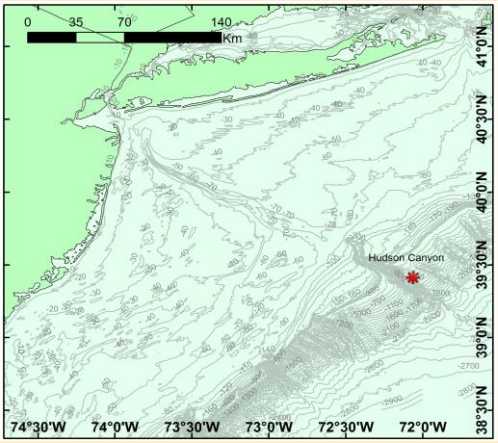
Original dives were on U-matic tapes, then transferred to digital media and stored on an external hard drive. Video quality was generally clear. While four fixes were taken during the dive, habitat type could only be assigned to two fix positions that overlap on the map above as audio cues are necessary to align fixes with the correct portion of the video. Video footage was not continuous but jumped from one tilefish burrow to the next without recording the habitats between burrows. Galatheid crabs and a *Conger* sp. eel were collected.

DIVE NUMBER: JSLI-1239 *STUDY AREA: Hudson Canyon*

STATION OVERVIEW

Project	Tilefish Assessment
Principal investigators	CB Grimes[1] KW Able, RS Jones, DC Twichell, SC Turner
PI Contact Info[1]	Southwest Fisheries Science Center, Fisheries Ecology Division, 110 Shaffer Rd, Santa Cruz, CA 95060
Purpose	Investigation of tilefish fishery on the middle Atlantic and southern New England continental shelf
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	C Grimes (bow), G Miller (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☐
Other	
Acknowledgements	K Able, Mid-Atlantic Fishery Management Council
SEADESC Analyst	M Watts
Date Compiled	10/24/2012
PI Station Number	

GENERAL LOCATION



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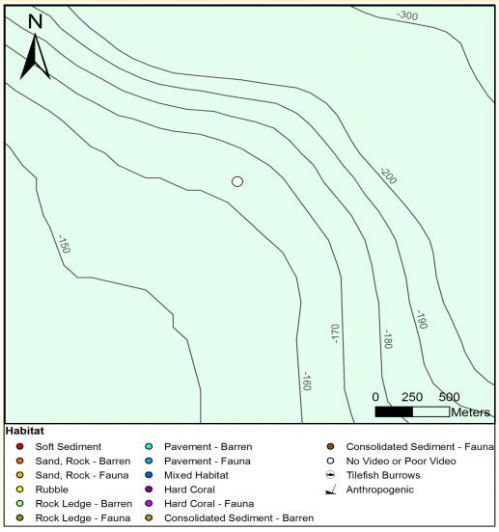


DIVE DATA

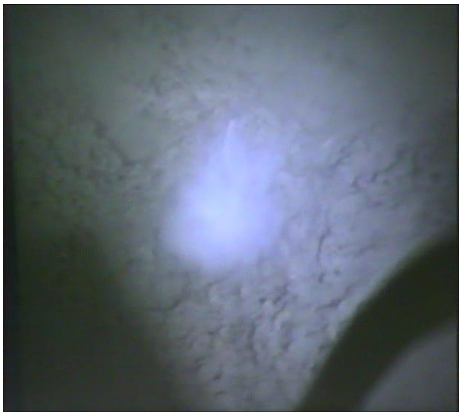
Date	26-Jul-82
Minimum Bottom Depth (m)	175
Maximum Bottom Depth (m)	175
Start Bottom Time (EDT)	16:33
End Bottom End (EDT)	
Starting Latitude (N)	39° 27.660'
Starting Longitude (W)	72° 18.540'
Ending Latitude (N)	
Ending Longitude (W)	
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Tilefish Habitat

DIVE NUMBER: JSLI-1239 *STUDY AREA: Hudson Canyon*

IMAGE GALLERY *** indicates image position is approximated**

Image B: Tilefish Habitat **Image C: Tilefish Habitat** **Image D: Tilefish Habitat**



RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Rowe et al. (1972, 1982)
Twitchell and Roberts (1982)
Forde et al. (1984)
Williams (1988)
Able (2002)
Watling and Auster (2005)

BIOLOGICAL ENVIRONMENT

This dive traversed part of the southwest region of Hudson Canyon. Tilefish habitats supported tilefish (*Lopholatilus chamaeleonticeps*), a conger eel, and a lobster.

PHYSICAL ENVIRONMENT

This dive traversed southwest Hudson Canyon. The submersible encountered five tilefish burrows surrounded by soft and consolidated sediment with significant bioerosion.

ADDITIONAL COMMENTS

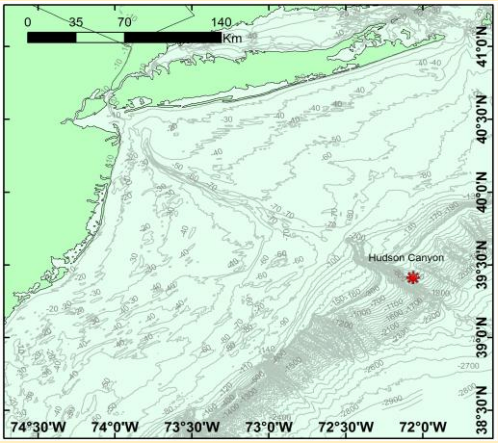
Original dives were on U-matic tapes, then transferred to digital media and stored on an external hard drive. Video quality was generally clear except when the submersible stirred up sediment. Only one fix was taken during the dive, at the time the submersible reached the bottom. Habitat type could not be assigned to this fix position as audio cues are necessary to align fixes with the correct portion of the video. Video footage was not continuous but jumped from one tilefish burrow to the next without recording the habitats between burrows. An unsuccessful attempt was made to collect a tilefish.

DIVE NUMBER: JSLI-1423 *STUDY AREA: Hudson Canyon*

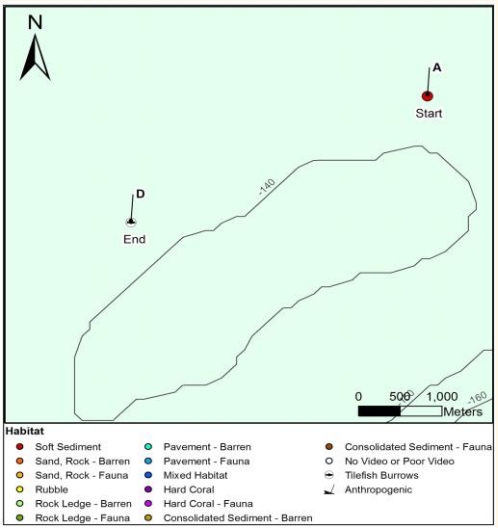
STATION OVERVIEW

Project	Tilefish Assessment
Principal investigators	CB Grimes[1] KW Able, RS Jones, DC Twichell, SC Turner
PI Contact Info[1]	Southwest Fisheries Science Center, Fisheries Ecology Division, 110 Shaffer Rd, Santa Cruz, CA 95060
Purpose	Investigation of tilefish fishery on the middle Atlantic and southern New England continental shelf
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	R Jones (bow), S Turner (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	K Able, Mid-Atlantic Fishery Management Council
SEADESC Analyst	M Watts
Date Compiled	10/11/2012
PI Station Number	

GENERAL LOCATION



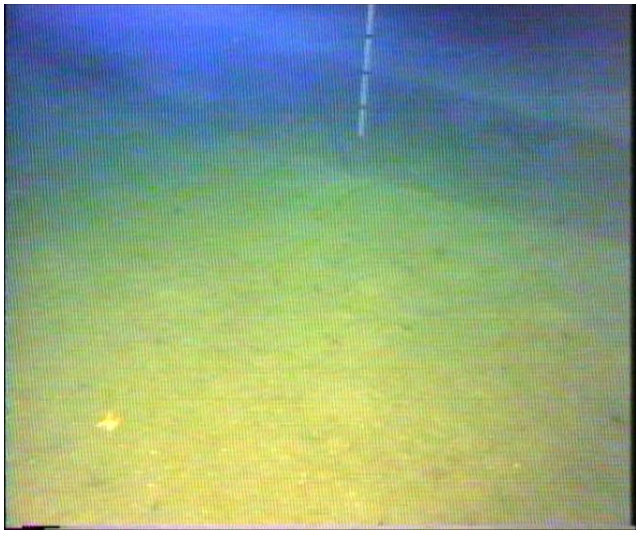
Dive Track:



DIVE DATA

Date	15-Aug-83
Minimum Bottom Depth (m)	143
Maximum Bottom Depth (m)	144
Start Bottom Time (EDT)	16:47
End Bottom End (EDT)	19:35
Starting Latitude (N)	39° 15.460'
Starting Longitude (W)	72° 31.140'
Ending Latitude (N)	39° 14.590'
Ending Longitude (W)	72° 33.060'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Soft Substrate
39° 15.460' N, 72° 31.140' W



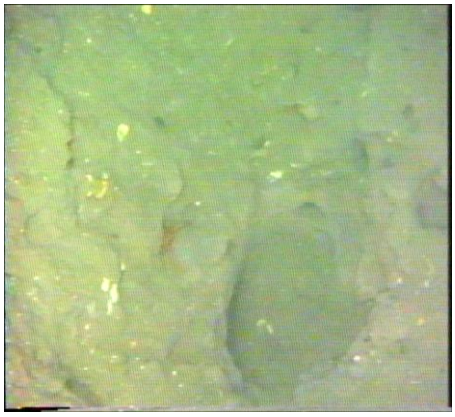
DIVE NUMBER: JSLI-1423 *STUDY AREA: Hudson Canyon*

IMAGE GALLERY *** indicates image position is approximated**

Image B: Tilefish Habitat

Image C: Tilefish Habitat

Image D: Tilefish Habitat
39° 15.590' N, 72° 33.060' W



RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Rowe et al. (1972, 1982)
Twitchell and Roberts (1982)
Forde et al. (1984)
Williams (1988)
Able (2002)
Watling and Auster (2005)

BIOLOGICAL ENVIRONMENT

This dive traversed part of the southwest side of Hudson Canyon. Soft sediment habitat supported sea stars and cancer crabs. Tilefish burrows supported tilefish (*Lopholatilus chamaeleonticeps*) and galatheid crabs.

PHYSICAL ENVIRONMENT

This dive traversed the southwest region of Hudson Canyon. The submersible first covered soft sediment before encountering four tilefish burrows excavated from consolidated sediment.

ADDITIONAL COMMENTS

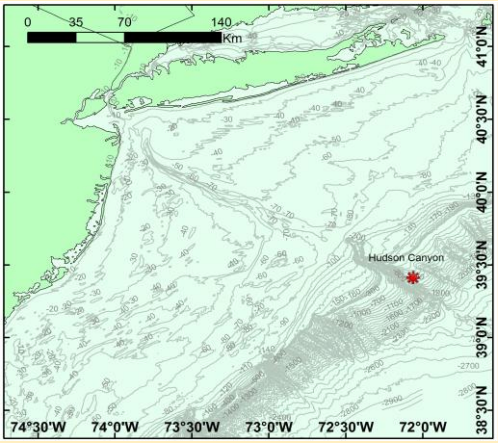
Original dives were on U-matic tapes, then transferred to digital media and stored on an external hard drive. Video quality was clear overall. Only two fixes were taken, at the start and end of the dive. Habitat type could be assigned to both fixes as the start and end of the dive were evident. However, video footage was not continuous but jumped from one tilefish burrow to the next without recording the habitats between burrows. Sediment samples were taken in soft sediment and the consolidated mud of the tilefish burrows. Also, measurements of sediment depth were taken in and outside of each tilefish burrow.

DIVE NUMBER: JSLI-1425 *STUDY AREA: Hudson Canyon*

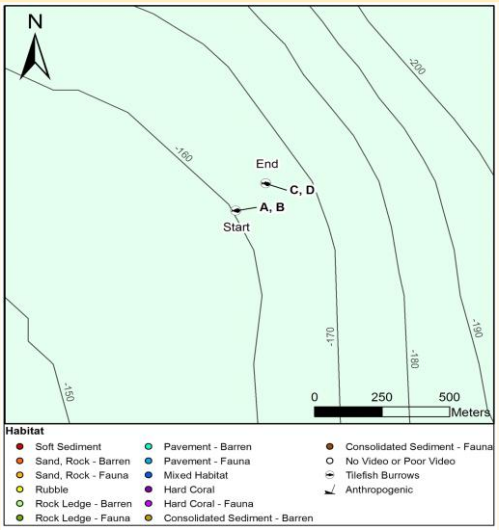
STATION OVERVIEW

Project	Tilefish Assessment
Principal investigators	CB Grimes[1] KW Able, RS Jones, DC Twichell, SC Turner
PI Contact Info[1]	Southwest Fisheries Science Center, Fisheries Ecology Division, 110 Shaffer Rd, Santa Cruz, CA 95060
Purpose	Investigation of tilefish fishery on the middle Atlantic and southern New England continental shelf
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	N/A
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	K Able, Mid-Atlantic Fishery Management Council
SEADESC Analyst	M Watts
Date Compiled	10/13/2012
PI Station Number	

GENERAL LOCATION



Dive Track:



DIVE DATA

Date	16-Aug-83
Minimum Bottom Depth (m)	101
Maximum Bottom Depth (m)	105
Start Bottom Time (EDT)	12:37
End Bottom End (EDT)	15:14
Starting Latitude (N)	39° 27.370'
Starting Longitude (W)	72° 18.350'
Ending Latitude (N)	39° 27.430'
Ending Longitude (W)	72° 18.320'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Consolidated Sediment - without Attached Fauna
39° 27.370' N, 72° 18.350' W

DIVE NUMBER: JSLI-1425 *STUDY AREA: Hudson Canyon*

IMAGE GALLERY *** indicates image position is approximated**

Image B: Tilefish Habitat
39° 27.370' N, 72° 18.350' W

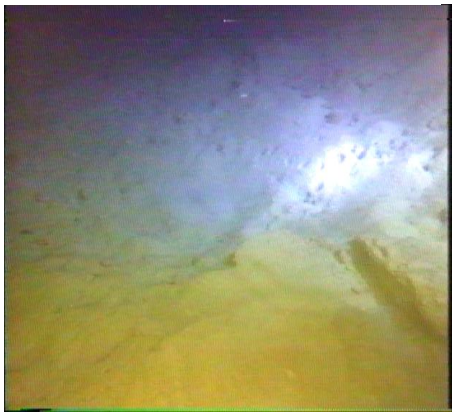


Image C: Tilefish Habitat
39° 27.430' N, 72° 18.320' W

Image D: Tilefish Habitat
39° 27.430' N, 72° 18.320' W

RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Rowe et al. (1972, 1982)
Twitchell and Roberts (1982)
Forde et al. (1984)
Williams (1988)
Able (2002)
Watling and Auster (2005)

BIOLOGICAL ENVIRONMENT

This dive traversed part of the southwest side of Hudson Canyon. Tilefish burrows and surrounding consolidated mud supported tilefish (*Lopholatilus chamaeleonticeps*) and galatheid crabs.

PHYSICAL ENVIRONMENT

This dive traversed the southwest side of Hudson Canyon. The submersible encountered tilefish burrows excavated from consolidated mud. The submersible likely encountered other habitat types such as soft sediment and consolidated mud without tilefish burrows but the video only recorded the tilefish burrows and the surrounding consolidated mud.

ADDITIONAL COMMENTS

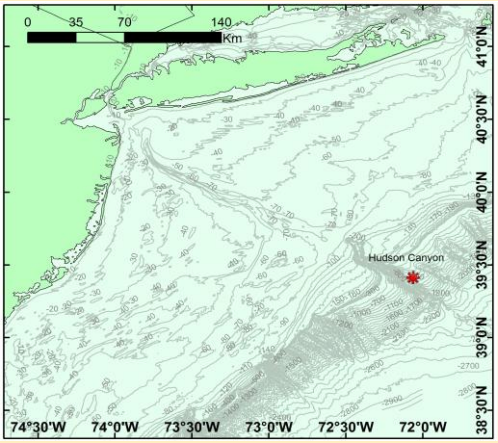
Original dives were on U-matic tapes, then transferred to digital media and stored on an external hard drive. Video quality was clear overall. Only two fixes were taken, at the start and end of the dive. Habitat type could be assigned to these fixes as the start and end of the dive were evident. However, video footage was not continuous but jumped from one tilefish burrow to the next without recording the habitats between burrows. A pinger was retrieved near the first tilefish burrow. A tilefish was collected by placing a net over a burrow and flushing out the fish.

DIVE NUMBER: JSLI-1973 *STUDY AREA: Hudson Canyon*

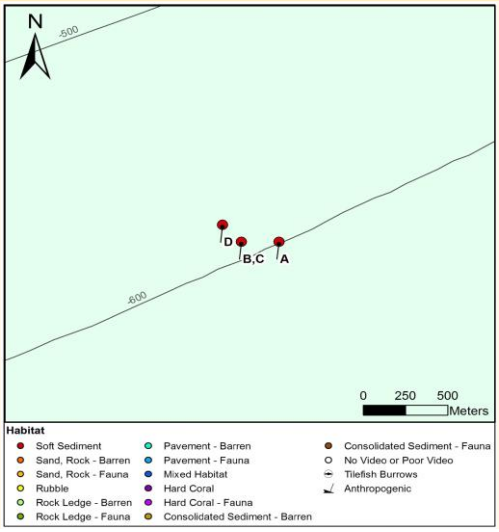
STATION OVERVIEW

Project	Ocean Dumping Impact Assessment
Principal investigators	RA Cooper[1] (deceased)
PI Contact Info[1]	University of Connecticut at Avery Point, Groton, CT 06340
Purpose	Assess the impact of sewage sludge dumping in canyons off New England and Mid-Atlantic Bight States
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	G Small (bow), D Rogers (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	R Cooper, I Babb, P Auster, NURC-UCAP
SEADESC Analyst	M Watts
Date Compiled	9/21/2012
PI Station Number	

GENERAL LOCATION



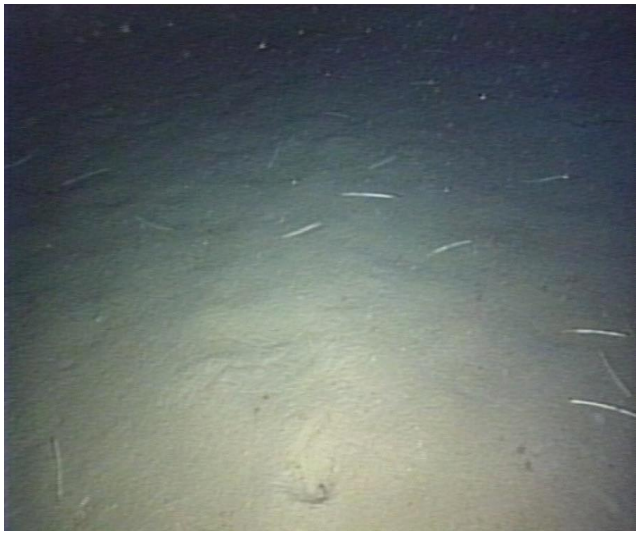
Dive Track:



DIVE DATA

Date	08-Jun-90
Minimum Bottom Depth (m)	606
Maximum Bottom Depth (m)	606
Start Bottom Time (EDT)	15:21
End Bottom End (EDT)	16:29
Starting Latitude (N)	39° 13.920'
Starting Longitude (W)	72° 16.380'
Ending Latitude (N)	39° 13.980'
Ending Longitude (W)	72° 16.560'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Soft Substrate
39° 13.920' N, 72° 16.380' W



DIVE NUMBER: JSLI-1973 *STUDY AREA: Hudson Canyon*

IMAGE GALLERY

*** indicates image position is approximated**

Image B: Soft Substrate
39° 13.890' N, 72° 16.500' W

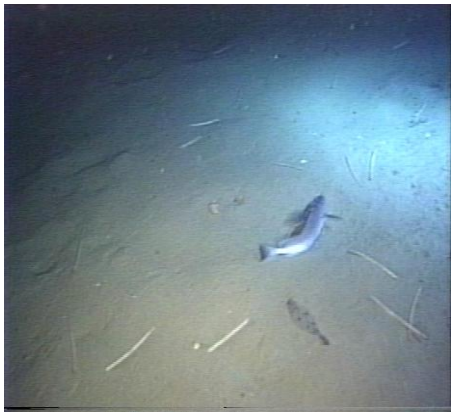


Image C: Soft Substrate
39° 13.890' N, 72° 16.500' W

Image D: Soft Substrate
39° 13.980' N, 72° 16.560' W

RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Rowe et al. (1972, 1982)
Twitchell and Roberts (1982)
Forde et al. (1984)
Williams (1988)
Able (2002)
Watling and Auster (2005)

BIOLOGICAL ENVIRONMENT

This dive traversed part of southwest Hudson Canyon. Soft sediment substrate supported an abundance of quillworms, *Actinoscyphia* sp., hermit crabs, *Chaceon quinquedens* and *Cancer* crabs, *Nezumia* sp., synaphobranchid eels, longfin hakes, chain catsharks, and flounder.

PHYSICAL ENVIRONMENT

This dive covered part of southwest Hudson Canyon. The submersible traversed soft sediment habitat exclusively with evidence of significant bioturbation in the form of burrows and small mounds.

ADDITIONAL COMMENTS

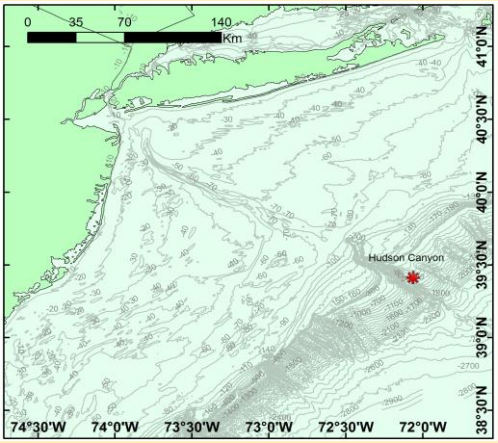
Original dives were on 8-mm tapes, then converted to digital media and stored on an external hard drive. Video quality was clear overall. Three reliable fixes were taken along the dive. Habitat type could be assigned to all three of the fixes as the bottom time was evident and the video tape continuous. Though not recorded on the video, quillworms, tubeworms, snails, and bivalves were collected with a bag suction according to the dive log.

DIVE NUMBER: JSLI-1975 *STUDY AREA: Hudson Canyon*

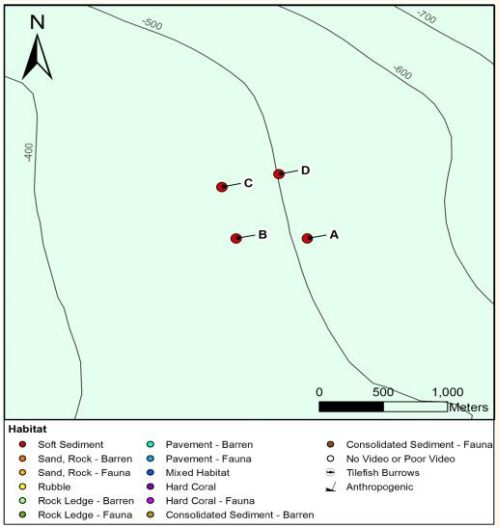
STATION OVERVIEW

Project	Ocean Dumping Impact Assessment
Principal investigators	RA Cooper[1] (deceased)
PI Contact Info[1]	University of Connecticut at Avery Point, Groton, CT 06340
Purpose	Assess the impact of sewage sludge dumping in canyons off New England and Mid-Atlantic Bight States
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	L Stuart (bow), K Harrica (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	R Cooper, I Babb, P Auster, NURC-UCAP
SEADESC Analyst	M Watts
Date Compiled	9/18/2012
PI Station Number	

GENERAL LOCATION



Dive Track:



DIVE DATA

Date	09-Jun-90
Minimum Bottom Depth (m)	555
Maximum Bottom Depth (m)	602
Start Bottom Time (EDT)	8:34
End Bottom End (EDT)	10:49
Starting Latitude (N)	39° 21.300'
Starting Longitude (W)	72° 10.200'
Ending Latitude (N)	39° 21.600'
Ending Longitude (W)	72° 10.320'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Soft Substrate
39° 21.300' N, 72° 10.200' W

DIVE NUMBER: JSLI-1975 *STUDY AREA: Hudson Canyon*

IMAGE GALLERY

*** indicates image position is approximated**

Image B: Soft Substrate
39° 21.290' N, 72° 10.490' W

Image C: Soft Substrate
39° 21.520' N, 72° 10.530' W

Image D: Soft Substrate
39° 21.600' N, 72° 10.320' W

RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Rowe et al. (1972, 1982)
Twitchell and Roberts (1982)
Forde et al. (1984)
Williams (1988)
Able (2002)
Watling and Auster (2005)

BIOLOGICAL ENVIRONMENT

This dive traversed part of the western wall of Hudson Canyon. Soft sediment substrate supported an abundance of quillworms, *Chaceon quinquedens*, longfin hake, *Nezumia* sp. with its parasitic isopod, synaphobranchid eels, flounder, chain catsharks, and a few *Actinoscyphia* sp., hermit crabs, scorpionfish, skates, a codling, a galatheid crab, a red shrimp and a wolffish.

PHYSICAL ENVIRONMENT

This dive covered the western wall of Hudson Canyon. The submersible traversed soft sediment habitat with evidence of significant bioturbation in the form of burrows, depressions, and small mounds that covered the ocean floor. Quillworms and their tracks were abundant during the first half of the dive but disappeared as the submersible headed downslope at the end of the dive.

ADDITIONAL COMMENTS

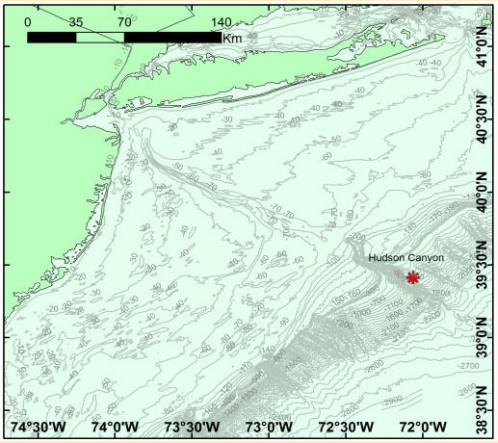
Original dives were on 8-mm tapes, then converted to digital media and stored on an external hard drive. Video quality was clear overall. Four reliable fixes were taken along the dive. Habitat type could be assigned to all four of the fixes as the bottom time was evident and the video tape continuous. Box and punch cores and suction sediment samples were taken during video footage.

DIVE NUMBER: JSLI-1976 *STUDY AREA: Hudson Canyon*

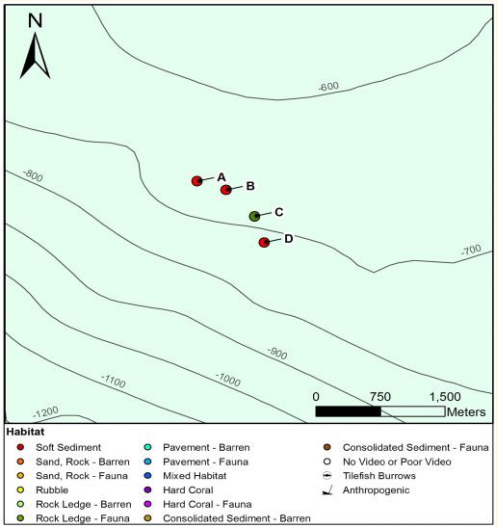
STATION OVERVIEW

Project	Ocean Dumping Impact Assessment
Principal investigators	RA Cooper[1] (deceased)
PI Contact Info[1]	University of Connecticut at Avery Point, Groton, CT 06340
Purpose	Assess the impact of sewage sludge dumping in canyons off New England and Mid-Atlantic Bight States
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	M Fecky (bow), M Ryan (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	R Cooper, I Babb, P Auster, NURC-UCAP
SEADESC Analyst	M Watts
Date Compiled	8/21/2012
PI Station Number	

GENERAL LOCATION



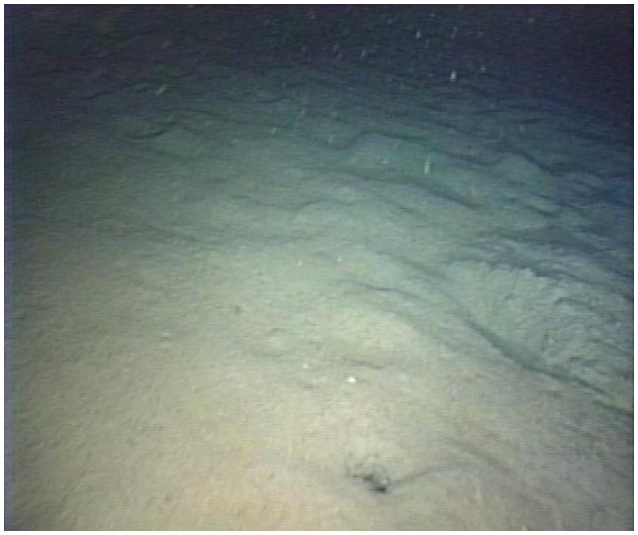
Dive Track:



DIVE DATA

Date	09-Jun-90
Minimum Bottom Depth (m)	642
Maximum Bottom Depth (m)	691
Start Bottom Time (EDT)	16:26
End Bottom End (EDT)	17:50
Starting Latitude (N)	39° 24.600'
Starting Longitude (W)	72° 03.780'
Ending Latitude (N)	39° 24.360'
Ending Longitude (W)	72° 03.360'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Soft Substrate
39° 06.580' N, 72° 40.670' W



DIVE NUMBER: JSLI-1976 *STUDY AREA: Hudson Canyon*

IMAGE GALLERY *** indicates image position is approximated**

Image B: Soft Substrate
39° 06.690' N, 72° 40.580' W

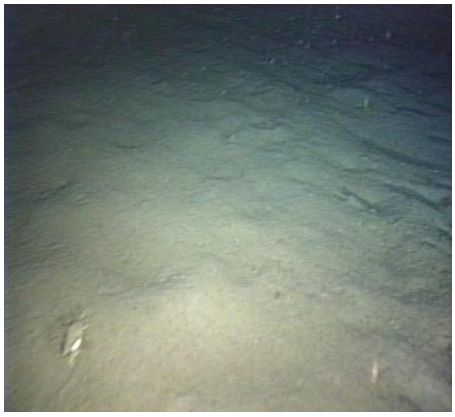


Image C: Rock Ledge - with Attached Fauna
39° 06.690' N, 72° 40.580' W

Image D: Soft Substrate
39° 06.690' N, 72° 40.580' W

RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Rowe et al. (1972, 1982)
Twitchell and Roberts (1982)
Forde et al. (1984)
Williams (1988)
Able (2002)
Watling and Auster (2005)

BIOLOGICAL ENVIRONMENT

This dive traversed part of the east wall of Hudson Canyon. Soft sediment substrate supported hermit crabs, galatheid crabs, *Chaceon quinquedens*, *Nezumia* sp., synaphobranchid eels, longfin hakes, chain catsharks, flounders, a large skate, an ophiuroid, and a few unidentified sharks. Occasional boulders supported *Actinoscyphia* sp.

PHYSICAL ENVIRONMENT

This dive covered the east wall of Hudson Canyon. The submersible traversed soft sediment habitat with evidence of significant bioturbation in the form of burrows and small mounds. Trawling scars were apparent in the soft sediment at the end of the dive. Two large boulders with attached fauna were encountered during the dive.

ADDITIONAL COMMENTS

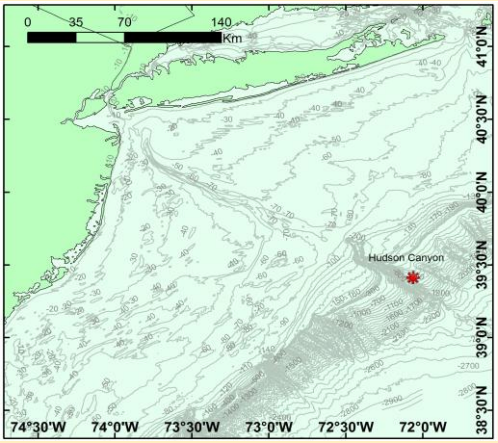
Original dives were on 8-mm tapes, then converted to digital media and stored on an external hard drive. Video quality was clear overall. Four reliable fixes were taken along the dive. Habitat type could be assigned to all four of the fixes as the bottom time was evident and the video tape continuous. Box cores and suction sediment samples as well as a galatheid crab were taken during video footage.

DIVE NUMBER: JSLI-1977 *STUDY AREA: Hudson Canyon*

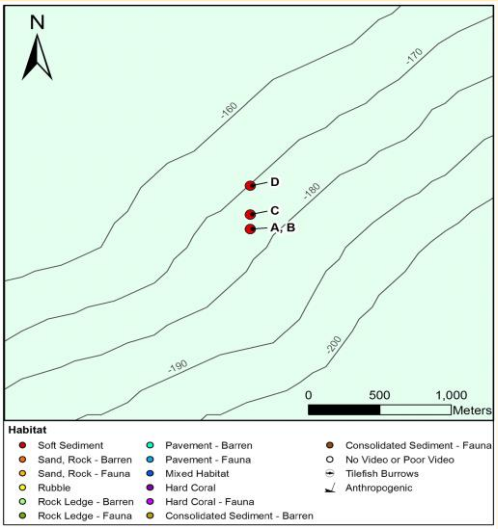
STATION OVERVIEW

Project	Ocean Dumping Impact Assessment
Principal investigators	RA Cooper[1] (deceased)
PI Contact Info[1]	University of Connecticut at Avery Point, Groton, CT 06340
Purpose	Assess the impact of sewage sludge dumping in canyons off New England and Mid-Atlantic Bight States
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	N Worobey (bow), J Gaines (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	R Cooper, I Babb, P Auster, NURC-UCAP
SEADESC Analyst	M Watts
Date Compiled	9/4/2012
PI Station Number	

GENERAL LOCATION



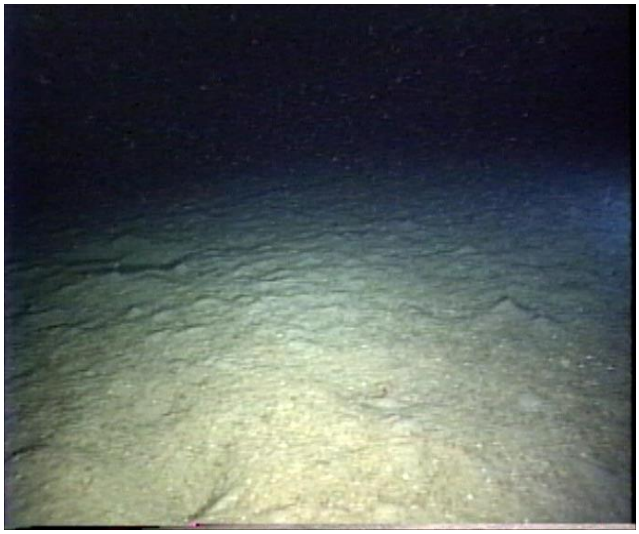
Dive Track:



DIVE DATA

Date	10-Jun-90
Minimum Bottom Depth (m)	183
Maximum Bottom Depth (m)	188
Start Bottom Time (EDT)	8:17
End Bottom End (EDT)	8:54
Starting Latitude (N)	39° 32.700'
Starting Longitude (W)	72° 09.060'
Ending Latitude (N)	39° 32.880'
Ending Longitude (W)	72° 09.060'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Soft Substrate
39° 32.700' N, 72° 09.060' W



DIVE NUMBER: JSLI-1977 *STUDY AREA: Hudson Canyon*

IMAGE GALLERY *** indicates image position is approximated**

Image B: Soft Substrate
39° 32.700' N, 72° 09.060' W

Image C: Soft Substrate
39° 32.760' N, 72° 09.060' W

Image D: Soft Substrate
39° 32.880' N, 72° 09.060' W

RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Rowe et al. (1972, 1982)
Twitchell and Roberts (1982)
Forde et al. (1984)
Williams (1988)
Able (2002)
Watling and Auster (2005)

BIOLOGICAL ENVIRONMENT

This dive traversed part of the shallow northeastern wall of Hudson Canyon. Soft sediment substrate supported an abundance of sea pens and small hakes with occasional cerianthid anemones, flounder, galatheid and *Bathynectes* sp. crab, lobsters, and an unidentified shark.

PHYSICAL ENVIRONMENT

This dive covered the shallow northeastern wall of Hudson Canyon. The submersible traversed soft sediment habitat with small shell hash. There was evidence of significant bioturbation in the form of burrows, depressions, and small mounds that covered the ocean floor.

ADDITIONAL COMMENTS

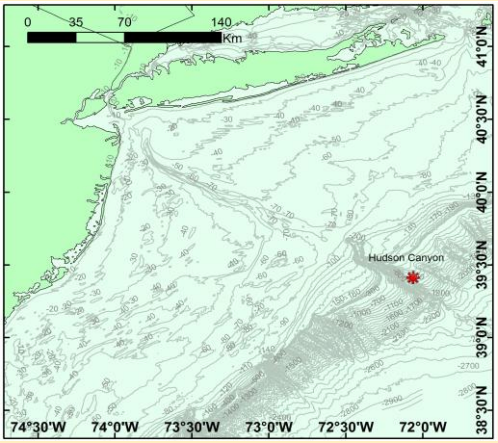
Original dives were on 8-mm tapes, then converted to digital media and stored on an external hard drive. Video quality was clear overall. Three reliable fixes were taken along the dive. Habitat type could be assigned to all three of the fixes as the bottom time was evident and the video tape continuous. Box cores and suction sediment samples were taken during video footage.

DIVE NUMBER: JSLI-1978 *STUDY AREA: Hudson Canyon*

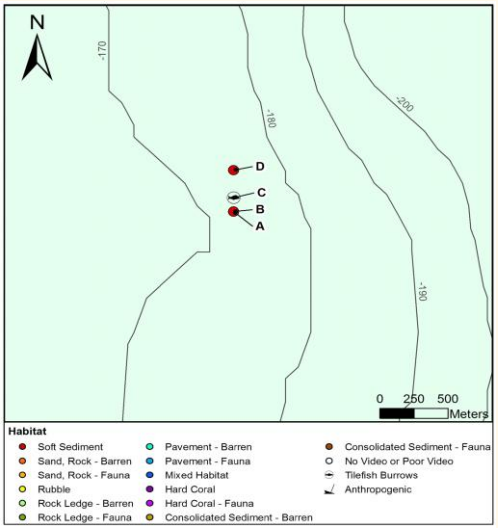
STATION OVERVIEW

Project	Ocean Dumping Impact Assessment
Principal investigators	RA Cooper[1] (deceased)
PI Contact Info[1]	University of Connecticut at Avery Point, Groton, CT 06340
Purpose	Assess the impact of sewage sludge dumping in canyons off New England and Mid-Atlantic Bight States
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	K Jessen (bow), L Stewart (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	R Cooper, I Babb, P Auster, NURC-UCAP
SEADESC Analyst	M Watts
Date Compiled	9/7/2012
PI Station Number	

GENERAL LOCATION



Dive Track:



DIVE DATA

Date	10-Jun-90
Minimum Bottom Depth (m)	179
Maximum Bottom Depth (m)	181
Start Bottom Time (EDT)	12:47
End Bottom End (EDT)	14:36
Starting Latitude (N)	39° 25.200'
Starting Longitude (W)	72° 16.980'
Ending Latitude (N)	39° 25.380'
Ending Longitude (W)	72° 16.980'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Soft Substrate
39° 25.200' N, 72° 16.980' W

DIVE NUMBER: JSLI-1978 *STUDY AREA: Hudson Canyon*

IMAGE GALLERY *** indicates image position is approximated**

Image B: Soft Substrate
39° 25.200' N, 72° 16.980' W

Image C: Tilefish Habitat
39° 25.270' N, 72° 16.980' W

Image D: Soft Substrate
39° 25.380' N, 72° 16.980' W

RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Rowe et al. (1972, 1982)
Twitchell and Roberts (1982)
Forde et al. (1984)
Williams (1988)
Able (2002)
Watling and Auster (2005)

BIOLOGICAL ENVIRONMENT

This dive traversed part of the shallow southwestern wall of Hudson Canyon. Soft sediment substrate supported an abundance of small tubeworms, small white clustered anemones and cerianthid anemones, sea stars, flounder, *Bathynectes* sp., *Cancer* sp., and *Chaceon quinquedens*, hake, scorpionfish, a sea robin, a goosefish, and a tilefish (*Lopholatilus chamaeleonticeps*).

PHYSICAL ENVIRONMENT

This dive covered the shallow southwestern wall of Hudson Canyon. The submersible traversed soft sediment habitat with evidence of significant bioturbation in the form of burrows, depressions, and small mounds. Attached fauna such as cerianthid and small white clustered anemones and small tubeworms were abundant on the soft sediment. Near the end of the dive, the submersible encountered two large tilefish burrows excavated from consolidated sediment that resided under a thick layer of soft sediment. The dive ended with a series of large depressions in the substrate.

ADDITIONAL COMMENTS

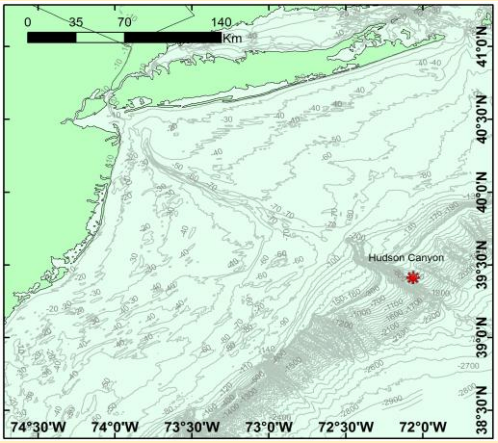
Original dives were on 8-mm tapes, then converted to digital media and stored on an external hard drive. Video quality was clear overall. Four reliable fixes were taken along the dive, though two had the same coordinates, resulting in overlap on the map. Habitat type could be assigned to all four of the fixes as the bottom time was evident and the video tape continuous. Box cores and suction sediment samples were taken during video footage.

DIVE NUMBER: JSLI-1979 *STUDY AREA: Hudson Canyon*

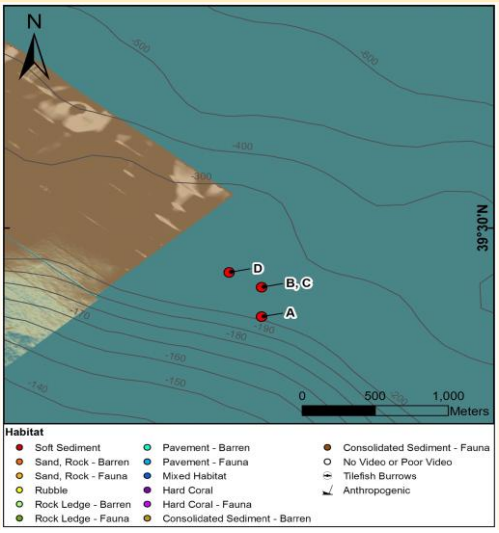
STATION OVERVIEW

Project	Ocean Dumping Impact Assessment
Principal investigators	RA Cooper[1] (deceased)
PI Contact Info[1]	University of Connecticut at Avery Point, Groton, CT 06340
Purpose	Assess the impact of sewage sludge dumping in canyons off New England and Mid-Atlantic Bight States
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	J Busa (bow), L Rader (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	R Cooper, I Babb, P Auster, NURC-UCAP
SEADESC Analyst	M Watts
Date Compiled	8/23/2012
PI Station Number	

GENERAL LOCATION



Dive Track:



DIVE DATA

Date	10-Jun-90
Minimum Bottom Depth (m)	199
Maximum Bottom Depth (m)	251
Start Bottom Time (EDT)	17:48
End Bottom End (EDT)	18:56
Starting Latitude (N)	39° 29.640'
Starting Longitude (W)	72° 21.600'
Ending Latitude (N)	39° 29.820'
Ending Longitude (W)	72° 21.720'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Soft Substrate
39° 29.640' N, 72° 21.600' W

DIVE NUMBER: JSLI-1979 *STUDY AREA: Hudson Canyon*

IMAGE GALLERY

*** indicates image position is approximated**

Image B: Soft Substrate
39° 29.730' N, 72° 21.590' W

Image C: Soft Substrate
39° 29.730' N, 72° 21.590' W

Image D: Soft Substrate
39° 29.820' N, 72° 21.720' W

RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Rowe et al. (1972, 1982)
Twitchell and Roberts (1982)
Forde et al. (1984)
Williams (1988)
Able (2002)
Watling and Auster (2005)

BIOLOGICAL ENVIRONMENT

This dive traversed part of north central Hudson Canyon. Soft sediment substrate supported sea pens, cerianthid anemones, *Chaceon quinquedens*, *Cancer* sp., and *Bathynectes* sp. crabs, longfin hakes, flounders, scorpionfish, two large skates, an ophiuroid, and a large school of squid.

PHYSICAL ENVIRONMENT

This dive covered north central Hudson Canyon. The submersible traversed soft sediment habitat with shell hash with evidence of significant bioturbation in the form of burrows and small mounds.

ADDITIONAL COMMENTS

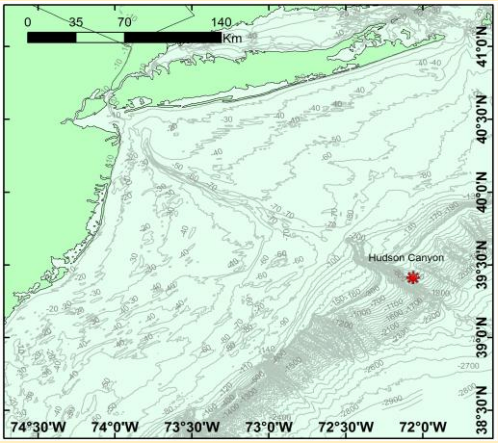
Original dives were on 8-mm tapes, then converted to digital media and stored on an external hard drive. Video quality was clear overall. Three reliable fixes were taken along the dive. Habitat type could be assigned to all three of the fixes as the bottom time was evident and the video tape continuous. Box cores and suction sediment samples were taken during video footage.

DIVE NUMBER: JSLI-1980 *STUDY AREA: Hudson Canyon*

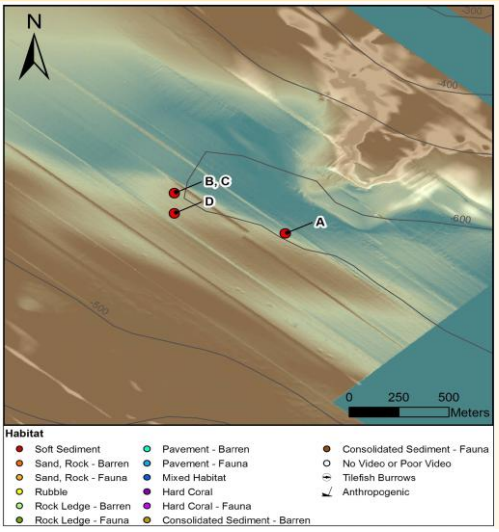
STATION OVERVIEW

Project	Ocean Dumping Impact Assessment
Principal investigators	RA Cooper[1] (deceased)
PI Contact Info[1]	University of Connecticut at Avery Point, Groton, CT 06340
Purpose	Assess the impact of sewage sludge dumping in canyons off New England and Mid-Atlantic Bight States
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	J Baker (bow), K O'Brien (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	R Cooper, I Babb, P Auster, NURC-UCAP
SEADESC Analyst	M Watts
Date Compiled	8/27/2012
PI Station Number	

GENERAL LOCATION



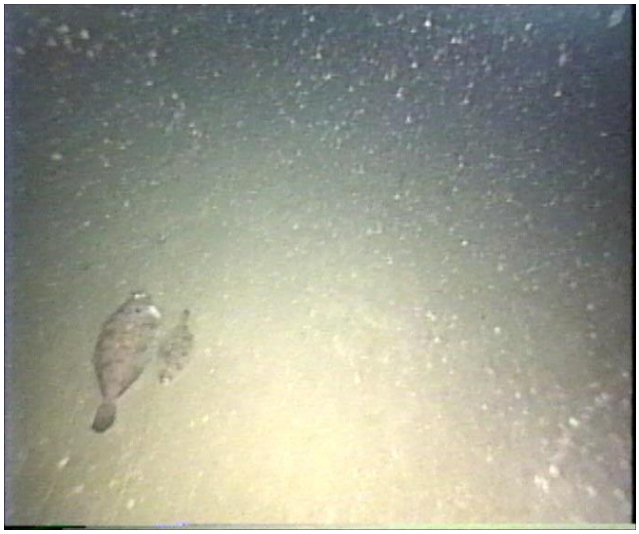
Dive Track:



DIVE DATA

Date	11-Jun-12
Minimum Bottom Depth (m)	620
Maximum Bottom Depth (m)	622
Start Bottom Time (EDT)	8:12
End Bottom End (EDT)	9:11
Starting Latitude (N)	39° 31.620'
Starting Longitude (W)	72° 23.160'
Ending Latitude (N)	39° 31.680'
Ending Longitude (W)	72° 23.460'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Soft Substrate
39° 31.620' N, 72° 23.160' W



DIVE NUMBER: JSLI-1980 *STUDY AREA: Hudson Canyon*

IMAGE GALLERY *** indicates image position is approximated**

Image B: Soft Substrate
39° 31.710' N, 72° 23.450' W

Image C: Soft Substrate
39° 31.710' N, 72° 23.450' W

Image D: Soft Substrate
39° 31.680' N, 72° 23.460' W

RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Rowe et al. (1972, 1982)
Twitchell and Roberts (1982)
Forde et al. (1984)
Williams (1988)
Able (2002)
Watling and Auster (2005)

BIOLOGICAL ENVIRONMENT

This dive traversed part of the head of Hudson Canyon. Soft sediment substrate supported *Chaceon quinquedens*, a hermit and a spider crab, *Nezumia* sp., longfin hake, flounder, synaphobranchid eels, and skates.

PHYSICAL ENVIRONMENT

This dive covered the head of Hudson Canyon. The submersible traversed soft sediment habitat with evidence of significant bioturbation in the form of tracks, burrows and small mounds.

ADDITIONAL COMMENTS

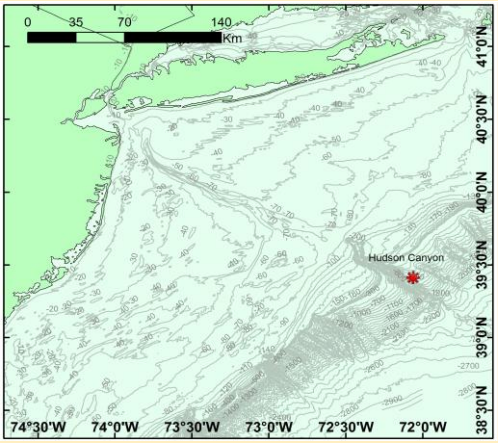
Original dives were on 8-mm tapes, then converted to digital media and stored on an external hard drive. Video quality was clear overall. Three reliable fixes were taken along the dive. Habitat type could be assigned to all three of the fixes as the bottom time was evident and the video tape continuous. Box cores and suction sediment samples were taken during video footage.

DIVE NUMBER: JSLI-1981 *STUDY AREA: Hudson Canyon*

STATION OVERVIEW

Project	Ocean Dumping Impact Assessment
Principal investigators	RA Cooper[1] (deceased)
PI Contact Info[1]	University of Connecticut at Avery Point, Groton, CT 06340
Purpose	Assess the impact of sewage sludge dumping in canyons off New England and Mid-Atlantic Bight States
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	K Harrica (bow), B Bullis (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	R Cooper, I Babb, P Auster, NURC-UCAP
SEADESC Analyst	M Watts
Date Compiled	8/30/2012
PI Station Number	

GENERAL LOCATION



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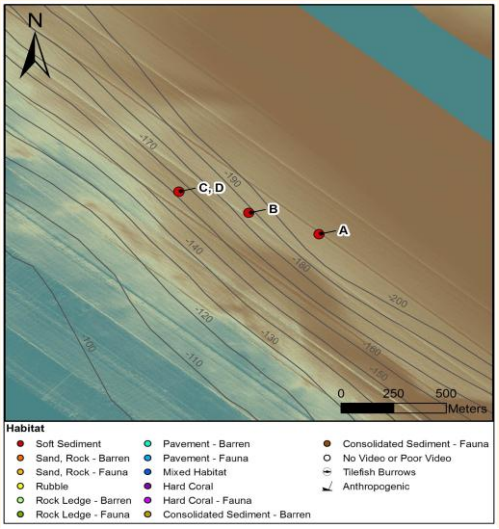


DIVE DATA

Date	11-Jun-90
Minimum Bottom Depth (m)	197
Maximum Bottom Depth (m)	224
Start Bottom Time (EDT)	12:25
End Bottom End (EDT)	13:41
Starting Latitude (N)	39° 38.640'
Starting Longitude (W)	72° 27.540'
Ending Latitude (N)	39° 38.760'
Ending Longitude (W)	72° 27.900'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Soft Substrate
39° 38.640' N, 72° 27.540' W

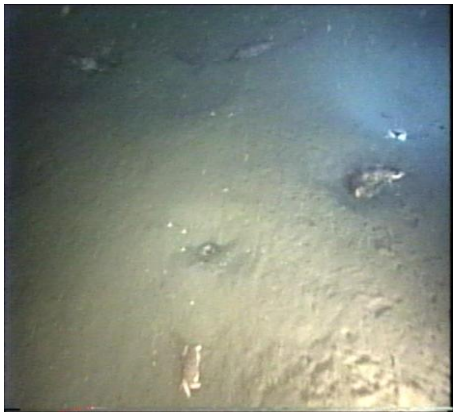
DIVE NUMBER: JSLI-1981 *STUDY AREA: Hudson Canyon*

IMAGE GALLERY *** indicates image position is approximated**

Image B: Soft Substrate
39° 38.720' N, 72° 27.720' W

Image C: Soft Substrate
39° 38.760' N, 72° 27.900' W

Image D: Soft Substrate
39° 38.760' N, 72° 27.900' W



RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Rowe et al. (1972, 1982)
Twitchell and Roberts (1982)
Forde et al. (1984)
Williams (1988)
Able (2002)
Watling and Auster (2005)

BIOLOGICAL ENVIRONMENT

This dive traversed part of the west side of northern Hudson Canyon. Soft sediment substrate supported an abundance of longfin hake and *Cancer* crabs and a few tilefish (*Lopholatilus chamaeleonticeps*).

PHYSICAL ENVIRONMENT

This dive covered part of northwestern Hudson Canyon. The submersible traversed soft sediment habitat with evidence of significant bioturbation in the form of tracks, burrows and small mounds.

ADDITIONAL COMMENTS

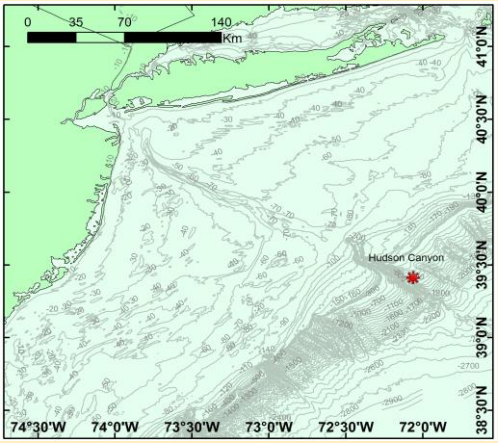
Original dives were on 8-mm tapes, then converted to digital media and stored on an external hard drive. Video quality was clear overall. Three reliable fixes were taken along the dive. Habitat type could be assigned to all three of the fixes as the bottom time was evident and the video tape continuous. Box cores were taken and a cancer crab collected during the dive.

DIVE NUMBER: JSLI-1982 *STUDY AREA: Hudson Canyon*

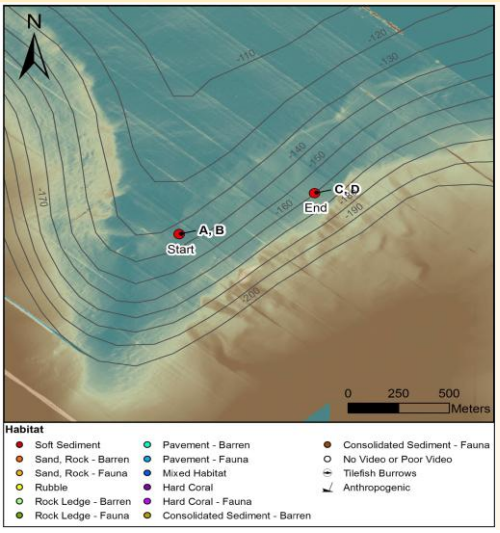
STATION OVERVIEW

Project	Ocean Dumping Impact Assessment
Principal investigators	RA Cooper[1] (deceased)
PI Contact Info[1]	University of Connecticut at Avery Point, Groton, CT 06340
Purpose	Assess the impact of sewage sludge dumping in canyons off New England and Mid-Atlantic Bight States
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	L Rader (bow), M Feeley (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	R Cooper, I Babb, P Auster, NURC-UCAP
SEADESC Analyst	M Watts
Date Compiled	9/3/2012
PI Station Number	

GENERAL LOCATION



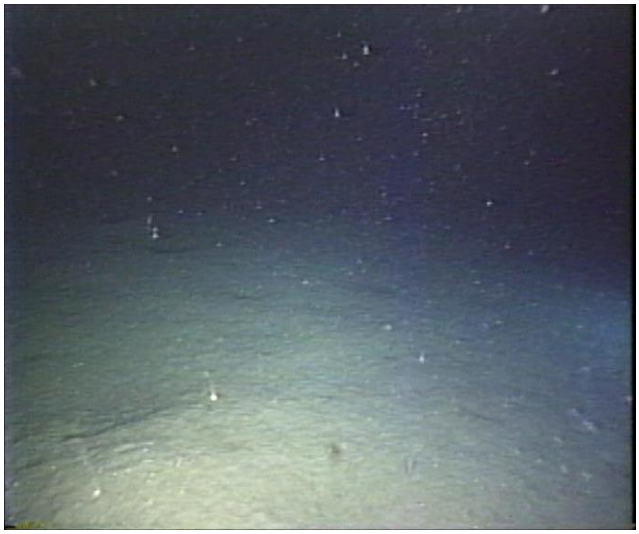
Dive Track:



DIVE DATA

Date	11-Jun-90
Minimum Bottom Depth (m)	193
Maximum Bottom Depth (m)	221
Start Bottom Time (EDT)	16:53
End Bottom End (EDT)	17:27
Starting Latitude (N)	39° 38.520'
Starting Longitude (W)	72° 24.960'
Ending Latitude (N)	39° 38.720'
Ending Longitude (W)	72° 24.600'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Soft Substrate
39° 38.520' N, 72° 24.960' W



DIVE NUMBER: JSLI-1982 *STUDY AREA: Hudson Canyon*

IMAGE GALLERY *** indicates image position is approximated**

Image B: Soft Substrate
39° 38.520' N, 72° 24.960' W

Image C: Soft Substrate
39° 38.720' N, 72° 24.600' W

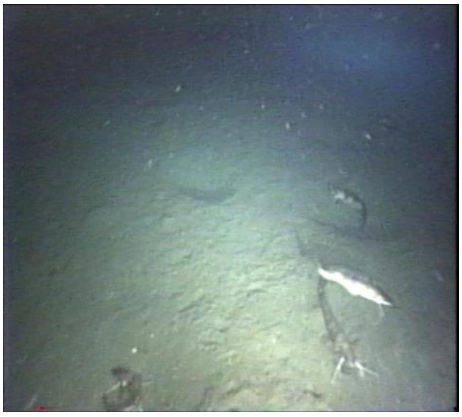


Image D: Soft Substrate
39° 38.720' N, 72° 24.600' W

RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Rowe et al. (1972, 1982)
Twitchell and Roberts (1982)
Forde et al. (1984)
Williams (1988)
Able (2002)
Watling and Auster (2005)

BIOLOGICAL ENVIRONMENT

This dive traversed part of the shallow east slope of northern Hudson Canyon. Soft sediment substrate supported an abundance of longfin hake, *Cancer* crabs, sea pens and a few sea stars.

PHYSICAL ENVIRONMENT

This dive covered part of northeastern Hudson Canyon. The submersible traversed soft sediment habitat with evidence of significant bioturbation in the form of tracks and burrows.

ADDITIONAL COMMENTS

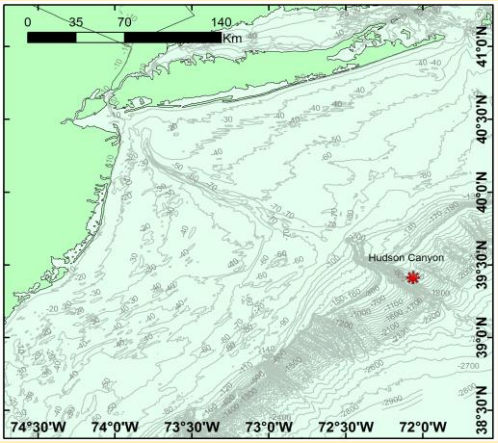
Original dives were on 8-mm tapes, then converted to digital media and stored on an external hard drive. Video quality was clear overall. Two reliable fixes were taken along the dive. Habitat type could be assigned to both of the fixes as the bottom time was evident and the video tape continuous. Box cores were taken during the dive.

DIVE NUMBER: JSLI-1987 *STUDY AREA: Hudson Canyon*

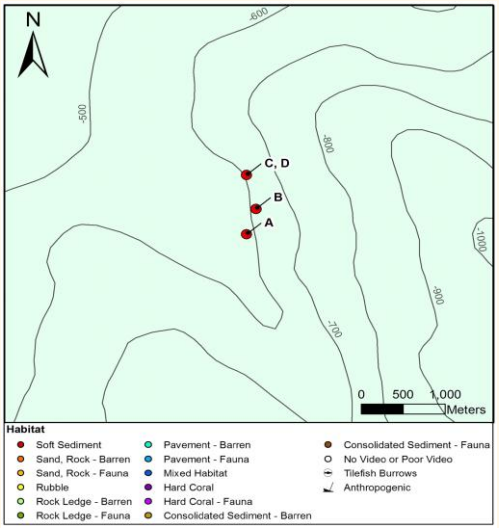
STATION OVERVIEW

Project	Ocean Dumping Impact Assessment
Principal investigators	RA Cooper[1] (deceased)
PI Contact Info[1]	University of Connecticut at Avery Point, Groton, CT 06340
Purpose	Assess the impact of sewage sludge dumping in canyons off New England and Mid-Atlantic Bight States
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	B Hughes (bow), L Bryant (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	R Cooper, I Babb, P Auster, NURC-UCAP
SEADESC Analyst	M Watts
Date Compiled	9/24/2012
PI Station Number	

GENERAL LOCATION



Dive Track:



DIVE DATA

Date	16-Jun-90
Minimum Bottom Depth (m)	630
Maximum Bottom Depth (m)	630
Start Bottom Time (EDT)	13:14
End Bottom End (EDT)	14:33
Starting Latitude (N)	39° 07.320'
Starting Longitude (W)	72° 32.460'
Ending Latitude (N)	39° 07.740'
Ending Longitude (W)	72° 32.460'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Soft Substrate
39° 07.320' N, 72° 32.460' W

DIVE NUMBER: JSLI-1987 *STUDY AREA: Hudson Canyon*

IMAGE GALLERY *** indicates image position is approximated**

Image B: Soft Substrate
39° 07.500' N, 72° 32.400' W

Image C: Soft Substrate
39° 07.740' N, 72° 32.460' W

Image D: Soft Substrate
39° 07.740' N, 72° 32.460' W

RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Rowe et al. (1972, 1982)
Twitchell and Roberts (1982)
Forde et al. (1984)
Williams (1988)
Able (2002)
Watling and Auster (2005)

BIOLOGICAL ENVIRONMENT

This dive traversed the southwest corner of Hudson Canyon. Soft sediment substrate supported an abundance of synaphobranchid eels, longfin hake, flounder, *Chaceon quinquedens,* and a few *Actinoscyphia* sp., hermit crabs, and scorpionfish.

PHYSICAL ENVIRONMENT

This dive covered part of Hudson Canyon. The submersible traversed soft sediment habitat with evidence of significant bioturbation in the form of burrows, depressions, and small mounds that covered the ocean floor.

ADDITIONAL COMMENTS

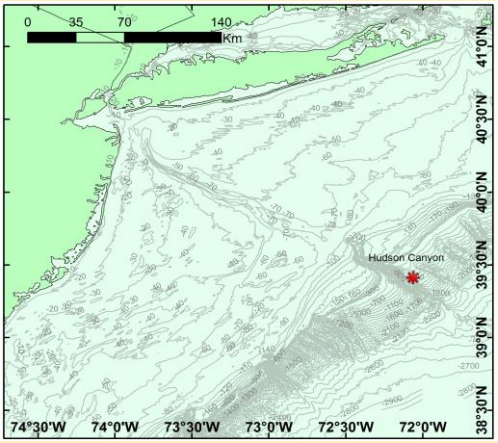
Original dives were on 8-mm tapes, then converted to digital media and stored on an external hard drive. Video quality was clear overall. Three reliable fixes were taken along the dive. Habitat type could be assigned to all three of the fixes as the bottom time was evident and the video tape continuous. Box and punch cores and suction sediment samples were taken during video footage.

DIVE NUMBER: JSLI-1988 *STUDY AREA: Hudson Canyon*

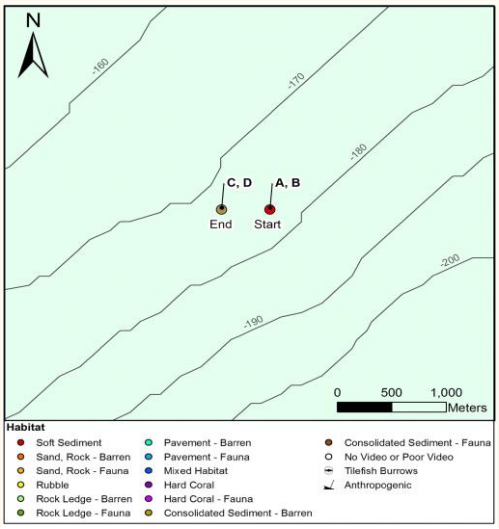
STATION OVERVIEW

Project	Ocean Dumping Impact Assessment
Principal investigators	RA Cooper[1] (deceased)
PI Contact Info[1]	University of Connecticut at Avery Point, Groton, CT 06340
Purpose	Assess the impact of sewage sludge dumping in canyons off New England and Mid-Atlantic Bight States
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	J Hess (bow), T Reynolds (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	R Cooper, I Babb, P Auster, NURC-UCAP
SEADESC Analyst	M Watts
Date Compiled	9/25/2012
PI Station Number	

GENERAL LOCATION



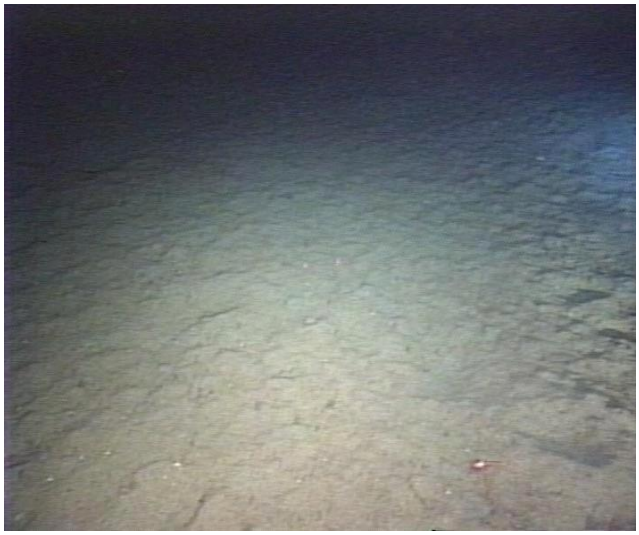
Dive Track:



DIVE DATA

Date	16-Jun-90
Minimum Bottom Depth (m)	175
Maximum Bottom Depth (m)	175
Start Bottom Time (EDT)	17:39
End Bottom End (EDT)	18:07
Starting Latitude (N)	39° 18.540'
Starting Longitude (W)	72° 21.490'
Ending Latitude (N)	39° 18.550'
Ending Longitude (W)	72° 21.720'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Soft Substrate
39° 18.540' N, 72° 21.490' W



DIVE NUMBER: JSLI-1988 *STUDY AREA: Hudson Canyon*

IMAGE GALLERY *** indicates image position is approximated**

Image B: Soft Substrate
39° 18.540' N, 72° 21.490' W

Image C: Consolidated Sediment - without Attached Fauna
39° 18.550' N, 72° 21.720' W

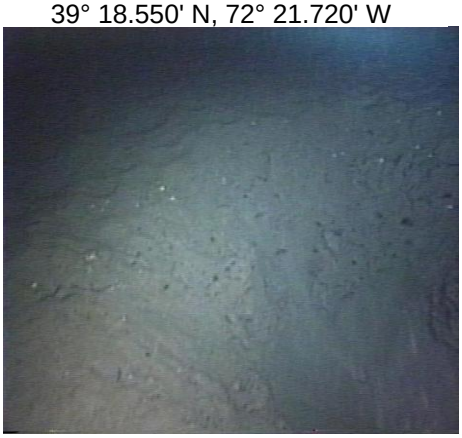


Image D: Consolidated Sediment - without Attached Fauna
39° 18.550' N, 72° 21.720' W

RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Rowe et al. (1972, 1982)
Twitchell and Roberts (1982)
Forde et al. (1984)
Williams (1988)
Able (2002)
Watling and Auster (2005)

BIOLOGICAL ENVIRONMENT

This dive traversed the southwest corner of Hudson Canyon. Soft sediment substrate supported an abundance of galatheid crabs and small tubeworms, a few cerianthid anemones, *Cancer* sp. and hermit crabs, sea stars, hake, and flounder. A small area of consolidated mud supported a large depression, small excavated burrows and a single goosefish.

PHYSICAL ENVIRONMENT

This dive covered part of Hudson Canyon. The submersible traversed soft sediment habitat with evidence of significant bioturbation in the form of burrows, depressions, and small mounds that covered the ocean floor. At the end of the dive, the submersible passed over a large depression consisting of barren consolidated mud.

ADDITIONAL COMMENTS

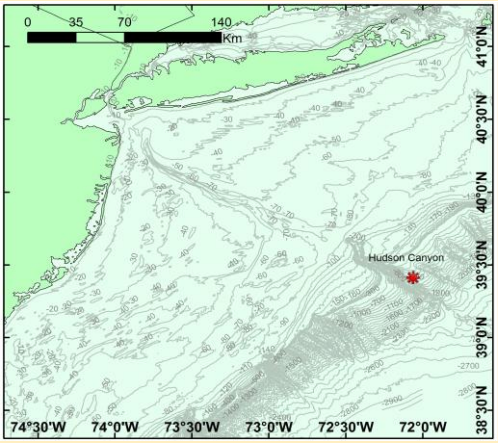
Original dives were on 8-mm tapes, then converted to digital media and stored on an external hard drive. Video quality was clear overall. Two reliable fixes were taken along the dive. Habitat type could be assigned to both of the fixes as the bottom time was evident and the video tape continuous. A single box core was taken during video footage.

DIVE NUMBER: JSLI-1989 *STUDY AREA: Hudson Canyon*

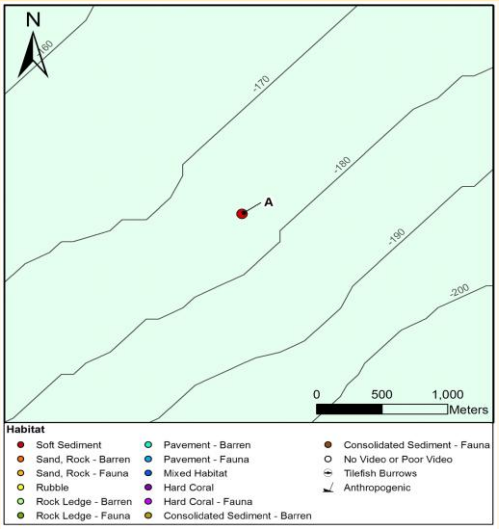
STATION OVERVIEW

Project	Ocean Dumping Impact Assessment
Principal investigators	RA Cooper[1] (deceased)
PI Contact Info[1]	University of Connecticut at Avery Point, Groton, CT 06340
Purpose	Assess the impact of sewage sludge dumping in canyons off New England and Mid-Atlantic Bight States
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	M Bortman (bow), R Rice (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	R Cooper, I Babb, P Auster, NURC-UCAP
SEADESC Analyst	M Watts
Date Compiled	9/26/2012
PI Station Number	

GENERAL LOCATION



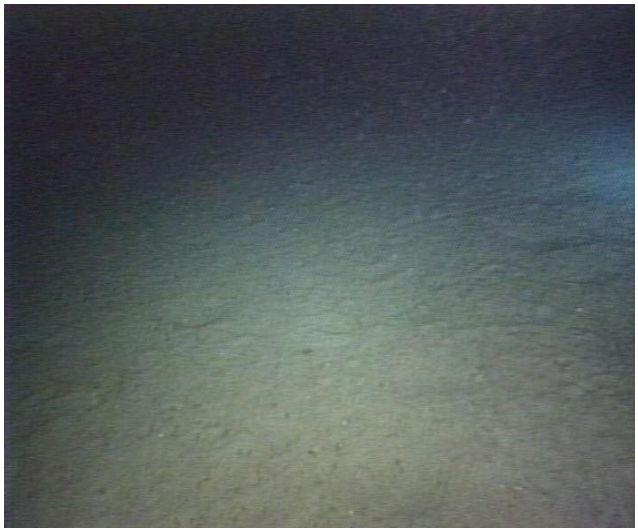
Dive Track:



DIVE DATA

Date	16-Jun-90
Minimum Bottom Depth (m)	181
Maximum Bottom Depth (m)	181
Start Bottom Time (EDT)	19:39
End Bottom End (EDT)	
Starting Latitude (N)	39° 18.600'
Starting Longitude (W)	72° 21.480'
Ending Latitude (N)	
Ending Longitude (W)	
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Soft Substrate
39° 18.600' N, 72° 21.480' W



DIVE NUMBER: JSLI-1989 *STUDY AREA: Hudson Canyon*

IMAGE GALLERY *** indicates image position is approximated**

Image B: Soft Substrate **Image C: Soft Substrate** **Image D: Soft Substrate**

RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Rowe et al. (1972, 1982)
Twitchell and Roberts (1982)
Forde et al. (1984)
Williams (1988)
Able (2002)
Watling and Auster (2005)

BIOLOGICAL ENVIRONMENT

This dive traversed the southwest corner of Hudson Canyon. Soft sediment substrate supported very little fauna including small tubeworms and a few sea pens, sea stars, flounder, and a cerianthid anemone.

PHYSICAL ENVIRONMENT

This dive covered part of Hudson Canyon. The submersible traversed soft sediment habitat with evidence of significant bioturbation in the form of burrows, depressions, and small mounds that covered the ocean floor. The submersible passed over two large depressions with associated small burrows.

ADDITIONAL COMMENTS

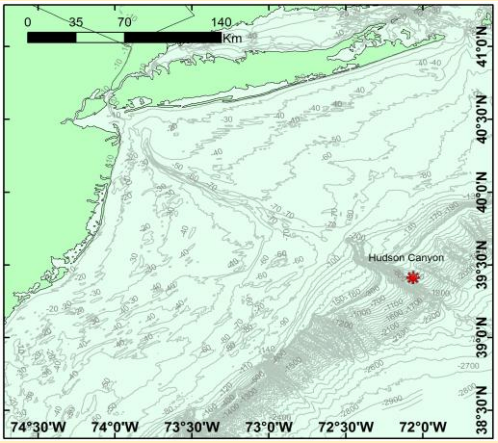
Original dives were on 8-mm tapes, then converted to digital media and stored on an external hard drive. Video quality was clear overall. Only one reliable fix, the start time fix, was taken along the dive. Habitat type could be assigned to this fix as the bottom time was evident though no audio was recorded. Therefore, only the position of picture A is known. A single box core was taken during video footage.

DIVE NUMBER: JSLI-2172 *STUDY AREA: Hudson Canyon*

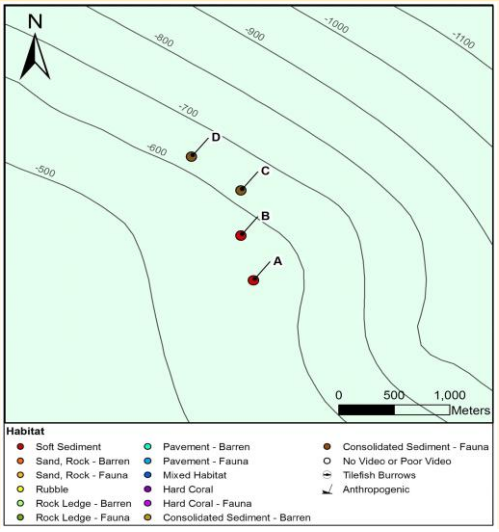
STATION OVERVIEW

Project	Ocean Dumping Impact Assessment
Principal investigators	RA Cooper[1] (deceased)
PI Contact Info[1]	University of Connecticut at Avery Point, Groton, CT 06340
Purpose	Assess the impact of sewage sludge dumping in canyons off New England and Mid-Atlantic Bight States
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	D Tedeshi (bow), J Busa (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	R Cooper, I Babb, P Auster, NURC-UCAP
SEADESC Analyst	M Watts
Date Compiled	10/4/2012
PI Station Number	

GENERAL LOCATION



Dive Track:



DIVE DATA

Date	15-Jul-91
Minimum Bottom Depth (m)	
Maximum Bottom Depth (m)	
Start Bottom Time (EDT)	8:25
End Bottom End (EDT)	10:30
Starting Latitude (N)	39° 21.710'
Starting Longitude (W)	72° 09.850'
Ending Latitude (N)	39° 22.350'
Ending Longitude (W)	72° 10.140'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Soft Substrate
39° 21.710' N, 72° 09.850' W

DIVE NUMBER: JSLI-2172 *STUDY AREA: Hudson Canyon*

IMAGE GALLERY

*** indicates image position is approximated**

Image B: Soft Substrate
39° 21.980' N, 72° 09.910' W

Image C: Consolidated Sediment - without Attached Fauna
39° 22.220' N, 72° 09.910' W

Image D: Consolidated Sediment - without Attached Fauna
39° 22.350' N, 72° 10.140' W

RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Rowe et al. (1972, 1982)
Twitchell and Roberts (1982)
Forde et al. (1984)
Williams (1988)
Able (2002)
Watling and Auster (2005)

BIOLOGICAL ENVIRONMENT

This dive traversed part of the southwest wall of Hudson Canyon. At the start of the dive, the submersible lights attracted a swarm of amphipods and shrimp that obstructed the view of the video camera. Soft sediment and consolidated sediment substrate supported an abundance of flounder, offshore and longfin hake, *Nezumia* sp., *Chaceon quinquedens,* hermit and galatheid crabs, synaphobranchid eels, goosefish, scorpionfish, an octopus, a skate and an octocoral.

PHYSICAL ENVIRONMENT

This dive covered part of the southwest wall of Hudson Canyon. The submersible traversed soft sediment habitat with evidence of significant bioturbation in the form of burrows, depressions, and small mounds that covered the ocean floor. Half way through the dive the habitat transitioned into barren consolidated sediment with burrows, excavations, and an abundance of galatheid crabs.

ADDITIONAL COMMENTS

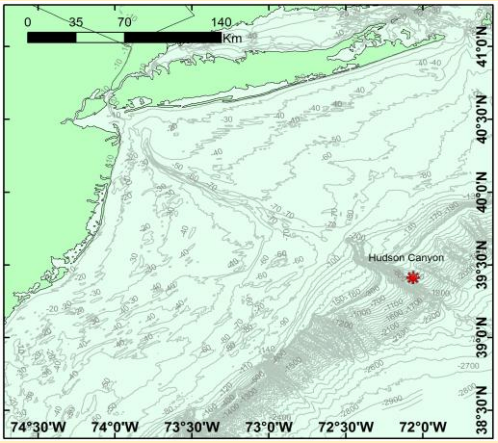
Original dives were on 8-mm tapes, then converted to digital media and stored on an external hard drive. Audio was not converted. Video quality was clear overall. Four reliable fixes were taken along the dive. Habitat type could be assigned to all four of the fixes as the bottom time was evident and the video tape continuous. Box and punch cores were taken during the dive.

DIVE NUMBER: JSLI-2175 *STUDY AREA: Hudson Canyon*

STATION OVERVIEW

Project	Ocean Dumping Impact Assessment
Principal investigators	RA Cooper[1] (deceased)
PI Contact Info[1]	University of Connecticut at Avery Point, Groton, CT 06340
Purpose	Assess the impact of sewage sludge dumping in canyons off New England and Mid-Atlantic Bight States
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	M Ryan (bow), M Jones (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	R Cooper, I Babb, P Auster, NURC-UCAP
SEADESC Analyst	M Watts
Date Compiled	10/5/2012
PI Station Number	

GENERAL LOCATION



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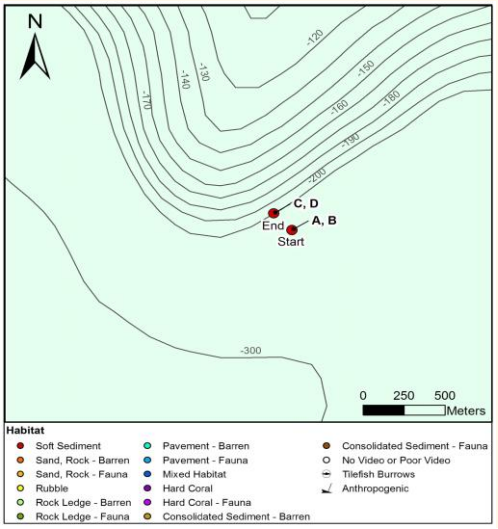


DIVE DATA

Date	16-Jul-91
Minimum Bottom Depth (m)	229
Maximum Bottom Depth (m)	229
Start Bottom Time (EDT)	15:50
End Bottom End (EDT)	16:28
Starting Latitude (N)	39° 38.150'
Starting Longitude (W)	72° 24.830'
Ending Latitude (N)	39° 38.210'
Ending Longitude (W)	72° 24.870'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Soft Substrate
39° 38.150' N, 72° 24.830' W

DIVE NUMBER: JSLI-2175 *STUDY AREA: Hudson Canyon*

IMAGE GALLERY *** indicates image position is approximated**

Image B: Soft Substrate
39° 38.150' N, 72° 24.830' W

Image C: Soft Substrate
39° 38.210' N, 72° 24.870' W

Image D: Soft Substrate
39° 38.210' N, 72° 24.870' W

RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Rowe et al. (1972, 1982)
Twitchell and Roberts (1982)
Forde et al. (1984)
Williams (1988)
Able (2002)
Watling and Auster (2005)

BIOLOGICAL ENVIRONMENT

This dive traversed part of the head of Hudson Canyon. Soft sediment habitat supported an abundance of sea pens, *Cancer* sp., shrimp, a few sea stars, flounder, offshore and longfin hake, *Chaceon quinquedens*, synaphobranchid eels, lobsters, a large ophiuroid, and a scorpionfish.

PHYSICAL ENVIRONMENT

This dive covered part of the head of Hudson Canyon. The submersible traversed soft sediment habitat with evidence of significant bioturbation in the form of burrows, depressions, and small mounds that covered the ocean floor.

ADDITIONAL COMMENTS

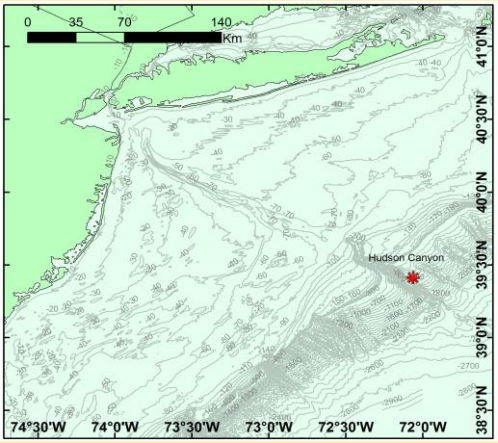
Original dives were on 8-mm tapes, then converted to digital media and stored on an external hard drive. Audio was not converted. Video quality was clear overall. Two reliable fixes were taken along the dive. Habitat type could be assigned to both of the fixes as the bottom time was evident and the video tape continuous. Box and punch cores were taken during the dive.

DIVE NUMBER: JSLI-2368 *STUDY AREA: Hudson Canyon*

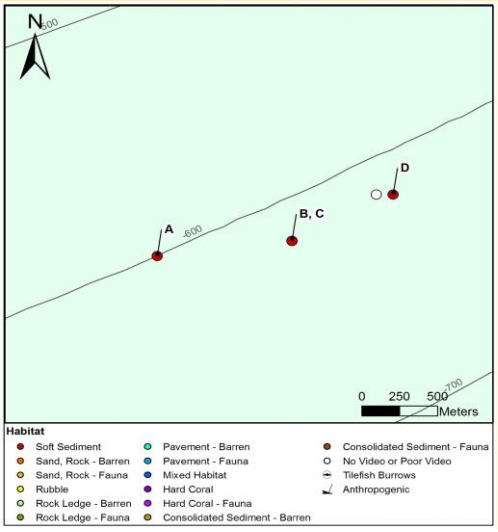
STATION OVERVIEW

Project	Ocean Dumping Impact Assessment
Principal investigators	RA Cooper[1] (deceased)
PI Contact Info[1]	University of Connecticut at Avery Point, Groton, CT 06340
Purpose	Assess the impact of sewage sludge dumping in canyons off New England and Mid-Atlantic Bight States
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	J Busa (bow), S Levenbach (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	R Cooper, I Babb, P Auster, NURC-UCAP
SEADESC Analyst	M Watts
Date Compiled	10/1/2012
PI Station Number	

GENERAL LOCATION



Dive Track:



DIVE DATA

Date	17-Jun-92
Minimum Bottom Depth (m)	594
Maximum Bottom Depth (m)	613
Start Bottom Time (EDT)	15:20
End Bottom End (EDT)	17:25
Starting Latitude (N)	39° 13.664'
Starting Longitude (W)	72° 16.834'
Ending Latitude (N)	39° 13.910'
Ending Longitude (W)	72° 16.016'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Soft Substrate
39° 13.664' N, 72° 16.834' W

DIVE NUMBER: JSLI-2368 *STUDY AREA: Hudson Canyon*

IMAGE GALLERY *** indicates image position is approximated**

Image B: Soft Substrate
39° 13.711' N, 72° 16.364' W

Image C: Soft Substrate
39° 13.711' N, 72° 16.364' W

Image D: Soft Substrate
39° 13.910' N, 72° 16.016' W

RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Rowe et al. (1972, 1982)
Twitchell and Roberts (1982)
Forde et al. (1984)
Williams (1988)
Able (2002)
Watling and Auster (2005)

BIOLOGICAL ENVIRONMENT

This dive traversed part of southwest Hudson Canyon. Soft sediment substrate supported huge aggregations of *Chaceon quinquedens*, as well as an abundance of quillworms, synaphobranchid eels, flounder, longfin hake, *Nezumia* sp., a few *Actinoscyphia* sp., sea stars, hermit crabs, a large red shrimp, a galatheid crab, an octopus, a goosefish, and a skate.

PHYSICAL ENVIRONMENT

This dive covered part of southwest Hudson Canyon. The submersible traversed soft sediment habitat with evidence of significant bioturbation in the form of burrows, depressions, and small mounds that covered the ocean floor.

ADDITIONAL COMMENTS

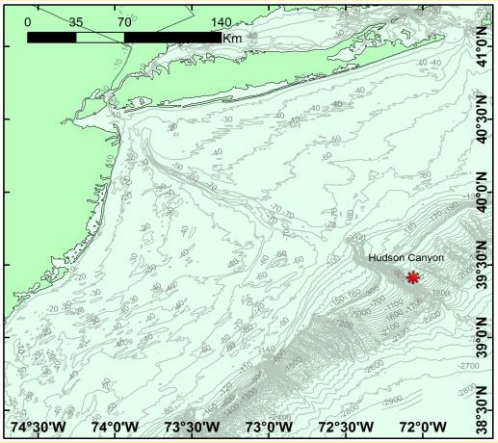
Original dives were on 8-mm tapes, then converted to digital media and stored on an external hard drive. Video quality was poor and dark with the external camera angled too far off the bottom to accurately identify all fauna. Four reliable fixes were taken along the dive. Habitat type could be assigned to three of the fixes as audio cues were necessary to align the time of the fixes with the video as no time stamp overlay was present on the video. Video footage was not continuous in a few instances. Box and punch cores were taken and an *Actinoscyphia* sp. and amphipods were collected during the dive.

DIVE NUMBER: JSLI-2369 *STUDY AREA: Hudson Canyon*

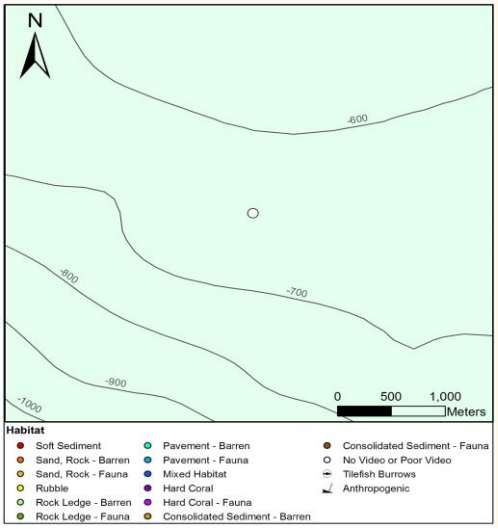
STATION OVERVIEW

Project	Ocean Dumping Impact Assessment
Principal investigators	RA Cooper[1] (deceased)
PI Contact Info[1]	University of Connecticut at Avery Point, Groton, CT 06340
Purpose	Assess the impact of sewage sludge dumping in canyons off New England and Mid-Atlantic Bight States
Vessel	R/V Seward Johnson, Johnson Sea Link I Submersible
Science Divers	M Wohlleber (bow), M Morgan (stern)
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☑
Other	
Acknowledgements	R Cooper, I Babb, P Auster, NURC-UCAP
SEADESC Analyst	M Watts
Date Compiled	10/6/2012
PI Station Number	

GENERAL LOCATION



Dive Track:



DIVE DATA

Date	18-Jun-92
Minimum Bottom Depth (m)	625
Maximum Bottom Depth (m)	640
Start Bottom Time (EDT)	
End Bottom End (EDT)	
Starting Latitude (N)	39° 24.700'
Starting Longitude (W)	72° 03.500'
Ending Latitude (N)	
Ending Longitude (W)	
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Soft Substrate

DIVE NUMBER: JSLI-2369 *STUDY AREA: Hudson Canyon*

IMAGE GALLERY *** indicates image position is approximated**

Image B: Soft Substrate

Image C: Soft Substrate

Image D: Sand/Rubble/Rock-without Attached Fauna

RELEVANT WORK AND/OR LITERATURE CITED

Stetson (1949)
Rowe et al. (1972, 1982)
Twitchell and Roberts (1982)
Forde et al. (1984)
Williams (1988)
Able (2002)
Watling and Auster (2005)

BIOLOGICAL ENVIRONMENT

This dive traversed part of southeastern Hudson Canyon. Soft sediment substrate supported large aggregations of *Chaceon quinquedens*, *Nezumia* sp., synaphobranchid eels, offshore hakes, flounders, and two skates. Occasional rocks supported *Actinoscyphia* sp. and hydroids.

PHYSICAL ENVIRONMENT

This dive covered a region of southeastern Hudson Canyon. The submersible traversed soft sediment habitat with evidence of significant bioturbation in the form of burrows, tracks, and small mounds. At the end of the dive, the submersible covered soft sediment with rock habitat consisting of a few small outcrops of rocks.

ADDITIONAL COMMENTS

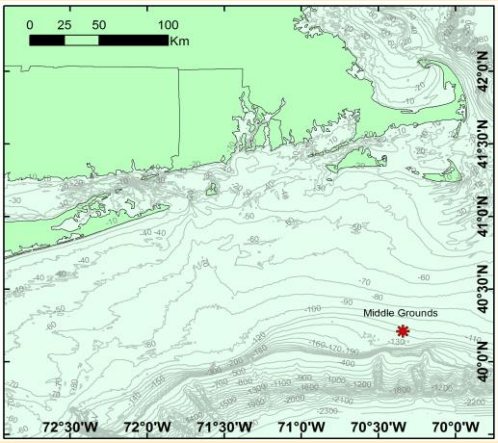
Original dives were on 8-mm tapes, then converted to digital media and stored on an external hard drive. Video quality was clear overall. Audio was not recorded. Only one reliable fix was taken along the dive. Habitat type could not be assigned to this fix as there was no time reference in the dive log for the fix. Therefore, images representing habitat type are given without positional reference above. Box and punch cores were taken and an *Actinoscyphia* sp. collected during video footage.

DIVE NUMBER: Delta-633 *STUDY AREA: Middle Grounds*

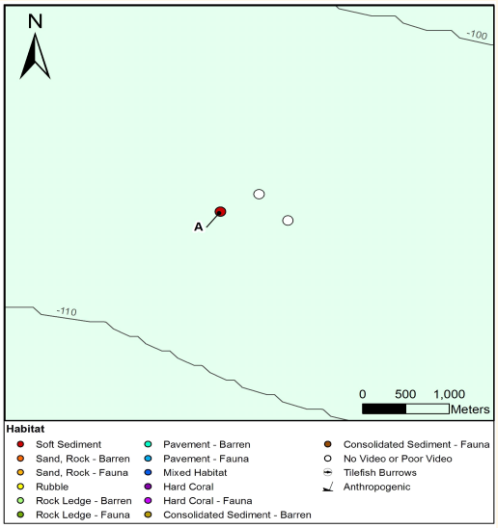
STATION OVERVIEW

Project	Ocean Dumping Impact Assessment
Principal investigators	CB Grimes[1] KW Able, RS Jones, DC Twichell, SC Turner
PI Contact Info[1]	Southwest Fisheries Science Center, Fisheries Ecology Division, 110 Shaffer Rd, Santa Cruz, CA 95060
Purpose	Investigation of tilefish fishery on the middle Atlantic and southern New England continental shelf
Vessel	Delta Submersible
Science Divers	K Able
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☐
Other	
Acknowledgements	K Able, Mid-Atlantic Fishery Management Council
SEADESC Analyst	M Watts
Date Compiled	10/9/2012
PI Station Number	

GENERAL LOCATION



Dive Track:



DIVE DATA

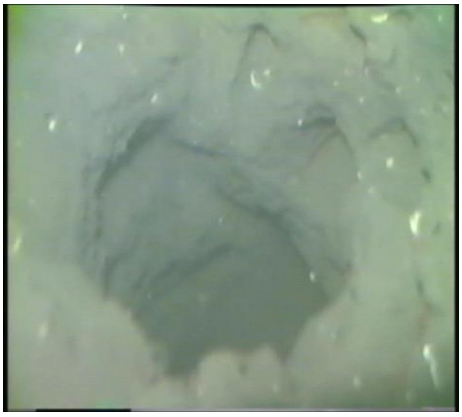
Date	02-Jun-87
Minimum Bottom Depth (m)	
Maximum Bottom Depth (m)	
Start Bottom Time (EDT)	8:35
End Bottom End (EDT)	9:26
Starting Latitude (N)	40° 12.490'
Starting Longitude (W)	70° 20.430'
Ending Latitude (N)	40° 12.410'
Ending Longitude (W)	70° 20.040'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Soft Substrate
40° 12.490' N, 70° 20.430' W

DIVE NUMBER: Delta-633 *STUDY AREA: Middle Grounds*

IMAGE GALLERY *** indicates image position is approximated**

Image B: Tilefish Habitat **Image C: Tilefish Habitat** **Image D: Soft Substrate**



RELEVANT WORK AND/OR LITERATURE CITED

Grimes et al. (1980, 1987)
Turner et al. (1983)
Able (2002)

BIOLOGICAL ENVIRONMENT

This dive traversed part of the "Middle Grounds," an area between Hudson Canyon and the Great South Channel. Soft sediment substrate supported an abundance of *Cancer* sp., sea pens, a few sea stars, cerianthid anemones, a hake, a lobster and squid eggs. Tilefish habitat supported tilefish (*Lopholatilus chamaeleonticeps*), and galatheid crabs.

PHYSICAL ENVIRONMENT

This dive covered part of the "Middle Grounds." The submersible traversed soft sediment habitat with evidence of significant bioturbation in the form of burrows, depressions, and small mounds that covered the ocean floor. Occupied and filled-in tilefish burrows were common.

ADDITIONAL COMMENTS

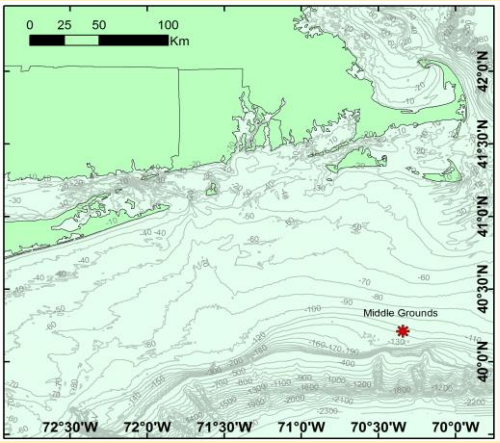
Original dives were on VHS tapes, then converted to digital media and stored on an external hard drive. Video quality was clear overall. Four reliable fixes were taken along the dive. Two fixes had the same coordinates, causing overlap on the map. Habitat type could only be assigned to the start time fix as audio cues necessary to align the time of the rest of the fixes with the video were not given. No video overlay was present on the tape and video footage was not continuous. Therefore, images B-D representing habitat type are given without positional reference above.

DIVE NUMBER: Delta-634 *STUDY AREA: Middle Grounds*

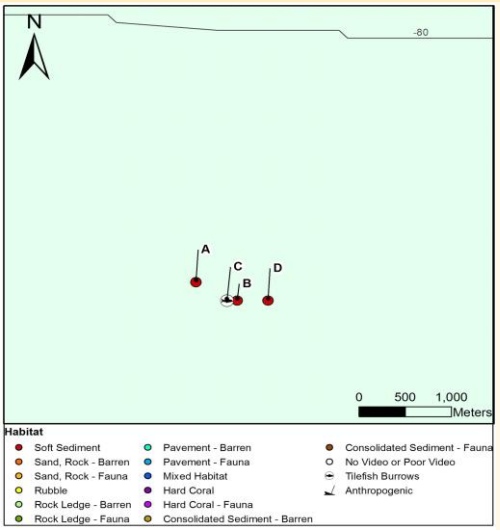
STATION OVERVIEW

Project	Ocean Dumping Impact Assessment
Principal investigators	CB Grimes[1] KW Able, RS Jones, DC Twichell, SC Turner
PI Contact Info[1]	Southwest Fisheries Science Center, Fisheries Ecology Division, 110 Shaffer Rd, Santa Cruz, CA 95060
Purpose	Investigation of tilefish fishery on the middle Atlantic and southern New England continental shelf
Vessel	Delta Submersible
Science Divers	D Twichell
External Video Tapes	External Hard Drive
Internal Video Tapes	
Digital Still Photos	
Positioning System	Loran C
CTD File	☐
Specimens Collected	☐
Other	
Acknowledgements	K Able, Mid-Atlantic Fishery Management Council
SEADESC Analyst	M Watts
Date Compiled	10/10/2012
PI Station Number	

GENERAL LOCATION



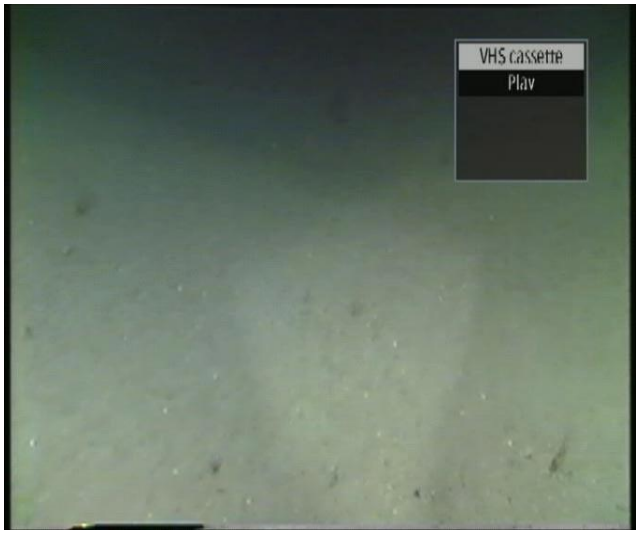
Dive Track:



DIVE DATA

Date	02-Jun-87
Minimum Bottom Depth (m)	117
Maximum Bottom Depth (m)	119
Start Bottom Time (EDT)	11:10
End Bottom End (EDT)	11:42
Starting Latitude (N)	40° 08.190'
Starting Longitude (W)	70° 21.040'
Ending Latitude (N)	40° 07.740'
Ending Longitude (W)	70° 20.910'
Surface Current (Kts)	
Bottom Current (Kts)	

Image A: Soft Substrate
40° 08.190' N, 70° 21.040' W



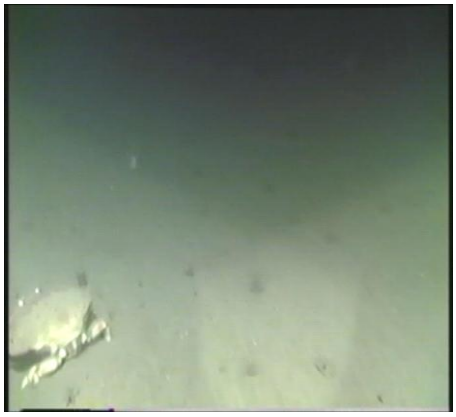
DIVE NUMBER: Delta-634 *STUDY AREA: Middle Grounds*

IMAGE GALLERY *** indicates image position is approximated**

Image B: Soft Substrate
40° 08.020' N, 70° 20.910' W

Image C: Tilefish Habitat
40° 08.010' N, 70° 20.930' W

Image D: Soft Substrate
40° 07.740' N, 70° 20.910' W



RELEVANT WORK AND/OR LITERATURE CITED

Grimes et al. (1980, 1987)
Turner et al. (1983)
Able (2002)

BIOLOGICAL ENVIRONMENT

This dive traversed part of the "Middle Grounds," an area between Hudson Canyon and the Great South Channel. Soft sediment substrate supported an abundance of *Cancer* sp., sea pens, a few sea stars, topshell snails, cerianthid anemones, a hake, a lobster and squid eggs. Tilefish habitat supported tilefish (*Lopholatilus chamaeleonticeps*), and galatheid crabs.

PHYSICAL ENVIRONMENT

This dive covered part of the "Middle Grounds." The submersible traversed soft sediment habitat with evidence of significant bioturbation in the form of burrows, depressions, and small mounds that covered the ocean floor. Occupied and filled-in tilefish burrows were common.

ADDITIONAL COMMENTS

Original dives were on VHS tapes, then converted to digital media and stored on an external hard drive. Video quality was clear overall. Four reliable fixes were taken along the dive. Habitat type could be assigned to all four fixes with the audio cues necessary to align the time with the video. No video overlay was present on the tape and video footage was not continuous.

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