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Deep-Water Benthic Habitat Characterization and Cable Impact Assessment for the South Florida Ocean Measurement Facility (SFOMF)

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1 INTRODUCTION

The purpose of this effort was to (1) provide a characterization of benthic habitats within the South Florida Ocean Measurement Facility (SFOMF) OP AREA cable corridor along deep fiber-optic cable C/S 96 from a depth of ~30 m to the reported eastern seaward terminus on the Miami Terrace (~500 m depth), and (2) identify and estimate impacts to deep benthic habitat resources from cable infrastructure in the same corridor preparatory to an Essential Fish Habitat (EFH) Assessment.

The project was carried out in response to a request from the SFOMF (a detachment of Naval Surface Warfare Center Carderock Division [NSWCCD]). This effort was carried out within the SFOMF OP AREA located just south of the Port Everglades entrance channel in Broward County, Florida (Figure 1-1). The survey consisted of a videographic and still photographic survey executed using the NSWCCD's Television Observed Nautical Grappling System (TONGS) Remotely Operated Vehicle (ROV) to examine a cable route and comparable areas without cables. The survey included a 26.2-km-long transect along a cable route, 1-km-long parallel transects 150 m on each side of the cable route between 30 m and 90 m depth, a 20.2-km-long transect ~1.6 km north of the cable route between 250 and 500 m depth, a 13.4-km-long transect ~2.2 km south of the cable route between 285 and 565 m depth, plus three north-south oriented transects along the cable route. The total length of the survey was approximately 67 km (=~36 nm).

Tasks included (1) review of video and still photographic data for organism identification, (2) analyses of still images for substrate type, taxon abundances and density by habitat/substrate type and location, and percent cover by taxon, (3) characterization and mapping of benthic habitats/biological zones, and (4) comparison of Cable and Non-Cable habitats.

The data and analyses in this report are part of a larger study that also assessed cable impacts in seven selected shallower-water habitats (0-30 m) in the OP AREA. Major differences in methodologies between the shallow-water study and this one necessitated different approaches to data collection. Environments beyond scuba depth are inherently far more difficult of access, and data acquisition is more limited for a given time effort. In addition, resource management agencies (e.g., BOEM, NOAA, SAFMC) apply different regulatory criteria to shallow versus deeper-water habitats (e.g., Coral Habitat of Particular Concern for deep-water corals; Section 2.4, below). The survey reported here was carried out at depths greater than recreational scuba diving limits (30 m). As a result, all data were collected remotely; results and analyses were based entirely on video and photographs, and all data were analyzed and reported to conform with agency criteria for deep-water habitats.

Although cable-associated EFH impacts may occur during cable deployment and continuously over the time cable remains on reef habitat, this project was not designed to and could not distinguish among impacts associated with deployment and those that have occurred since deployment. Similarly, it cannot anticipate the nature and breadth of future deployment impacts.

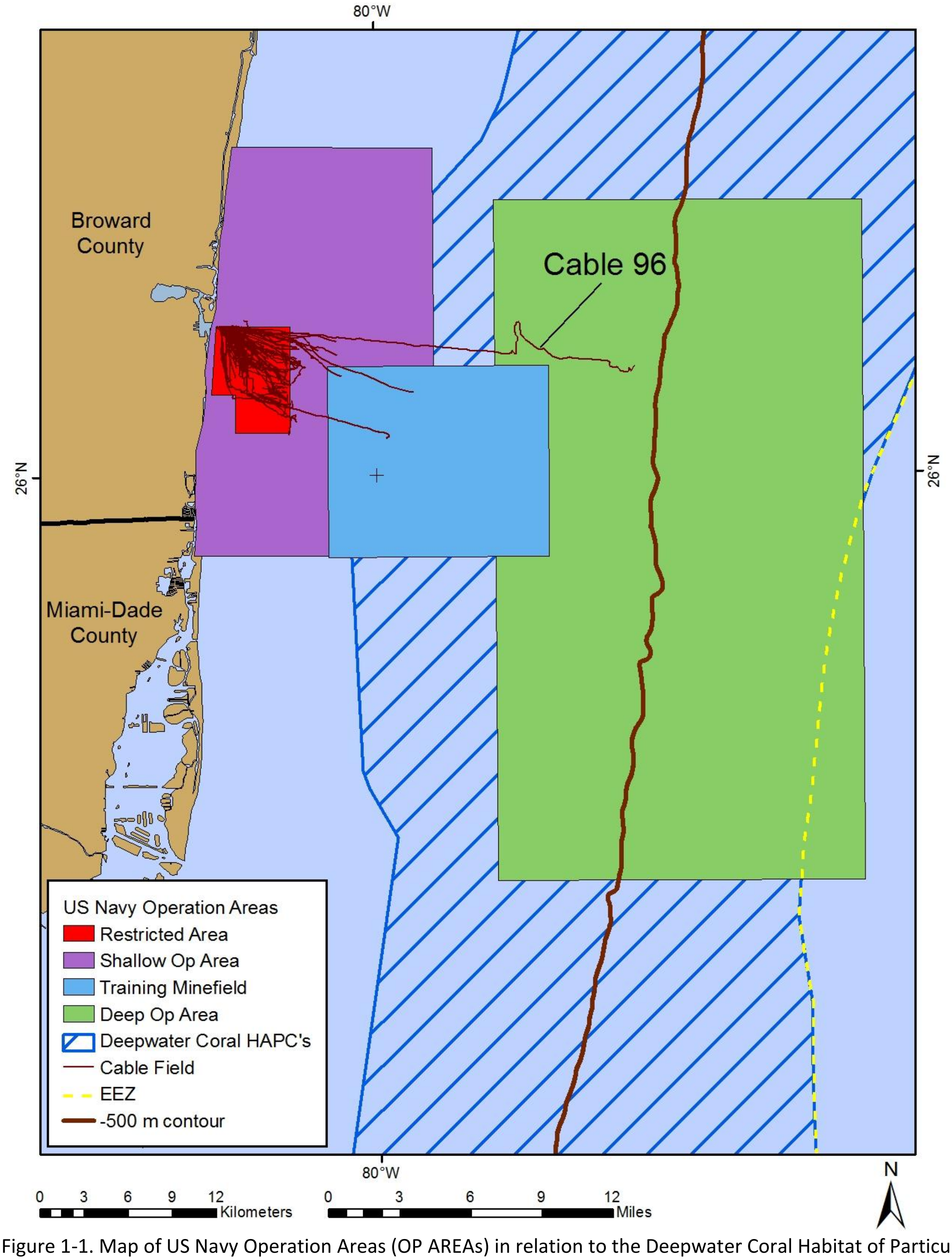

Figure 1-1. Map of US Navy Operation Areas (OP AREAs) in relation to the Deepwater Coral Habitat of Particular Concern (HAPC) and the Economic Exclusive Zone (EEZ) along the southeast Florida coast. This study aimed to provide a characterization of benthic habitats along submarine Cable 96 from a depth of ~30 m to the reported eastern seaward terminus on the Miami Terrace (~500 m depth).

2 BACKGROUND

2.1 Essential Fish Habitat (EFH)

The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA; Public Law 104-208) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" [16 U.S.C. 1802 (10)]. The National Marine Fisheries Service (NMFS) and the South Atlantic Fisheries Management Council (SAFMC), one of eight regional fisheries management councils, are responsible for managing and protecting fisheries and habitat essential for the survival of managed species within the federal 200-nautical-mile limit off U.S. coasts extending from North Carolina to Key West, Florida. The provisions of the MSFCMA delegate this authority to the U.S. Secretary of Commerce, who acts through NMFS and the SAFMC. As amended by the Sustainable Fisheries Act of 1996, Section 303(a)(7), the MSFCMA includes several mandates for NMFS and SAFMC to identify and protect EFH for all managed species in each Fisheries Management Plan (FMP); minimize to the extent practicable the adverse effects of fishing on EFH, and identify other actions to encourage the conservation and enhancement of EFH (FDOT, 2010).

EFH identified in the FMP Amendments for the SAFMC off southeastern Florida include live/hard bottoms, coral and coral reefs, artificial/manmade reefs, *Sargassum* and the water column (NOAA NMFS, 2000), which established the basis for quantitative photostation selection in this study. Note that BOEM (**Gulf of Mexico OCS Region,** NTL No. 99-G16) defines Live Bottom (in addition to shallow-water seagrass communities) as areas containing biological assemblages consisting of sessile invertebrates living upon and attached to naturally occurring hard or rocky formations with rough, broken, or smooth topography, and areas where the lithotope (i.e., sedimentary environment) favors the accumulation of turtles, fishes, or other fauna. However, because extensive portions of the hard substrates in the study area support sparse to widely scattered sessile invertebrates, we use the term Hard Bottom exclusively.

This report provides a benthic habitat characterization along a designated cable route and additional transects in the SFOMC's OP AREA as described in Section 1.0, to examine the distribution of benthic habitats and evaluate existing and potential effects of cables on benthic communities. The report supports portions of two of the items required by the MSFCMA for an EFH Assessment for any proposed future cable deployment: 1) an analysis of the effects, including cumulative effects, of the action on EFH, the managed species, and associated species by life history stage, and 2) results of an on- site inspection, the views of recognized experts on the habitat or species affects, a literature review, an analysis of alternatives to the proposed action, and any other relevant information (NOAA NMFS, 2000). Potential effects of future cables on EFH cannot be assessed without detailed information on techniques and procedures for cable deployment and are beyond the scope of this survey report.

2.2 Habitats of Particular Concern (HAPCs)

The MFSCMA describes HAPCs as subsets of EFH which are "rare, particularly susceptible to human-induced degradation, especially ecologically important, or located in an environmentally stressed area" (NOAA NMFS, 2000). Within the OP AREA treated here (Figure 1-1), NOAA NMFS (2000) indicates hermatypic coral habitat and reefs, and hard bottoms as HAPCs. In addition, one of the five deep-water Coral Habitat Areas of Particular Concern (CHAPCs), which includes coral, coral reefs, and live/hardbottom habitat, established by NOAA in 2010, also spans part of the OP AREA, in waters extending from the 250-m isobath, roughly along longitude 80.016 W, to the Exclusive Economic Zone boundary with the Bahamas. All deep-water hardbottom habitat encountered at depths >100 m fall within the CHAPC. Within the CHAPCs, it is prohibited to possess coral species or use all bottom-damaging gear, including bottom longline, trawl (bottom and mid-water), dredge, pot or trap, or anchor, anchor and chain, or grapple and chain by all fishing vessels. NOAA and the SAFMC have previously expressed concern regarding possible damage to Deep Sea Coral Ecosystem habitat from bottom-disturbing activities in this deep-water area. Although this is an extensive designated area, it spans a variety of habitats, some characterized by protected species such as deep-water mound-building corals, and some not. As a result, on 22 July 2010, NOAA Fisheries Service put into effect a final rule to its Comprehensive Ecosystem-Based Amendment 1 (CE-BA 1), which established allowable gear areas for golden crab and deepwater shrimp fisheries within the CHAPC, permitting continued access to historical fishing grounds that have little or no negative impacts on protected deepwater coral habitat.

2.3 Physical Setting

The southeastern Florida continental shelf is part of an extensive subsiding carbonate platform that includes the Florida peninsula and west Florida shelf. Shallow-water coral reefs along the inner southeastern margin of this platform off Broward County chiefly form three linear terrace-like features parallel to the coastline and separated by sand channels (Walker et al. 2008). The crest of the most seaward lies at a depth of ~16-18 m. An unpublished U.S. Navy multibeam bathymetric survey indicates an additional linear feature parallel to the coastline in 85-90 m that might represent a relict reef or erosional feature (Walker et al., 2004). Below ~300 m, submersible observations have revealed phosphorite nodules and slabs that begin to crop out of prograding sediments at the inshore margin of the northern end of the Miami Terrace, an elongated, 120-km-long, portion of a drowned carbonate platform that parallels the coast from Broward County to northern Key Largo. Since Siegler (1959) first reported the Terrace as "an old coral reef," its geology has been investigated in substantial detail via high-resolution seismic reflection profiling, rock dredge sampling and submersible observations. It covers ~740 km^2, is widest off Miami (22.2 km), and tapers to the north and south where it disappears under prograding sediments (Kofoed & Malloy 1965, Rona & Clay 1966, Malloy & Hurley 1970, Neumann & Ball 1970, Ballard & Uchupi 1971, Mullins & Neumann 1979, Reed et al. 2006).

A distinct upper terrace, in ~200 to 375 m, exhibits highly irregular karstic topography with massive phosphoritic limestone outcrops and pavements most likely produced by subaerial exposure during the Middle to Late Miocene (Neumann & Ball 1970, Ballard & Uchupi 1971, Mullins & Neumann 1979). Ballard & Uchupi (1971) described the outer Terrace edge near the proposed pipeline track as continuous phosphoritic limestone with steep ridges 50 to >80 m in relief with some near-vertical slopes, undercuts and slump blocks, as well as shallower steps. South of the pipeline route off Miami, the outer Terrace margin consists of a pair of north-south ridges cresting in as little as 310 (west ridge) and 412 m (east ridge), with steep phosphoritic limestone escarpments and vertical relief reaching ~90 m (Neumann & Ball 1970, Reed et al. 2005, 2006). A narrower, discontinuous lower terrace in ~600-700 m apparently formed as a result of middle Miocene submarine erosion perhaps brought about by intensification of the Gulf Stream/Florida Current system associated with closure of the Isthmus of Panamá (Mullins &

Neumann 1979, Bartoli et al. 2005). Below the Terrace, extensive sediment deposits of the Pourtalès Drift, which extends from about 24°N to almost 26°30'N (Bergmann & Eberli 2003), are topped by mounds of azooxanthellate corals (Neumann & Ball 1970).

The survey area lies under the Florida Current, which flows northerly at 150 cm sec^{-1} or greater and transports a mean of 31.5 Sv to the North Atlantic with a seasonal range of up to ~10 Sv (Larsen and Sanford, 1985, Lee et al. 1985, Molinari et al. 1985, Leaman et al. 1987, Schott et al. 1988). Over 40% derives from the South Atlantic, restoring to the North Atlantic the water volume lost to the Southern Hemisphere via the deep thermohaline conveyor (Schmitz and Richardson 1991, Schmitz et al. 1993). The current has been subject to extensive modeling and observational studies (e.g., Düing 1973 1975, Kielmann & Düing 1974, Düing et al. 1977, Johns and Schott, 1987, Lee et al. 1995, Wang & Mooers 1998) and is influenced by inflows through channels in the Bahama banks (Atkinson et al. 1995, Leaman et al. 1995), local synoptic atmospheric (Lee & Williams 1988) and tidal forcing (Mayer et al. 1984), Gulf of Mexico Loop Current variability, and occasional large migrating mesoscale eddies (Lee et al. 1996). The current also sheds smaller mesoscale eddies inshore along the Florida Coast (Lee and Mayer 1977, Lee et al. 1992, Shay et al. 2000 2003). However, detailed physical characteristics of its complex benthic boundary layer remain largely unexplored, although both the face and foot of the Miami Terrace, the western slope of Little Bahama Bank, and the northern Strait floor to at least 845 m experience transient southward undercurrents and benthic countercurrents reaching 50 cm sec^{-1} (Hurley & Fink 1963, Neumann & Ball 1970, Düing & Johnson 1971, Düing 1975, Brooks & Niiler 1975, Lee et al. 1985, Messing, unpublished *in situ* observations).

2.4 Biological Environment

The Strait of Florida serves as both a biological conduit and barrier, and, although just a small marginal arm of the Atlantic Ocean, forms an important hotspot of biodiversity. The chiefly unidirectional flow of the Florida Current creates a continuous enough environment so that many bottom-associated organisms have ranges extending from northern South America to southern Florida. By contrast, the combination of water mass properties within the Strait and the physiographic features of its margins create important physical and biological barriers. The geostrophic flow characteristic of western boundary currents such as the Florida Current tilts isotherms across the channel so steeply that similar depths on opposite sides experience substantially different conditions, e.g., a mean temperature of 10°C occurs in 200 m on the Florida side of the northern Strait but almost 600 m on the Bahama side (Leaman et al. 1987). Similarly, although the Florida and Bahama platforms share a common origin, the relict phosphoritic terraces and thick sediment drapes of the Florida margin of the Strait contrast strongly with the steep bank-edge escarpments and lithified mounds of the Bahama side (Malloy & Hurley 1970, Ballard & Uchupi 1971, Neumann et al. 1977, Mullins & Neumann 1979, Anselmetti et al. 2000). As a result, the Strait represents an important biogeographic boundary where different faunas, especially those at ≥200-600-m depths, meet to contribute to what might be the greatest species richness in the western central Atlantic. The Strait also exhibits the greatest number of endemic marine fishes in the region (Carpenter 2002). As examples, northern taxa such as *Cancer borealis* (Brachyura) and *Coronaster briareus* (Asteroidea) reach their southern limits along the Florida side of the Strait, while many Caribbean taxa, e.g., *Iliacantha subglobosa* (Brachyura), *Endoxocrinus parrae* (Crinoidea) and *Triakis barbouri* (Chondrichthyes) occur only along the insular margin.

Although a substantial number of papers document composition and distribution of specific taxa collected in deep water off southeastern Florida, e.g., goniasterid sea stars (Halpern 1970), benthic fishes (Staiger 1970), nephropid lobsters (Holthuis 1974), crinoids (Meyer et al. 1978), scleractinian and stylasterid corals (Cairns 1979 1986), and brachyuran crabs (Soto 1985), focused investigations of the composition and distribution of benthic habitats in the survey areas have only begun recently. Ballard and Uchupi (1971) published two photographs of apparently barren phosphorite and sediment substrates on the Miami Terrace, though one showed a wreckfish, *Polyprion americanus*. At the foot of the Terrace south of the pipeline route off Miami in 700-825 m, Neumann and Ball (1970) observed thickets of unidentified deep-water branching azooxanthellate corals (most likely *Enallopsammia profunda* based on observations herein) capping mounds of muddy sand up to 0.5 m high and 3-4 m long, separated by patches of winnowed foram-thecosome sand, and Brooke *et al.* (2006) briefly noted the low *E. profunda*-capped mud mounds near the EEZ boundary. Reed et al. (2006) reported that the attached macrofauna on the terrace rim included the mound-forming scleractinian coral *Lophelia pertusa*, stylasterid lace corals (Hydrozoa), bamboo corals (Octocorallia, Isididae) and a variety of sponges (both Demospongiae and Hexactinellida) and other octocorals, as well as schools of jacks (Carangidae) and *P. americanus*. More recently, Shirur et al. (2008) quantified benthic habitat characteristics and sessile macrofaunal composition and abundances along nine submersible transects at three local sites from West Palm Beach to Miami (as well as along 12 transects at four sites further north from Cape Canaveral to St. Augustine, FL). Transects on the Miami Terrace in 321-383 m were dominated by *L. pertusa* accompanied by abundant primnoid octocorals, stylasterids and demosponges.

3 METHODS

3.1 Geophysical data and benthic habitat maps

The high-resolution multibeam bathymetry and benthic habitat maps spanning much of the Miami Terrace (~255-550 m) used in this study for site selection and depth profiles originated from a recent study by the authors for the Department of Energy. In 2010, a geophysical survey using multibeam sonar was carried out in an area overlapping the proposed cable survey area as part of the project “Siting Study for a Hydrokinetic Energy Project Located Offshore Southeast Florida” with funds provided by the US Department of Energy (DOE) to Dehlsen Associates LLC (Vinick et al., 2012). The multibeam survey covered almost all of Bureau of Ocean Energy Management (BOEM) Interim Policy block numbers 7053, 7054, and 7055 plus limited additional swaths to the west, east, northeast and southeast. This survey was conducted during November 2010 under the direction of David F. Naar, Associate Professor, University of South Florida, under contract with Dehlsen as part of the siting study mentioned above. The survey used a Kongsberg EM 710 FM sweep multibeam backscatter and bathymetry system that operated in the 70 to 100 kHz range.

Other seafloor topography data were derived from multiple sources. The NOAA National Geophysical Data Center's U.S. Coastal Relief Model Volume 3 provided a comprehensive regional view, integrating various offshore bathymetry datasets into one seamless representation of the seafloor. Bathymetric data sources included the U.S. National Ocean Service Hydrographic Database, the U.S. Geological Survey, the Monterey Bay Aquarium Research Institute, the U.S. Army Corps of Engineers, the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico project, and various other academic institutions. A custom-sized DEM was downloaded from the NGDC DEM portal, imported into ArcGIS, and hill-shaded to provide a 3-D modeled surface illuminated at 45° sun angle and azimuth. 2001 Naval Oceanographic multibeam survey provided by NSWCCD was used to image the seafloor from 30 to ~230 m depth. NSWCCD also provided high-resolution sidescan sonar for an area from 30 to 200 m depth. Detailed metadata were not available for either dataset; thus we cannot report on how they were collected and processed. The only depth data available for the ~230-260-m depth range were low-resolution NOAA bathymetry, which did not offer enough resolution to generate an appropriate depth profile.

The benthic habitat map of the northern Miami Terrace (OP AREA) used in this study was modified from the results of the DOE siting study (Vinick et al., 2012). The benthic habitat map classification was organized by three main components: geomorphologic zone, substrate type, and slope. The geomorphologic zones were identified by previous research on the Miami Terrace (Mullins and Neumann, 1979). Mullins and Neumann (1979) divided the Miami Terrace into several cross-shelf zones according to their geomorphology as: Upper Terrace, Outer Terrace ridge, and Lower Terrace. This terminology was based on a cross-section across the southern portion of the Miami Terrace; however, it applied to the northern portion with some modifications. Differences in the benthic biological communities were evident between these zones; thus they were utilized as a habitat classifier. Differences in biological communities were also evident between two separate platforms of differing depths along the Upper Terrace, which was therefore divided into Inner and Outer Terrace Platforms to distinguish them as separate biological communities. Differences in biological communities between low and high slope areas within geomorphologic zones were also recognized; therefore a slope layer was calculated from the DOE multibeam geophysical data to distinguish low and high slope areas. Based on the results, areas with >5° were considered High-Slope and those with ≤5° were Low-Slope. The final benthic classification was supported by statistical analysis of species' density between quantitative photostations. Areas outside of the detailed multibeam bathymetry were extrapolated based on the geomorphology present in the DOE multibeam and the NOAA NGDC DEM and the field notes. Straight lines were drawn due north or west and the area was designated as a "probable" habitat type. Probable habitat types were used to characterize the photostations in areas outside of the DOE benthic habitat map.

3.2 Benthic video and photographic ROV survey

Benthic surveys were conducted using a ship-tethered remote operated vehicle (ROV). The ROV was lowered to the bottom and towed by the ship. Steering was accomplished by the ROV motors and radio communications to the ship captain. The surveys were conducted along several cross-shelf (east-west transects) and shorter north-south segments. One transect followed cables in all habitats across the shelf between 30 m - ~550 m depth. Then cross-shelf transects were conducted north and south of that route in areas thought to be free of cables. Three relatively short north-south segments bisecting the cable route were conducted as well.

The ROV used for the surveys was the Television Observed Nautical Grappling System (TONGS) (Figure 3-1), a deep-water heavy-lift underwater vehicle owned and operated by NSWCCD-Ft. Lauderdale. TONGS has a 3,000-m operating depth, 4,500-kg lift capability, and can operate in currents in excess of 5 kt within a 1-m radius on the seafloor for prolonged periods. Underwater position is determined using an ultra-short baseline acoustic tracking system integrated into a differential global positioning system (DGPS), which provides georeferenced bottom positions of ±15 m in deep water. Occasional greater scatter (to 20 m or more) may have been due to multipath or bottom bounce in the acoustic signal of the Track Point. TONGS is equipped with 3 Standard Definition color cameras, one High-Definition color camera, one digital stills camera, multiple underwater lights, dual-frequency imaging and search sonar, altimeter and depth sensor. Two cameras are mounted to a pan-and-tilt unit to provide variable camera orientation. TONGS also has two thrusters for orientation and minor positional changes (±10 m). All Non-Cable, data, and video are multiplexed thru a fiber-optic telemetry system to the surface, providing wide bandwidth and high-quality video (Eric S. Dykes, CIV NSWCCD, personal communication). For this survey, TONGS was equipped with a Kongsberg OE14-502 high-definition video camera, OE11-242 Flashgun and OE14-208 Digital stills camera, the latter provided with a pair of parallel scaling lasers spaced 8.3 cm apart. The survey was carried out aboard the NASA vessel *Freedom Star* (length 53.6 m; beam 11.2 m; draft 3.7 m; displacement 1,052 tons). TONGS carried out 13 dives to complete the survey.

Oblique frontal and side-looking video was run continuously throughout surveys while the ROV was on the bottom (i.e., within 1-2 m of the seafloor). Nadir still images (1-2 MB each) were taken at ~5-min intervals over sediment substrates. Over areas of biological interest on hard substrates, nadir still images were taken repeatedly as soon as the strobe recycled (which ranged from ~5 to over 20 sec) and the ROV moved far enough to avoid overlapping exposures. Images were also taken of specific organisms on all substrates for identification purposes.

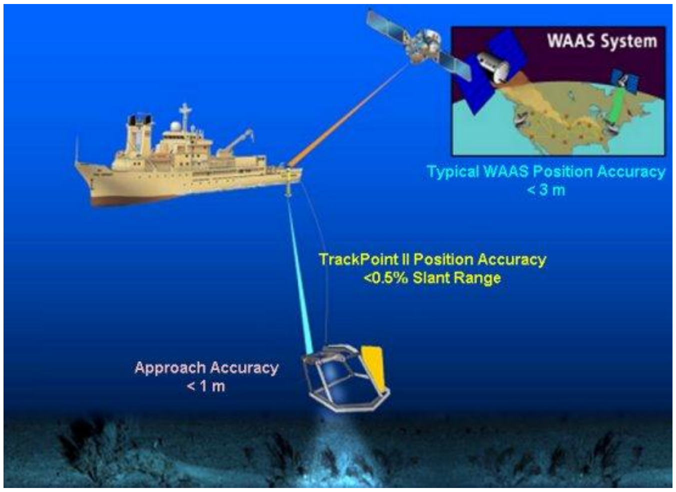

Figure 3-1. Television Observed Nautical Grappling System (TONGS).

3.3 Photographic station selection

Quantitative nadir digital photography stations (i.e., photo stations) were selected along sections of transects that traversed exposed hard substrates and thus represented Essential Fish Habitat as defined by the MSFCMA. Stations were selected in hard substrate areas on the basis of benthic habitats as defined by Vinick et al. (2012). The data from the field notes were also plotted onto the geophysical data in GIS to help guide photostation selection in probable habitats outside the DOE habitat map footprint. The field data indicated the presence of hard-bottom substrate along the ROV track in 200 – 500 m depth along the cable route. Stations were chosen along the cable route and the Non-Cable transects in areas that spanned single habitats that were identified as mostly hardbottom in the field notes. The size of the station depended on the density of photos taken in a given area. Quantitative images were analyzed from a total of 49 stations: 30 Low-Slope, 17 High-Slope, and 2 Sinkhole.

3.4 Data Analyses

Following the field surveys, video data were reviewed in the laboratory to confirm organism identifications to the lowest possible taxonomic level and to define biological zones and benthic habitats. Original field transcripts were summarized to produce habitat descriptions and identify transitions between habitats. Quantitative digital photographs were processed in the laboratory to improve image contrast when possible and to eliminate poor images due to excessive shadowing (due to strobe placement), darkness (due to excessive elevation above bottom), turbidity (when the ROV stirred up sediment following contact with the sea floor) and blurring (due to excessive speed over bottom). Images varied in brightness and area of cover dependent upon the height of the ROV off the bottom. Significant darkening and shadowing occurred when the ROV was >1 m off bottom, either due to distance above the sea floor or because a part of the ROV obscured the strobe. The strobe was re-oriented several times between dives to reduce this problem, but it was never completely solved. To provide the best image possible, each image was examined in Photoshop. Some were lightened using the Levels/midtone adjustment. Images were then cropped to remove unusable remaining shadowed portions. Images unusable because of dimness, lack of contrast, excessive elevation above bottom, or without visible paired lasers were deleted. Table 3-1 lists all quantitative photostations with numbers and percentages of used and removed images.

Table 3-1. Photostations showing numbers and percentages of images used and removed, and total area used in m^2 of each. Abbreviations: C - Cable stations (left columns); NC - Non-Cable stations (right columns); ITP – Inner Terrace Platform; OTP – Outer Terrace Platform; OTR – Outer Terrace Ridge; LT – Lower Terrace; SH – Sinkhole; HS – High Slope; LS – Low Slope. Horizontal lines separate sets of stations by habitat and slope. Station sets are listed in order of habitat from west to east (ITP, OTP, OTR, LS, SH) with low-slope stations listed first for each habitat.

PhotoStation	Images			Percent		Area	PhotoStation	Images			Percent		Area
	Removed	Used	Total	Removed	Used	m^2		Removed	Used	Total	Removed	Used	m^2
C ITP-LS 1	26	50	76	34.2	65.8	44.26	NC ITP-LS 1	11	50	61	18.0	82.0	43.77
C ITP-LS 2	14	49	63	22.2	77.8	74.46	NC ITP-LS 2	1	50	51	2.0	98.0	87.56
C ITP-LS 3	17	50	67	25.4	74.6	52	NC ITP-LS 3	7	50	57	12.3	87.7	56.69
C ITP-LS 4	15	50	65	23.1	76.9	55.12	NC ITP-LS 4	15	51	66	22.7	77.3	55.08
C ITP-LS 5	21	50	71	29.6	70.4	47.81	NC ITP-LS 5	17	50	67	25.4	74.6	68.94
C ITP-LS 6	22	50	72	30.6	69.4	44.06	NC ITP-LS 6	1	56	57	1.8	98.2	86.71
C ITP-LS 7	18	50	68	26.5	73.5	50.35	NC ITP-LS 7	0	54	54	0.0	100.0	87.24
C ITP-LS 8	18	48	66	27.3	72.7	28.53	NC ITP-HS 1	9	38	47	19.1	80.9	141.3
C ITP-LS 9	27	50	77	35.1	64.9	59.38	NC OTP-LS 1	21	51	72	29.2	70.8	52.66
C ITP-LS 10	34	41	75	45.3	54.7	40.4	NC OTP-LS 2	2	55	57	3.5	96.5	120.6
C OTP-LS 1	18	50	68	26.5	73.5	50.86	NC OTP-LS 3	4	50	54	7.4	92.6	57.8
C OTP-LS 2	22	50	72	30.6	69.4	44.81	NC OTP-LS 4	19	50	69	27.5	72.5	99.4
C OTP-LS 3	27	50	77	35.1	64.9	37.59	NC OTP-LS 5	4	51	55	7.3	92.7	132.7
C OTP-LS 4	22	50	72	30.6	69.4	47.9	NC OTP-HS 1	12	18	30	40.0	60.0	66.1
C OTP-LS 5	23	50	73	31.5	68.5	34.22	NC OTP-HS 2	0	29	29	0.0	100.0	73.91
C OTP-HS 1	2	34	36	5.6	94.4	30.57	NC OTR-LS 1	22	50	72	30.6	69.4	84.08
C OTP-HS 2	17	46	63	27.0	73.0	49.51	NC OTR-LS 2	1	62	63	1.6	98.4	127.3
C OTP-HS 3	21	50	71	29.6	70.4	59.3	NC OTR-HS 1	0	54	54	0.0	100.0	120.7
C OTP-HS 4	6	33	39	15.4	84.6	72.3	NC OTR-HS 2	0	65	65	0.0	100.0	110.9
C OTR-HS 1	0	56	56	0.0	100.0	100.5	NC OTR-HS 3	1	37	38	2.6	97.4	63.61
C OTR-HS 2	1	48	49	2.0	98.0	56.26	NC LT-HS 1	0	29	29	0.0	100.0	44.62
C OTR-HS 3	0	26	26	0.0	100.0	31.67	NC LT-SH 1	5	41	46	10.9	89.1	78.29
C OTR-HS 4	13	16	29	44.8	55.2	44.24							
C OTR-HS 5	37	40	77	48.1	51.9	55.3							
C OTR-LS 1	26	48	74	35.1	64.9	64.4							
C LT-HS 1	2	20	22	9.1	90.9	19.8							
C LT-SH 1	11	50	61	18.0	82.0	68.3							

All usable photostation images were analyzed in Coral Point Count with Excel extensions (CPCe)© (Kohler & Gill 2006), a Windows-based software tool for determining benthic habitat and organism cover, area analysis and for image calibration using transect photographs. The relatively low densities of benthic hard-bottom macrofauna anticipated in this study required a high number of random points to accurately capture the diversity of organisms and reflect their densities and percent cover. As a result, following successful previous analyses (Messing et al. 2006a, b), images were subjected to a two-stage analysis. Each image was initially analyzed using CPCe software for percent substrate cover (e.g., hard bottom, sediment-veneered hard bottom, sediment) with organisms identified to a general taxonomic level (e.g., sponge, cnidarian, echinoderm) at a density of 50 points per image (Table 3-2). Each image was then reexamined and all organisms larger than ~4 cm enumerated and identified as specifically as possible (e.g., *Pseudodrifa nigra*, *Phakellia* sp., Isididae, anemone sp. 1, unidentified hexactinellid). A question mark preceding a scientific name in text or tables indicates uncertain identification. Borderline small organisms were measured by magnifying the image (usually to ~50%), spanning the laser dots with a pair of 10-point dividers, and using 0.4 of that length (~3 cm) to decide which animals should be included or omitted.

Numbers of encrusting and smaller colonial organisms (e.g., zoanthids) were estimated. Several groups of organisms could not be accurately quantified for several reasons. Although some hydroids (Hydroidolina) were resolvable as individual colonies, many occurred in clusters of overlapping, filmy colonies. The great majority of ophiuroids (Ophiurida; which does not include euryalid snakestars and basketstars) were visible only as arms protruding from crevices, burrows or sediment (often overlapping and impossible to quantify accurately); in many cases, substantial numbers were out of focus in a given image (e.g., due to various combinations of small size, slenderness and ROV velocity). Solitary corals (Scleractinia) were chiefly <3 cm across. These three groups (hydroids, Ophiurida and solitary corals) were ranked by relative abundance classes [i.e., few (1), common (5), abundant (10)] and were not included in summary density tables and pie diagrams. Image area was calculated by converting image length and width in pixels to centimeters based on the number of pixels equivalent to the 8-cm laser scale. Organism densities per square meter (m^{-2}) were calculated by extrapolating from the number of organisms in the image area. Table 3-3 lists taxa used for density calculations. Both tables 3-2 and 3-3 include a few taxonomic updates relative to the original designations used in the analyses (e.g., Hydroidolina for Hydroida, *Gracilechinus* for *Echinus* and Octocorallia unidentified for Octocorallia, gorgonacea); none alter the analyses. After analysis of each image, the data were saved into an Excel database for analyses of (1) raw percent composition and (2) percent composition per area for each quantitative photostation. Calculations excluded all points categorized as photo effects (i.e., shadow, laser).

Organism densities are illustrated graphically with pie diagrams that show the percentages that major groups contribute to total density at the photostations for a given habitat. Taxa contributing small percentages (generally <1-2%) have been consolidated into larger groups for graphic clarity. As a result, groups named in the pie diagrams of Cable and Non-Cable photostations at a given habitat may differ, e.g., for sponges, the pie diagram for NC ITP L-S (Figure 4-25) shows Other Porifera [all identified taxa occurring at very low densities] and Unidentified Hexactinellida, whereas the equivalent for the Cable photostations (C ITP L-S, Figure 4-36A) shows Unidentified Demospongiae, Desmacellidae, Other Porifera [identified] and Unidentified Porifera. Such variations are a function of the taxa present and their densities. To permit straightforward comparison between Non-Cable and Cable photostations by habitat, section 4.3.2 (Cable Impact Assessment) includes tables that list density data for Cable photostations alongside the previously listed density data for Non-Cable photostations, and bar graphs that illustrate Cable and Non-Cable densities side by side for each taxonomic group with less consolidation than the pie diagrams, i.e., all groups that contribute at least 1% of the mean densities for that photostation (e.g., Figure 4-36B).

The percent cover and density data from the CPCe image analyses were analyzed using a multivariate approach. Benthic data at the subcategory level (Table 2A) (excluding fish, human debris, Detritus, Cable, Shadow, and unidentified organism) were analyzed using Bray-Curtis similarity indices (PRIMER v6) for similarity between quantitative still photographic stations. A cluster analysis and corresponding non-metric multi-dimensional scaling (MDS) plot was constructed of the data (square-root transformed) to understand the statistical relationships between stations. Stations were displayed by the map habitat classifications. MDS and cluster analyses were performed on all Non-Cable station data for the benthic characterization and on Cable and Non-Cable stations within each defined habitat type to elucidate potential cable impacts. In some cases, similarity percentages (SIMPER) were obtained for the geomorphologic zones and slope classifications to gauge what cover categories contributed most to the differences between Cable and Non-Cable stations. An analysis of similarity (ANOSIM) was performed in each test to determine the significance of the Cable and Non-Cable categories. ANOSIM is a permutation-based hypothesis test analogous to univariate analyses of variance (ANOVAs) that tests for differences between groups of (multivariate) samples from different experimental treatments. The closer the R statistic is to 1, the stronger the categorical groups. Its strength is dependent on the number of samples per category which defines the number of possible permutations. A low number of stations in a category limits the reliability of the results.

Table 3-2. Percent cover categories (BOLDFACE CAPS) and subcategories used in the photostation image analyses.

CORAL (COR)	**ECHIURA (ECR)**
Colonial Dead Coral (DC)	Forked Tongued Echiura (ECR)
Coral Rubble (CR)	**MOLLUSCA (MOL)**
Lophelia (LOP)	Gastropoda (GAS)
Madrepora (MAD)	Polyplacophora (CHI)
Solitary Coral (SC)	**BRYZOA (BRY)**
ARTHROPODA (ART)	Bryzoa (BRY)
Galatheidae (GAL)	**PORIFERA (POR)**
Lobster- *Acanthacaris,* Astacidea, *Nephropsis* (LOB)	Demospongiae (DEM)
Shrimp (SHR)	Hexactinellida (HEX)
CHORDATA (CHO)	Unidentified Porifera (UPO)
Fish (FIS)	**UNIDENTIFIED ORGANISM (UND)**
CNIDARIA NON SCLERACTINIA (CNI)	Unidentified Organism (UND)
Actinaria Non-Ceriantharia (ACT)	**SOFT BOTTOM SUBSTRATE (SB)**
Alcyonacea (ALC)	Sand-Shell Hash (HAS)
Antipatharia (ANT)	Soft Bottom Substrate (SB)
Ceriantharia (CER)	**HARD BOTTOM SUBSTRATE (HB)**
Gorgonacea (GOR)	Rock Outcrops, Rock Pavement, Sediment Veneer on Hard Bottom, Ledges, Boulders (ROC)
Hydroida (HYD)	Rubble, Cobble, Gravel (RUB)
Pennatulacea (PEN)	**CABLE (CB)**
Stylasteridae (STY)	Cable (CB)
Unidentified Cnidarian (UCN)	**HUMAN DEBRIS (HUM)**
Zoanthidea (ZOO)	Fishing Line/Long Line (FSL)
ECHINODERMATA (ECH)	Other Human Debris (HUM)
Asteroidea (AST)	**NATURAL DETRITUS (DET)**
Crinoidea (CRI)	Plant/Animal Detritus (DET)
Echinoidea (ECI)	**TAPE, WAND, SHADOW, PHOTO EFFECT (TWS)**
Ophiuroidea (OPH)	Tape, Wand, Shadow , Photo Effect (TWS)

Table 3-3. Taxonomic categories used in density calculations.

Annelida	*Anthomastus* sp.	Psolidae
Sabellida	Antipatharia unid.	*Sclerasterias* sp.
Arthropoda	*Bathypathes alternata*	*Tremaster mirabilis*
Bathynectes longispina	Ceriantharia	**Echiura**
Brachyura	Corallimorpharia	Echiura
Cirripedia	*Eunicella* sp.	**Mollusca**
Crustacea unid.	Hydroidolina	*Calliostoma* sp.
Eumunida sp.	Isididae	Cephalopoda
Galatheidae	*Liponema* sp.	Gastropoda
Paguroidea	*Lophelia pertusa*	Pleurotomariidae
Paguroidea 1	*Madrepora* sp.	Polyplacophora
Penaeidae	Octocorallia, gorgonacea	*Scaphella junonia*
Pycnogonida	Pennatulacea	**Porifera**
Rochinia sp.	Plexauridae (Paramuriceidae)	*Aphrocallistes beatrix*
Brachiopoda	Primnoidae	Astrophorida
Brachiopoda	*Pseudodrifa nigra*	Axinellidae
Bryozoa	Sagartiidae	Demospongiae unid.
Bryozoa	Scleractinia (solitary)	Desmacellidae
Chordata	Stylasteridae	Euritidae/Farreidae
Actinopterygii	Zoanthidae	Geodiidae
Anguilliformes	**Echinodermata**	*Hertwigia falcifera*
Ascidiacea	*Araeosoma* sp.	Hexactinellida
Chlorophthalmus agassizi	Asteroidea	*Hyalonema* sp.
Elasmobranchii unid.	Cidaridae	*Hyatella* sp.
Helicolenus dactylopterus	*Coelopleurus floridianus*	*Leiodermatium* sp.
Laemonema sp.	Comatulida	Lithistida 1
Macrouridae	*Coronaster briareus*	Lithistida 2
Phycidae	Crinoidea (stalked)	Pachastrellidae
Pleuronectiformes	Echinoidea	*Phakellia* sp.
Rajidae	Euryalidae	Porifera unid.
Scorpaenidae	Goniasteridae	Raspailiidae
Cnidaria	Gorgonocephalidae	*Spongosorites* sp.
Actiniaria 1 (Actinauge?)	*Gracilechinus* sp.	*Vazella* sp.
Actiniaria 2	*Linckia* sp.	**Unknown**
Actiniaria unid.	Novodinia sp.	Unknown animal
Actinoscyphia sp.	Ophiuroidea	

4 RESULTS

As noted in Section 2.1 above, the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA; Public Law 104-208) defines Essential Fish Habitat (EFH) as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity” [16 U.S.C. 1802 (10)]. EFH identified in the Fisheries Management Plan Amendments for the SAFMC includes live/hard bottoms, and coral and coral reefs (NOAA NMFS, 2000). Therefore, all hard substrates described below represent EFH.

This section is divided into three parts: a description of the survey transects (4.1), the benthic characterization (4.2), and the impact assessment (4.3). The benthic characterization section first describes in detail the habitats and biota encountered along each transect. Then a statistical analysis was performed on the Non-Cable stations data to help determine habitat delineations. The impact assessment section analyzes the similarities between Cable and Non-Cable photostations grouped by habitat to determine any community-level cable impacts.

4.1 Description of the Survey Transects

On 26-31 January 2011 and 29-31 March 2011, the benthic video and photographic survey was conducted under the direction of Professor Charles Messing, PhD (Nova Southeastern University Oceanographic Center [NSU OC]), in cooperation with Brian Walker, PhD (NSU OC), and John Reed, MS (Harbor Branch Oceanographic Institute at Florida Atlantic University). Figure 4-1 illustrates the ROV transects in relation to the benthic habitats and existing cable routes supplied by the Naval Surface Warfare Center Carderock Division’s SFOMF Dania Beach, Florida, in the study area. Table 4-1 lists the beginning and ending coordinates for all transect lines in both decimal degrees and decimal minutes. The transect along the cable route (transect A in Figure 4-1) was executed in multiple ROV dives and, as a result, surveyed two different cables; it is uncertain which cables were surveyed. In addition to the primary transect along the cable, the Statement of Work called for two additional transects “parallel to Cable 96, 50 m on each side of it where hard-bottom habitats occur [in order to represent] areas unimpacted by the cable, as a control for comparison purposes to the area where the cable is present,” as well as “two 610 m long transects…in a north-south direction along areas of high biological interest to determine if areas exist that might represent alternative cable routes: one along the crest of the Miami Terrace escarpment [=Outer Terrace Ridge] and one near the EEZ along the deep-water coral thickets habitat.” The SOW left the precise locations of these two north-south transects unspecified. The second of these was abandoned as being far eastward of any current Navy cables and was replaced by another transect [here termed West N-S Transect] along the border of the Inner and Outer Terrace Platforms along apparent high slope based on multibeam topography (transect D in Figure 4-1). The transect along the Outer Terrace Ridge is here termed East N-S Transect (transect E in Figure 4-1).

In the shallowest hard-bottom portion, two transects were spaced ~50 m on each side of the cable as planned, from ~30 m through the disappearance of hard substrates in ~90-93 m (transects An and As in Figure 4-1). Transect lengths over this depth range were 1.1 km for the cable route (transect A), 1.1 km along An, and 1.2 km along As. The two flanking lines were planned as North and South Non-Cable Transects. However, cables were observed along both of these transects in this depth range. Limited ship time prevented execution of additional alternative shallow transects. Subsequently, cable data provided by Kameron Corregan

(NSWCCD) indicated that the large number of additional cables in the area (Figure 4-1) eliminated the possibility of selecting any nearby Non-Cable transects in similar habitat. Most of the hard bottom habitat along these transects was derived from the dumping of spoil during the creation of Port Everglades (Walker et al., In press). The GIS data show that cables have been deployed throughout the Port Everglades spoil habitat. The nearest similar spoil habitat potentially free of cables is at Government Cut, Miami; ~50 km south. Due to the recognized changes in biological communities with latitude along southeast FL (Walker, 2012), this habitat is too far away to be considered comparable and serve as a control. As a result, no valid Non-Cable transects could be examined in this depth range.

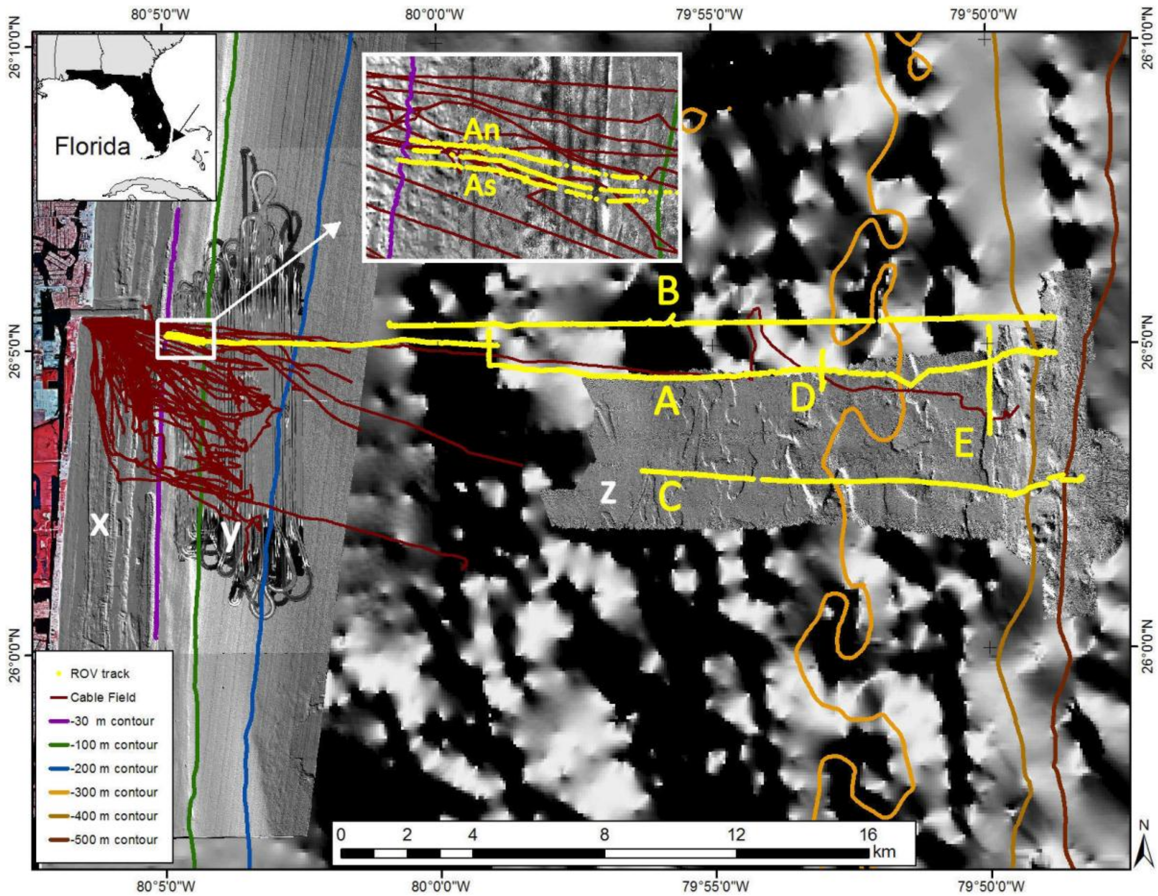

Figure 4-1. Study area showing cables (dark red) and ROV transects (yellow). A. Main cross-shelf cable transect (An and As in the insert indicate the flanking transects within the spoil habitat). The short vertical line below the insert indicates the Cable jog traversed to verify cable location and connect eastern and western portions of transect A. B. North Non-Cable Transect. C. South Non-Cable Transect. D. West N-S Transect. E. East N-S Transect. Upper center inset magnifies the three transects from ~30 to ~90-93 m. Cable field data provided by Kameron Corregan, NSWCCD. Bathymetric databases are x: inshore LIDAR (National Coral Reef Institute, NSU); y: sidescan and multibeam (NSWCCD), and z: multibeam (Dehlsen LLC). Background is low-resolution NOAA NGDC hydrographic data.

From ~90 m, the Cable Transect traversed 6.6 km of unconsolidated sediment substrates to a depth of 245 m, where the hard substrates of the Miami Terrace were first exposed, and was completed to a maximum depth of 457 m, east of the recorded terminus of the cable. Surface conditions, currents and intermittent sediment cover prevented the ROV from maintaining the cable in continuous view. As a result, a westward leg of the cable transect terminated in a north-south segment (on line A below the upper center insert in Figure 4-1; termed Cable jog in Table 4-1) to verify a cable's location and connect to the western shallower end of the transect. The eastern and western portions of cable transect A were separated at the jog by ~600 m suggesting they were not the same cable. Although the project plan called for a survey of Cable 96, it is not clear how much of the transect followed this cable. Cable was repeatedly lost from ROV view due to current and surface wind. At 26°04.568'N, 79°51.028'W (334 m), the ROV crew reported that the cable in sight might be number 58. At 26°04.565'N, 79°50.883'W (334 m) cable was in view, but the ROV position was ~1000 m north of the plotted line for cable 96. Finally, two cables were visible at the same time at 26°04.557'N, 79°52.6108'W (268 m) and 26°04.509'N, 79°51.778'W (279 m).

At least 11 cables appear to reach depths greater than 183 m (600 ft), of which nine were deployed between 1952 and 1979. Records are sparse as they were kept on paper and in log books. These nine were type 201 Harbor Defense Cables, with six attached to CAPTOR developmental mines (no ordnance) and three attached to underwater submarine tracking arrays. Two others are the well documented deep fiber optic cable (C/S 96) and the Acoustic Observatory cable (C/S 120) (William Venezia, SFOMC, personal communication, 15 May 2012).

The North Transect, located ~1.0-1.5 km north of the Cable route in an attempt to avoid other cables, spanned across the shelf from 235 m to 451 m water depth. The shallow terminus was selected to intercept the initial western appearance of hard substrate. However, cables were encountered between 243 and 262 m. Segments with observed cables were not considered during photo station selection. The South Transect, located ~3.0-3.5 km south of the cable route, spanned across the shelf from 272 m to 510 m water depth. Its shallow western end was terminated by time constraints.

Table 4-1. Beginning and ending coordinates for transects in decimal degrees (LatDD, LonDD) and decimal minutes (LatDM, LonDM). The N-S Cable jog transect connected the Shallow and Deep Cable Transects.

Transect End	LatDD	LonDD	LatDM	LonDM
Shallow North - East	26.086264	-80.071258	26 05.17584	-80 04.27548
Shallow North - West	26.087834	-80.081998	26 05.27004	-80 04.91988
Shallow Cable - East	26.08391	-79.981874	26 05.0346	-79 58.91244
Shallow Cable - West	26.087437	-80.081981	26 05.24622	-80 04.91886
Shallow South - East	26.08529	-80.071242	26 05.1174	-80 04.27452
Shallow South - West	26.087066	-80.082676	26 05.22396	-80 04.96056
Deep North - East	26.090363	-79.812938	26 05.42178	-79 48.77628
Deep North - West	26.089516	-80.014775	26 05.37096	-80 00.8865
Deep Cable - East	26.080679	-79.812652	26 04.84074	-79 48.75912
Deep Cable - West	26.078516	-79.984482	26 04.71096	-79 59.06892
Deep South - East	26.046727	-79.805155	26 02.80362	-79 48.3093
Deep South - West	26.049264	-79.938297	26 02.95584	-79 56.29782
Cable jog N-S - North	26.087977	-79.984509	26 05.27862	-79 59.07054
Cable jog N-S - South	26.078516	-79.984482	26 04.71096	-79 59.06892
West N-S - North	26.081745	-79.883315	26 04.9047	-79 52.9989
West N-S - South	26.071103	-79.88382	26 04.26618	-79 53.0292
East N-S - North	26.088163	-79.832844	26 05.28978	-79 49.97064
East N-S - South	26.058615	-79.832814	26 03.5169	-79 49.96884

4.2 Benthic Habitat Characterization

4.2.1 Geomorphologic Zone and Benthic Habitat Classification

The benthic habitat map classification was adopted from the US Department of Energy (DOE) project "Siting Study for a Hydrokinetic Energy Project Located Offshore Southeast Florida." Since the methodology for habitat polygon development used a subset of the data reported herein, the mapping results are presented here as well.

Benthic habitat classification was organized by three main components: geomorphologic zone, substrate type, and slope (see Section 3.1, paragraph 3). The geomorphologic zones of the topographically complex Miami Terrace were identified by previous research (Mullins and Neumann 1979). Mullins and Neumann (1979) divided the Miami Terrace into several cross-shelf zones according to their geomorphology as: Upper Terrace, Outer Terrace ridge, and Lower Terrace (Figures 4-2, 4-3). This terminology was based on a cross-section across the southern portion of the Miami Terrace; however, it applies to the northern portion as well with some modifications. Differences in the benthic biological communities were evident across these zones; thus they were utilized as an overall habitat classifier. Differences in biological communities were also evident between two separate platforms of differing depths along the Upper Terrace, which was therefore divided into Inner and Outer Terrace Platforms to distinguish them as separate biological communities. Although not easily recognizable in either plan-view or 3-dimensional images of multibeam topography (Figures 4-1, 4-2, 4-3), the bathymetry of the Outer Terrace Platform generally shoals from south to north across the surveyed area, while the Inner Terrace Platform gently deepens from south to north. It is possible that the two Terrace Platform subdivisions merge north of the survey area and contain similar biological communities.

The area surveyed by multibeam began in ~550 m and ran up the ~40º Lower Terrace and Outer Terrace Ridge across a swath of numerous sinkholes in ~475-360 m before reaching the narrow N-S-oriented crest of the Outer Terrace Ridge in 337 m with up to 20 m local vertical relief. West of this ridge, across the Outer Terrace Platform, the seafloor sloped very gradually upward from 348 m, shoaling only ~20 m overall across a distance of 4.0 nm, although with several broad platforms, depressions and narrow ridges of up to 20-m vertical relief. This gradual slope terminated along the transect line at what appeared to be a spur of Inner Terrace Platform with a vertical relief of ~70 m (~330-260 m). The western margin of this spur dropped to an almost flat stretch of the Outer Terrace Platform about 0.75 nm across in ~310 m before climbing another escarpment of ~60 m vertical relief. Above this feature, the Inner Terrace Platform consisted of chiefly low-relief substrates in 275-250 m with local depressions of 10-m vertical relief that suggested the irregular karstic topography most likely produced by subaerial exposure during the Middle to Late Miocene as reported by Neumann & Ball (1970), Ballard & Uchupi (1971), and Mullins & Neumann (1979).

Depth profiles were drawn from multibeam data along the South Non-Cable and East N-S Transects and along the deeper portion of the Cable Transect. Because available NOAA bathymetry outside the area surveyed by multibeam was low resolution, depth profiles could not be drawn for the North Non-Cable and West N-S Transects, and western portion of the Cable Transect (Figure 4-2). However, a depth profile was also drawn along the Cable Transect in 30-90 m using 2001 US Navy bathymetric multibeam data (Figure 4-4).

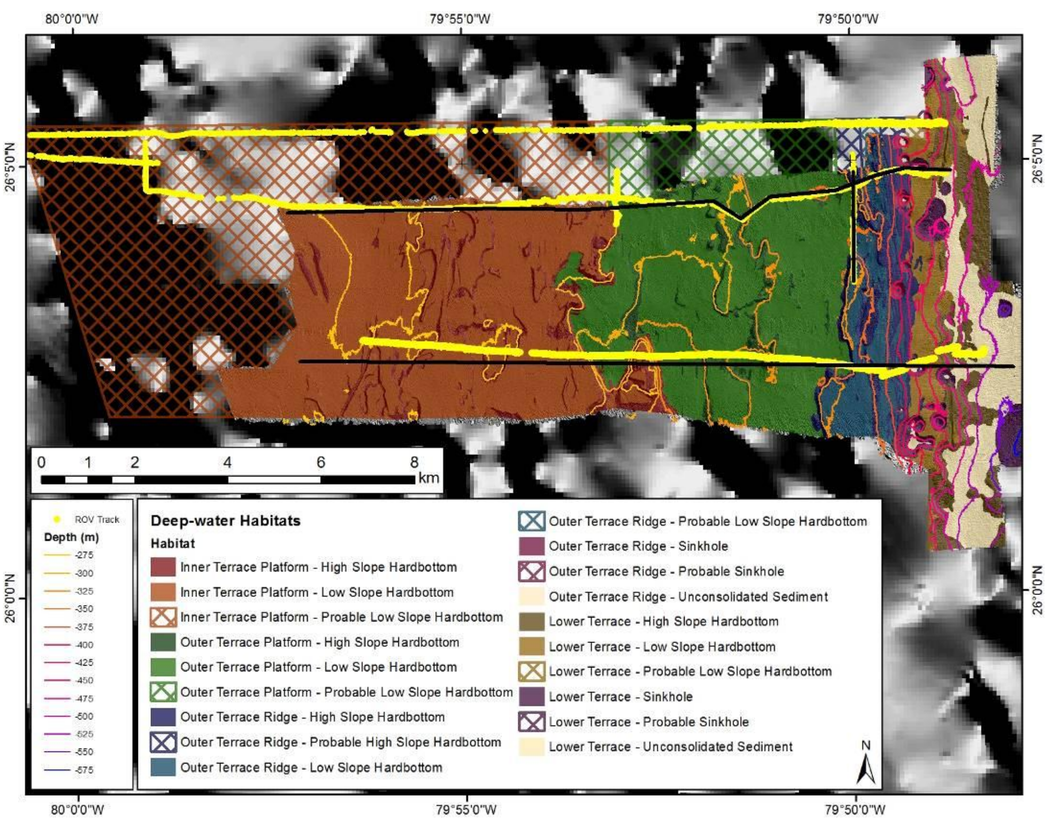

Figure 4-2. Plan view of multibeam topography overlain by benthic habitats illustrating the four major geomorphologic zones. Habitats in areas beyond the multibeam survey are suggested by cross hatching. Yellow lines are ROV transects; black lines are depth profiles derived from multibeam data.

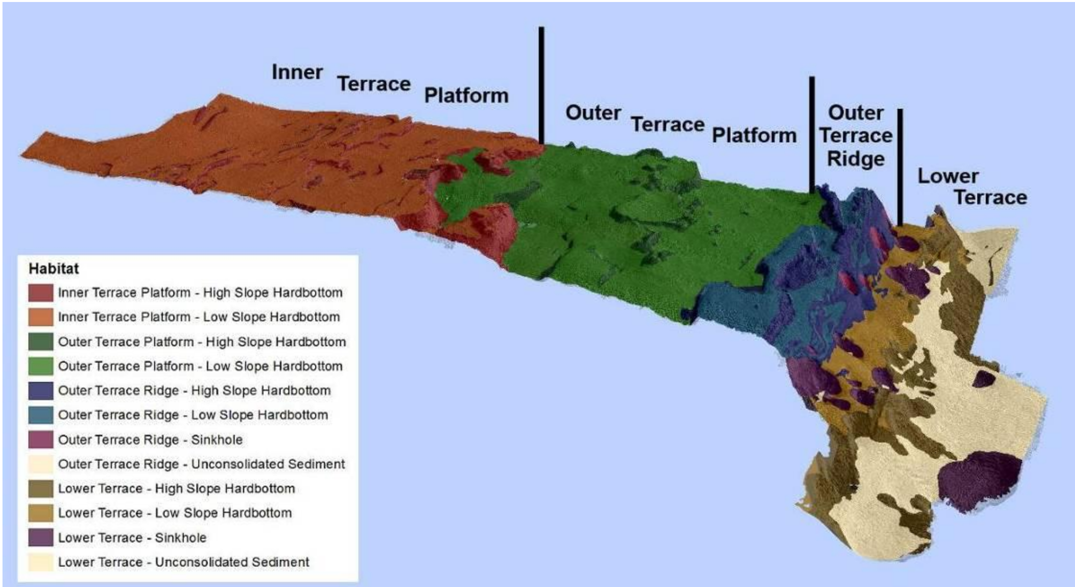

Figure 4-3. Three-dimensional rendering of multibeam topography overlain by benthic habitats illustrating the four major geomorphologic zones.

4.2.2 Qualitative Benthic ROV Transects and Habitat Mapping Results

This section describes the substrates and fauna encountered along the Cable and parallel Non-Cable ROV transects from shallow to deep, as well as the two shorter north-south transects along the Upper Terrace Platform and Outer Terrace Ridge.

4.2.2.1 ROV Transect A - Shallow Portion (30 m to 245 m)

This subsection refers to primary cable transect A and parallel transects An and As from 30 to 255 m depth (Figure 4-4). As all three included cables and crossed similar habitats at similar depths, they are treated here in a single descriptive narrative beginning with the bottom profile and then describing substrates and fauna.

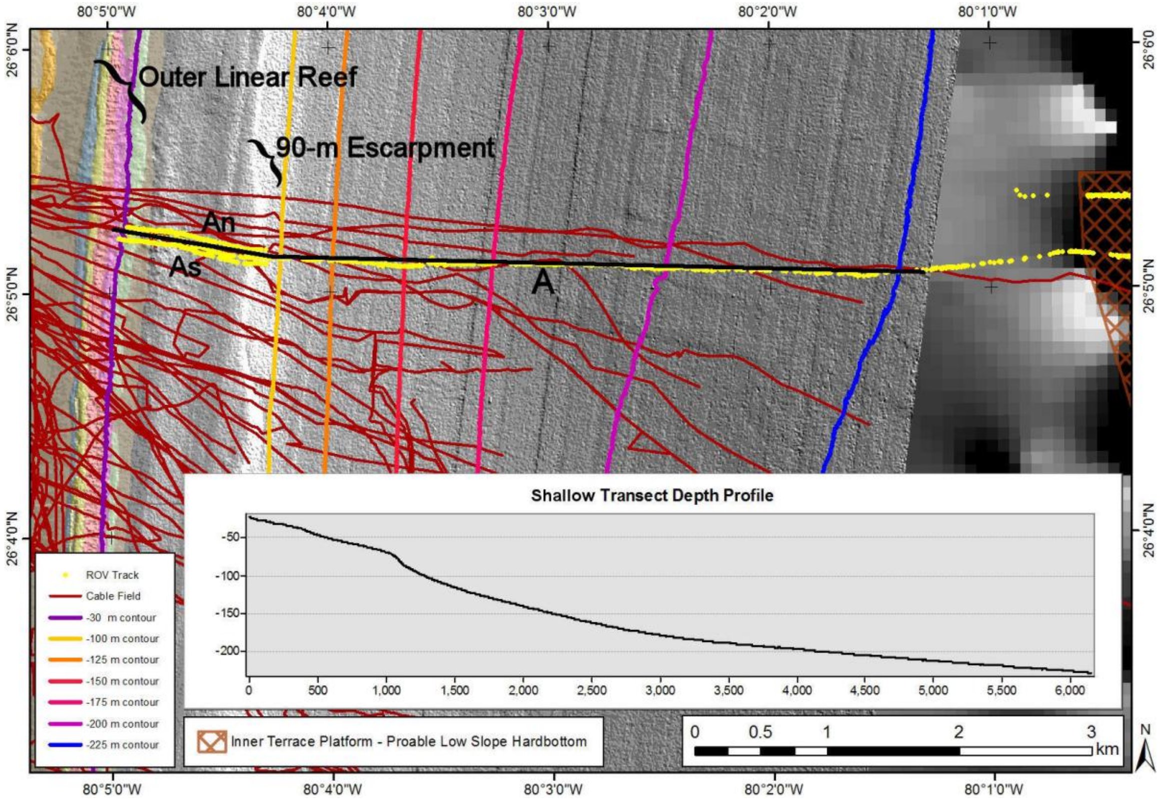

Figure 4-4. ROV Cable transect (transect A as in Figure 4-1) from western terminus in ~30 m to ~230 m (yellow line) with corresponding depth profile (black line) to just over 225 m shown in insert. The shallow (~30-90 m) North and South parallel Non-Cable transects (As and An) are visible at left. Background bathymetry: 2001 US Navy multibeam bathymetry.

From 30 to 36 m, the substrate consisted of combinations of rubble- to boulder-sized clasts and low-relief pavements with occasional outcroppings of underlying limestone. The clasts were likely deposited during the dredging of Port Everglades during the 1920s, and are distributed southeastward from the eastern end of the Port Everglades channel, covering 295 hectares, including the entire Outer Linear Reef of the Florida Reef Tract (Figure 4-4) along the cable route (Walker et al., 2006; Walker et al., in press). It is uncertain if any natural limestone substrate was visible. Algal turf covered most hard substrates as well as extending onto sediment in places. From ~36 to 44 m, the sea floor was 50-90% hard substrate, including boulders reaching ~1.5 m high. Small pockmark burrows and a microalgal film characterized sediment. Organisms on hardbottoms included a wide variety of sponges (e.g., *Amphimedon* sp., *Callyspongia vaginalis*, *Agelas* spp., *Geodia neptuni* and large *Xestospongia muta*), octocorals (e.g., *Ctenocella barbadensis*, *Ellisella* sp., *Iciligorgia schrammi*, *Swiftia exserta* and plexaurids), a few small stony corals (chiefly *Montastraea cavernosa* and fewer *Stephanocoenia intersepta* and *Siderastrea siderea*), antipatharians (several unidentified species, ?*Stichopathes luetkeni* and ?*Parantipathes tetrasticha*) and (in <38 m) the basketstar *Astrophyton muricatum* (Figure 4-5, Table 4-2).

Hard substrates became more scattered with increasing depth, diminishing to 20-50% of cover by 51-56 m, but still including cobbles up to ~30 cm across. Sponges (e.g., *Amphimedon* sp., *G. neptuni*), octocorals (*Swiftia exserta*, *I. schrammi*) and antipatharians decreased in numbers and richness with increasing depth. A few reticulated brittlestars (*Ophionereis reticulata*) were observed on sediment. By 63 m, *S. exserta*, pockmark burrows and the microalgal film had disappeared. Table 4-2 lists all animal taxa recorded from 30 m to the disappearance of *S. exserta* in ~63 m.

Although no comparative quantitative analysis was carried out in this depth range as all three transects traversed cables, an examination of 845 still photographs taken from the shallow end of the transects to the disappearance of *S. exserta* revealed that sponges (Porifera) appeared in 75-84% of images, octocorals in 33-69%, antipatharians in 14-22% and stony corals (Scleractinia) in 7-14% (possibly 16%) of images (Table 4-3). In addition to the (tentatively identified) main survey cable, the survey crossed other cables, particularly along transect An, where many lay perpendicular to the east-west route. Cables were covered with sediment, a pale turf similar to that covering adjacent hard substrates, sometimes abundant small hydroids, encrusting sponges, occasional larger sponges (e.g., *Aplysina cauliformis*), a few small octocorals, and cyanobacterial mat.

Hard substrates below 63 m were scattered small rubble clasts. In 67-73 m, the substrate was almost entirely rippled sediment with a few widely scattered bits of rubble. An artificial reef at 73 m (Transect An) supported encrusting sponges, hydroids, arrow crabs (*Stenorhynchus seticornis*), an unidentified scyllarid lobster, greater amberjack (*Seriola dumerili*) and lionfish (*Pterois volitans*). An amberjack was also seen at this depth on the Cable Transect A.

Small rock clasts covered with a low turf appeared in ~73 m, increased in abundance and included scattered larger cobbles to ~84 m and then disappeared by ~90 to 93 m (Figure 4-5F). The identity of the low turf is unknown; it may be algal, or possibly agglutinated foraminiferans, bryozoans, hydroids, or a combination. Moving winnowed sediment, octocoral whips bent against the seafloor, and pressure on the ROV and tether all indicated a strong bottom current. Organisms included small, chiefly encrusting sponges, the orange octocoral whip *Ctenocella barbadensis*, arrow crabs *S. seticornis*, box crab *Calappa* sp., and (on Transect As) a single corallimorph anemone *Pseudocorynactis caribbeorum*. Octocorals protruding from sediment suggested that the sediment is a veneer over buried hard substrate. These hard substrates may represent the more steeply sloping shore-parallel linear feature previously recorded in bathymetric maps extending north and south along southeastern Florida and referred to as the 90-m Escarpment (Walker et al., 2004).

Table 4-2. Animal taxa recorded in the video data log and in photographs from ~30 m to the disappearance of the octocoral *Swiftia exserta* in ~63 m. *indicates likely multiple species within genera.

PORIFERA	SCLERACTINIA	CRUSTACEA
*Agelas spp.	*Agaricia* sp.	*Panulirus argus*
Aiolocroia crassa	*Diploria* sp.	ANNELIDA
Amphimedon compressa	?*Madracis* sp.	*Filograna implexa*
Amphimedon sp.	*Meandrina meandrites*	*Hermodice carunculata*
Aplysina cauliformis	*Montastraea annularis*	MOLLUSCA
Aplysina sp.	*Montastraea cavernosa*	*Hypselodoris edenticulata*
Callyspongia plicifera	*Montastraea faveolata*	*Prunum carneum*
Callyspongia vaginalis	*Mycetophyllia* sp.	*Spondylus americanus*
Cliona delitrix	*Scolymia* sp.	Unidentified squid
?*Cribrochalina vasculum*	*Siderastrea siderea*	ECHINODERMATA
Geodia neptuni	*Stephanocoenia intersepta*	*Astrophyton muricatum*
Iotrochota birotulata	ANTIPATHARIA	*Ophionereis reticulata*
?*Ircinia campana*	*Antipathes spp.	OSTEICHTHYES
Ircinia strobilina	?*Parantipathes tetrasticha*	*Acanthostracion quadricornis*
Monanchora arbuscula	?*Stichopathes luetkeni*	Acanthuridae
Neofibularia nolitangere	OCTOCORALLIA	*Anisotremus virginicus*
Niphates digitalis	*Ctenocella barbadensis*	*Canthidermis sufflamen*
Niphates erecta	*Ellisella* sp.	Chaetodontidae
?*Smenospongia* sp.	*Eunicea* sp.	Diodontidae
?*Spirastrella coccinea*	*Iciligorgia schrammi*	Haemulidae
Xestospongia muta	?*Leptogorgia* sp.	Holocentridae
Unidentified black encrusting	*Plexaurella* sp.	*Lachnolaimus maximus*
Unidentified red encrusting	*Pseudoplexaura* sp.	*Malacanthus plumieri*
Unidentified tan encrusting	*Pseudopterogorgia* sp.	Ostraciidae
ZOANTHIDEA	*Swiftia exserta*	Pomacanthidae
Parazoanthus parasiticus	HYDROZOA	*Pterois volitans*
Parazoanthus swiftii	Unidentified hydroidiolina	Scaridae
	CHELICERATA	Synodontidae
	Unidentified pycnogonid	?Tetraodontidae
		Unidentified fish

Table 4-3. Numbers and percentages of major reef taxonomic components in images along the three shallow transects, from the shallow end (~30 m) to the disappearance of the octocoral *Swiftia exserta*. Numbers in parentheses include possible stony coral records that could not be confirmed. Because all three transects traversed cables, there were no control transects, and no quantitative photostations were occupied.

Taxon	**Transect**					
	Cable (A)		**North (An)**		**South (As)**	
	No.	%	No.	%	No.	%
Porifera	186	75.0	228	80.0	261	83.7
Octocorallia	172	69.4	94	33.0	133	42.6
Antipatharia	35	14.1	63	22.1	66	21.2
Scleractinia	18 (21?)	7.3(8.5)	21(23?)	7.4(8.1)	44(50?)	14.1(16.0)
Total images	248		285		312	

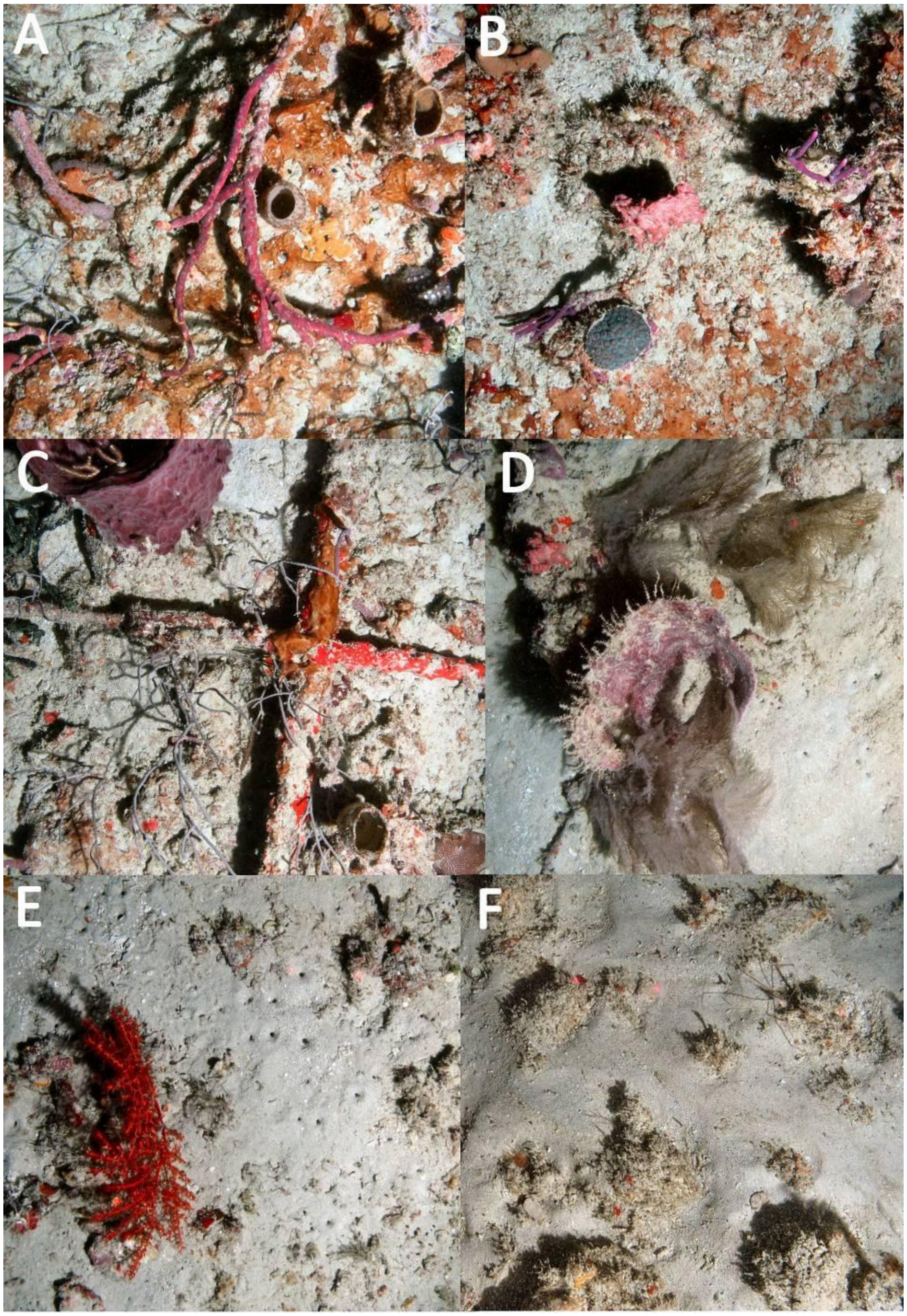

Figure 4-5. Characteristic substrates and fauna along the cable survey route, ~30-90 m. A. Brown cyanobacterial mat, sponges (*Niphates erecta*—purple branch, left; *Aplysina cauliformis*—long branches, center; *N. digitalis*—tubes, center, right) and plexaurid octocorals (left and bottom); ~33 m. B. Coral (*Montastraea cavernosa* lower center left); sponges (*Monanchora arbuscula* red, center; ?*Aplysina* sp.—branches, right, lower left; *Amphimedon* sp.---brown, upper left); ~38 m. C. Crossing cables with encrusting red sponge, cyanobacterial mat, plexaurid octocorals and barrel sponge (*Xestospongia muta*); ~30 m. D. Barrel sponge (*X. muta*) and unidentified antipatharians; ~50 m. E. Red octocoral (*Swiftia exserta*) on rubble; with pockmark burrows in sediment; ~53 m. F. Rubble with fine unidentified turf and arrow crab (*Stenorhynchus seticornis*); ~82 m.

The deepest observed stony coral (*M. cavernosa*) was between 38 and 43 m; reef sponges disappeared below ~49 m; antipatharians occurred between 38 and 51 m in association with the apparent spoil ridge and just overlapping the deepest occurrence of stony corals; *S. exserta* was characteristic of low-relief hard substrates chiefly in ~48-63 m, and octocorals disappeared below ~82 m.

From ~93 to 245 m, the seafloor was smooth or weakly bioturbated sediment with scattered small (5-10-cm) mounds, burrows, and trails, and (from ~215 m) with sparse to numerous small (~ 1 cm) tubes or tufts (possibly produced by polychaetes). A limited area of chiefly small, scattered rubble (to ~10 cm across) appeared in 220-223 m, and another patch with at least one larger clast in 230 m, both sparsely colonized by small anemones and plumulariid hydroids. An isolated dead head of a shallow-water reef coral and a patch of what appeared to be shallow-water staghorn coral (*Acropora cervicornis*) fragments were observed in 221 m and 245 m, respectively. Messing et al. (2006b) also found a cluster of dead shallow coral heads at a similar depth just north of the Port Everglades entrance channel. None appeared to have grown *in situ.* In 185-187 m and again in 242-245 m, two more or less parallel cables were visible at the same time, and, in 197-199 m (26°05.088'N, 80°02.545'W and 26°05.084'N, 80°02.481'W), the cable lay in a series of loops.

From 93 to ~125 m, benthic macrofauna included a few burrowing anemones (Ceriantharia), box crab (Calappidae), purse crab (Leucosiidae), spider crab (Majoidea), snake eels (Ophichthidae), batfish (Ogcocephalidae), unidentified flatfish (possibly *Citharichthys arctifrons*, Paralichthyidae), and blueline tilefish (*Caulolatilus microps*). Blueline tilefish crater-burrows were most common in 105-120 m and disappeared by ~190 m. Video records referenced three observations of these fishes in 102-132 m along the cable transect. Note that, although blueline tilefish is included under the SAFMC Snapper-Grouper Fishery Management Plan (FMP), the habitat requirements of this species differ substantially from those of other fishes under this FMP. As a result, SAFMC (2011a, b) has proposed a separate EFH-HAPC for this species (see discussion below).

Macroorganisms associated chiefly with sediment substrates that formed an assemblage characteristic of the outer shelf to at least 300 m and previously recorded at similar depths just north of the Port Everglades Entrance Channel (Messing et al. 2006a, b) gradually appeared between ~128 and 220 m. Table 4-4 lists their initial depths of appearance. Some, such as the fishes *Laemonema* sp. (Moridae) and *Helicolenus dactylopterus* (Sebastidae), and the pancake urchin *Araeosoma* sp. (all also associated with hard substrates), extended beyond the Outer Terrace Ridge into substantially deeper water.

In 230-231 m, organisms characteristic of the limestone substrates of the Miami Terrace to the east began to appear on or in association with the cable: the soft coral *Pseudodrifa nigra*, a colonial zoanthid anemone, the echiuran worm ?*Ochetostoma* sp, and the chirostylid squat lobster *Eumunida picta.* Table 4-5 in section 4.2.2.2 lists macrofaunal taxa associated with hard substrates on the Upper Miami Terrace, from 230 to 350 m.

Table 4-4. Initial depths of appearance in meters (m) of common outer-shelf, bottom-associated macrofauna on sediment substrates. Asterisks indicate taxa also often found on hard substrates on the Upper Terrace.

TAXON	m	TAXON	m	TAXON	m
CNIDARIA		BRACHYURA		ASTEROIDEA	
ACTINIARIA		*Bathynectes longispina*	146	*Coronaster briareus**	152
?*Actinauge* sp.*	152	*Cancer borealis*	~128	*Sclerasterias* sp.	~208
CERIANTHARIA		*Rochinia crassa**	154	CHONDRICHTHYES	
Unident. white cerianthid	141	ECHINODERMATA		*Benthobatis marcida*	196
CRUSTACEA		ECHINOIDEA		Unidentified Rajidae	170
ANOMURA		*Araeosoma* sp.*	235	OSTEICHTHYES	
?*Munida iris*	162	*Cidaris* sp.*	230	*Helicolenus dactylopterus**	220
?*Pylopagurus* sp.	177	*Gracilechinus* sp.*	~227	*Laemonema* sp.*	218
Unidentified hermit crab*	206			*Peristedion* sp.	175
				Unidentified Scorpaenidae*	199

Figure 4-6. Organisms associated with cable on sediment in <250 m. Left: Anemones (including one large ?*Actinauge* sp.) and plumulariid hydroids, 208 m. Right: Two unidentified octocorals, small anemones and two Venus flytrap anemones (*Actinoscyphia* sp.) with scattered tufts visible on sediment, 230 m. Blades of turtle grass (*Thalassia testudinum*) and gulfweed (*Sargassum* sp.) have been swept against the cable.

4.2.2.2 ROV Transect A - Deep Portion (245 m to 457 m)

The remainder of the cable route transect described here begins at a depth of 245 m and continues to the eastern end in 457 m (Figures 4-7). Substrates and fauna are described in order of increasing depth. Note that the depth profile in Figure 4-7 begins at the western boundary of the 2010 DOE multibeam survey area in ~260 m, because the only depth data available between 225 m and 260 m was low-resolution NOAA bathymetry, which does not offer enough resolution to generate an appropriate depth profile.

Inner Terrace Platform.—Beginning in 245 m, black phosphoritic hard substrates of the western reaches of the Miami Terrace began to appear as scattered gravel and rubble, and small, low-relief exposed outcrops interspersed with expanses of either smooth weakly bioturbated sediment or raised rippled sediment. Depth shoaled gradually and irregularly to <240 m as more extensive hard substrates appeared in the form of patches of low aggregated hardbottom, low- to moderate-relief outcrops, fields of gravel and cobbles, sediment-veneered and exposed pavements, and occasional ledges and areas with larger cobbles, slabs or boulders with relief up to ~1 m. Qualitative estimates from video of percent cover of hardbottom substrates ranged from 20 to 80%. As depth shoaled to 236 m, the transect encountered more extensive hard substrates reaching 100% cover, including rubble-cobble fields, ledges, pavements and boulders with relief up to 1 m, but still with some patches of sediment.

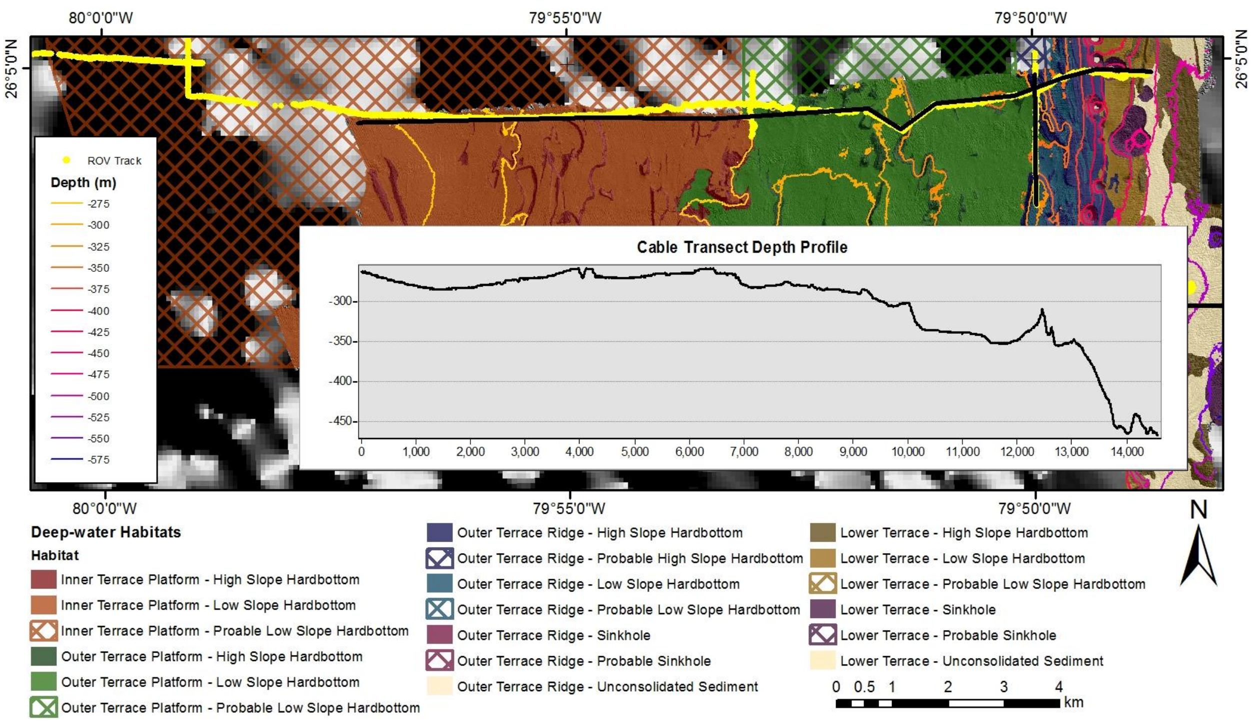

Figure 4-7. Cable Transect (A) habitat map continued from Figure 4-4 with depth profile from the western boundary of the multibeam survey area to the eastern transect terminus.

Organisms remained sparse, with gravel-rubble fields and some low-relief hardbottoms completely or almost devoid of benthic macrofauna. Numerous additional macrofaunal taxa characteristic of the Upper Terrace and Outer Terrace Ridge appeared for the first time (Table 4-5). The echiuran spoonworm, ?*Ochetostoma* sp., which buries its sausage-shaped body in crevices in hard substrates and extends its slender Y-shaped proboscis along the sediment surface, was often the most common macrofaunal taxon on low-relief, mixed hardbottom and sediment substrates (Figure 4-8).

As depth increased to the east from ~238 through ~265 m, percent cover of hard substrates—low-relief irregular pavements, rubble and mixed rubble-pavement—decreased somewhat, accounting for 30-80% of seafloor separated by broader areas of sediment. From ~267 through 280 m, low-relief exposed rubble (<15 cm) and hardbottom often formed north-south-oriented fingers populated by the same sparse fauna described above, with the addition of patches of sometimes numerous tiny white sponges, and separated by expanses of sediment. The short-nose greeneye, *Chlorophthalmus agassizi*, common on low-relief and sediment bottoms, first appeared in 280 m. At the same depth, a single *Phakellia* sp. fan sponge was found lying detached on the seafloor ~3 m away from the cable, with no indication of scour or scraping.

Between 79º 56.266'W and 79º54.361'W, the seafloor shoaled from 281 m to 264 m before reaching steeper irregular slopes and walls with vertical relief of ~5 m leading to a rocky plateau in 260 m at 26º04.489'N, 79º54.915'W. Substrates approaching the plateau remained chiefly the same with some limited areas of 100% low- to moderate-relief rock pavement, outcrops or boulders, but also with raised expanses of rippled sediment. Adjacent to the plateau, the cable was suspended up to ~ 5 m above the seafloor and supported *Actinoscyphia* sp. anemones, zoanthids and colonies of the stony branching coral *Lophelia pertusa* up to 2 m long. East of the plateau, the seafloor descended to 267 m with substrates including low-relief pavements, mixed rubble-cobble and sediment, rippled sediment with or without sparse rubble, and limited areas of larger clasts with up to 0.3 m relief before rising briefly up a rocky slope to 254 m with pavements, boulders up to 0.5 m vertical relief, and rubble and cobble clasts of both black phosphoritic and white limestone. The seafloor then sloped to 264 m and again rose to 254 m across a ridge before descending again to the Outer Terrace Platform.

Table 4-5. Benthic macrofauna associated with hard substrates on the Upper Terrace Platform; 230-350 m. Asterisks indicate taxa that likely include more than one species.

PORIFERA	ZOANTHIDEA	ECHINODERMATA
DEMOSPONGIAE	Unident. Zoanthidea*	ASTEROIDEA
Corallistes sp.	CORALLIMORPHARIA	?*Ceramaster* sp.
?*Discodermia* sp.	*Corallimorphus* sp.	Goniasteridae
Geodia sp.	ANTIPATHARIA	*Novodinia antillensis*
?*Leiodermatium* sp.	*Antipathes bipinnata*	*Porania* sp.
Phakellia sp.	*Leiopathes* sp.	*Tosia parva*
Spongosorites sp.	Unident. Antipatharia*	*Tremaster mirabilis*
Desmacellidae	SCLERACTINIA	Unident. Asteroidea*
Lithistida	*Lophelia pertusa*	CRINOIDEA
Pachastrellidae	Unident. solitary corals*	*Comatonia cristata*
Petrosiidae	OCTOCORALLIA	ECHINOIDEA
Raspailiidae	*Anthomastus* sp.	*Araeosoma* sp.
Spirophorida	*Eunicella* sp.	*Cidaris* ?*rugosa*
Unident. brown encrusting	*Isidella* sp.	*Gracilechinus* sp.
Unident. green mound	*Plumarella* sp.	Unident. Echinoidea
Unident. white fingers	*Pseudodrifa nigra*	OPHIUROIDEA
Unident. Demospongiae*	*Pennatula* or *Ptilosarcus* sp.	*Astroporpa annulata*
HEXACTINELLIDA	CRUSTACEA	*Gorgonocephalus arcticus*
Aphrocallistes beatrix	PENAEIDEA	?*Ophiomusium lymani*
Farrea sp.	?*Pleoticus robustus*	Unidentified Ophiuroidea
Vazella sp.	CARIDEA	HOLOTHUROIDEA
Unident. Hexactinellida*	Unident. rock shrimp	*Psolus* sp.
CNIDARIA	ANOMURA	CHONDRICHTHYES
HYDROIDLIOLINA	*Eumunida picta*	*Galeus arae*
Plumulariidae*	Unident. Paguroidea*	Unident. Rajidae
Stylasteridae*	BRACHYURA	OSTEICHTHYES
Unidentified hydroids*	*Chaceon fenneri*	*Chaunax suttkusi*
ACTINIARIA	ANNELIDA	*Chlorophthalmus agassizi*
Actinauge sp.	?*Ochetostoma* sp.	*Helicolenus dactylopterus*
Actinoscyphia sp.	MOLLUSCA	*Laemonema* sp.
Liponema sp.	GASTROPODA	Anthiinae
Sagartiidae	*Calliostoma* sp.	Callionymidae
		Scorpaenidae
		Unident. fish

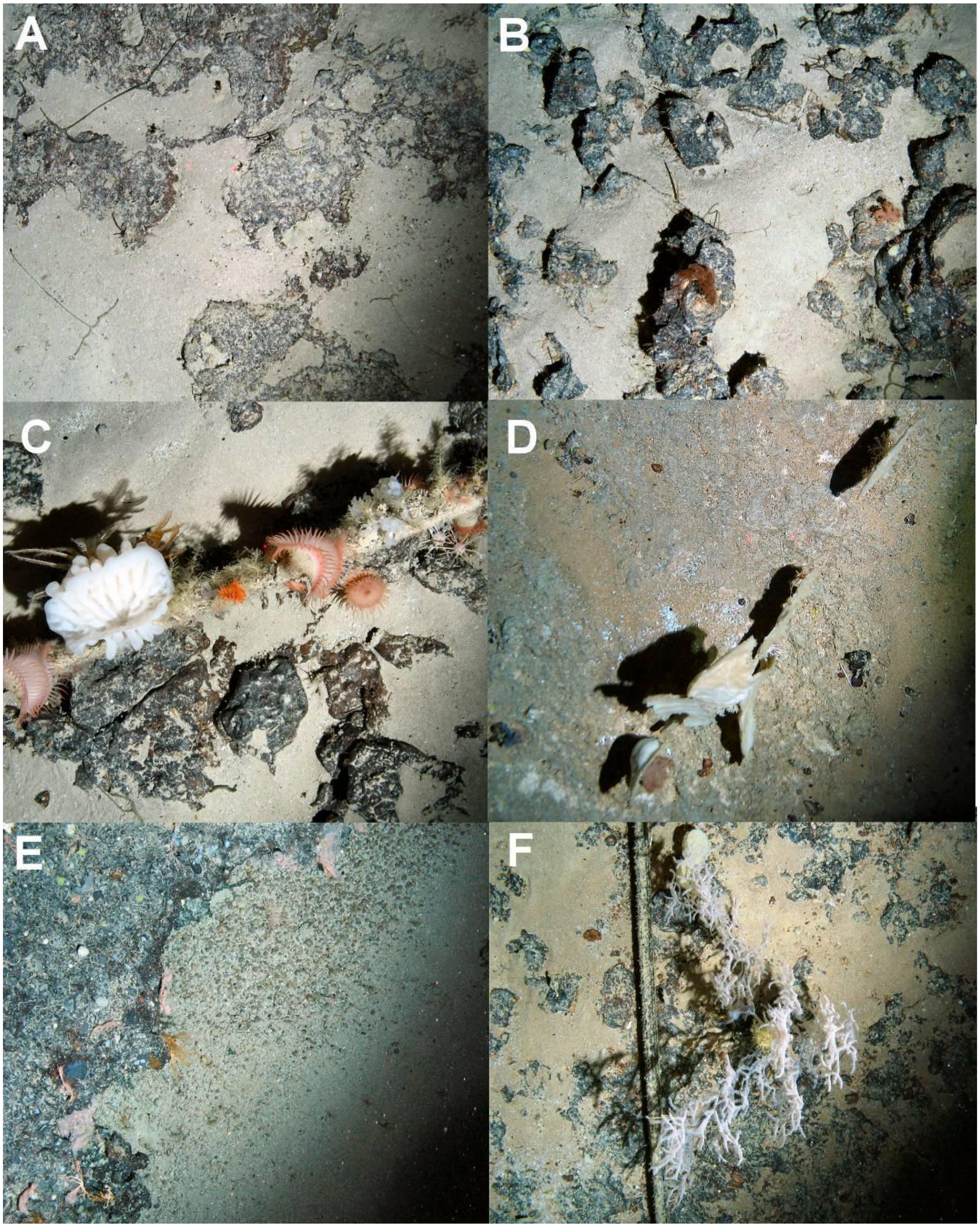

Figure 4-8. A-C. Inner Terrace Platform. A. Low-relief pavement and sediment with echiuran worms (?*Ochetostoma* sp.); 242 m. B. Cobbles on sediment with small soft coral, *Pseudodrifa nigra*; 236 m. C. Cable over cobbles; fouling organisms include Venus flytrap anemones (*Actinoscyphia* sp.), glass sponge (*Aphrocallistes beatrix*), crinoids (*Comatonia cristata*)(behind sponge), *Corallimorphus* sp. (pink anemone, right center) and hydroids; 273 m. D-F. Outer Terrace Platform. D. Sediment-veneered pavement with fan sponges (*Phakellia* sp.); 281 m. E. Sediment with brachiopod-shell lag at edge of pavement with crinoids and octocorals (*Plumarella* sp.); 282 m. F. Black coral (*Leiopathes* sp.) adjacent to cable on low-relief substrate near western base of Outer Terrace Ridge; 349 m.

Outer Terrace Platform.—The descent to the Outer Terrace Platform was a series of 1-2-m ledges widely separated by low- to moderate-relief gently sloping pavements, slabs and outcrops, boulders up to ~0.6 m tall, expanses of rubble and cobbles (both white and black phosphoritic limestone), and rubbly aggregated pavements, ranging chiefly between 50 and 100% cover, with occasional expanses of rippled sediment with or without scattered rubble. Occasional localized concentrations of brachiopod valves on sediment adjacent to higher relief irregular hard substrates and ledges reflect a cryptic fauna under overhanging surfaces not visible in downward-looking images (Figure 4-8E).

The fauna remained essentially the same but added a few more characteristic Terrace taxa: *Astroporpa annulata* and *Gorgonocephalus arcticus* (Ophiuroidea) and *Comatonia cristata* (Crinoidea), all suspension feeders associated with at least moderate benthic boundary flow, and, on sediment, a sea pen (*Pennatula* sp. or *Ptilosarcus* sp) up to 50 cm tall. Locally abundant organisms included the fan sponge *Phakellia* sp. and stylasterid fans on hard substrates, and unidentified ophiuroids (possibly *Ophiomusium lymani*) on sediment. Several colonies of *L. pertusa* were observed on higher-relief (up to 2 m) irregular outcrops and boulders in 298 m. Sections of cable suspended between elevated seafloor again supported anemones and *L. pertusa*.

From ~300 m, the bottom descended rapidly in steep irregular slopes with rugged slabs, boulders and ledges to sediment with up to 10-cm ripples in 321 m, and continued downward in a mixture of sediment and rubble, cobbles, boulders and possibly sediment-veneered hardbottom to 333 m. In 331 m (26°04.479'N, 79°51.179'W), the cable exhibited a 45° bend. Below this to 350 m, the slope became more gradual, chiefly inactively rippled sediment or sediment-veneered hardbottom, with patches or expanses of 5-10-cm rubble or larger (to 20-cm) cobbles usually accounting for no more than ~30% of cover, and with occasional outcrops and narrow, linear phosphoritic rock outcrops 10-15 cm high. Hardbottom fauna was dominated by the small white octocoral *Eunicella* sp., and fan sponges *Phakellia* sp. Other taxa included the glass sponges *A. beatrix*, *Farrea* sp. and *Hertwigia falcifera*, demosponges *Geodia* sp., Pachastrellidae, Lithistida and Raspailiidae, bamboo octocoral *Isidella* sp., anemones *Corallimorphus* sp. and *Liponema* sp., soft coral *P. nigra*, cidarid urchins, goniasterid seastars, and sometimes abundant ophiuroids. The sea pen *Pennatula* or *Ptilosarcus* sp. was sometimes common on sediment, although it was also appeared to anchor on or among gravel and rubble. Fishes included an unidentified rajid, the catshark *Galeus arae*, the gaper *Chaunax suttkusi*, *H. dactylopterus*, and *Laemonema* sp.

Outer Terrace Ridge.—From ~350 m, the seafloor gradually sloped upward to the crest of the Outer Terrace Ridge in 306 m. Hard substrates accounted for a greater proportion of the bottom, beginning with low-relief exposed and sediment-veneered pavements and ledges, and becoming higher-relief pavements and irregular ridges by 330 m, but still with many areas of rubble or cobble. Organisms remained similar but increased in abundance on higher-relief substrates. Additional fishes included a phycid hake (?*Urophycis* sp.) and Zeidae (?*Zenopsis* sp.). From 314 m to the crest, the substrate was chiefly high-relief rugged pavement with scattered sediment. The ridge crest was a flat, low-relief pavement with pockets of sediment. Organisms included numerous sponges (e.g., Pachastrellidae, Desmacellidae, Lithistida, *Farrea* sp. *Geodia* sp.), Stylasteridae, octocorals (*Eunicella* sp., *Plumarella* sp., *P. nigra*), *Lophelia pertusa*, *Comatonia cristata* and cidarid urchins (Figure 4-9).

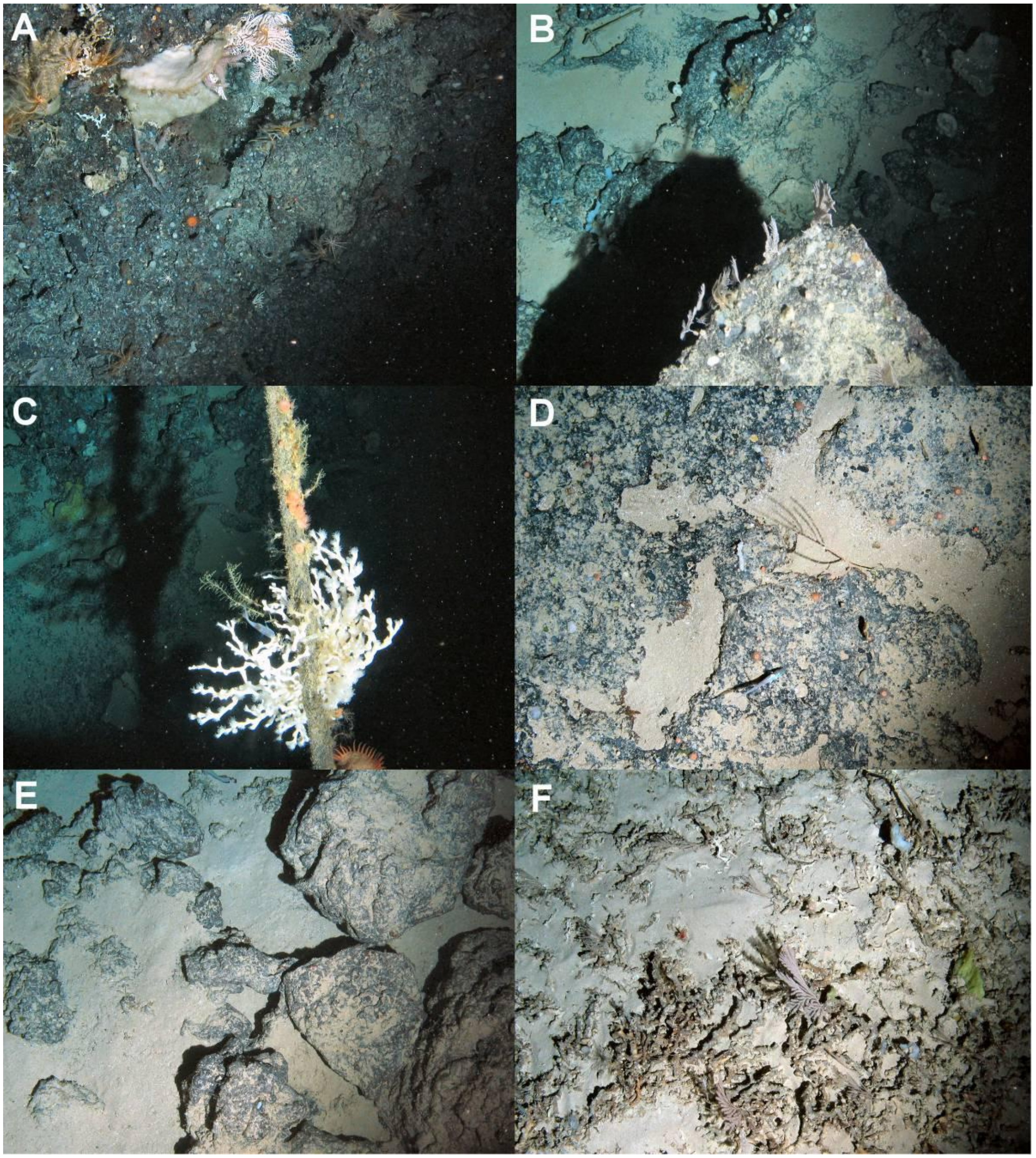

Figure 4-9. A-D. Outer Terrace Ridge. A. Sponges, crinoids (*Comatonia cristata*), Stylasteridae (white lace coral fan), and orange solitary corals on steep rugged drop-off near ridge crest; 307 m. B. Overhanging ledge with octocorals (*Plumarella* sp.); 400 m. C. *Lophelia pertusa*, anemones and hydroids on cable suspended between rugged elevations; 345 m. D. Low-relief, sediment veneered pavement on outer ridge slope, with bamboo octocoral (Isididae), solitary corals, and rattail fish (*Nezumia* sp.); 404 m. E. Barren cobbles and boulders on upper western slope of sinkhole; 440 m. F.Coral rubble with octocorals (*Plumarella* sp.) and sponge on Lower Terrace; 452 m.

The eastern slope of the Outer Terrace Ridge descended in a series of ledges, narrow ridges and high-relief rugged pavements with relatively little sediment cover and with the cable suspended up to 7 m above bottom in places. The slope was steep but irregular, dropping to 355 m and rising again to 342 m before continuing downward. Substrates varied among low-relief sediment-veneered pavements with or without loose gravel or cobbles, and moderate- to high-relief slabs, outcrops, and boulders. By 360 m, the substrate was chiefly low-relief, sediment-veneered, fractured pavement with some cobbly irregular low- to moderate-relief outcrops and patches of gravel or sediment. The fauna was similar to that on the western slope and crest but decreased in abundance with depth. The deep-water rattail fish *Nezumia* sp. first appeared in 385 m. Between 399 and 417 m, the substrate was largely barren, low-relief pavement with some sediment channels.

Sinkhole.—In 419 m, the transect descended into a sinkhole characterized by numerous boulders and rubble (Figure 4-9E) mixed with sediment and with almost no visible organisms except for *Actinoscyphia* sp. and *Comatonia cristata* on the suspended cable, and a single roughy or alfonsino, *Beryx decadactylus*. Rippled sediment floored the sinkhole in 440-443 m. Hard substrates appeared again on the eastern slope, first as patches of boulders and slabs on sediment with small coral rubble fragments, then becoming low- to moderate-relief pavement, slabs, and outcrops with gravel and cobbles upslope. Fauna was similar to that on the eastern slope of the Outer Terrace Ridge, with *Lophelia pertusa*, *Plumarella* sp., Stylasteridae, Isididae, demosponges and hexactinellids on boulders at and near the eastern rim in 432-435 m.

Lower Terrace.—East of the sinkhole rim, the seafloor continued to descend, varying among sediment-veneered pavements, rippled sediment, and low-relief hardbottom, with areas of sparse to dense *L. pertusa* coral rubble (Figure 4-9F). Organisms included hexactinellid sponges, Stylasteridae, *Plumarella* sp. and the first deep-water bamboo octocoral, *Keratoisis flexibilis* (436 m). The transect was terminated in 457 m, well east of the recorded terminus of cable 96.

4.2.2.3 South Non-Cable ROV Transect (C)

Figure 4-10 shows the South Non-Cable Transect and depth profile derived from multibeam data superimposed on the benthic habitats. Substrates and fauna are described in order of increasing depth.

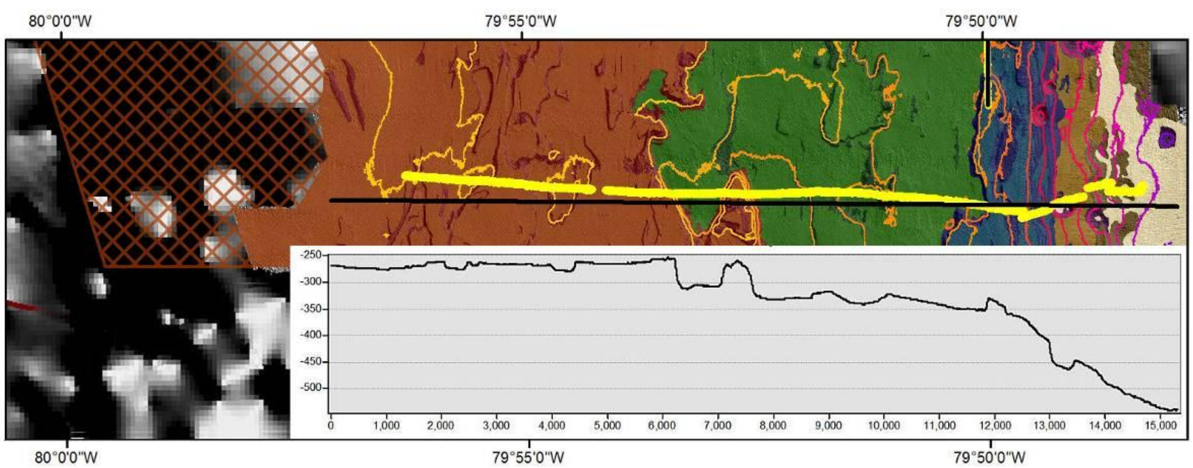

Figure 4-10. South Non-Cable Transect habitat map with depth profile derived from multibeam survey data. Isobath and habitat key as in Figure 4-7.

Inner Terrace Platform.—The westernmost portion of the transect beginning in 272 m was dominated by sediment substrates alternating between smooth, with unidentified tufts (possibly polychaete tubes), and rippled, interspersed with fields of sparse to dense gravel to cobbles, and low-relief pavements and irregular outcrops infrequently reaching ~0.6 m vertical relief with sediment pooling in depressions. Much of the western Inner Terrace Platform was vast fields of phosphoritic gravel, rubble and cobbles on sediment, with hard substrates accounting generally for 10-50% of cover, but interspersed with areas of more extensive low-relief pavement, outcrops, slabs and narrow low ridges. The transect crossed two depressions with vertical relief of up to 10 m (floor in 273 m) bordered by ledges and irregular high-relief outcrops and boulders, and floored by expanses of rippled sediment and fields of gravel and rubble on sediment. Eastward, the Inner Terrace Platform was characterized by low-relief, highly irregular phosphoritic outcrops, pavement and aggregated cobble substrate accounting for ~40-90% of cover, with sediment pooling in depressions (Figure 4-10). A phosphoritic ledge in 255 m dropped ~0.6 m to a distinctly different pale limestone pavement, which rapidly transitioned again to low-relief phosphoritic irregular outcrops.

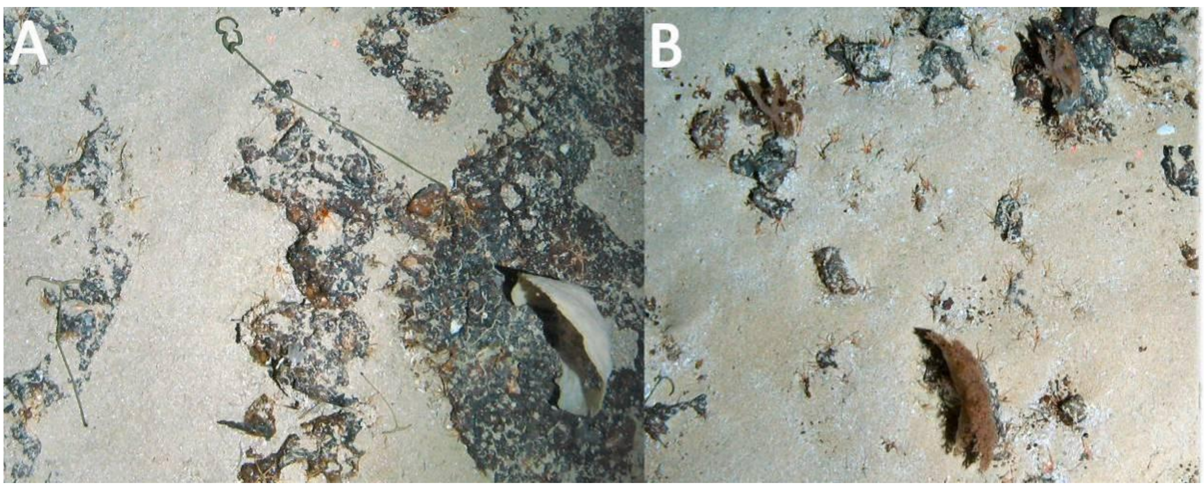

Figure 4-11. Inner Terrace Platform. A. Several echiuran worms ?*Ochetostoma* sp., fan sponge *Phakellia* sp. and numerous ophiuroids on low-relief, sediment-veneered pavement. B. Several soft corals *Pseudodrifa nigra* on phosphoritic rubble.

Most hard substrates supported sparse benthic macrofauna except for occasional local increases on low-relief substrates and typical often denser concentrations on local high-relief substrates (boulders and edges of ledges and raised slabs). Dominant organisms included fan sponges (*Phakellia* sp.), the spoonworm ?*Ochetostoma* sp. (Figure 4-11A), and the anemone *Liponema* sp., with local increases in pink-lipped sagartiid anemones, soft corals (*Pseudodrifa nigra*) (Figure 4-11B) and sea pens (*Pennatula* sp. or *Ptilosarcus* sp.), and enormous concentrations of ophiuroids. The shallowest, westernmost colony of *Lophelia pertusa* was observed on the rugged western lip of one of the sediment-floored depressions in 261 m, accompanied by sponges, antipatharians, hydroids and octocorals. Species richness clearly declined toward the western end of the transect; several taxa not previously seen and some characteristic of the Outer Terrace Platform were observed only once or rarely. Table 4-6 lists fauna observed on the Inner Terrace Platform, including the top of a triangular spur that extended northward from the southern edge of the geophysical survey area eastward of the Inner Terrace Platform escarpment.

Table 4-6. Benthic macrofauna observed on the Inner Terrace Platform. Asterisks indicate taxa observed once or rarely.

TAXON	TAXON	TAXON
PORIFERA	Unidentified Sagartiidae	ECHINODERMATA
DEMOSPONGIAE	Unidentified stripe-disk anemone*	CRINOIDEA
Geodia sp.	CORALLIMORPHARIA	_Comatonia cristata_
Phakellia sp.	_Corallimorphus_ sp.	Unidentified comatulid*
Unidentified Desmacellidae	CERIANTHARIA	ASTEROIDEA
Unidentified lithistid*	Unidentified cerianthid	Goniasteridae*
Unidentified Pachastrellidae*	SCLERACTINIA	_Tremaster mirabilis_
Unidentified Petrosiidae*	_Lophelia pertusa_*	Unidentified asteroids
Unidentified Raspailliidae	Unidentified solitary corals	OPHIUROIDEA
Slender branching sponge*	ANTIPATHARIA	_Astroporpa annulata_*
Spherical white sponge	_Leiopathes_ sp.	?_Ophiomusium lymani_
White encrusting sponge*	Unidentified black coral*	Unidentified ophiuroids
Yellow encrusting sponge	HYDROZOA	ECHINOIDEA
Unidentified demosponges	Unidentified Stylasteridae	_Cidaris_ sp.
HEXACTINELLIDA	Unidentified hydroids	_Echinus_ sp.*
_Aphrocallistes beatrix_*	ANNELIDA	HOLOTHUROIDEA
Farrea sp.	? _Ochetostoma_ sp.	_Psolus_ sp.*
Vazella sp.*	MOLLUSCA	VERTEBRATA
CNIDARIA	GASTROPODA	CHONDRICHTHYES
OCTOCORALLIA	_Calliostoma_ sp.	Unidentified Rajidae
?_Anthomastus_ sp.*	CRUSTACEA	OSTEICHTHYES
Eunicella sp.	ANOMURA	_Chlorophthalmus agassizi_
Isidella sp.*	Unidentified galatheoid*	_Helicolenus dactylopterus_ *
Pennatula or _Ptilosarcus_ sp.	Unidentified paguroid	_Laemonema_ sp.
Plumarella sp.*	BRACHYURA	_Polyprion americanum_ *
Pseudodrifa nigra	_Bathynectes longispina_*	Unidentified Scorpaenidae*
ACTINIARIA	_Cancer borealis_*	Unidentified fish*
Actinoscyphia sp.	?_Rochinia_ sp.*	
Liponema sp.		

Outer Terrace Platform.—The slopes of the spur and the escarpment at the western margin of the Outer Terrace Platform reached 60º with locally vertical ledges, and consisted chiefly of low-relief, mostly barren pavement with areas of phosphoritic rubble, boulders and irregular phosphoritic outcrops up to ~0.6 m tall on slopes and up to 2.0 m tall on the crest. Much of the pavement was pale limestone, in places overlain with contrasting phosphoritic gravel, rubble or cobbles (Figure 4-12E). Abrupt changes in slope and major local zones of high-relief conformed well with the 2010 DOE multibeam topography. The eastern escarpment of the Inner Terrace Platform dropped from 252 m to 300 m at its base. The triangular spur rose to 264 m and dropped on its eastern side back to the Outer Terrace Platform in 328 m.

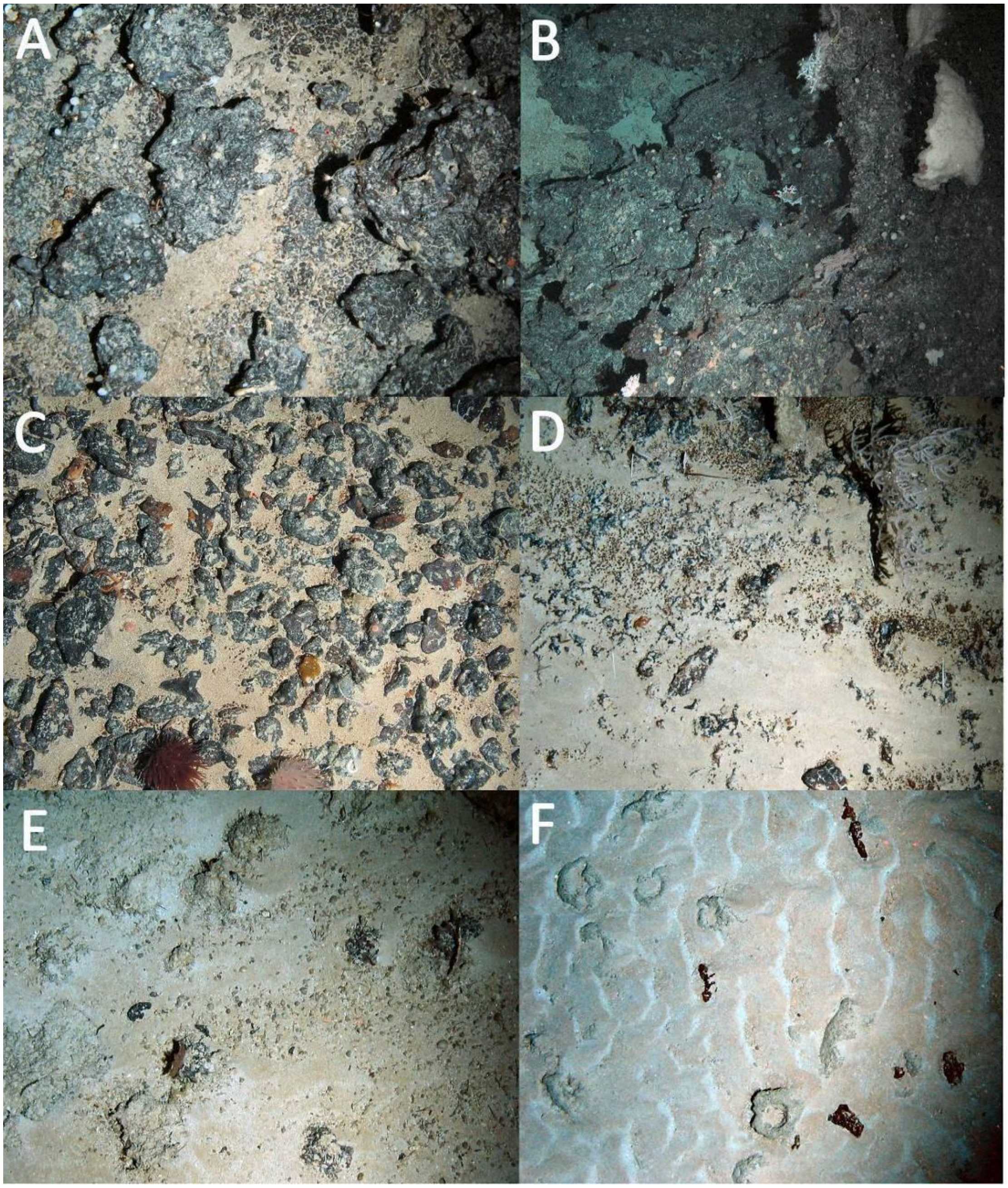

Figure 4-12. South Transect, Outer Terrace Platform. A. Sediment-veneered pavement with slab-like low-relief outcrops and patchy gravel and small cobbles. B. A series of ledges with Lophelia pertusa (small white colony at upper center), the octocoral Plumarella sp. and large white Phakellia sp. sponges. C. Low-relief field of rubble intermixed with gravel and the anemone Liponema sp. (bottom). D. Sediment-veneered pavement with gravel; a pachastrellid sponge and the black coral Leiopathes sp. are visible at top right. E. Pale sediment-veneered limestone pavement with a few small black phosphoritic clasts, gravel, and scattered brachiopod valves. F. Unusual bowl-like outcrops of pale limestone on rippled sediment-veneered hard bottom.

Beyond the triangular spur of the Upper Terrace the seafloor passed from sediment-veneered pale carbonate pavement overlain with phosphoritic rubble (Figure 4-12E) through decreasing density of gravel and rubble to an extensive rippled sediment field with broad sand waves up to 1 m high. A unique hard bottom appeared as local low-relief fields of pale bowl-like features 10-20 cm across (Figure 4-12F). Several images, particularly near steep substrates, revealed numerous brachiopod valves, sometimes accompanied by echinoid spines (Figure 4-12E).

The Outer Terrace Platform between the crest of the escarpment at the eastern boundary of the Inner Terrace Platform and the western escarpment of the Outer Terrace Ridge included a wide diversity of chiefly hard substrates including: a) low-relief, continuous, jointed or broken pavements with occasional abruptly delimited patches of gravel or small cobbles (Figure 4-12A); b) irregular low- to moderate-relief outcrops with sediment pooling in depressions; and c) occasional moderate- to high-relief ledges, jumbled boulders and tilted slabs, with higher relief associated with slopes below ledges (Figure 4-12B). However, much of the area consisted of extensive fields of gravel, rubble or cobbles (Figure 4-12C) with occasional patches of exposed hard substrates. Smooth or rippled sediment ranged from extensive areas with no exposed hard substrate through deeply or thinly-veneered pavement, or scattered small to large cobbles, to mixtures of aggregated gravelly hard bottom and more open sediment (Figure 4-12D) with broader hardbottom patches. The multibeam backscatter data did not appear to resolve differences between the sediment substrates and flatter hard bottoms, suggesting that the sediment was not particularly deep.

Hard substrates ranged from largely barren with only widely scattered organisms (although close-up images sometimes revealed large numbers of small ophiuroids) (Figure 4-13A), to supporting locally dense assemblages, particularly in areas of higher relief, although no consistency appeared between qualitative densities or composition relative to substrate complexity or topographic relief. For example, one slender white branching sponge was seen toward the western end of the Outer Terrace Platform but nowhere else on apparently similar substrates; isolated colonies of *Lophelia pertusa* were observed chiefly on higher-relief ledge edges but not on a pinnacle that rose 15 m above surrounding seafloor; and stylasterid hydrocorals or cidarid echinoids appeared in numbers in a few areas and were absent elsewhere on similar substrates. Nevertheless, the primnoid octocoral, *Plumarella* sp. generally appeared in numbers only near or on apparently elevated exposed substrates, and ledge edges typically supported diverse and often dense assemblages of sponges, stylasterids, and crinoids. Table 4-7 lists organisms observed on the Outer Terrace Platform, including the steep slopes rising to the Inner Terrace Platform.

The low-relief rubble-cobble fields between escarpments supported a sparse fauna dominated by the anemone *Liponema* sp. with some sponges, abundant ophiuroids, and a few widely scattered large black coral colonies (*Leiopathes* sp.). *Pennatula* or *Ptilosarcus* sp. was found both on sediment and among gravel and rubble (Figure 4-13B).

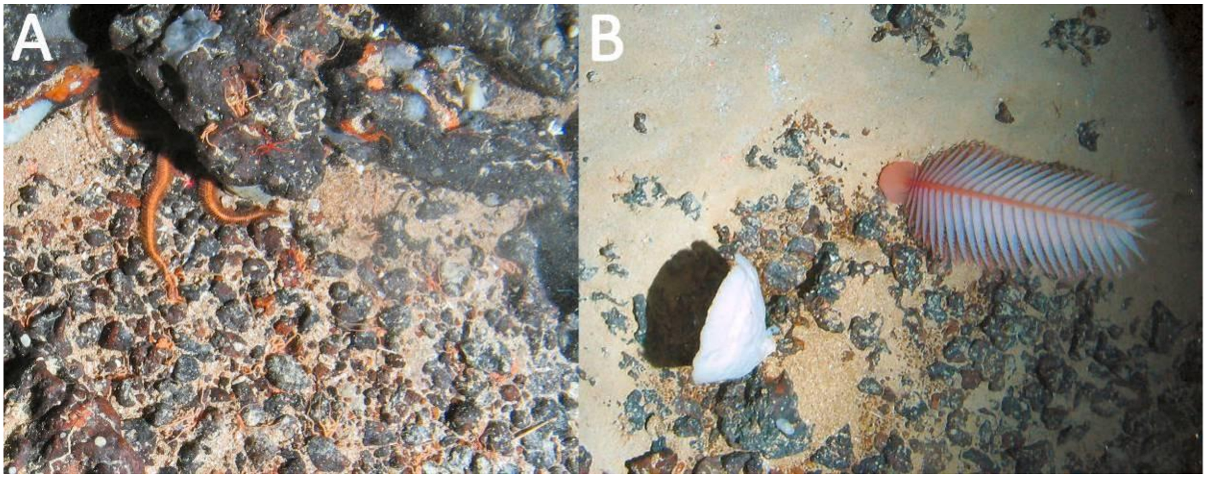

Figure 4-13. South Transect, Outer Terrace Platform. A. Abundant ophiuroids belonging to three species. B. Sea pen (*Pennatula* or *Ptilosarcus* sp.) apparently on sediment-veneered hard bottom, accompanied by the fan sponge *Phakellia* sp.

Table 4-7. Outer Terrace Platform, South Transect: Benthic macrofauna.

TAXON	TAXON	TAXON
PORIFERA	ACTINIARIA	ASTEROIDEA
DEMOSPONGIAE	*Actinoscyphia* sp.	Goniasteridae
Geodia sp.	*Liponema* sp.	Unidentified asteroids (~1)
Unidentified lithistid	Unidentified Sagartiidae	OPHIUROIDEA
Phakellia sp.	Unidentified anemone	*Asteroporpa annulata*
Spongosorites sp.	CORALLIMORPHARIA	Unidentified Asteroschematidae
Unidentified Desmacellidae	*Corallimorphus* sp.	Unidentified ophiuroids
Unidentified Pachastrellidae	SCLERACTINIA	ECHINOIDEA
Unidentified Raspailliidae	*Lophelia pertusa*	*Araeosoma* sp.
Unidentified spherical astrophorid	Solitary corals	*Cidaris* sp.
Brown encrusting sponge	ANTIPATHARIA	*Echinus* sp.
White wall sponge	*Leiopathes* sp.	*Stylocidaris* sp.
Unidentified demosponges	HYDROZOA	Unidentified echinoid
HEXACTINELLIDA	Unidentified Stylasteridae	VERTEBRATA
Aphrocallistes beatrix	Unidentified hydroids	CHONDRICHTHYES
Farrea sp.	ANNELIDA	*Benthobatis marcida*
Vazella sp.	*Ochetostoma* sp.	*Galeus arae*
Unidentified hexactinellid	CRUSTACEA	Unidentified Rajidae
CNIDARIA	ANOMURA	OSTEICHTHYES
OCTOCORALLIA	*Eumunida picta*	*Chaunax* sp.
Eunicella sp.	Unidentified paguroid	*Chlorophthalmus agassizi*
Isidella sp.	BRACHYURA	*Helicolenus dactylopterus*
Pseudodrifa nigra	*Cancer borealis*	*Laemonema* sp.
Plumarella sp.	ISOPODA	*Nezumia* sp.
Unidentified octocoral	*Bathynomus giganteus*	*Polymixia* sp.
Pennatula sp. (or *Ptilosarcus* sp.)	ECHINODERMATA	Unidentified Scorpaenidae
	CRINOIDEA	Unidentified fish
	Comatonia cristata	

Outer Terrace Ridge.—The slope below the Outer Terrace Ridge crest in ~337 m consisted of chiefly low-relief, clean and sediment-veneered, often jointed pavements with a flat top of aggregated rubble, slabs and sediment-veneered pavement. The eastern side of the Outer Terrace

Ridge began with a steep ledge with large blocks and slabs in 356 m that dropped to abundant cobbles (10-30 cm), larger blocks and slabs. The slope continued downward as low- to high-relief jointed and irregular pavements with slabs, outcrops, occasional low ledges, cobbles, a few isolated gravel patches, and pools and small expanses of sediment. Attached organisms were more diverse and abundant higher on the slope (the unidentified taxa in Table 4-8 likely conceal multiple species), but their distributions remained extremely patchy. Sponges dominated, with patches of stylasterid hydrocorals and, near the top of the slope, numerous small *Plumarella* sp. Several Outer Platform taxa reached their maximum depth limit here, e.g., demosponges *Geodia* sp. and Pachastrellidae, and the anemone *Liponema* sp.

Table 4-8. Outer Terrace Ridge, South Transect. Benthic macrofauna.

TAXON	TAXON	TAXON
PORIFERA	Unidentified octocoral	ECHINODERMATA
DEMOSPONGIAE	ACTINIARIA	CRINOIDEA
Corallistes sp.	*Actinoscyphia* sp.	*Comatonia cristata*
Geodia sp.	*Liponema* sp.	ASTEROIDEA
Unidentified lithistid	Unidentified orange anemone	Goniasteridae
Phakellia sp.	Unidentified red anemone	*Tosia parva*
Spongosorites sp.	Unidentified anemone	Unidentified asteroids (~4-5 species)
Unidentified Choristidae	CORALLIMORPHARIA	OPHIUROIDEA
Unidentified Desmacellidae	*Corallimorphus* sp.	*Asteroporpa annulata*
Unidentified Pachastrellidae	SCLERACTINIA	Unidentified ophiuroids
Unidentified Petrosiidae	*Lophelia pertusa*	ECHINOIDEA
Unidentified Raspailiidae	Solitary corals	*Araeosoma* sp.
Unidentified spherical astrophorid	ANTIPATHARIA	*Cidaris* sp.
Unidentified white branching sponge	*Leiopathes* sp.	Unidentified echinoid
Yellow encrusting sponge	HYDROZOA	HOLOTHUROIDEA
White wall sponge	Unidentified Stylasteridae	*Psolus* sp.
Unidentified demosponges	Unidentified hydroids	VERTEBRATA
HEXACTINELLIDA	BRYOZOA	CHONDRICHTHYES
Vazella sp.	Unidentfied bryozoan	*Galeus arae*
Unidentified hexactinellid	CRUSTACEA	Unidentified Rajidae
CNIDARIA	ANOMURA	OSTEICHTHYES
OCTOCORALLIA	Unidentified paguroid	*Helicolenus dactylopterus*
Eunicella sp.	BRACHYURA	*Laemonema* sp.
Isidella sp.	*Chaceon fenneri*	Unidentified fish
Pseudodrifa nigra		
Plumarella sp.		

*Sinkhole.—*The base of the Outer Terrace Ridge was a steep irregular escarpment of blocks, slabs and boulders to 418 m, the western edge of a sinkhole that sloped down as a smooth pavement thinly veneered with sediment, with small clumps of dead *L. pertusa* rubble on the western slope (Figure 4-14B). The sinkhole floor in 450 m was rippled and smooth sediment with small patches of pavement that alternated with fine coral rubble and sediment up the eastern slope to higher relief slabs, boulders and outcrops and coral rubble inside the edge at 436 m. An unidentified rajid skate and greeneye, *C. agassizi*, were the most common mobile organisms on the sinkhole floor.

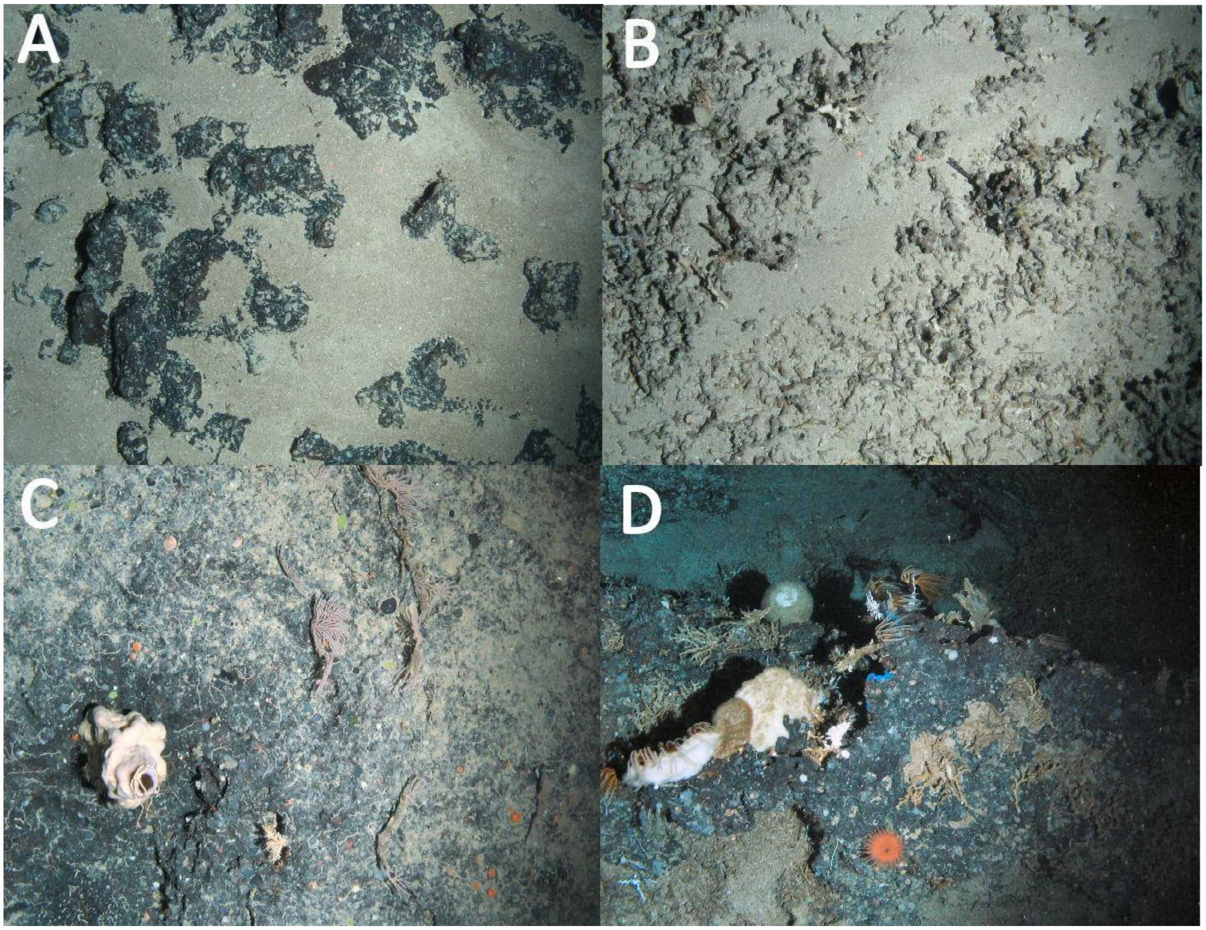

Figure 4-14. A. Low-relief aggregated phosphoritic cobble-rubble field on the deeper Lower Terrace slope in 507-510 m. B. *Lophelia pertusa* rubble on the Lower Terrace slope. C. Low-relief pavement near the top of the Outer Terrace Ridge with octocorals (*Plumarella* sp.), orange solitary corals, and white petrosiid sponge. D. Ledge near the top of the Outer Terrace Ridge with sponges, crinoids, *Corallimorphus* sp.(orange) and *Lophelia pertusa* fragments.

Lower Terrace.—Beyond the sinkhole, substrates ranged from low-relief cobble and rubble (10-30 cm across) fields to moderate- to high-relief phosphoritic boulders, low ledges, overhanging slabs and pavements up to 80-90% cover in 443-461 m, with ponds and expanses of chiefly rippled sediment. Benthic macrofauna was extremely sparse on low-relief substrates, and more common but still generally widely scattered and patchy on higher relief substrates. The most frequently seen organisms included the anemone *Corallimorphus* sp., isidid octocorals, golden crab *C. fenneri*, codling *Laemonema* sp., and small mottled rajids. In 467 m, the seafloor transitioned abruptly from the hard substrates of the Lower Terrace to largely barren sediment with ripples indicating southbound bottom flow, alternating with weakly bioturbated smooth sediment with scattered craters.

The deeper Lower Terrace slope from 507 to 510 m consisted of a series of intermixed substrates: low-relief aggregated phosphoritic cobble-rubble fields (20-40% hard bottom) (Figure 4-14A) alternating with areas that included low outcrops (to ~60% cover), a few areas of low- to moderate-relief outcrops, tilted slabs and boulders (to ~70% cover), patches of *L. pertusa* coral rubble in low mounds to ~1 m across (possibly isolated dead thickets), and fields of coral debris that in some places appeared as a continuous sediment-veneered pavement. All were separated by frequently oval patches of rippled or smooth, weakly-bioturbated sediment up to several meters across. Again, benthic attached organisms, such as stylasterid hydrocorals, octocorals and sponges, were somewhat more common on higher relief substrates. Table 4-9 lists organisms found on the western edge of the sinkhole in 418 m to the Lower Terrace slope in 510 m.

Table 4-9. Lower Terrace, South Transect. Benthic macrofauna from the western edge of the sinkhole to the east end of the transect.

TAXON	TAXON	TAXON
PORIFERA	CERIANTHARIA	ECHINODERMATA
DEMOSPONGIAE	Unidentified cerianthid	CRINOIDEA
Phakellia sp.	SCLERACTINIA	?*Comatonia cristata*
Spongosorites sp.	*Lophelia pertusa*	ASTEROIDEA
HEXACTINELLIDA	Solitary corals	Goniasteridae
Aphrocallistes beatrix	ANTIPATHARIA	OPHIUROIDEA
Hyalonema sp.	Unidentified black coral	?*Ophiomusium* sp.
Vazella sp.	HYDROZOA	VERTEBRATA
Unidentified sponge	Unidentified Stylasteridae	CHONDRICHTHYES
CNIDARIA	Unidentified hydroids	*Benthobatis marcida*
OCTOCORALLIA	CRUSTACEA	*Galeus arae*
Anthomastus sp.	PENAEOIDEA	Unidentified Rajidae
Isidella sp.	*Pleoticus robustus*	OSTEICHTHYES
Keratoisis sp.	CARIDEA	*Chaunax pictus*
Plexauridae (yellow fan)	*Glyphocrangon* sp.	*Chlorophthalmus agassizi*
Plumarella sp.	ANOMURA	*Helicolenus dactylopterus*
CORALLIMORPHARIA	Unidentified paguroid	*Laemonema* sp.
Corallimorphus sp.	BRACHYURA	*Nezumia* sp.
	Cancer borealis	*Peristedion* sp.
	Chaceon fenneri	

4.2.2.4 North Non-Cable ROV Transect (B)

The North non-cable ROV transect was run to the north of the multibeam survey area (Figure 4-1). Because the NOAA low-resolution data was the only bathymetry available, no depth profile was drawn. Similarly, precise transitions between successive habitats could not be confirmed.

The transect began in 235 m on weakly bioturbated sediment with a few mounds and depressions and probable polychaete tubes that continued to 245 m, where a combination of white and black rubble appeared and quickly transitioned to a mixture of rippled sediment, rubble, low relief outcrops, ledges, and sediment-veneered hardbottom. Organisms were the same as along both Cable and South Non-Cable Transects, e.g., the cnidarians ?*Actinauge* sp., *Liponema* sp., *Pseudodrifa nigra*, *Eunicella* sp., and solitary corals; the echinoderms *Coronaster briareus*, *Gracilechinus* sp., *Araeosoma* sp., Goniasteridae, and *Cidaris* ?*rugosa*; the crustaceans ?*Pylopagurus* sp., *Cancer borealis* and galatheids; the spoonworm ?*Ochetostoma* sp., and the fishes *Laemonema* sp., *Benthobatis marcida*, *Helicolenus dactylopterus*, *Chlorophthalmus agassizi*, and unidentified Scorpaenidae. A single possible colony of *Lophelia pertusa* was seen in 244 m.

Substrates subsequently became more variable, ranging from expanses of weakly bioturbated sediment with abundant worm tubes through fields of gravel- or rubble- to cobble-sized clasts, to low-relief smooth or fractured pavements (Figure 4-15), low- to moderate-relief outcrops, scattered slabs on sediment, and some areas with abrupt ledges, boulders and higher-relief outcrops. Depth varied irregularly between 242 and 235 m. Areas of sediment often alternated with north-south-oriented strips of hard substrate. Fauna increased in diversity and again included the same taxa as observed on the other transects, now including, e.g., sponges *Phakellia* sp., *Farrea* sp., *Aphrocallistes beatrix*, *Geodia* sp., *Spongosorites* sp., *Vazella* sp., unidentified branching sponge, unidentified Astrophorida, Pachastrellidae, Petrosiidae and Lithistida; cnidarians *Actinoscyphia* sp., *Corallimorphus* sp., Sagartiidae, zoanthids, *Isidella* sp., *Plumarella* sp., *Leiopathes* sp., and Stylasteridae; crustaceans *Eumunida picta*, *Bathynectes longispina*, and paguroid hermit crabs; echinoderms *Astropecten* sp., *Tosia parva* and ophiuroids; the gastropod *Calliostoma* sp., and the fishes *Chaunax* sp., unidentified anthiine and an unidentified Rajidae.

North-south-oriented strips of low-relief irregular pavements with rubble and cobbles alternated with areas of either rippled or weakly bioturbated sediment to 280 m. The only attached benthic organism observed along this transect but not along either the cable route or southern transect on the Terrace Platform was the primnoid octocoral *Callogorgia* cf. *americana*: ten colonies between 245 and 299 m. Scattered colonies were also seen along the LNG pipeline survey transects just north of the Port Everglades entrance channel (Messing et al. 2006a, b).

From 280 m, the seafloor sloped gently upward to 257 m as low-relief, chiefly sediment-veneered, irregular pavements sometimes broken into slabs, and rare low (<1 m) ledges; areas of gravel- through rubble- to cobble-sized clasts (often obviously over sediment-veneered pavement); rare larger boulders and irregular outcrops, and expanses of rippled sediment with or without scattered rubble. From this depth, the bottom descended gradually again over similar substrates to 264 m, where continuous irregular pavement was followed by drop-offs to 280 and then 292 m to irregular, moderate-relief slabs, outcrops and pavement followed by fields of gravel to cobbles, continuous rubbly pavement, and expanses of rippled sediment in 297 m.

The seafloor again rose gradually to 265 m at a possible transition to the Outer Terrace Platform, based on topography and habitats extrapolated beyond the 2010 DOE multibeam survey area, before sloping eastward to 308 m and ascending again up the western slope of the Outer Terrace Ridge in a series of rugged shelves and undercut overhanging ledges. The crest of the Outer Terrace Ridge in 280 m was chiefly low- to moderate-relief irregular pavement with sediment pooling in depressions. Characteristic organisms included demosponges (e.g., Astrophorida, Desmacellidae, *Geodia* sp., Lithistida, Pachastrellidae, *Phakellia* sp., Raspailiidae), hexactinellids (e.g., *Farrea* sp., *Vazella* sp.), Stylasteridae, anemones (e.g., *Actinoscyphia* sp., *Corallimorphus* sp., *Liponema* sp., Sagartiidae), octocorals (e.g,. *Pseudodrifa nigra*, *Plumarella* sp., *Callogorgia* sp.), the basketstar *Gorgonocephalus arcticus*, the crinoid *Comatonia cristata*, echinoids (*Araeosoma* sp., *Cidaris* ?*rugosa*, *Gracilechinus* sp.), numerous ophiuroids, and fishes (e.g., *Helicolenus dactylopterus* and *Laemonema* sp.).

From the eastern edge of the ridge crest in 289 m, the seafloor dropped in a series of irregular ledges and outcrops including an escarpment of ~25 m, interspersed with interspersed with low- to moderate-relief, sediment-veneered, often broken pavements and slabs, with or without overlying rubble; some irregular isolated table-like ledges; deeply eroded “ironshore”-like hard bottom, and short patches of barren rippled or smooth sediment, sometimes with gravel, to

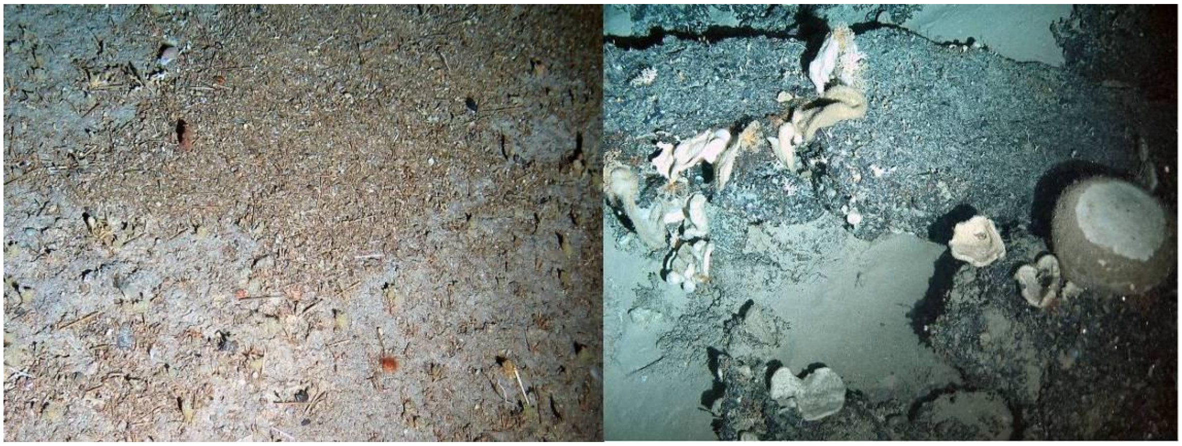

Figure 4-15. North transect. A. Coarse shelly hash including echinoid spines on low-relief pavement with gastropod (?*Sconsia* sp.), solitary corals and ophiuroids. B. High-relief tilted phosphoritic slabs with a variety of sponges including lithistids (fluted plates) and a spherical astrophorid.

Table 4-10. North Transect benthic macrofauna.

TAXON	TAXON	TAXON
PORIFERA	*Keratoisis* sp.	BRACHYURA
DEMOSPONGIAE	*Pseudodrifa nigra*	*Bathynectes longispina*
Corallistes sp.	*Plumarella* sp.	*Chaceon fenneri*
Phakellia sp.	Unidentified octocoral	ECHINODERMATA
Spongosorites sp.	ACTINIARIA	CRINOIDEA
Unidentified Desmacellidae	*Liponema* sp.	*Comatonia cristata*
Unidentified Lithistida	Unidentified red anemone	Unidentified comatulid
Unidentified Lithistida (vase)	Unidentified Sagartiidae	ASTEROIDEA
Unidentified Pachastrellidae	CORALLIMORPHARIA	Goniasteridae
Unidentified Petrosiidae	*Corallimorphus* sp.	*Tosia parva*
Unidentified Raspailliidae	SCLERACTINIA	*Tremaster mirabilis*
Unidentified brown encrusting sponge	*Lophelia pertusa*	Unidentified asteroids (~4-5 species)
Unidentified spherical astrophorid	Solitary corals	OPHIUROIDEA
Unidentified white amphitheater sponge	ANTIPATHARIA	?*Ophiomusium lymani*
Unidentified white branching sponge	?*Leiopathes* sp.	Unidentified ophiuroids
Unidentified white conulose sponge	Unidentified black coral	ECHINOIDEA
Brown encrusting sponge	HYDROZOA	*Cidaris* sp.
White wall sponge	Unidentified Stylasteridae	*Echinus* sp.
Unidentified demosponges	Unidentified hydroids	VERTEBRATA
HEXACTINELLIDA	BRYOZOA	CHONDRICHTHYES
Aphrocallistes beatrix	Unidentfied bryozoan	*Benthobatis marcida*
Farrea sp.	MOLLUSCA	OSTEICHTHYES
Hertwigia falcifera	GASTROPODA	?*Aulopus* sp.
Heterotella sp.	?*Sconsia* sp.	?*Aldrovandia* sp.
Vazella sp.	CRUSTACEA	*Beryx decadactylus*
Unidentified hexactinellid	CARIDEA	*Chaunax pictus*
CNIDARIA	Unidentified caridean shrimp	*Chlorophthalmus agassizi*
OCTOCORALLIA	ANOMURA	*Helicolenus dactylopterus*
Anthomastus sp.	*Eumunida picta*	*Laemonema* sp.
Eunicella sp.	Unidentified galatheoid	*Nezumia* sp.
?*Eunicella* sp. (branched)	Unidentified paguroid	Unidentified Scorpaenidae
Isidella sp.		

continuous rippled sediment with isolated patches of hardbottom in 327 m. Much of the initial portion of this descent was continuous pale pavement overlain in many places with either a coarse shelly hash or phosphoritic rubble, or both,

Below this depth, perhaps corresponding to the transition between the Outer Terrace Ridge and the Lower Terrace (unconfirmed; the transect was outside the 2010 DOE multibeam survey), high-relief substrates were fewer and further apart, and were separated by a) low- to moderate-relief broken or jointed, sediment-veneered, pavements with sediment pooling in depressions; b) slabs; c) patches of gravel and rubble on sediment, and d) more frequent entirely sediment substrates. *Lophelia pertusa* coral rubble first appeared in 409 m and continued intermittently to at least 474 m in a sinkhole. The sinkhole slopes included broken and tilted slabs and cobbles, largely barren pavement, some ledges and boulders, with sediment, rubble, cobbles and coral rubble in the deeper portions. The easternmost end of the transect in 451 m was a combination of rippled and smooth gravelly sediment, small areas of scattered cobbles, largely barren hard bottom, deeply eroded cobbly hard bottom, and broken slabs.

Some areas of sea floor along this transect were largely or completely barren of macrofauna, with contrasting and often dense aggregations along and near the edges of ledges, overhanging pavement and other locally high-relief substrates (Figure 4-15B). Demosponges were the most diverse and abundant organisms (e.g., *Phakellia* sp., Raspailiidae, Pachastrellidae, Lithistida), accompanied by hexactinellid sponges, stylasterids, the anemone *Liponema* sp., local concentrations of the octocorals *Isidella* sp. or *Plumarella* sp., and locally dense populations of ophiuroids (Table 4-10).

4.2.2.5 West North-South ROV Transect (D)

The West North-South ROV transect ran from north to south, beginning in 275 m and ending in 262 m (Figure 4-1). Because most of its length lay outside the multibeam survey area, no depth profile was mapped.

The initial portion of the transect remained within a depth range of 274-278 m over chiefly sediment-veneered hardbottom with areas of gravel and rubble, dominated by *Liponema* sp., *P. nigra*, *Cidaris* ?*rugosa* and abundant ophiuroids. This low density and diversity segment ran from the beginning of the transect at 26°04.902’N, 79°53.003’W to 26°04.72’N, 79°53.013’W. The transect passed over several low-moderate relief irregular outcrops beginning at 26º04.6629’N, 79º53.004’W, an area of moderate-relief outcrops, boulders and cobbles at 26º04.439’N, 79º53.039’W, and ended on a combination of irregular pavements, ledges, large boulders and slabs mixed with cobbles in 258-278 m. The areas of greater hard-substrate exposure and relief were separated by sediment-veneered pavements and areas of gravel and rubble (e.g., 26°04.508’N, 79°53.04’W to 26°04.442’N, 79°53.045’W), the latter sometimes with numerous sea pens (*Pennatula* sp. or *Ptilosarcus* sp.) (14 in a sequence of 20 successive images, including 3 in one image) (26°04.07’N, 79°53.014’W to 26°04.364’N, 79°52.989’W). Table 4-11 lists organisms observed. Cable was crossed at 26°4.797’N, 79°53.01’W, 26°04.61’N, 79°52.996’W, and 26°04.313’N, 79°53.017’W.

Table 4-11. Organisms observed along the western North-South Transect (D).

PORIFERA	CORALLIMORPHARIA	ECHINODERMATA
DEMOSPONGIAE	*Corallimorphus* sp.	ASTEROIDEA
Geodia sp.	ANTIPATHARIA	*Astropecten* sp.
Phakellia sp.	Unident. Antipatharia	*Coronaster briareus*
Spongosorites sp.	SCLERACTINIA	*Tremaster mirabilis*
Desmacellidae	Unident. solitary corals	Unident. Asteroidea
Pachastrellidae	OCTOCORALLIA	CRINOIDEA
Unident. brown encrusting	*Eunicella* sp.	*Comatonia cristata*
Unident. Demospongiae	*Plumarella* sp.	ECHINOIDEA
HEXACTINELLIDA	*Pseudodrifa nigra*	*Cidaris* ?*rugosa*
Aphrocallistes beatrix	*Pennatula* or *Ptilosarcus* sp.	*Gracilechinus* sp.
Farrea sp.	CRUSTACEA	OPHIUROIDEA
CNIDARIA	ANOMURA	*Astroporpa annulata*
HYDROIDLIOLINA	?*Pylopagurus* sp.	?*Ophiomusium lymani*
Stylasteridae	Unident. Paguroidea	Unidentified Ophiuroidea
ACTINIARIA	ANNELIDA	CHONDRICHTHYES
Actinoscyphia sp.	?*Ochetostoma* sp.	*Galeus arae*
Liponema sp.	MOLLUSCA	Unident. Rajidae
Sagartiidae	GASTROPODA	OSTEICHTHYES
	Scaphella sp.	*Chlorophthalmus agassizi*
		Laemonema sp.
		Urophycis sp.

4.2.2.6 East North-South ROV Transect (E)

The East North-South ROV transect began north of the Cable Transect and traversed south along the western edge of the Outer Terrace Ridge beginning in 331 m, based on multibeam data (Figure 4-16).

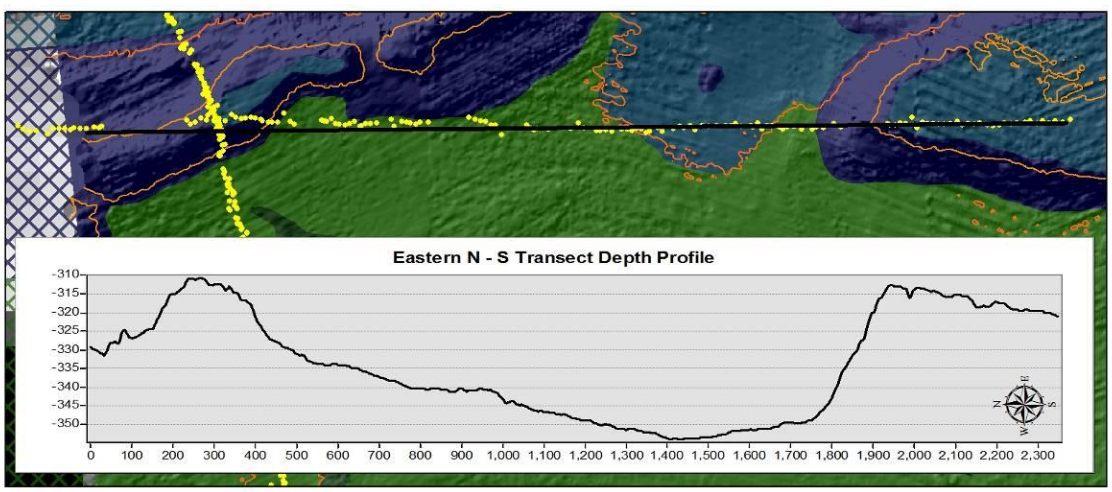

Figure 4-16. East N-S Transect (E) depth profile. North is on left. The almost vertical line of yellow dots at left represents the primary E-W Cable transect line (A), although additional cables were crossed.

The substrate at the beginning of the transect consisted of low-relief ridges and sediment-veneered pavement that ascended via a series of rugged ledges with vertical relief up to 2 m, and boulders up to 1 m tall interspersed with pavement, rubble patches and areas of coral rubble to a peak in 308 m. Characteristic Outer Ridge organisms included demosponges (e.g., *Corallistes* sp., *Geodia* sp., Pachastrellidae, *Phakellia* sp., Raspailiidae), hexactinellids (e.g., *Aphrocallistes beatrix*), Stylasteridae, abundant solitary scleractinian corals, and large antipatharians (*Leiopathes* sp.) (Figure 4-17). Live colonies of *Lophelia pertusa* to 20 cm across first appeared in ~314 m; larger thickets with colonies up to 1 m across were observed on the crest in 308 m (Figure 4-17A).

The transect then descended along an initially steep rugged slope over sediment-veneered pavement, boulders, and high-relief phosphoritic outcrops to a more gradual slope that still included up to 1-m ledges, narrow rock ridges, and boulders, before becoming chiefly pavement and rubble. The maximum depth recorded in the ROV datalog was 348 m, whereas the multibeam depth profile reached ~354 m. Metal wreckage was observed in 314 m between 26º04.339'N, 79º49.953'W and 26º04.264'N, 79º49.955'W (Figure 4-17B). Demosponges were the dominant organisms noted (e.g., *Corallistes* sp., *Discodermia* sp., *Geodia* sp., Pachastrellidae, *Phakellia* sp., *Spongosorites* sp. and *Stylocordyla* sp.). The lowest relief segment with the lowest qualitative organism richness ran from 26°04.269'N, 79°50.005'W to about 26°04.088'N, 79°49.973'W, but still included occasional ridges with up to ~0.5 m relief, a 1-m ledge, and scattered sponges (e.g., Pachastrellidae, *Vazella*).

The transect then ascended a steep slope of rugged rocky ledges with boulders to the top of a plateau in 307 m. The top consisted of low-relief, sediment-veneered pavement with cobbles, and gradually descended to the transect end in 317 m. Organisms on the upward slope and crest were similar to those noted on the higher elevations earlier in the transect, including a thicket of *L. pertusa* ~1 m across in 318 m.

Several cables were crossed during this transect, as follows: between 26º05.297'N, 79º50.011'W and 26º05.169'N, 79º50.004'W (~331 m); at 26º05.148'N, 79º049.972'W (331 m); between 26º04.418'N, 79º049.954'W and 26º04.698'W, 79º49.953'W (~308 m); between 26º04.17'N, 79º49.993'W and 26º04.414'N, 79º49.952'W (between 330-336 m), and between 26º04.00'N, 79º49.966'W and 26º03.893'N, 79º49.966'W (335 m).

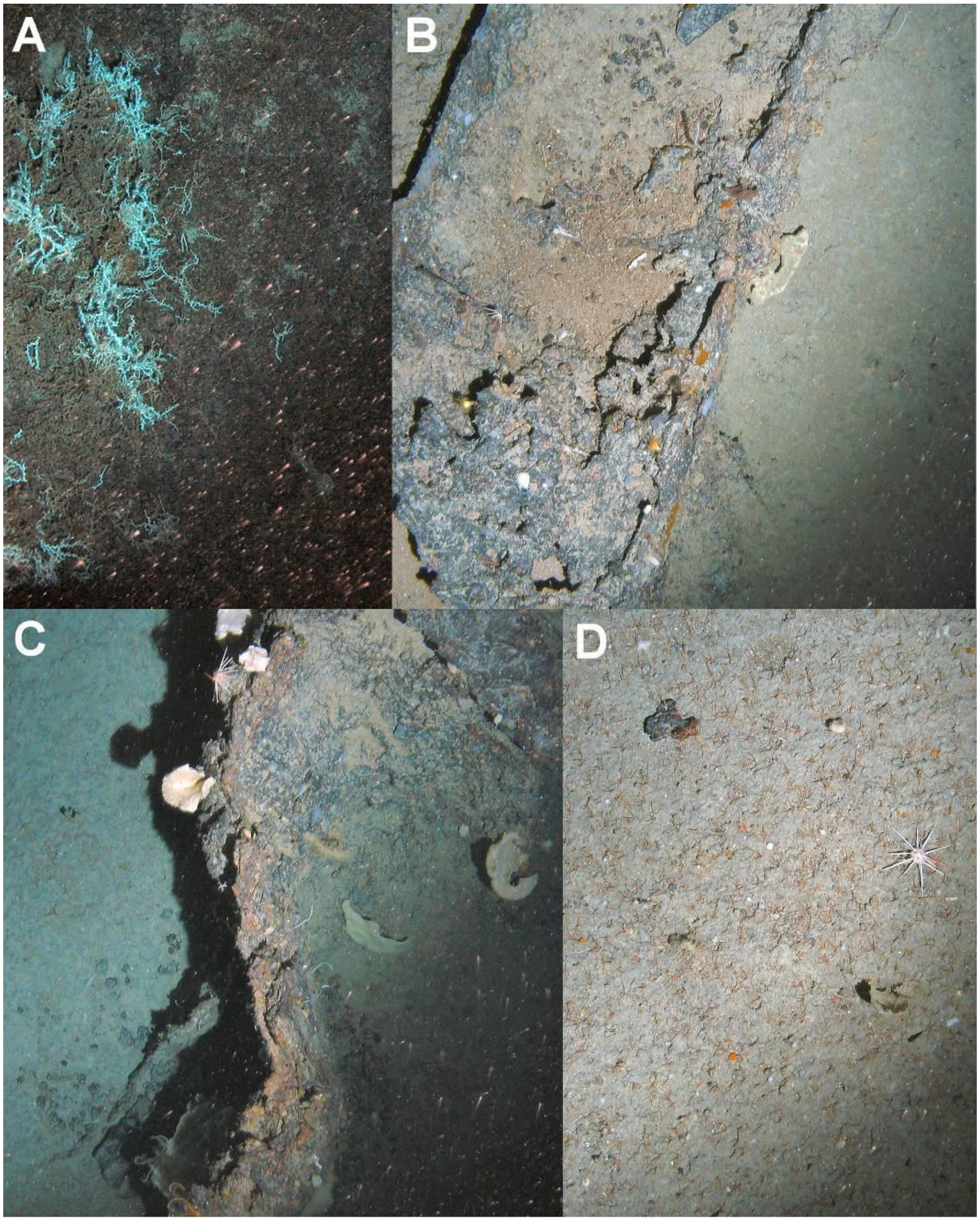

Figure 4-17. East N-S Transect (E) benthic habitats. A. *Lophelia pertusa* thicket on coral rubble; 308 m. B. Metal wreckage; 314 m. C. Narrow phosphoritic limestone ridge with lithistid sponges and *Cidaris* ?*rugosa*; ~348 m. D. Limestone pavement with *Cidaris* ?*rugosa* and abundant ophiuroids; ~347 m.

4.2.2.7 Summary of Qualitative Benthic ROV Transects Results

The preceding subsections 4.2.2.1 through 4.2.2.6 provide a detailed description of substrates and fauna along all transects.

- Seven transects were run:
  - Main Cable Transect (A; including Cable jog): ~30-457 m.
  - North Shallow Transect (An): ~30-90 m.
  - South Shallow Transect (As): ~30-90 m.
  - North Non-Cable Transect (B): 235-451 m.
  - South Non-Cable Transect (C): 272-510 m.
  - West N-S Transect (D): 262-275 m.
  - East N-S Transect (E): 308-348 m.
- Each description of east-west-oriented transects ran from shallow to deep.
- Descriptions were derived from both video observations and all still photographs (not just those in the quantitative stations treated below).
- Substrate features corresponded well with multibeam bathymetry, where available.
- The survey encountered four EFH (a fifth, coral reef, is questionable, because it is uncertain if any natural substrate identifiable as this habitat was visible):
  - artificial reef (the apparent spoil habitat encountered along the shallow transects in <93 m. Although not originally designed or deposited as such, the substrate currently functions as artificial reef),
  - hard bottom: chiefly phosphoritic limestone substrates including gravel and cobble fields, exposed and sediment-veneered pavements, irregular outcrops, boulders, slabs and escarpments, often in various combinations, with associated benthic macrofauna (e.g., sponges, anemones, zoanthids, octocorals, black corals, echinoderms, and a low richness bottom-associated fish fauna, e.g., *Laemonema* sp., *Helicolenus dactylopterus*, *Beryx decadactylus*),
  - tilefish habitat (*Caulolatilus microps* and burrows), and
  - deep-sea coral (*Lophelia pertusa* and associated organisms).
- The survey encountered two additional non-EFH:
  - rippled sediment, and
  - bioturbated sediment.
- On hard substrates below the coral reef and spoil deposit habitats (>200 m), benthic macrofaunal richness generally increased with a combination of increasing depth and higher substrate relief.
- Observed Effects of Cable on EFH
  - Splitting of a large sponge that continued to survive (43 m).
  - Fouling of cable by cyanobacterial mat and chiefly encrusting sponges in <90 m
  - Fouling by a variety of attached invertebrates, including *Lophelia pertusa*, in >90 m
  - Exposure of hard substrate via current scour around cable with apparent sheltering by a variety of taxa.

4.2.3 Quantitative Benthic ROV Transects & Habitat Mapping Results

This section provides a multivariate statistical analysis and summary of both percent cover and organism densities for hardbottom habitats on the Northern Miami Terrace (>245 m). All Non-Cable stations were analyzed to validate the habitat delineations of Vinick et al. 2012. Photostations along the Cable Transects (A, An, As) were considered separately in section 4.3.

4.2.3.1 Distribution of Photostations

Figures 4-18, 4-19, and 4-20 show the distribution of quantitative still photographic stations distributed along the Cable Transect (A) and the North and South Non-Cable transects. There was a total of 30 Low-Slope photostations: 10 Cable and 7 Non-Cable on the Inner Terrace Platform (ITP); 5 Cable and 5 Non-Cable on the Outer Terrace Platform (OTP), and one Cable and 2 Non-Cable on the Outer Terrace Ridge (OTR); the latter was limited by the small span of habitat crossed. There were also 17 High-Slope photostations, again limited by the span of habitats crossed: 1 Non-Cable on the ITP; 4 Cable and 2 Non-Cable on the OTP, 5 Cable and 3 Non-Cable on the OTR, and 1 Cable and Non-Cable on the Lower Terrace. We selected 1 Cable and 1 Non-Cable photostation in the Sinkhole habitat.

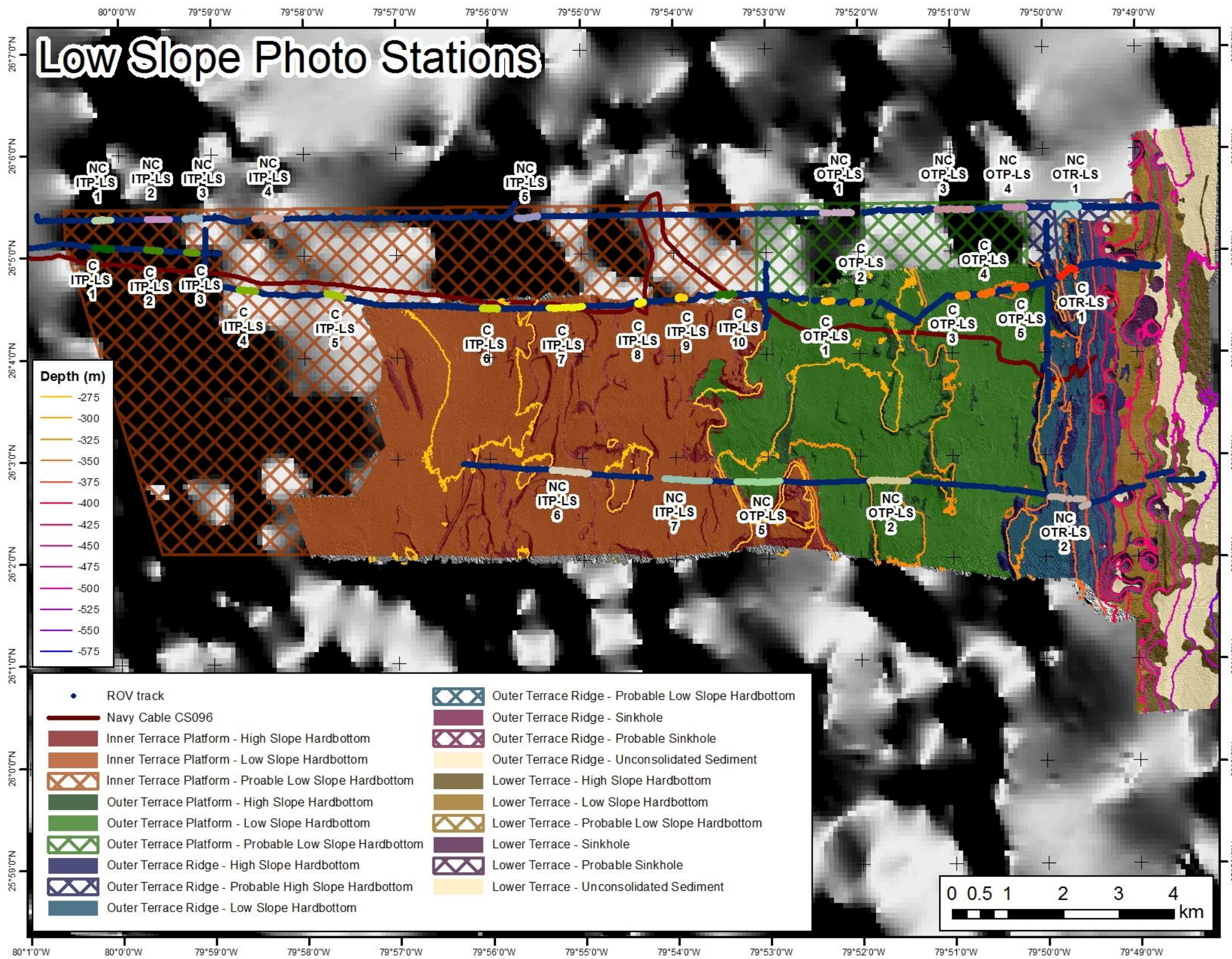

Figure 4-18. Low-Slope (LS) quantitative still photographic stations. C=Cable; NC=Non-Cable. Colors distinguish benthic habitats from Vinick et al. (2012) based on geomorphological zones and high- and low-slope substrates. ITP=Inner Terrace Platform; OTP=Outer Terrace Platform; OTR=Outer Terrace Ridge. Hatched areas are habitats identified as probable based on extrapolations beyond the geophysical survey area.

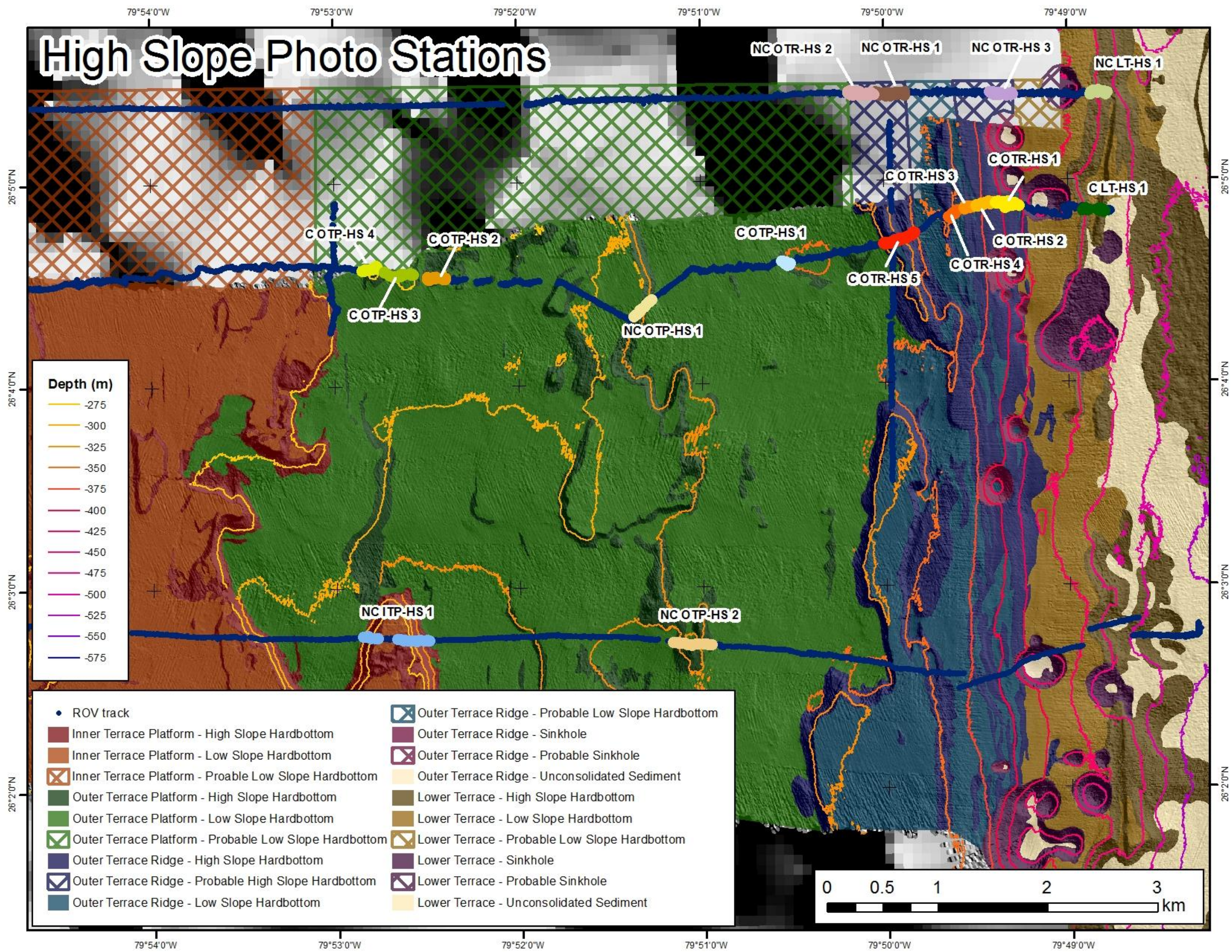

Figure 4-19. High-Slope (HS) quantitative still photographic stations. C=Cable; NC=Non-Cable. Non-Cable Outer Terrace Platform High-Slope station 1 (NC OTP-HS 1) was located on the ROV Cable Transect, but along a significant southerly departure that placed it at least ~0.25 km from the cable route; it was therefore treated as a Non-Cable station. Colors distinguish benthic habitats from Vinick et al. (2012) based on geomorphological zones and high- and low-slope substrates. . ITP=Inner Terrace Platform; OTP=Outer Terrace Platform; OTR=Outer Terrace Ridge; LT=Lower Terrace. Hatched areas are habitats identified as probable based on extrapolations beyond the geophysical survey area.

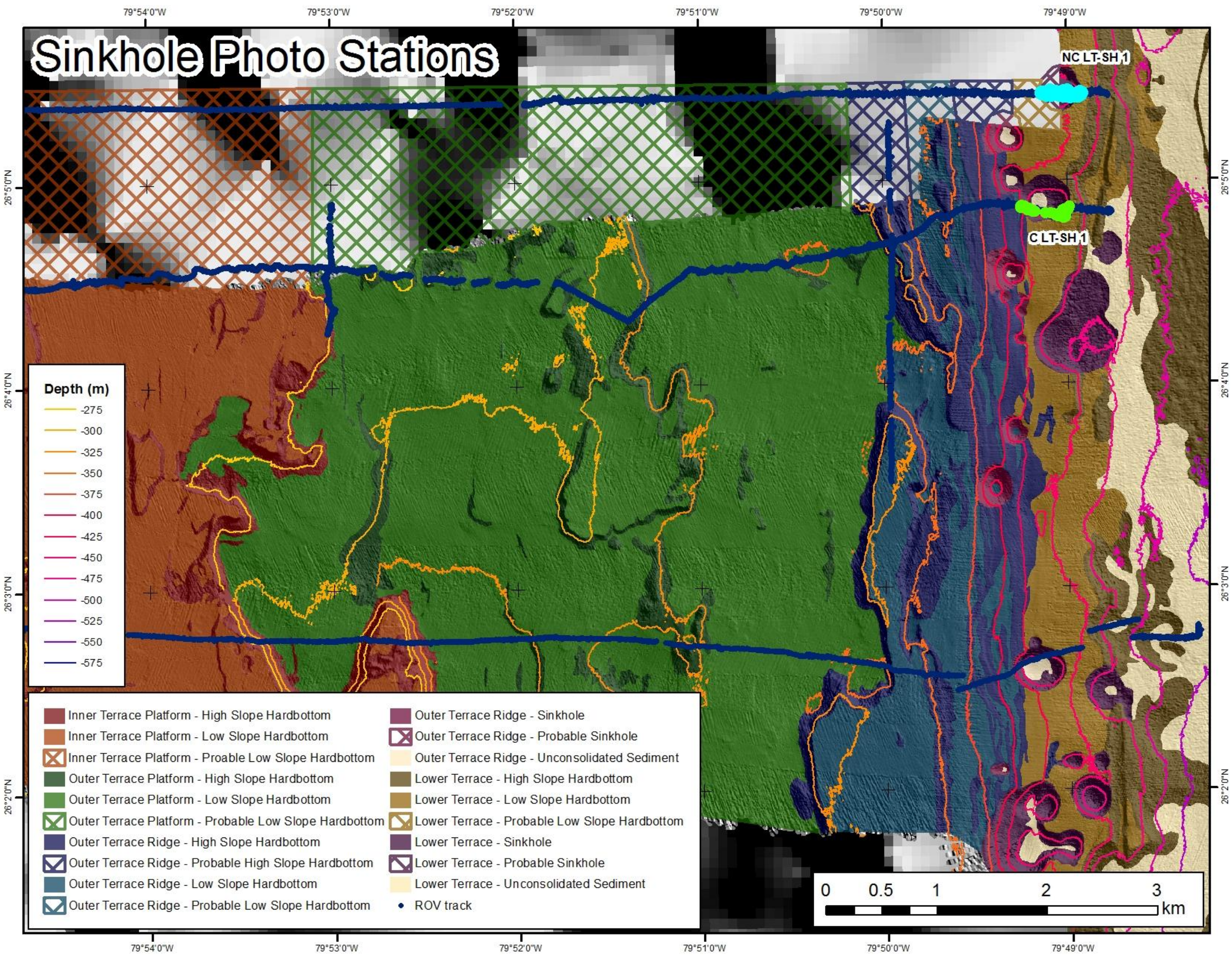

Figure 4-20. Sinkhole (SH) quantitative still photographic stations. C=Cable; NC=Non-Cable. Colors distinguish benthic habitats from Vinick et al. (2012) based on geomorphological zones and high- and low-slope substrates. Hatched areas are habitats identified as probable based on extrapolations beyond the geophysical survey area.

4.2.3.2 Multivariate Results of Non-Cable Photostations

The multivariate analyses of percent cover data of Non-Cable photostations showed no discernible patterns with regard to benthic habitats. There was no distinct clustering of stations by habitats in the dendrogram (Figure 4-21) or the Multidimensional Scaling (MDS) plot (Figure 4-22). This was due to a combination of the extremely low cover of organisms in these habitats and wide range of variation in proportions of hard substrate versus sediment within and across habitats. Percent cover analyses are most useful in areas that have large amounts of different organisms not discernible as individuals (e.g. algae, seagrass). In areas where organism densities are extremely low, percent cover analyses require a very large number of points to discern differences among sites and may still be masked by differences in substrates. In this study, the CPC data were almost completely driven by the relative cover of hard and soft substrates at each station and not by biological components. The maximum percent cover contributed by all living organisms to any individual photostation was 3.47% (NC OTR-LS 1; Table 4-20 below). Therefore the percent cover data was most useful at examining the variations of substrate between photostations and density was used to examine the biological communities.

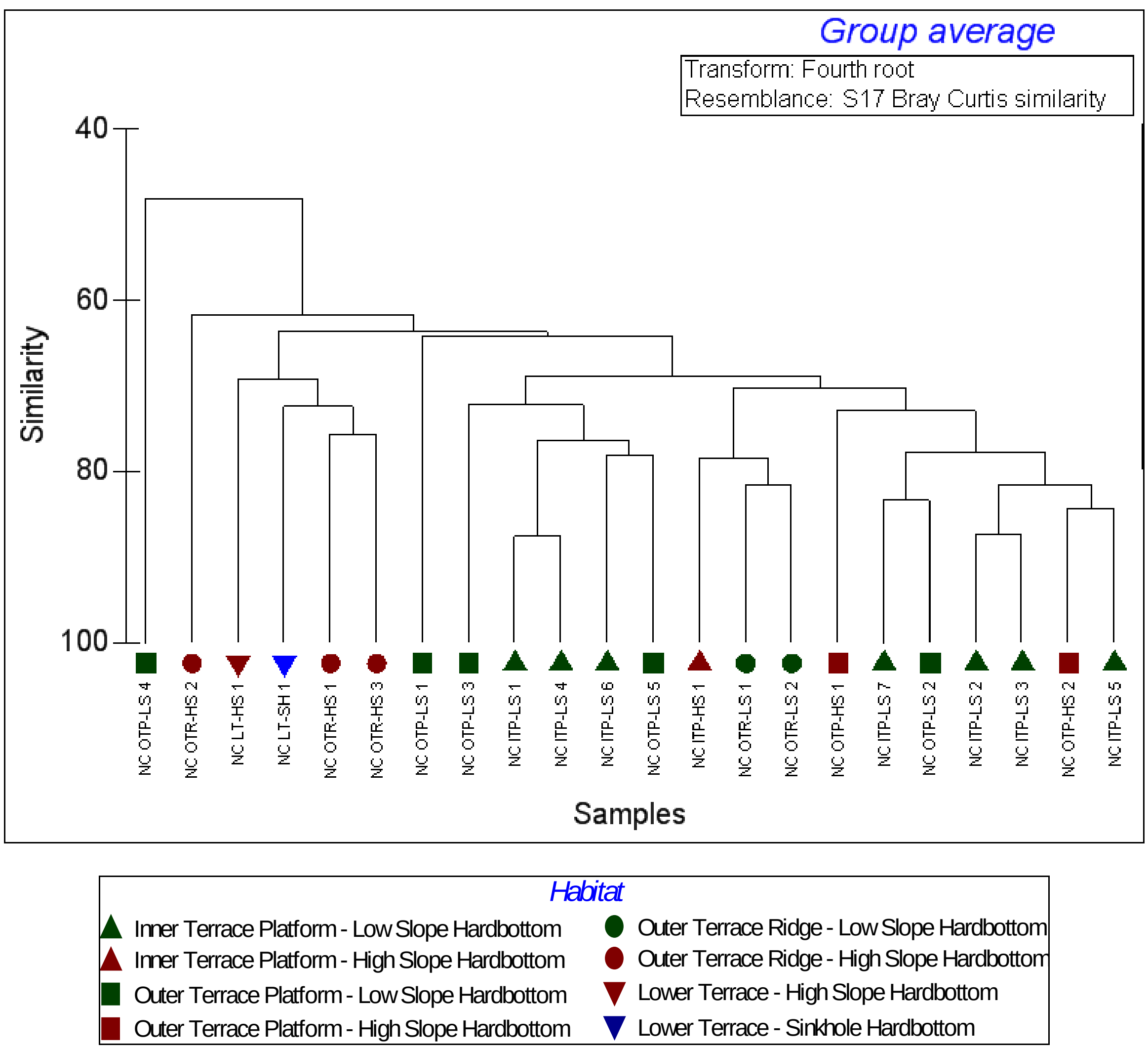

Figure 4-21. Dendrogram of percent cover data at all Non-Cable photostations categorized by habitat.

MDS plots illustrate the relationship of organism type and amounts among stations in a graphical form, in which sites nearest to each other are most similar (contain similar proportions of the same species or substrate types) and vice versa. As examples of some of the wider variations among photostations shown in the MDS plot in Figure 4-22, the outlying placement of Low-Slope Outer Terrace Platform station 4 (NC OTP-LS 4) is likely due to its high percentage of hard substrate (86%) and coral rubble (9%) relative to the other stations in this habitat (0% coral rubble and no more than 37.4% hard substrate). The outermost green circle separating this station from the others represents a similarity percentage of 60%. The relatively close placement of the outlying High-Slope and Sinkhole Lower Terrace stations (NC LT-HS 1 and NC LT-SH 1) is likely due to the combination of their similar values for percent cover by soft substrate (24.3 and 19.1%, respectively) and coral rubble (13.8 and 8.3%, respectively).

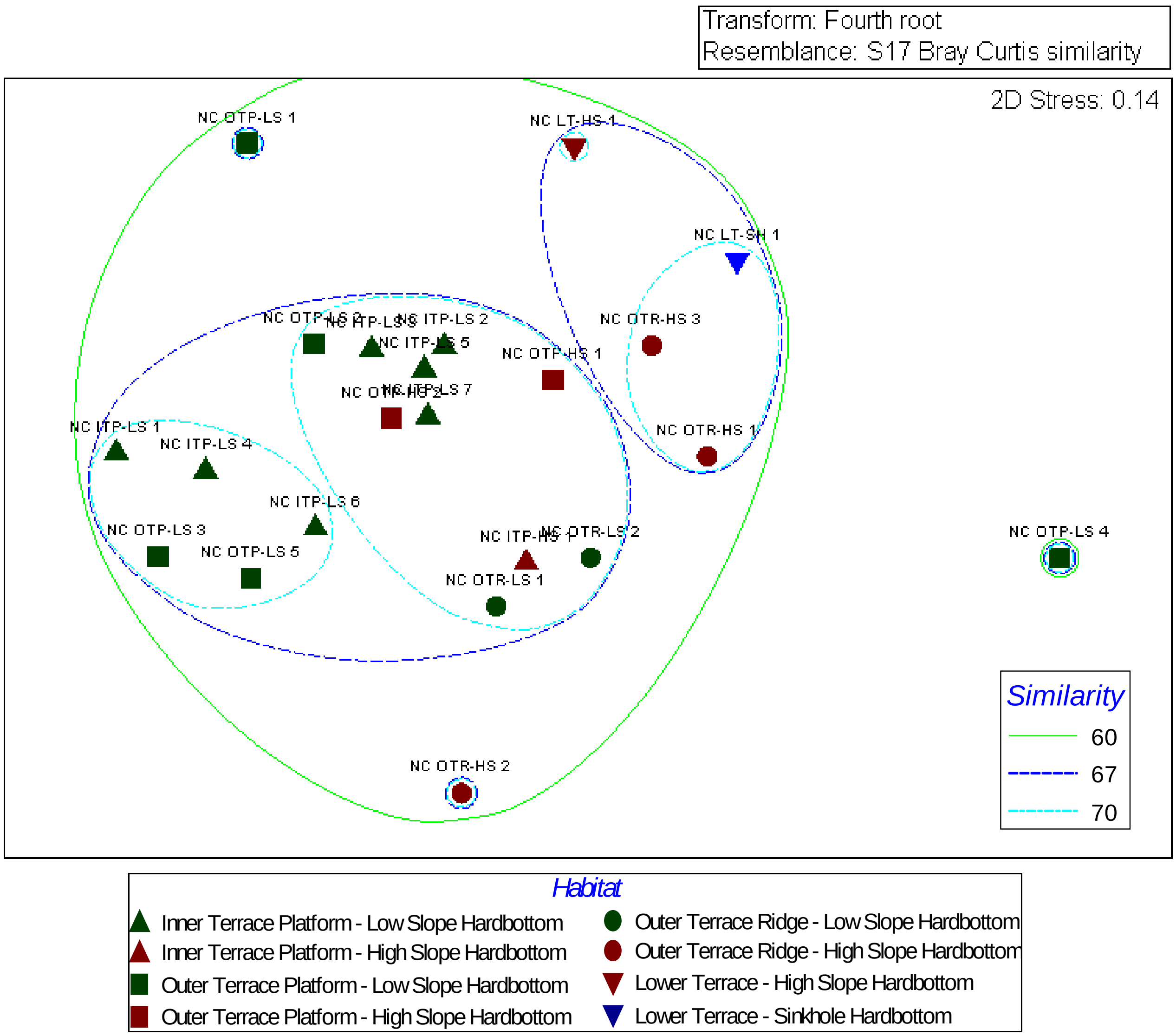

Figure 4-22. MDS plot of percent cover data at all photostations categorized by habitat. Circles indicate percent similarity from the cluster analysis.

Multivariate analyses of organism densities at all Non-Cable sites substantiated the habitat designations of Vinick et al. 2012. A cluster analysis of a Bray-Curtis similarity index analysis showed the relationship between stations based on organism type density at each site (Figure 4-23). The Sinkhole (SH), Lower Terrace (LT), and one High Slope Outer Terrace Ridge (OTR-HS) stations were the most distinct and split into a separate group at the lowest level. This means all other stations were more similar to each other than to these three and vice versa. Within the larger group, all of the shallowest Low Slope Inner Terrace Platform (ITP-LS) stations formed a separate cluster indicating they were distinctly different as well.

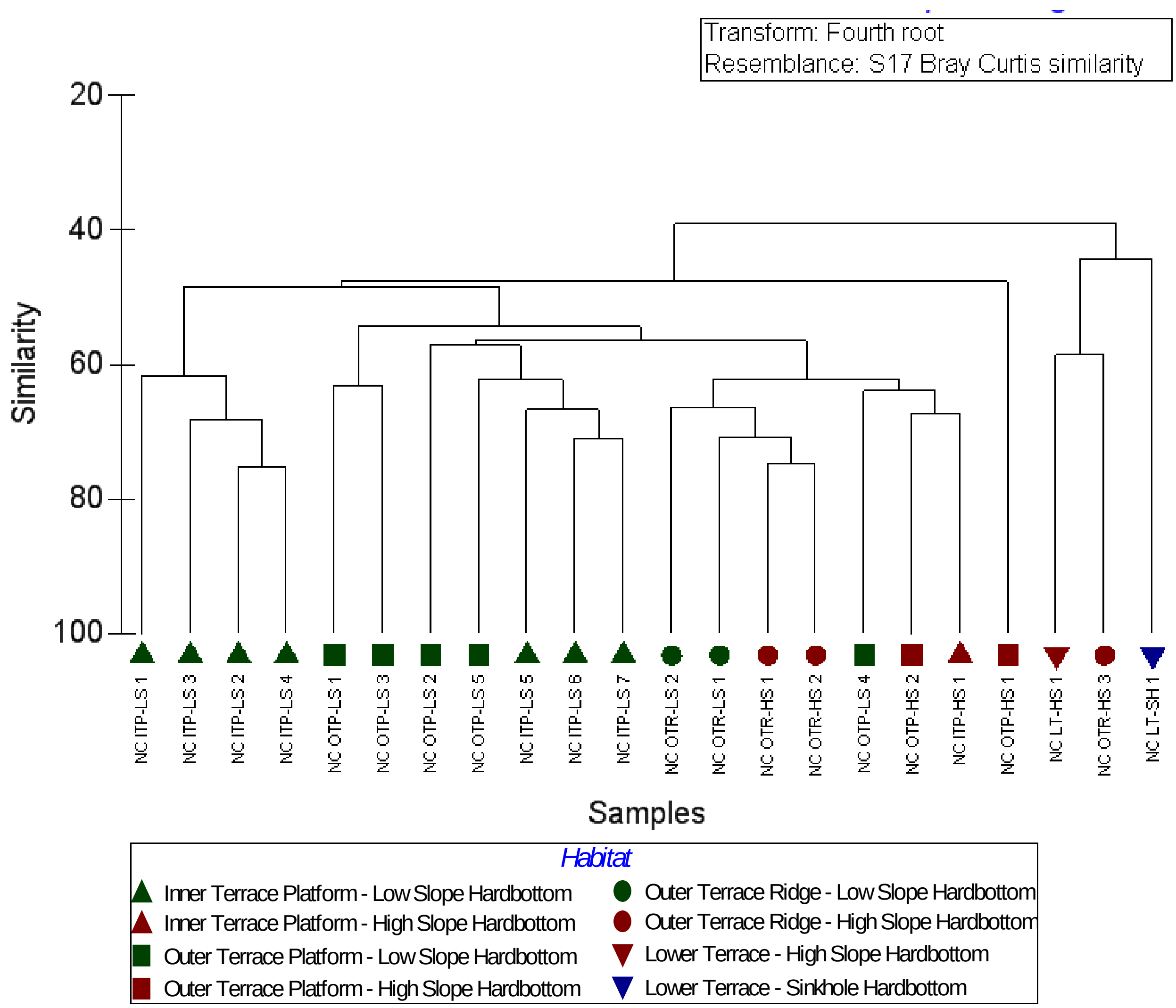

Figure 4-23. Dendrogram of density data at all Non-Cable photostations categorized by habitat.

These distinctions were best illustrated in an MDS plot (Figure 4-24). Two of the similarities in the cluster analysis are displayed as circles around the groups at different similarity percentages: 55% and 62%. Four stations (LT SH-1, LT HS-1, OTR HS-3, and OTP HS-1) were very distinct from the main group of stations and from each other. This was evident by the distance from other sites in the MDS and the single-station clusters formed at 62%. The remaining stations formed two distinct clusters at 55% and were relatively close to one another. The 4 shallow ITP-LS sites

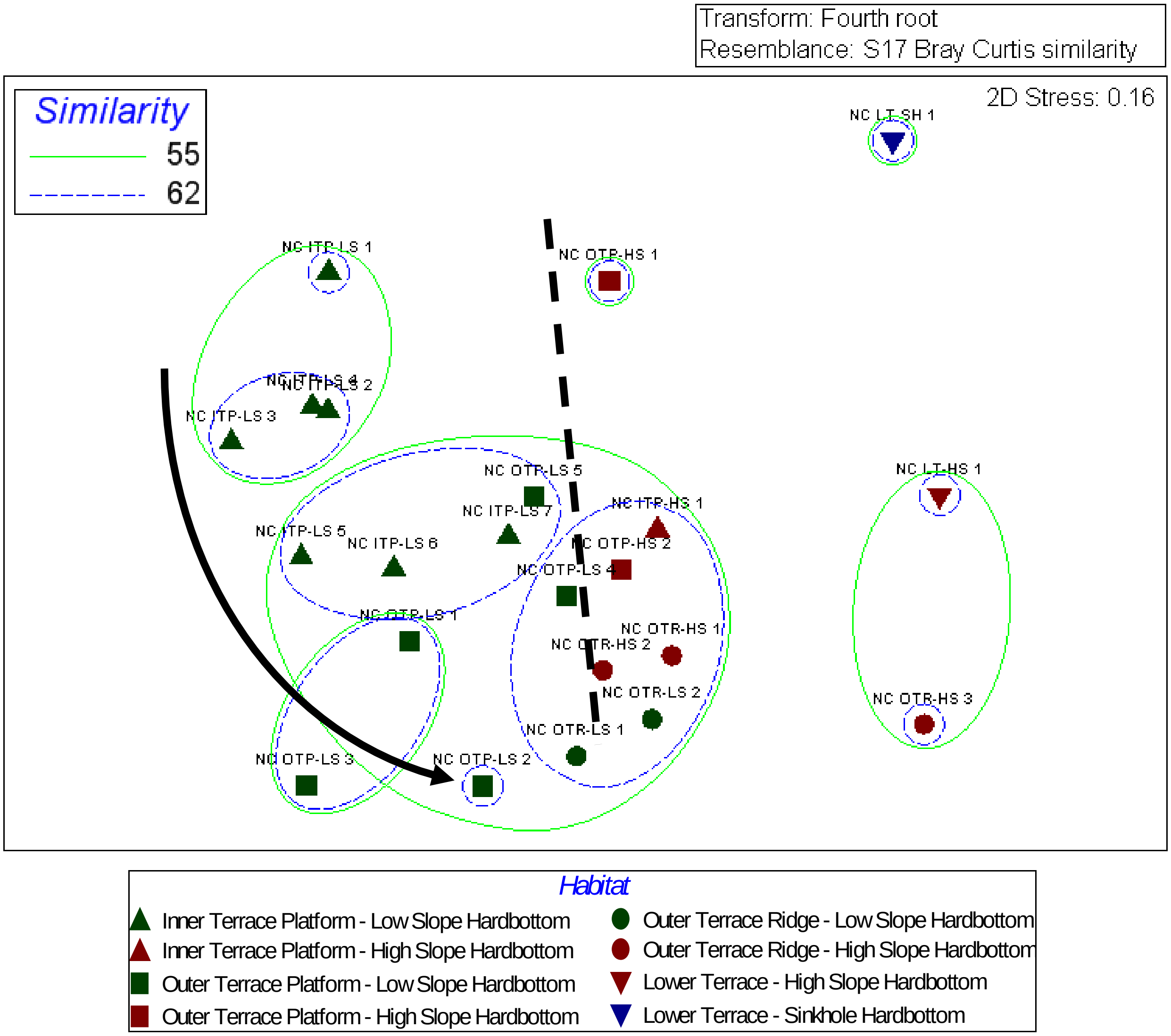

Figure 4-24. MDS plot of density data at all Non-Cable photostations categorized by habitat. The arrow illustrates the cross-shelf geomorphologic zone and depth trends from shallow to deep. The dashed line separates High-Slope (red) and Low-Slope (green) stations. Circles indicate percent similarity from the cluster analysis.

composed one of those groups, indicating they are more similar to each other than to stations in other habitats.

The MDS plot showed subtler distinctions than evident in the cluster analyses. The relationships among Non-Cable stations were arranged by geomorphology and depth. The plot progressed from shallow to deep habitats from the upper left to lower right. This progression also included cross-shelf changes in geomorphology. For example, the separate group of shallowest ITP-LS stations plotted in the upper left, whereas the three deeper Inner Terrace Platform stations were nearest to them towards the lower right. Next were the Outer Terrace Platform stations and finally the Outer Terrace Ridge stations. The MDS plot also indicated slope as a role in the relationship between stations. All of the High-Slope stations (red) were located on the right side of the plot and, with the exception of NC OTR-LS 2, the Low-Slope stations on the left. Since geomorphology, slope, and depth appear to be contributing to the similarity of organism types and densities between stations, the benthic habitat classification (which was based on these criteria as well) was used to categorize the photostations and statistically test for cable impacts.

4.2.3.3 Non-Cable Percent Cover and Density Data Summaries by Habitat

Tables 4-12 to 4-27 list percent cover and densities (in m^{-2}) of organisms, and Figures 4-25 to 4-31 illustrate important taxa as percentages of total benthic density, at Non-Cable photostations in order of geomorphological habitats containing EFH from west to east, with Low-Slope photostations treated first for each habitat. In tables listing percent cover, Colonial Dead Coral refers to intact, standing, dead colonies; Coral Rubble refers to broken dead coral fragments, and *Lophelia* refers to living colonies of the stony coral *Lophelia pertusa*. Because Hydroidolina, solitary scleractinian corals, and ophiurid ophiuroids often could not be counted accurately, they have been excluded from density summary tables and pie diagrams. Bottom-associated fishes have not been included in density tables because of their extremely low frequency of occurrence in quantitative still images. Of the 49 density records of fish taxa at all Non-Cable photostations, 45 were <0.05 fishes m^{-2}; the greatest density recorded was 0.14 Scorpaenidae m^{-2} at NC ITP-HS 1. The most frequently recorded recognizable taxon was the codling *Laemonema* sp. (at 19 of 22 stations), followed by the greeneye, *Chlorophthalmus agassizi* (at 8), unidentified Scorpaenidae (at 5), and blackbelly rosefish, *Helicolenus dactylopterus* (at 3). Other infrequently encountered groups for which component taxa have been combined in density tables are Arthropoda (most commonly paguroid hermit crabs and the chyrostylid squat lobster *Eumunida picta*), Mollusca (most commonly unidentified gastropods) and Annelida (chiefly sabellid featherduster worms). Other minor groups, e.g., Bryozoa, Brachiopoda, Urochordata (Ascidiacea), have not been divided into component taxa.

Inner Terrace Platform – Low-Slope Hardbottom (Tables 4-12, 4-13; Figure 4-25)

Hard substrates never accounted for more than 50% of cover at any of the 7 ITP-LS stations, with most stations ranging between 32 and 46%, and with station 1, the furthest inshore, exhibiting the lowest percent hard substrate cover (17.4%). Negligible contributions of unidentified coral rubble (≤0.075%) were recorded at two stations.

Table 4-12. Percent cover data for all Non-Cable Inner Terrace Platform Low Slope Hardbottom habitat photostations.

Non-cable Inner Terrace Platform - Low Slope	NC ITP-LS 1	NC ITP-LS 2	NC ITP-LS 3	NC ITP-LS 4	NC ITP-LS 5	NC ITP-LS 6	NC ITP-LS 7	MEAN	Std.Dev.	Std.Err.
CORAL (COR)	0	0.039	0	0	0	0	0.075	0.016	0.030	0.011
Coral Rubble (CR)	0	0.039	0	0	0	0	0.075	0.016	0.030	0.011
CHORDATA (CHO)	0	0	0.038	0	0.030	0	0	0.010	0.017	0.006
CNIDARIA NON SCLERACTINIA (CNI)	0.164	0.039	0.038	0.280	0.150	0.750	0.600	0.289	0.280	0.106
ECHINODERMATA (ECH)	0.164	0.039	0.077	0.031	0.210	0.143	0.375	0.148	0.120	0.045
ECHIURA (ECR)	0.263	0.118	0.077	0.062	0	0	0	0.074	0.095	0.036
PORIFERA (POR)	0.033	0.039	0.077	0.093	0.090	0.286	0.187	0.115	0.091	0.034
UNIDENTIFIED ORGANISM (UND)	0	0	0	0	0	0	0.037	0.005	0.014	0.005
SOFT BOTTOM SUBSTRATE (SB)	81.976	53.725	56.979	57.947	61.848	49.000	66.979	61.208	10.790	4.078
HARD BOTTOM SUBSTRATE (HB)	17.400	45.960	42.715	41.586	37.672	49.821	31.747	38.129	10.814	4.087
HUMAN DEBRIS (HUM)	0	0.039	0	0	0	0	0	0.006	0.015	0.006
TAPE, WAND, SHADOW, PHOTO EFFECT (TWS)	0.131	0.510	1.585	2.576	0.478	0	1.185	0.923	0.921	0.348
Sum (excluding tape+shadow+wand)	100	100	100	100	100	100	100			

Overall, echiuran spoonworms (?*Ochetostoma* sp.) accounted for 26% of organism density at all ITP-LS stations taken together, followed by the soft coral *Pseudodrifa nigra* (15%) and unidentified sea anemones (Actiniaria) (14%). The spoonworm and *P. nigra* exhibited an inverse density relationship at these stations; the worms were the most abundant organisms at stations 1 through 4 and were far less common at stations 5-7, whereas the soft coral recorded the highest density of any organism at 5-7 and were less common at 1-4. Among other more common taxa, both the pompom anemone *Liponema* sp. and the octocoral *Eunicella* sp. generally increased in density from inshore to offshore.

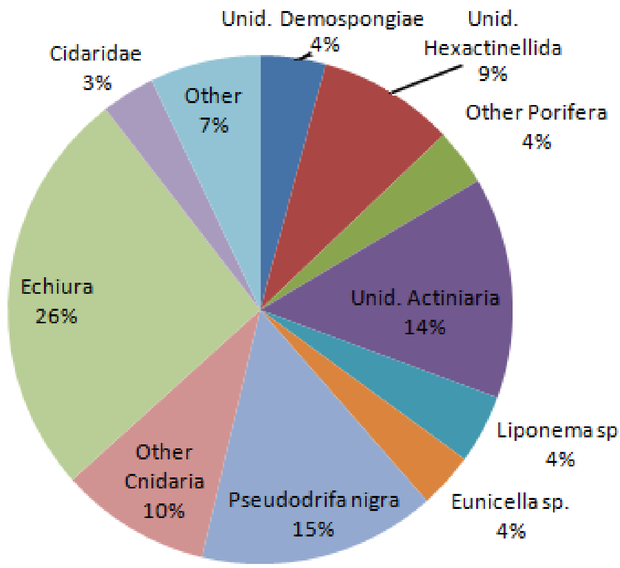

Figure 4-25. Macrofaunal organism densities (in m^{-2}) at Non-Cable Inner Terrace Platform Low-Slope photostations 1-7 expressed as percentages of mean organism densities summarized from Table 4-13. Other Porifera includes identified hexactinellid and both identified and unidentified demosponge taxa, each of which contributed less than ~3% of mean density.

Table 4-13. Density data (in m^{-2}): Non-Cable Inner Terrace Platform Low-Slope Hardbottom habitat photostations.

NC ITP-LS	1	2	3	4	5	6	7	TOT	MEAN	STD.DEV.	STD.ERR.
PORIFERA											
DEMOSPONGIAE											
Astrophorida			0.018					0.018	0.003		
Axinellidae						0.012		0.012	0.002		
Demospongiae unident.	0.046	0.069	0.071	0.454	0.044	0.254	0.195	1.131	0.162	0.152	0.108
Desmacellidae						0.046	0.092	0.138	0.020	0.036	0.026
Geodiidae		0.011		0.018		0.012	0.023	0.064	0.009	0.009	0.007
Lithistida 1			0.018	0.018				0.036	0.005	0.009	
Pachastrellidae							0.011	0.011	0.002		
Phakellia sp.			0.018		0.116	0.023	0.011	0.168	0.024	0.042	0.029
HEXACTINELLIDA											
Euritidae/Farreidae			0.018		0.015	0.058	0.011	0.101	0.014	0.020	0.014
Hexactinellida unident.	0.183	0.023				1.407	0.756	2.369	0.338	0.545	0.386
Porifera unident.	0.023	0.011	0.053	0.254	0.087			0.428	0.061	0.091	0.064
CNIDARIA											
HEXACORALLIA											
?Actinauge sp.							0.069	0.069	0.010		
Actiniaria 2	0.183	0.023	0.018				0.160	0.384	0.055	0.081	0.057
Actiniaria unident.	1.348	0.525	0.635	0.563	0.203	0.231	0.309	3.814	0.545	0.393	0.278
Actinoscyphia sp.	0.023	0.023	0.018	0.018		0.023	0.080	0.185	0.026	0.025	0.018
Corallimorphidae						0.012	0.023	0.034	0.005	0.009	0.006
Liponema sp.		0.034	0.018	0.127	0.102	0.231	0.676	1.187	0.170	0.237	0.168
Sagartiidae				0.018	0.189	0.046	0.115	0.367	0.052	0.073	0.052
Zoanthidea	0.525			0.109	0.087	0.023	0.080	0.825	0.118	0.185	0.131
OCTOCORALLIA											
Eunicella sp.	0.023				0.102	0.138	0.699	0.962	0.137	0.254	0.180
Isididae				0.018				0.018	0.003		
Octocorallia unident.		0.011		0.018				0.030	0.004	0.007	0.005
Primnoidae	0.091	0.011					0.011	0.114	0.016	0.034	0.024
Pseudodrifa nigra	0.525	0.263	0.159	0.236	0.638	1.418	0.871	4.111	0.587	0.445	0.315
STYLASTERIDAE		0.023		0.036	0.044	0.069	0.413	0.584	0.083	0.147	0.104
ANNELIDA	0.069	0.023						0.091	0.013	0.026	0.018
ECHIURA	2.102	1.108	1.640	1.362	0.261	0.357	0.252	7.082	1.012	0.740	0.523
MOLLUSCA	0.023	0.069	0.123	0.091	0.029	0.127	0.011	0.473	0.068	0.048	0.034
ARTHROPODA	0.274	0.034		0.054	0.029	0.012	0.011	0.415	0.059	0.096	0.068
ECHINODERMATA											
ASTEROIDEA											
Asteroidea unident.	0.091	0.023	0.071	0.036	0.029	0.012	0.023	0.285	0.041	0.029	0.021
Coronaster briareus				0.018				0.018	0.003		
Goniasteridae		0.011				0.012	0.023	0.046	0.007	0.009	0.006
Sclerasterias sp.							0.011	0.011	0.002		
Tremaster mirabilis						0.012		0.012	0.002		
ECHINOIDEA											
Cidaridae	0.091	0.126	0.053	0.109	0.160	0.173	0.218	0.929	0.133	0.055	0.039
Echinoidea unident.						0.012		0.012	0.002		
Gracilechinus sp.	0.023		0.035		0.015	0.023		0.096	0.014	0.014	0.010
CRINOIDEA											
Comatulida			0.035				0.046	0.081	0.012	0.020	0.014
Crinoidea (stalked)						0.012		0.012	0.002		
OPHIUROIDEA											
Euryalidae							0.034	0.034	0.005		
HOLOTHUROIDEA											
Psolidae	0.023	0.034	0.018	0.036	0.015	0.023		0.149	0.021	0.012	0.009
UNKNOWN ANIMAL	0.023		0.071	0.054		0.035		0.182	0.026	0.029	0.020
TOTAL	5.689	2.456	3.087	3.649	2.161	4.809	5.238	27.088	3.870	1.393	0.985

Inner Terrace Platform - High Slope Hardbottom (Tables 4-14, 4-15; Figure 4-25)

The single station in this habitat was chiefly hard substrate (70.2%); non-scleractinian cnidarians accounted for 1.8% of cover, the highest for this category at any Non-Cable photostation. Coral rubble accounted for 0.43% of cover. The most abundant taxa were octocorals, *Eunicella* sp. (1.23 m^{-2}), which accounted for 34% of mean density, and *P. nigra* (0.83 m^{-2} and 23%) , followed by stylasterid lace corals (0.45 m^{-2} and 12%) and comatulid crinoids (likely all *Comatonia cristata*) (0.38 m^{-2} and 10%).

Table 4-14. Percent cover data for the Non-Cable Inner Terrace Platform High Slope Hardbottom habitat photostation 1.

Non-cable - Inner Terrace Platform - High Slope	**NC ITP-HS 1**
CORAL (COR)	0.434
Coral Rubble (CR)	0.434
CNIDARIA NON SCLERACTINIA (CNI)	1.845
ECHINODERMATA (ECH)	0.217
PORIFERA (POR)	0.271
SOFT BOTTOM SUBSTRATE (SB)	27.021
HARD BOTTOM SUBSTRATE (HB)	70.212
TAPE, WAND, SHADOW, PHOTO EFFECT (TWS)	0.378
Sum (excluding tape+shadow+wand)	100

Table 4-15. Density data (in m^{-2}): Non-Cable Inner Terrace Platform High-Slope Hardbottom habitat photostation.

NC ITP HS	**1**		**1**
PORIFERA		Primnoidae	0.050
DEMOSPONGIAE		*Pseudodrifa nigra*	0.828
Demospongiae unident.	0.021	STYLASTERIDAE	0.446
Desmacellidae	0.141	ARTHROPODA	0.021
Pachastrellidae	0.021	BRYOZOA	0.007
Phakellia sp.	0.007	ECHINODERMATA	
Raspailiidae	0.014	ASTEROIDEA	
HEXACTINELLIDA		Asteroidea unident.	0.007
Euritidae/Farreidae	0.014	Goniasteridae	0.014
CNIDARIA		*Sclerasterias* sp.	0.014
HEXACORALLIA		ECHINOIDEA	
Actiniaria unident.	0.035	Cidaridae	0.156
Actinoscyphia sp.	0.035	CRINOIDEA	
Antipatharia unident.	0.007	Comatulida	0.375
Liponema sp.	0.120	OPHIUROIDEA	
Sagartiidae	0.085	Euryalidae	0.007
OCTOCORALLIA		UNKNOWN ANIMAL	0.014
Eunicella sp.	1.231	TOTAL	3.672

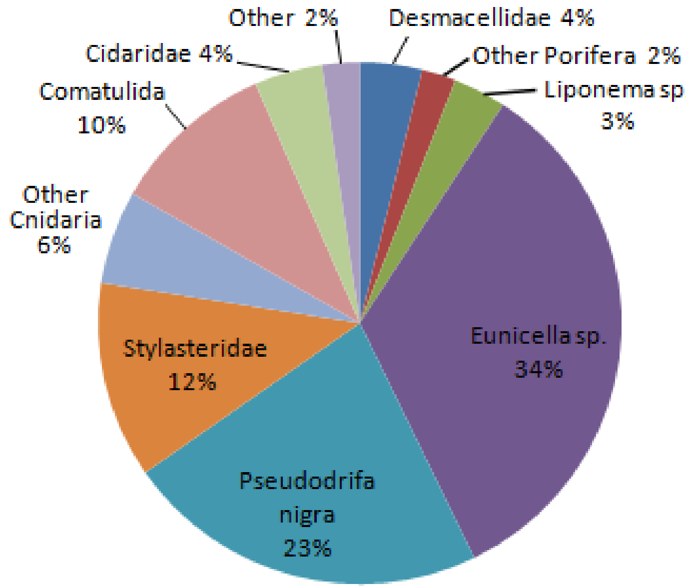

Figure 4-26. Macrofaunal organism densities at Non-Cable Inner Terrace Platform High-Slope photostation 1 expressed as percentages, summarized from Table 4-15.

Outer Terrace Platform – Low-Slope Hardbottom (Tables 4-16, 4-17; Figure 4-27)

Percent cover of hard substrates varied widely across this habitat, reflecting the diversity of local seafloor features within the major geomorphological habitats of the Miami Terrace. Station 4, located furthest offshore and closest to the Outer Terrace Ridge along the North Non-Cable Transect (B), differed substantially from the other four. Because it was located outside the area mapped in detail by multibeam, its assignment to habitat is uncertain (Figure 4-18). However, it did not cluster closely with any of the Outer Terrace Ridge photostations (Figure 4-22). Station 4 recorded the greatest percent cover of hard substrate (86.1%) despite being immediately adjacent to station 3, which recorded only 5.86% hard substrate. Station 4 also differed from the others in exhibiting a substantial percentage of coral cover. Although most was coral rubble (7.4%), living *Lophelia pertusa* contributed 0.24% of cover. Stations 1 through 3 recorded 2.54, 18.20 and 5.86% hard substrate cover, whereas station 5 recorded 37.37%. The greatest contribution to cover by a living group was 1.06% by non-scleractinian cnidarians.

Table 4-16. Percent cover data for all Non-Cable Outer Terrace Platform Low-Slope Hardbottom habitat photostations.

Non-cable - Outer Terrace Platform - Low Slope	NC OTP-LS 1	NC OTP-LS 2	NC OTP-LS 3	NC OTP-LS 4	NC OTP-LS 5	MEAN	Std.Dev.	Std.Err.
CORAL (COR)	0	0	0	9.469	0	1.894	4.235	1.894
Colonial Dead Coral (DC)	0	0	0	1.829	0	0.366	0.818	0.366
Coral Rubble (CR)	0	0	0	7.404	0	1.481	3.311	1.481
Lophelia (LOP)	0	0	0	0.236	0	0.047	0.106	0.047
CHORDATA (CHO)	0.028	0	0	0	0	0.006	0.012	0.006
CNIDARIA NON SCLERACTINIA (CNI)	0.363	0.395	0.297	1.062	0.623	0.548	0.313	0.140
ECHINODERMATA (ECH)	0.084	0.431	0.037	0.472	0.089	0.222	0.210	0.094
PORIFERA (POR)	0.223	0.179	0.297	0.619	0.044	0.273	0.215	0.096
UNIDENTIFIED ORGANISM (UND)	0.028	0	0	0	0	0.006	0.012	0.006
SOFT BOTTOM SUBSTRATE (SB)	96.737	80.797	93.511	2.242	61.877	67.033	38.721	17.317
HARD BOTTOM SUBSTRATE (HB)	2.538	18.198	5.858	86.106	37.367	30.013	34.200	15.295
HUMAN DEBRIS (HUM)	0	0	0	0.029	0	0.006	0.013	0.006
TAPE, WAND, SHADOW, PHOTO EFFECT (TWS)	0.306	2.246	0.111	0.294	0.089	0.609	0.920	0.412
Sum (excluding tape+shadow+wand)	100	100	100	100	100			

All sponges together contributed 21% of organism density, a contirbution greater than that found in the Inner Terrace Platform Low-Slope habitat (17%). The most abundant individual taxa were *Eunicella* sp. (mean 0.73 m^{-2} and 20%) and *P. nigra* (mean 0.56 m^{-2} and 15%), somewhat lower percentages than in the Inner Terrace Platform High-Slope stations. The greatest abundances of both taxa occurred at station 4.

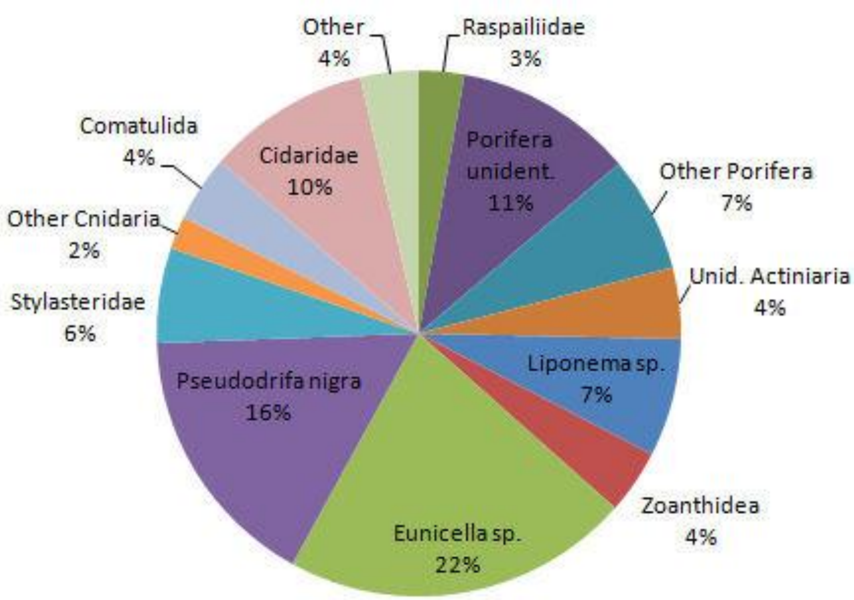

Figure 4-27. Macrofaunal organism densities (in m^{-2}) at the five Non-Cable Outer Terrace Platform Low-Slope photostations expressed as percentages of mean benthic organism densities, summarized from Table 4-17. Other Porifera includes both identified and unidentified demosponge and hexactinellid taxa, each of which contributed less than ~3% of mean density

Table 4-17. Density data (in m^{-2}): Non-Cable Outer Terrace Platform Low-Slope Hardbottom habitat photostations.

NC OTP LS	1	2	3	4	5	TOT	MEAN	STD.DEV.	STD.ERR.
PORIFERA									
DEMOSPONGIAE									
Astrophorida					0.008	0.008	0.002		
Demospongiae unident.		0.124	0.017		0.053	0.194	0.039	0.052	0.028
Desmacellidae	0.076		0.035	0.241	0.038	0.390	0.078	0.095	0.055
Geodiidae		0.017		0.010		0.027	0.005	0.008	0.004
Lithistida 1		0.008				0.008	0.002		
Pachastrellidae	0.019	0.008	0.069	0.060		0.157	0.031	0.031	0.022
Phakellia sp.	0.019	0.166	0.225	0.020	0.015	0.445	0.089	0.099	0.063
Raspailiidae				0.473		0.473	0.095		
HEXACTINELLIDA							0.000		
Aphrocallistes beatrix	0.171		0.017			0.188	0.038	0.075	0.027
Euritidae/Farreidae	0.076	0.017	0.121	0.020	0.008	0.241	0.048	0.049	0.034
Hexactinellida unident.	0.076	0.050	0.035	0.010	0.181	0.351	0.070	0.066	0.050
Porifera unident.	0.114		1.159	0.594		1.867	0.373	0.503	0.264
CNIDARIA							0.000		
HEXACORALLIA							0.000		
?*Actinauge* sp.					0.030	0.030	0.006		
Actiniaria unident.	0.437	0.008		0.181	0.113	0.739	0.148	0.178	0.105
Actinoscyphia sp.				0.080	0.008	0.088	0.018	0.035	0.012
Antipatharia unident.				0.010		0.010	0.002		
Corallimorphidae		0.008		0.010		0.018	0.004	0.005	0.003
Liponema sp.	0.209	0.332	0.052	0.161	0.475	1.228	0.246	0.163	0.174
Lophelia pertusa				0.141		0.141	0.028		
Madrepora sp.			0.017			0.017	0.003		
Sagartiidae				0.050	0.030	0.080	0.016	0.023	0.011
Zoanthidea	0.646	0.017			0.008	0.670	0.134	0.286	0.095
OCTOCORALLIA							0.000		
Anthomastus sp.		0.017				0.017	0.003		
Eunicella sp.	0.114	0.041	0.294	2.827	0.354	3.631	0.726	1.181	0.513
Isididae			0.017	0.010	0.008	0.035	0.007	0.007	0.005
Octocorallia unident.		0.008				0.008	0.002		
Pennatulacea	0.057	0.041			0.023	0.121	0.024	0.025	0.017
Pseudodrifa nigra	0.057	0.232		2.103	0.384	2.776	0.555	0.878	0.393
STYLASTERIDAE	0.152	0.373	0.035	0.151	0.279	0.990	0.198	0.131	0.140
ECHIURA			0.069		0.023	0.092	0.018	0.030	0.013
MOLLUSCA		0.025	0.017	0.020		0.062	0.012	0.012	0.009
ARTHROPODA	0.019	0.025	0.069	0.141	0.128	0.382	0.076	0.057	0.054
BRACHIOPODA				0.010		0.010	0.002		
ECHINODERMATA							0.000		
ASTEROIDEA							0.000		
Asteroidea unident.	0.038		0.035	0.101	0.015	0.188	0.038	0.038	0.027
Goniasteridae		0.025				0.025	0.005		
Sclerasterias sp.		0.008				0.008	0.002		
ECHINOIDEA							0.000		
Cidaridae	0.114	0.066	0.121	1.368	0.030	1.700	0.340	0.576	0.240
Gracilechinus sp.	0.019	0.008		0.020	0.008	0.055	0.011	0.008	0.008
CRINOIDEA							0.000		
Comatulida	0.019	0.017		0.513	0.143	0.692	0.138	0.217	0.098
OPHIUROIDEA							0.000		
Euryalidae		0.008		0.070		0.079	0.016	0.031	0.011
HOLOTHUROIDEA							0.000		
Psolidae				0.010		0.010	0.002		
UNKNOWN ANIMAL	0.019	0.017	0.035	0.030		0.100	0.020	0.014	0.014
TOTAL	2.450	1.667	2.439	9.437	2.359	18.352	3.670	3.240	2.595

Outer Terrace Platform - High Slope Hardbottom (Tables 4-18, 4-19; Figure 4-28)
Both stations had similarly mixed contributions from hard and soft substrates with living organisms totaling less than 1% cover, but station 2, with a lower percent cover of hard substrate, recorded twice the overall organism density. The most abundant taxa were Stylasteridae (mean 0.52 m^{-2} and 21%), and *P. nigra* (0.37 m^{-2} and 15%), although both occurred in far greater abundance at station 2. Several other important taxa occurred exclusively at station 2, e.g., *Liponema* sp., Primnoidae and unidentified Hexactinellida. Comatulids and unidentified Actiniaria were more abundant at station 1.

Table 4-18. Percent cover data for all Non-Cable Outer Terrace Platform High Slope Hardbottom habitat photostations.

Non-cable - Outer Terrace Platform - High Slope	NC OTP-HS 1	NC OTP-HS 2	MEAN	Std.Dev.	Std.Err.
CORAL (COR)	0.358	0.150	0.254	0.147	0.104
Coral Rubble (CR)	0.358	0	0.179	0.253	0.179
Lophelia (LOP)	0	0.150	0.075	0.106	0.075
CNIDARIA NON SCLERACTINIA (CNI)	0.179	0.451	0.315	0.193	0.136
ECHINODERMATA (ECH)	0.537	0	0.268	0.379	0.268
PORIFERA (POR)	0.089	0.075	0.082	0.010	0.007
SOFT BOTTOM SUBSTRATE (SB)	46.154	54.511	50.333	5.910	4.179
HARD BOTTOM SUBSTRATE (HB)	52.683	44.812	48.748	5.566	3.936
TAPE, WAND, SHADOW, PHOTO EFFECT (TWS)	6.833	1.481	4.157	3.784	2.676
Sum (excluding tape+shadow+wand)	100	100			

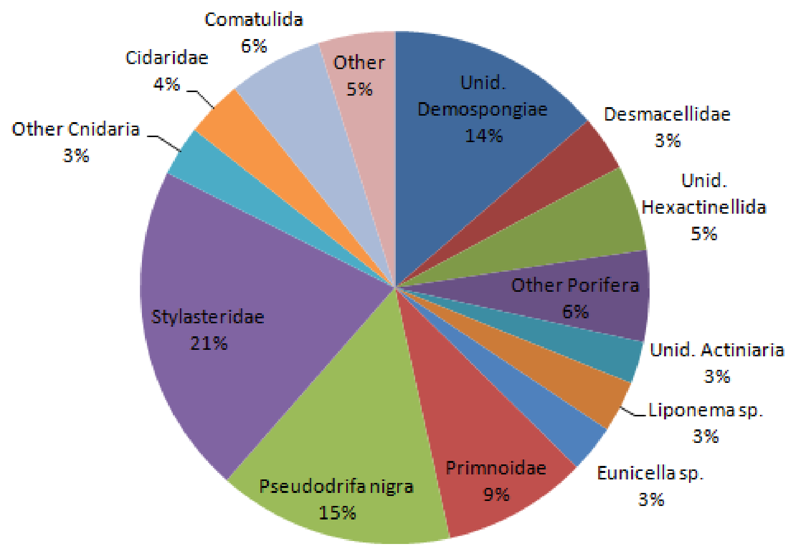

Figure 4-28. Total macrofaunal organism densities (in m^{-2}) at the two Non-Cable Outer Terrace Platform High-Slope photostations expressed as percentages of mean benthic organism abundance summarized from Table 4-19. Other Porifera includes identified demosponge and hexactinellid taxa and unidentified Porifera, each of which contributed less than ~3% of mean density.

Table 4-19. Density data (in m^{-2}): Non-Cable Outer Terrace Platform High-Slope Hardbottom habitat photostations.

NC OTP HS	1	2	TOT	MEAN	STD.DEV.	STD.ERR.
PORIFERA						
DEMOSPONGIAE						
Demospongiae unident.	0.333	0.352	0.685	0.343	0.013	0.242
Desmacellidae	0.121	0.054	0.175	0.088	0.047	0.062
Geodiidae	0.015	0.014	0.029	0.015	0.001	0.010
Pachastrellidae	0.015	0.054	0.069	0.035	0.028	0.024
Phakellia sp.		0.041	0.041	0.021		
Raspailiidae		0.095	0.095	0.048		
HEXACTINELLIDA						
Euritidae/Farreidae		0.041	0.041	0.021		
Hexactinellida unident.		0.271	0.271	0.136		
Porifera Unident.	0.015		0.015	0.008		
CNIDARIA						
HEXACORALLIA						
Actiniaria unident.	0.106	0.027	0.133	0.067	0.056	0.047
Actinoscyphia sp.	0.015	0.014	0.029	0.015	0.001	0.010
Antipatharia	0.030		0.030	0.015		
Corallimorphidae		0.027	0.027	0.014		
Liponema sp.		0.162	0.162	0.081		
Lophelia pertusa		0.014	0.014	0.007		
Sagartiidae		0.014	0.014	0.007		
OCTOCORALLIA						
Eunicella sp.	0.015	0.135	0.150	0.075	0.085	0.053
Octocorallia unident.	0.045		0.045	0.023		
Primnoidae		0.460	0.460	0.230		
Pseudodrifa nigra	0.030	0.717	0.747	0.374	0.486	0.264
STYLASTERIDAE	0.151	0.893	1.044	0.522	0.525	0.369
MOLLUSCA	0.015	0.041	0.056	0.028	0.018	0.020
ARTHROPODA	0.015	0.014	0.029	0.015	0.001	0.010
ECHINODERMATA						
ASTEROIDEA						
Asteroidea unident.	0.045	0.027	0.072	0.036	0.013	0.025
Novodinia sp.	0.015		0.015	0.008		
ECHINOIDEA						
Cidaridae	0.030	0.149	0.179	0.090	0.084	0.063
Coelopleurus floridanus		0.014	0.014	0.007		
CRINOIDEA						
Comatulida	0.272	0.027	0.299	0.150	0.173	0.106
HOLOTHUROIDEA						
Psolidae	0.015		0.015	0.008		
UNKNOWN ANIMAL	0.015	0.027	0.042	0.021	0.008	0.015
TOTAL	1.316	3.680	4.996	2.498	1.672	1.766

Outer Terrace Ridge - Low Slope Hardbottom (Tables 4-20, 4-21; Figure 4-29)

Hard substrates accounted for more than 50% of cover at both stations, although accounting for much more at station 2. Interestingly, cover attributed to living organisms was about 3.5 times as great at station 1, which had substantially less hard substrate cover. Unidentified sponges (including those only identified to either Demospongiae or Hexactinellida) accounted for the greatest proportion of density (24%). *Eunicella* sp. (mean 01.49 m^{-2} and 20%), Stylasteridae (mean 1.40 m^{-2} and 19%) and unidentified sponges accounted for the greatest percentages of total density, but each was far more abundant at one of the two stations, *Eunicella* sp. and unidentified sponges at station 1 and Stylasteridae at station 2. Similarly, comatulid density was much greater at station 1, whereas cidarid urchin density was similar at both.

Table 4-20. Percent cover data for both Non-Cable Outer Terrace Ridge Low-Slope Hardbottom habitat photostations.

Non-cable - Outer Terrrace Ridge - Low Slope	NC OTR-LS 1	NC OTR-LS 2	TOTAL	MEAN	Std.Dev.	Std.Err.
CNIDARIA NON SCLERACTINIA (CNI)	0.587	0.254	0.842	0.421	0.235	0.167
ECHINODERMATA (ECH)	0.280	0.095	0.375	0.188	0.130	0.092
PORIFERA (POR)	2.601	0.636	3.237	1.619	1.390	0.983
SOFT BOTTOM SUBSTRATE (SB)	40.420	11.097	51.517	25.758	20.734	14.661
HARD BOTTOM SUBSTRATE (HB)	56.056	87.886	143.941	71.971	22.507	15.915
HUMAN DEBRIS (HUM)	0.056	0.032	0.088	0.044	0.017	0.012
TAPE, WAND, SHADOW, PHOTO EFFECT (TWS)	0.694	0.159	0.853	0.427	0.379	0.268
Sum (excluding tape+shadow+wand)	100	100				

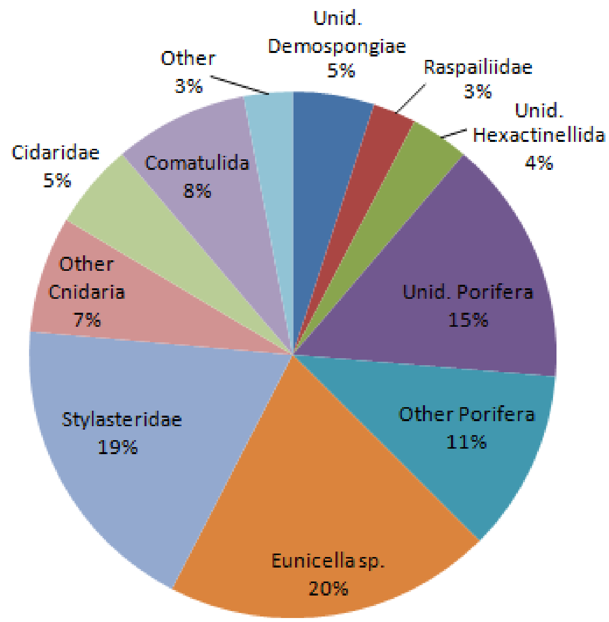

Figure 4-29. Macrofaunal organism densities (mean values of both stations in m^{-2}) at the two Non-Cable Outer Terrace Ridge Low-Slope photostations expressed as percentages of total benthic organism abundance summarized from Table 4-21. Other Porifera includes identified demosponge and hexactinellid taxa, each of which contributed less than ~3% of mean density.

Table 4-21. Density data (in m^{-2}): Non-Cable Outer Terrace Ridge Low-Slope Hardbottom habitat photostations.

NC OTR LS	1	2	TOT	MEAN	STD.DEV.	STD.ERR.
PORIFERA						
DEMOSPONGIAE						
Astrophorida	0.012	0.126	0.138	0.069	0.080	0.057
Demospongiae unident.	0.143	0.597	0.740	0.370	0.321	0.227
Desmacellidae	0.059	0.024	0.083	0.042	0.025	0.018
Geodiidae		0.016	0.016	0.008		
Lithistida 1	0.309	0.063	0.372	0.186	0.174	0.123
Lithistida 2	0.024	0.094	0.118	0.059	0.050	0.035
Pachastrellidae	0.143	0.047	0.190	0.095	0.068	0.048
Phakellia sp.	0.036	0.346	0.381	0.191	0.219	0.155
Raspailiidae	0.238	0.157	0.395	0.197	0.057	0.040
Spongosorites sp.	0.095	0.016	0.111	0.055	0.056	0.040
HEXACTINELLIDA						
Aphrocallistes beatrix	0.012		0.012	0.006		
Euritidae/Farreidae	0.202	0.024	0.226	0.113	0.126	0.089
Hexactinellida unident.	0.059	0.471	0.531	0.265	0.291	0.206
Hyalonema sp.		0.008	0.008	0.004		
Vazella sp.		0.008	0.008	0.004		
Porifera unident.	2.248		2.248	1.124		
CNIDARIA						
HEXACORALLIA						
Actiniaria unident.	0.048	0.228	0.275	0.138	0.127	0.090
Corallimorphidae	0.012		0.012	0.006		
Liponema sp.	0.095	0.079	0.174	0.087	0.012	0.008
Zoanthidea		0.024	0.024	0.012		
OCTOCORALLIA						
Eunicella sp.	2.866	0.118	2.984	1.492	1.944	1.374
Isididae		0.094	0.094	0.047		
Plexauridae		0.039	0.039	0.020		
Primnoidae	0.095	0.267	0.362	0.181	0.122	0.086
Pseudodrifa nigra	0.071	0.016	0.087	0.044	0.039	0.028
STYLASTERIDAE	0.856	1.948	2.804	1.402	0.772	0.546
ANNELIDA	0.012		0.012	0.006		
ECHIURA	0.012		0.012	0.006		
MOLLUSCA	0.012	0.016	0.028	0.014	0.003	0.002
ARTHROPODA	0.071	0.024	0.095	0.047	0.034	0.024
BRACHIOPODA	0.012		0.012	0.006		
BRYOZOA	0.036	0.024	0.059	0.030	0.009	0.006
ECHINODERMATA						
ASTEROIDEA						
Asteroidea unident.	0.059	0.008	0.067	0.034	0.036	0.026
Goniasteridae	0.012	0.008	0.020	0.010	0.003	0.002
Linckia sp.		0.008	0.008	0.004		
ECHINOIDEA						
Cidaridae	0.393	0.385	0.777	0.389	0.005	0.004
Coelopleurus floridanus		0.016	0.016	0.008		
CRINOIDEA						
Comatulida	1.070	0.149	1.220	0.610	0.651	0.461
OPHIUROIDEA						
Euryalidae		0.008	0.008	0.004		
HOLOTHUROIDEA						
Psolidae	0.024		0.024	0.012		
UNKNOWN ANIMAL	0.059	0.024	0.083	0.042	0.025	0.018
TOTAL	9.396	5.474	14.870	7.435	2.774	1.961

Outer Terrace Ridge - High Slope Hardbottom (Table 4-22, 4-23; Figure 4-30)

All three stations in this habitat exhibited high percentages of hard substrate (83.0-95.0%), with stations 1 and 2 recording between 1 and 2% non-coral living cover, and stations 1 and 3 recording some coral habitat: chiefly rubble but with 0.05-0.08% living coral of two species. The greatest contributor to overall density was *Eunicella* sp. (mean 2.27 m^{-2} and 40%), although it contributed significantly only at stations 1 and 2. No other identified taxon accounted for >10% of overall density (unidentified demosponges accounted for 11%).

Table 4-22. Percent cover data for Non-Cable Outer Terrace Ridge High Slope Hardbottom habitat photostations.

Non-cable - Outer Terrace Ridge - High Slope	NC OTR-HS 1	NC OTR-HS 2	NC OTR-HS 3	TOTAL	MEAN	Std.Dev.	Std.Err.
CORAL (COR)	0.724	0	0.654	1.378	0.459	0.399	0.231
Colonial Dead Coral (DC)	0	0	0.05	0.055	0.018	0.031	0.018
Coral Rubble (CR)	0.65	0	0.55	1.193	0.398	0.348	0.201
Lophelia (LOP)	0.08	0	0	0.076	0.025	0.044	0.025
Madrepora (MAD)	0	0	0.05	0.055	0.018	0.031	0.018
CHORDATA (CHO)	0	0	0.055	0.055	0.018	0.031	0.018
CNIDARIA NON SCLERACTINIA (CNI)	0.267	0.185	0.164	0.615	0.205	0.054	0.031
ECHINODERMATA (ECH)	0.305	0.556	0	0.860	0.287	0.278	0.161
PORIFERA (POR)	0.610	1.111	0.164	1.885	0.628	0.474	0.274
UNIDENTIFIED ORGANISM (UND)	0	0	0	0.000	0.000	0.000	0.000
SOFT BOTTOM SUBSTRATE (SB)	14.248	2.995	15.921	33.164	11.055	7.030	4.059
HARD BOTTOM SUBSTRATE (HB)	83.848	95.029	83.043	261.919	87.306	6.700	3.868
NATURAL DETRITUS (DET)	0	0.123	0	0.123	0.041	0.071	0.041
TAPE, WAND, SHADOW, PHOTO EFFECT (TWS)	2.778	0.338	3.474	6.590	2.197	1.646	0.951
Sum (excluding tape+shadow+wand)	100	100	100				

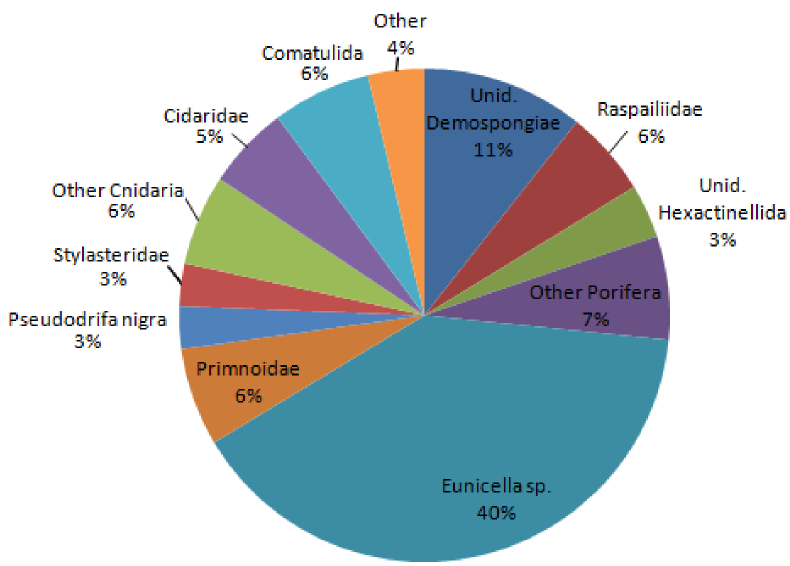

Figure 4-30. Macrofaunal organism densities (in m^{-2}) at the three Non-Cable Outer Terrace Ridge High-Slope photostations expressed as percentages of mean benthic organism densities summarized from Table 4-23. Other Porifera includes identified demosponge and hexactinellid taxa, each of which contributes less than~3% of mean density.

Table 4-23. Density data (in m^{-2}): Non-Cable Outer Terrace Ridge High-Slope Hardbottom habitat photostations.

NC OTR HS	1	2	3	TOT	MEAN	STD.DEV.	STD.ERR.
PORIFERA							
DEMOSPONGIAE							
Demospongiae unident.	0.754	0.532	0.534	1.820	0.607	0.127	0.090
Desmacellidae	0.017	0.099		0.116	0.039	0.053	0.038
Geodiidae	0.008			0.008	0.003		
Leiodermatium sp.			0.031	0.031	0.010		
Lithistida 1	0.215	0.054	0.016	0.285	0.095	0.106	0.075
Pachastrellidae	0.025	0.036	0.016	0.077	0.026	0.010	0.007
Phakellia sp.	0.099	0.180	0.110	0.390	0.130	0.044	0.031
Raspailiidae	0.240	0.694	0.031	0.966	0.322	0.339	0.240
Spongosorites sp.	0.008			0.008	0.003		
HEXACTINELLIDA							
Aphrocallistes beatrix		0.009		0.009	0.003		
Euritidae/Farreidae	0.099	0.099		0.199	0.066	0.057	0.041
Hexactinellida unident.	0.215	0.135	0.252	0.602	0.201	0.060	0.042
Vazella sp.	0.008		0.031	0.040	0.013	0.016	0.012
CNIDARIA							
HEXACORALLIA							
Actiniaria 2	0.008		0.031	0.040	0.013	0.016	0.012
Actiniaria unident.	0.025	0.108		0.133	0.044	0.057	0.040
Bathypathes alternata	0.008		0.031	0.040	0.013	0.016	0.012
Corallimorphidae	0.025	0.036	0.016	0.077	0.026	0.010	0.007
Liponema sp.	0.083	0.207	0.016	0.306	0.102	0.097	0.069
Lophelia pertusa	0.008			0.008	0.003		
Madrepora sp.			0.016	0.016	0.005		
Sagartiidae	0.008	0.009		0.017	0.006	0.005	0.004
OCTOCORALLIA							
Eunicella sp.	2.153	4.606	0.047	6.806	2.269	2.282	1.613
Isididae		0.009	0.063	0.072	0.024	0.034	0.024
Octocorallia unident.	0.008	0.009	0.283	0.300	0.100	0.158	0.112
Pennatulacea	0.008			0.008	0.003		
Primnoidae	0.066		1.037	1.104	0.368	0.581	0.411
Pseudodrifa nigra	0.091	0.388		0.479	0.160	0.203	0.143
STYLASTERIDAE	0.091	0.388		0.479	0.160	0.203	0.143
MOLLUSCA	0.017	0.009		0.026	0.009	0.008	0.006
ARTHROPODA	0.033	0.018	0.031	0.083	0.028	0.008	0.006
BRYOZOA	0.017	0.018	0.016	0.050	0.017	0.001	0.001
ECHINODERMATA							
ASTEROIDEA							
Asteroidea unident.	0.116	0.153		0.269	0.090	0.080	0.057
Goniasteridae	0.025		0.016	0.041	0.014	0.013	0.009
Linckia sp.		0.009		0.009	0.003		
Sclerasterias sp.	0.008			0.008	0.003		
Tremaster mirabilis	0.017			0.017	0.006		
ECHINOIDEA							
Cidaridae	0.373	0.568		0.941	0.314		
Echinoidea unident.	0.008			0.008	0.003		
Gracilechinus sp.	0.033			0.033	0.011		
CRINOIDEA							
Comatulida	0.613	0.370	0.126	1.108	0.369	0.244	0.172
UROCHORDATA		0.072	0.016	0.088	0.029	0.038	0.027
TOTAL	5.532	8.815	2.767	17.114	5.705	3.028	2.141

Lower Terrace - High Slope Hardbottom (Tables 4-24, 4-25; Figure 4-31)

This station exhibited the greatest percent cover by deep-sea coral habitat (14.4%), although almost all was coral rubble. Living *Lophelia pertusa* was not reported in the CPCe analysis but did appear (0.022 m^{-2}) in the density analysis. Taxon richness appeared to be substantially lower than on either the Outer Terrace Ridge or Terrace Platforms. Primnoid octocorals (chiefly, if not all, *Plumarella* sp.) accounted for the greatest proportion of density (1.21 m^{-2} and 32%); however, the second most important group, unidentified octocorals (0.87 m^{-2} and 23%), was likely also Primnoidae. Hexactinellid sponge density was far greater than that of demosponges for the first time (although unidentified hexactinellids were recorded at higher densities than demosponges at NC ITP LS 6 and 7.

Table 4-24. Percent cover data for all Non-Cable Lower Terrace High-Slope Hardbottom habitat photostations.

Non-cable Lower Terrace - High Slope	NC LT-HS 1
CORAL (COR)	14.385
Colonial Dead Coral (DC)	0.559
Coral Rubble (CR)	13.827
CNIDARIA NON SCLERACTINIA (CNI)	0.489
PORIFERA (POR)	0.349
SOFT BOTTOM SUBSTRATE (SB)	60.475
HARD BOTTOM SUBSTRATE (HB)	24.302
TAPE, WAND, SHADOW, PHOTO EFFECT (TWS)	1.241
Sum (excluding tape+shadow+wand)	100

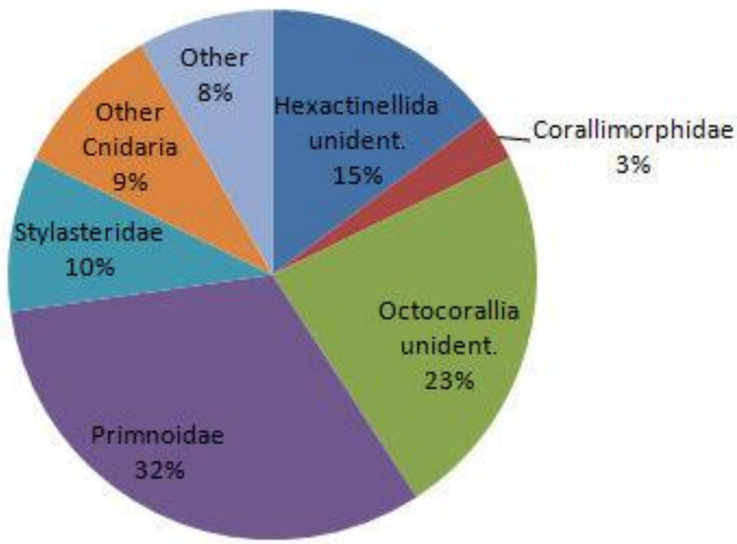

Figure 4-31. Macrofaunal organism densities (in m^{-2}) at the Non-Cable Lower Terrace High-Slope photostation expressed as percentages of total benthic organism density summarized from Table 4-25.

Table 4-25. Density data (in m^{-2}): Non-Cable Lower Terrace High Slope Hardbottom habitat photostation.

NC LT HS	1	NC LT HS	1
PORIFERA		OCTOCORALLIA	
DEMOSPONGIAE		*Eunicella* sp.	0.022
Demospongiae unident.	0.090	Isididae	0.022
Phakellia sp.	0.045	Octocorallia unident.	0.874
HEXACTINELLIDA		Primnoidae	1.210
Hexactinellida unident.	0.560	*Pseudodrifa nigra*	0.022
CNIDARIA		STYLASTERIDAE	0.359
HEXACORALLIA		MOLLUSCA	0.090
Actiniaria unident.	0.067	ARTHROPODA	0.045
Corallimorphidae	0.112	ECHINODERMATA	
Lophelia pertusa	0.022	CRINOIDEA	
Madrepora sp.	0.090	Comatulida	0.045
Sagartiidae	0.090	TOTAL	3.787
Zoanthidea	0.022		

Lower Terrace - Sinkhole Hardbottom (Tables 4-26, 4-27; Figure 4-32)

Percent cover was chiefly hard substrate (72.2%) with a substantial contribution from deep-sea coral rubble (8.3%). Living organisms accounted for <0.5% of cover. Living *Lophelia pertusa* was again not reported in the CPCe analysis but did appear (0.051 m^{-2}) in the density analysis. Primnoidae accounted for an even greater proportion of density (1.28 m^{-2} and 39%) than at the preceding station, and unidentified octocorals (1.29 m^{-2} and 39%) were again also likely Primnoidae. Again, hexactinellid sponge density was much greater than that of demosponges. Overall organism density (3.37 m^{-2}) was similar to that at the Lower Terrace High-Slope photostation (3.79 m^{-2}).

Table 4-26. Percent cover data: Non-Cable Lower Terrace Sinkhole Hardbottom habitat photostation.

Non-cable - Lower Terrace - Sinkhole	NC LT-SH 1
CORAL (COR)	8.264
Coral Rubble (CR)	8.264
CNIDARIA NON SCLERACTINIA (CNI)	0.220
PORIFERA (POR)	0.264
SOFT BOTTOM SUBSTRATE (SB)	19.077
HARD BOTTOM SUBSTRATE (HB)	72.176
TAPE, WAND, SHADOW, PHOTO EFFECT (TWS)	1.087
Sum (excluding tape+shadow+wand)	100

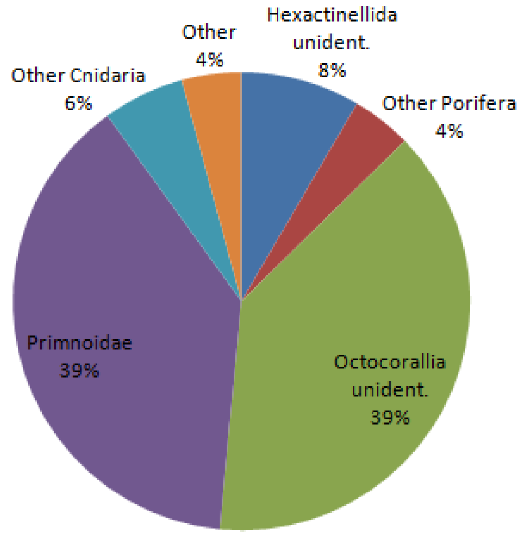

Figure 4-32. Macrofaunal organism densities (in m^{-2}) at the Non-Cable Lower Terrace Sinkhole Hardbottom photostation expressed as percentages of total benthic organism abundance summarized from Table 4-27.

Table 4-27. Density data for the Non-Cable Lower Terrace Sinkhole Hardbottom habitat photostation.

NC LT SH	1	NC LT SH	1
PORIFERA		OCTOCORALLIA	
HEXACTINELLIDA		Octocorallia unident.	1.290
Aphrocallistes beatrix	0.013	Primnoidae	1.277
Hexactinellida unident.	0.281	STYLASTERIDAE	0.089
Porifera Unident.	0.128	MOLLUSCA	0.013
CNIDARIA		ARTHROPODA	0.026
HEXACORALLIA		ECHINODERMATA	
Actiniaria unident.	0.026	Asteroidea unident.	0.013
Actinoscyphia sp.	0.013	Echinoidea unident.	0.013
Antipatharia unident.	0.013	UNKNOWN ANIMAL	0.077
Cerianthidae	0.038	TOTAL	3.372
Corallimorphidae	0.013		
Lophelia pertusa	0.051		

4.3 Cable Impact Assessment

This section provides a multivariate statistical analysis and summary of both percent cover and organism densities for hardbottom habitats on the Northern Miami Terrace to evaluate community-level impacts from cables. All photostations were categorized by benthic habitat types defined in Section 4.2. Percent cover and organism density at both Cable and Non-Cable stations were evaluated in each habitat to determine if the effects from cable presence on the benthic communities or substrate are significant at the community level.

Benthic habitats containing EFH are treated in order from west to east, with Low-Slope photostations treated first for each habitat. Section 4.3.1 summarizes percent cover and density analyses along the shallow Cable Transect and describes observed impacts from cable. Comparison of Cable versus Non-Cable was not possible in this habitat due to a lack of similar habitat without cables. Section 4.3.2 treats the deeper portion (>245 m) of Cable Transect A.

As noted in Sections 3.4 and 4.2.3.3, estimated organisms (Hydroidolina, solitary scleractinian corals, and ophiurid ophiuroids) have been excluded from density summary tables and pie diagrams. Bottom-associated fishes have not been included in density tables because of their extremely low frequency of occurrence in quantitative still images. Of the 30 density records of fish taxa at all Cable photostations, all were <0.05 m^{-2}. The most frequently recorded recognizable taxon was again the codling *Laemonema* sp. (at 12 of 27 stations), followed by the greeneye, *Chlorophthalmus agassizi* and blackbelly rosefish, *Helicolenus dactylopterus* (at 2 each). Other infrequently encountered groups for which component taxa have been combined in density tables are Arthropoda (again most commonly paguroid hermit crabs and *Eumunida picta*), Mollusca (again most commonly unidentified gastropods) and Annelida (chiefly sabellid featherduster worms). Other minor groups, e.g., Bryozoa, Brachiopoda, Urochordata (Ascidiacea), have not been divided into component taxa.

4.3.1 Shallow Transect

As noted in Section 4.1, because all three shallow transects (A, An, As) from ~30 to 90 m traversed cables, none could be used as Non-Cable transects, thus no detailed statistical comparison was carried out. The large number of additional cables in the area (Figure 4-1) and the limited amount of habitat precluded selection of any nearby Non-Cable transects in similar habitat using the ROV.

Section 4.2.2.1 described the shallow Cable Transects, but quantitative observations on stony corals (Scleractinia) are given here. A total of 83 (possibly 94) of 845 images taken between 30 m and the disappearance of the octocoral *Swiftia exserta* in 63 m included stony corals (the deepest observed in 38-43 m) (Table 4-2). Eight images included more than one colony for a total of 109 colonies (excluding unconfirmed, unidentified colonies). The great majority were <10 cm in maximum diameter; the largest recorded in still images were two *Montastraea cavernosa* (26 and 29 cm across) and two *Agaricia lamarcki* (26 and >26 cm [partly visible] across). None exhibited any recognizable impacts (dislodged, abraded or shaded).

The only direct effect on macrobenthos observed in the video and photographic record in this depth range and attributable to cable appeared at 26°05.249'N, 80°04.713'W, in 43 m along

Transect An, where a cable appeared to have split a large sponge, which continued to survive. Other effects included fouling of cables by cyanobacterial mat and chiefly encrusting sponges. At 26°05.219'N, 80°04.817'W, at a depth of 34 m, cable was also reported as "totally encrusted and embedded."

From the disappearance of hard substrate in 90-93 m to the seaward end of the shallow portion of Cable Transect A, exposed cable supported often numerous hydroids and anemones, including ?*Actinauge* sp., a small white anemone (beginning in 194 m), and Venus flytrap anemone *Actinoscyphia* sp. (199 m), as well as a rare or occasional antipatharian (from 213 m), an unidentified white octocoral (215 m) and unidentified sponge (219 m). Anemones often grew at regular intervals of ~15 cm along the cable (Figure 4-6). Organisms such as the swimming crab *Bathynectes longispina* either created or took advantage of shallow scour under the cable for shelter. Anemones were also observed attached to anthropogenic debris such as aluminum cans and plastic trash bags.

4.3.2 Deep Cable Transect

Multivariate Analyses of all sites combined

The following analyses examine whether any statistical evidence existed for differences in either percent cover or density at all photostations based on the presence versus absence of cable. An MDS plot of percent cover data for all hardbottom habitat photostations (Figure 4-33) showed no overall pattern distinguishing Cable versus Non-Cable stations. The percent cover analysis mostly showed distinctions between percent substrate cover. Cables did not appear to be a factor in determining substrate differences, i.e., cables did not cause a hardbottom station to become softbottom.

An MDS plot of density data for all hardbottom habitat photostations (Figure 4-34) indicates that the presence of cable does not appear to be driving densities of biological organisms at a regional level. If regional-level cable impacts existed, Cable stations would be expected to group separately from Non-Cable stations. Analysis of all sites did not show any overarching patterning for Cable and Non-Cable sites. The same MDS plot coded for habitats illustrates that habitat is contributing more to the similarity of stations than cable effects (Figure 4-35). Similar to the Non-Cable density analysis, benthic habitats based on geomorphology (e.g., Inner Terrace Platform, Lower Terrace Sinkhole) and slope derived from geophysical multibeam data (Low versus High) are driving the regional differences among all stations rather than the presence of cable. The arrow in Figure 4-35 illustrates the cross-shelf geomorphologic habitat and depth trends from west (shallow) to east (deep). High slope stations (red) occupy the center and right part of the graph. Low slope stations (green) occupy center to left side. This means that habitat had more of an effect on all station similarity than Cable; therefore cable impacts were investigated further in the following sections by analyzing the stations within each habitat separately.

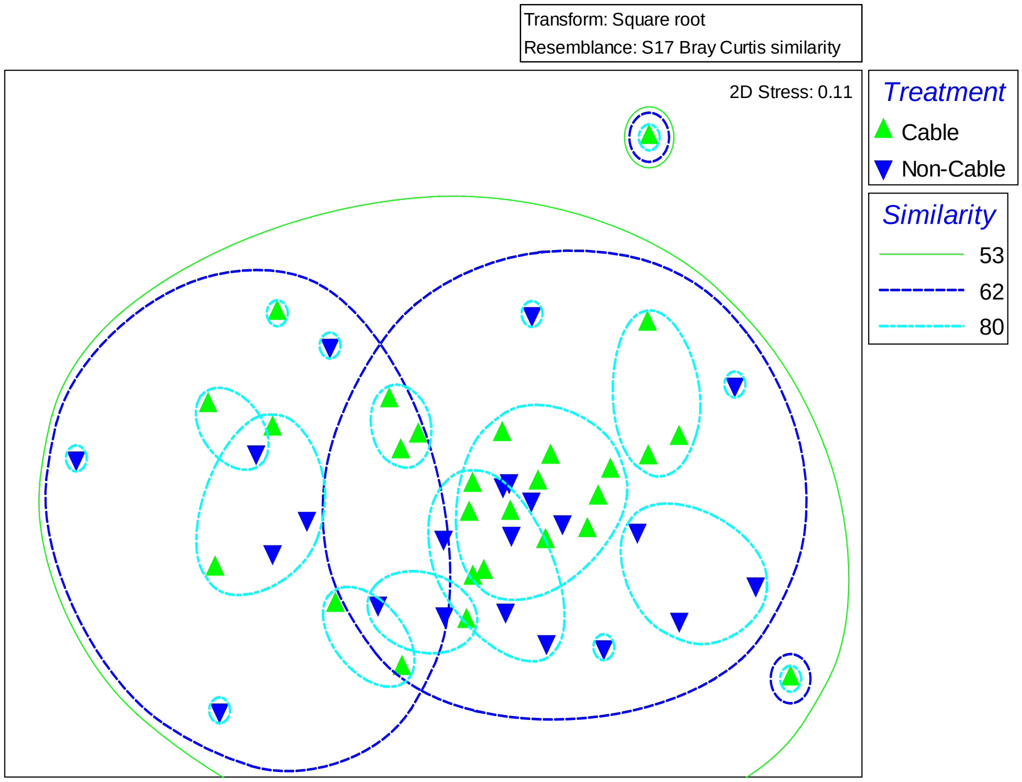

Figure 4-33. MDS plot of percent cover data for all hardbottom habitat photostations. Stations are coded by Cable and Non-Cable. Groupings indicate percent similarity from a cluster analysis.

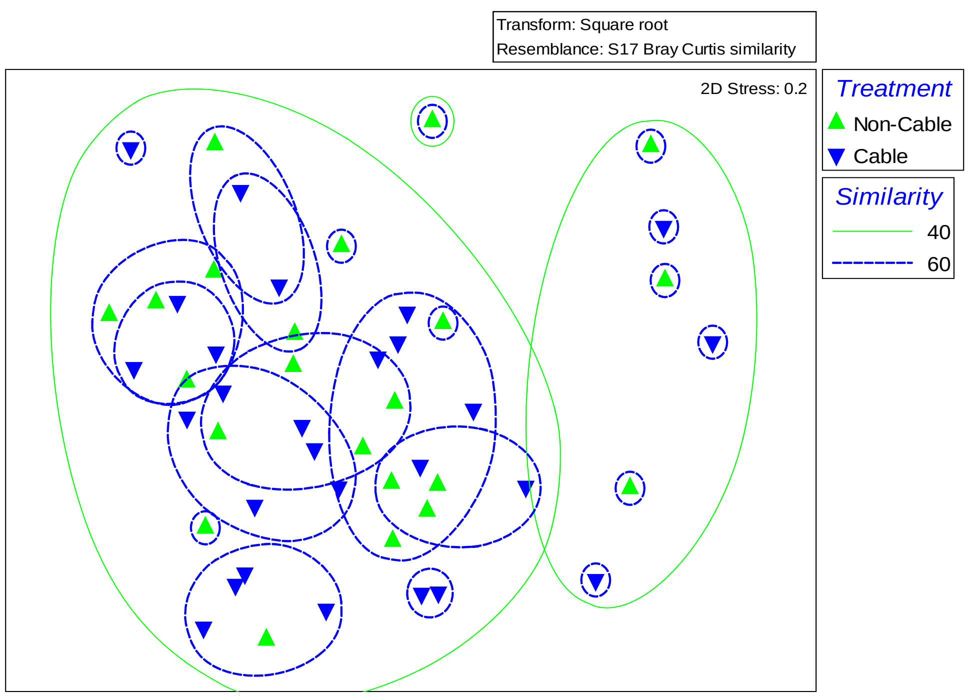

Figure 4-34. MDS plot of density data for all hardbottom habitat photostations. Stations are coded by Cable and Non-Cable. Groupings indicate percent similarity from a cluster analysis.

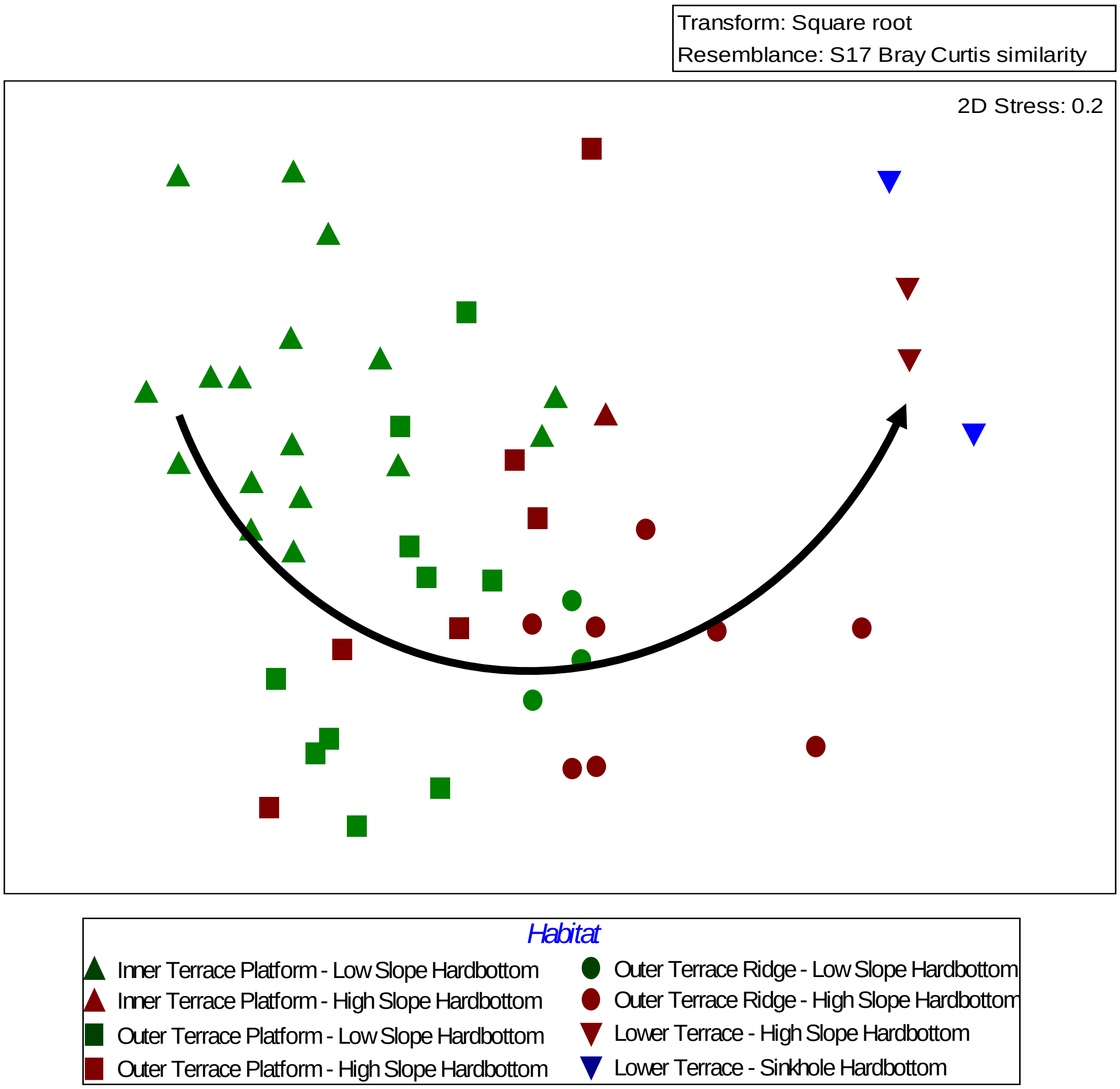

Figure 4-35. MDS plot of density data for all hardbottom habitat photostations. Stations are coded by Habitat. The arrow illustrates the cross-shelf geomorphologic zone and depth trends from shallow to deep. High slope stations (red) occupy the center and right part of the graph. Low slope stations (green) occupy center to left side.

Inner Terrace Platform Low-Slope Hardbottom (Tables 4-28 – 4-29; Figures 4-36 – 4-40)
Percent cover of hard substrates ranged from 9.3 to 54.4% cover, although six of the ten stations spanned a relatively narrow range of 37.9-54.4% (Table 4-28). Cover by all living organisms was chiefly <1% with a maximum of 2.0% at C ITP-LS 10. Although five stations recorded at least some deep-sea coral habitat, only two (2 and 10) included any living coral (maximum cover 0.069 m^{-2}). The greatest contribution was 6.06% cover of coral rubble at station 8.

An MDS plot of a cluster analysis of all ITP-LS hard substrate photostations (Figure 4-36) showed that percent cover of living organisms was too small to contribute any significant difference between Cable and Non-Cable stations. The complete overlap in the distribution of

Cable and Non-Cable stations indicates that the presence of cable did not significantly affect percent cover by substrate type.

Table 4-28. Percent cover data for all Cable Inner Terrace Platform Low-Slope Hardbottom habitat photostations.

Cable - Inner Terrace Platform - Low Slope	C ITP-LS 1	C ITP-LS 2	C ITP-LS 3	C ITP-LS 4	C ITP-LS 5	C ITP-LS 6	C ITP-LS 7	C ITP-LS 8	C ITP-LS 9	C ITP-LS 10	MEAN	Std.Dev.	Std.Err.
CORAL (COR)	0	0.138	0	0	0.060	0	0	6.126	0.535	0.032	0.689	1.917	0.606
Colonial Dead Coral (DC)	0	0	0	0	0.030	0	0	0.032	0	0	0.006	0.013	0.004
Coral Rubble (CR)	0	0	0	0	0.030	0	0	6.062	0.535	0	0.663	1.904	0.602
Lophelia (LOP)	0	0.069	0	0	0	0	0	0	0	0.032	0.010	0.023	0.007
Solitary Coral (SC)	0	0.069	0	0	0	0	0	0.032	0	0	0.010	0.023	0.007
ARTHROPODA (ART)	0	0	0	0	0	0	0	0	0	0.064	0.006	0.020	0.006
CHORDATA (CHO)	0	0	0	0	0	0.056	0	0	0	0	0.006	0.018	0.006
CNIDARIA NON SCLERACTINIA (CNI)	0.336	0.276	0.216	0.347	0.417	0.670	0.330	0.706	1.069	1.257	0.562	0.357	0.113
ECHINODERMATA (ECH)	0.084	0.034	0	0	0.060	0.168	0.300	0	0.134	0.355	0.113	0.127	0.040
ECHIURA (ECR)	0.112	0.241	0.124	0	0	0.056	0	0	0.027	0	0.056	0.081	0.026
PORIFERA (POR)	0.028	0.034	0.340	0.032	0.179	0.419	0.359	0.032	0.428	0.290	0.214	0.172	0.054
UNIDENTIFIED ORGANISM (UND)	0	0.034	0.031	0.063	0	0.056	0	0	0	0	0.018	0.025	0.008
SOFT BOTTOM SUBSTRATE (SB)	77.881	61.297	44.929	45.243	59.404	68.956	62.702	83.740	48.810	41.908	59.487	14.405	4.555
HARD BOTTOM SUBSTRATE (HB)	21.306	37.875	54.360	53.434	39.493	27.778	35.710	9.301	48.623	55.835	38.372	15.455	4.887
CABLE (CB)	0.196	0.069	0	0.851	0.238	1.787	0.539	0.032	0.374	0.226	0.431	0.542	0.171
HUMAN DEBRIS (HUM)	0	0	0	0.032	0.030	0.056	0.030	0.064	0	0.032	0.024	0.024	0.008
NATURAL DETRITUS (DET)	0.056	0	0	0	0.119	0	0.030	0	0	0	0.021	0.040	0.012
TAPE, WAND, SHADOW, PHOTO EFFECT (TWS)	2.247	4.951	0.431	2.338	4.143	0.417	1.824	2.563	0.240	1.524	2.068	1.566	0.495
Sum (excluding tape+shadow+wand)	100	100	100	100	100	100	100	100	100	100			

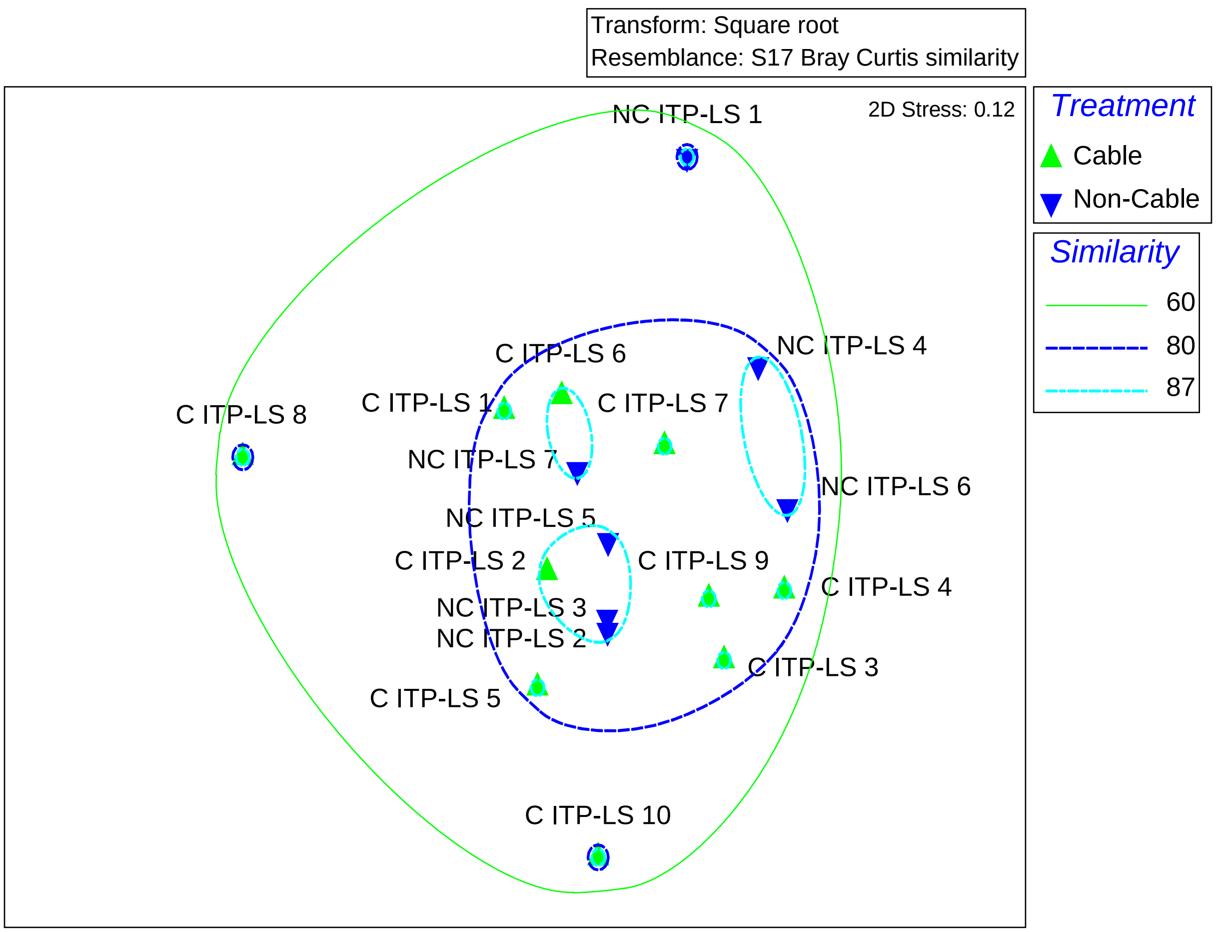

Figure 4-36. MDS plot of percent cover data for all Inner Terrace Platform Low Slope Hardbottom habitat photostations. Stations are coded by Cable and Non-Cable. Circles indicate percent similarity from the cluster analysis.

Total organism density at eight of the ten stations ranged from 3.03 to 5.78 m^{-2} with higher densities recorded at stations 8 (8.89 m^{-2}) and 10 (17.15 m^{-2}). Table 4-29 lists organism densities at both Cable and Non-Cable ITP-LS photostations for comparison. Mean density was somewhat greater at the Non-Cable (7.9 m^{-2}) than the Cable photostations (5.9 m^{-2}), but station-by-station densities varied widely: from 4.46 to 12.24 m^{-2} at NC photostations, and 3.53 to 17.15 m^{-2} at Cable photostations (with Cable station 10 exhibiting the highest density of any station in this habitat). Major faunal components were similar to those at the equivalent NC ITP-LS stations, e.g., *Eunicella* sp. and *P. nigra*, although they did not all contribute the same proportion of density, e.g., Echiura contributed 21% of density at the Non-Cable stations and 11% at the Cable stations (Figures 4-25, 4-37). The substantial contribution of Primnoidae at the Cable stations was due to its abundance at station 10 alone. *Eunicella* sp. and comatulids were also far more abundant at this station than at any other. Qualitative observations of these taxa indicate that they typically occur in greater abundances in areas exposed to stronger near-benthic current, often but not always in association with elevated topography. By contrast, echiurans are common on low-relief substrates with extensive areas of sediment. All sponges together contributed a similar percentage to overall density at both Non-Cable (21%) and Cable (25%) stations in this habitat, although most were recorded as unidentified Hexactinellida at the Non-Cable photostations, but as Unidentified Porifera at the Cable photostations (Figure 4-37B).

Table 4-29. Density data for all Non-Cable and Cable Inner Terrace Platform Low-Slope Hardbottom habitat photostations.

	Non-Cable Inner Terrace Platform Low-Slope											Cable Inner Terrace Platform Low-Slope													
	1	2	3	4	5	6	7	TOT	MEAN	STD.DEV.	STD.ERR.	1	2	3	4	5	6	7	8	9	10	TOT	MEAN	STD.DEV.	STD.ERR.
PORIFERA																									
DEMOSPONGIAE																									
Astrophorida			0.018					0.018	0.003																
Axinellidae						0.012		0.012	0.002																
Demospongiae unident.	0.046	0.069	0.071	0.454	0.044	0.254	0.195	1.131	0.162	0.152	0.108		0.081	0.385	0.599	0.146						1.210	0.121	0.215	0.152
Desmacellidae						0.046	0.092	0.138	0.020	0.036	0.026						0.023			0.556	0.446	1.024	0.102	0.221	0.156
Geodiidae		0.011		0.018		0.012	0.023	0.064	0.009	0.009	0.007					0.021				0.017		0.038	0.004	0.008	0.006
Lithistida 1			0.018	0.018				0.036	0.005	0.009					0.018	0.021						0.039	0.004	0.009	0.006
Pachastrellidae							0.011	0.011	0.002								0.023			0.034	0.074	0.131	0.013	0.026	0.018
Phakellia sp.			0.018		0.116	0.023	0.011	0.168	0.024	0.042	0.029	0.023	0.013		0.127	0.314	0.250	0.218		0.017		0.962	0.096	0.126	0.089
Raspailiidae																	0.023					0.023	0.002		
Spongosorites sp.														0.038				0.020				0.058	0.006	0.014	0.010
HEXACTINELLIDA																									
Aphrocallistes beatrix																		0.040				0.040	0.004		
Euritidae/Farreidae			0.018		0.015	0.058	0.011	0.101	0.014	0.020	0.014					0.021		0.040		0.067	0.099	0.227	0.023	0.036	0.026
Hexactinellida unident.	0.183	0.023				1.407	0.756	2.369	0.338	0.545	0.386		0.013	0.038	0.036	0.126		0.020	0.140	0.101		0.475	0.047	0.055	0.039
Vazella sp.														0.019		0.021						0.040	0.004	0.009	0.006
Porifera unident.	0.023	0.011	0.053	0.254	0.087			0.428	0.061	0.091	0.064					0.042	0.068	0.179		1.852	3.564	5.705	0.571	1.253	0.886
CNIDARIA																									
HEXACORALLIA																									
?Actinauge sp.							0.069	0.069	0.010			0.203				0.021						0.224	0.022		
Actiniaria 2	0.183	0.023	0.018				0.160	0.384	0.055	0.081	0.057	0.023		0.481	0.018	0.167						0.689	0.069	0.162	0.115
Actiniaria unident.	1.348	0.525	0.635	0.563	0.203	0.231	0.309	3.814	0.545	0.393	0.278	0.113	0.027	0.212	0.399	0.774	1.044	0.795	0.140	0.034	0.099	3.636	0.364	0.383	0.271
Actinoscyphia sp.	0.023	0.023	0.018	0.018		0.023	0.080	0.185	0.026	0.025	0.018	0.271	0.067	0.058	0.236	0.063	0.386	0.238	0.070	0.034	0.099	1.522	0.152	0.120	0.085
Cerianthidae															0.018			0.060		0.101	0.025	0.204	0.020	0.036	0.025
Corallimorphidae						0.012	0.023	0.034	0.005	0.009	0.006	0.023	0.040		0.018	0.105		0.099	0.035		0.050	0.369	0.037	0.040	0.029
Liponema sp.		0.034	0.018	0.127	0.102	0.231	0.676	1.187	0.170	0.237	0.168		0.027	0.019	0.018	0.586	0.091	0.278	0.596	0.051	0.173	1.838	0.184	0.235	0.166
Lophelia pertusa													0.013									0.013	0.001		
Sagartiidae				0.018	0.189	0.046	0.115	0.367	0.052	0.073	0.052		0.040	0.038		0.146		0.040		0.067	0.248	0.580	0.058	0.083	0.058
Zoanthidea	0.525			0.109	0.087	0.023	0.080	0.825	0.118	0.185	0.131	0.136	0.027	0.058	0.018	0.084		0.258	1.402		0.099	2.081	0.208	0.452	0.319
OCTOCORALLIA																									
Eunicella sp.	0.023				0.102	0.138	0.699	0.962	0.137	0.254	0.180				0.018	0.126	0.023	0.278	0.175	1.566	6.411	8.596	0.860	2.105	1.489
Isididae				0.018				0.018	0.003																
Pennatulacea																			0.035			0.035	0.004		
Primnoidae	0.091	0.011					0.011	0.114	0.016	0.034	0.024		0.175				0.023			1.044	2.822	4.063	0.406	0.952	0.673
Pseudodrifa nigra	0.525	0.263	0.159	0.236	0.638	1.418	0.871	4.111	0.587	0.445	0.315	0.746	0.470	0.635	0.671	1.025	0.635	1.271	0.806	1.987	0.941	9.187	0.919	0.462	0.327
Octocorallia unident.		0.011		0.018				0.030	0.004	0.007	0.005														
STYLASTERIDAE		0.023		0.036	0.044	0.069	0.413	0.584	0.083	0.147	0.104		0.013	0.019	0.018	0.021	0.068	0.139	0.035	0.236	0.421	0.970	0.097	0.139	0.098

Table 4-29, continued. Density data for all Non-Cable and Cable Inner Terrace Platform Low-Slope Hardbottom habitat photostations.

	Non-Cable Inner Terrace Platform Low-Slope											Cable Inner Terrace Platform Low-Slope													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**TOT**	**MEAN**	**STD.DEV.**	**STD.ERR.**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**TOT**	**MEAN**	**STD.DEV.**	**STD.ERR.**
ANNELIDA	0.069	0.023						0.091	0.013	0.026	0.018	0.023	0.013	0.038	0.036	0.021				0.017		0.149	0.015	0.016	0.011
ECHIURA	2.102	1.108	1.640	1.362	0.261	0.357	0.252	7.082	1.012	0.740	0.523	1.672	2.646	1.673	0.435	0.146	1.294	1.112	0.035	0.135	0.099	9.247	0.925	0.906	0.641
MOLLUSCA	0.023	0.069	0.123	0.091	0.029	0.127	0.011	0.473	0.068	0.048	0.034	0.045	0.013	0.096	0.036		0.023			0.017	0.025	0.255	0.026	0.030	0.021
BRYOZOA																0.021	0.023					0.044	0.004	0.010	0.007
ARTHROPODA	0.274	0.034		0.054	0.029	0.012	0.011	0.415	0.059	0.096	0.068		0.013	0.038	0.036	0.042	0.023			0.034	0.124	0.310	0.031	0.037	0.026
ECHINODERMATA																									
ASTEROIDEA																									
Asteroidea unident.	0.091	0.023	0.071	0.036	0.029	0.012	0.023	0.285	0.041	0.029	0.021	0.045	0.013	0.019		0.042	0.023			0.051	0.050	0.242	0.024	0.021	0.015
Coronaster briareus				0.018				0.018	0.003			0.023										0.023	0.002		
Goniasteridae		0.011				0.012	0.023	0.046	0.007	0.009	0.006					0.021						0.021	0.002		
Sclerasterias sp.							0.011	0.011	0.002																
Tremaster mirabilis						0.012		0.012	0.002				0.013				0.023	0.020				0.056	0.006	0.010	0.007
ECHINOIDEA																									
Cidaridae	0.091	0.126	0.053	0.109	0.160	0.173	0.218	0.929	0.133	0.055	0.039	0.045	0.107	0.038	0.109	0.084	0.295	0.298	0.070	0.404	0.470	1.921	0.192	0.161	0.113
Echinoidea unident.						0.012		0.012	0.002			0.023										0.023	0.002		
Gracilechinus sp.	0.023		0.035		0.015	0.023		0.096	0.014	0.014	0.010	0.023	0.013	0.019	0.054		0.023	0.020		0.051		0.203	0.020	0.021	0.015
CRINOIDEA																									
Comatulida			0.035				0.046	0.081	0.012	0.020	0.014	0.023		0.038	0.018		0.045	0.040	0.035	0.152	0.495	0.846	0.085	0.158	0.112
Crinoidea (stalked)						0.012		0.012	0.002																
OPHIUROIDEA																									
Euryalidae							0.034	0.034	0.005								0.023	0.119		0.051	0.124	0.316	0.032	0.052	0.037
HOLOTHUROIDEA																									
Psolidae	0.023	0.034	0.018	0.036	0.015	0.023		0.149	0.021	0.012	0.009	0.068	0.013	0.115	0.054	0.063	0.023	0.139		0.168	0.149	0.792	0.079	0.064	0.045
UNKNOWN ANIMAL	0.023		0.071	0.054		0.035		0.182	0.026	0.029	0.020				0.036	0.084	0.091	0.060	0.035	0.051	0.050	0.405	0.041	0.032	0.022
TOTAL	5.689	2.456	3.087	3.649	2.161	4.809	5.238	27.088	3.870	1.393	0.985	3.525	3.854	4.077	3.030	4.351	4.562	5.780	3.610	8.891	17.153	58.832	5.883	4.475	3.165

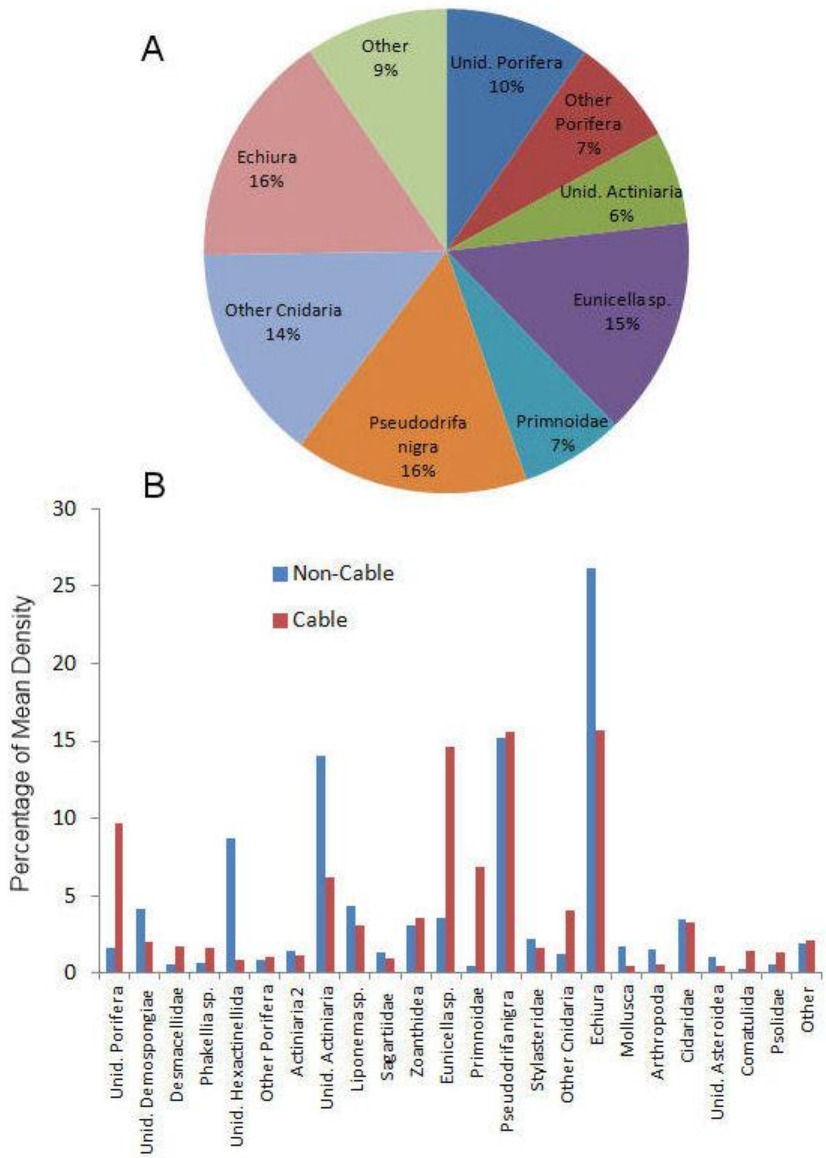

Figure 4-37. A. Macrofaunal organism densities (in m^{-2}) at the ten Cable Inner Terrace Platform Low-Slope photostations expressed as percentages of the total of mean organism densities. B. Comparison of percentage contributions to organism densities at Cable vs. Non-Cable ITP L-S photostations. Data summarized from Table 4-29.

No cable effects on organism density were detected among ITP LS stations, but there was an obvious separation by depth. All stations at depths <275 m appear on the right side of the MDS plot and all deeper stations on the left side (Figure 4-38). Stations C ITP LS 9 and 10 are outliers likely due to their substantially higher overall densities and associated higher densities of several taxa, e.g., *Eunicella* sp., Primnoidae, unidentified Porifera and *P. nigra* (Table 4-29). A MDS plot of the shallower stations showed a spatial separation between Cable and Non-Cable groups (Figure 4-39) but this was not supported by cluster analyses. Cable and Non-Cable sites were over 60% similar. An Analysis of Similarity (ANOSIM) was performed to test the significance of the Cable and Non-Cable groups and did not find Cable/Non-Cable as significant contributors to the station similarities (Table 4-42, below). A MDS plot of these deeper stations showed a spatial separation between Cable and Non-Cable groups (Figure 4-40) but this also was not supported by cluster analyses. Cable and Non-Cable sites were over 50% similar. The Non-Cable sites plotted very near one another while the Cable sites were farther apart. This indicates that the Non-Cable sites were more similar to one another and the Cable sites were more heterogeneous. An Analysis of Similarity (ANOSIM) was performed to test the significance of the Cable and Non-Cable groups and did not find Cable/Non-Cable as significant contributors to the station similarities (Table 4-42, below).

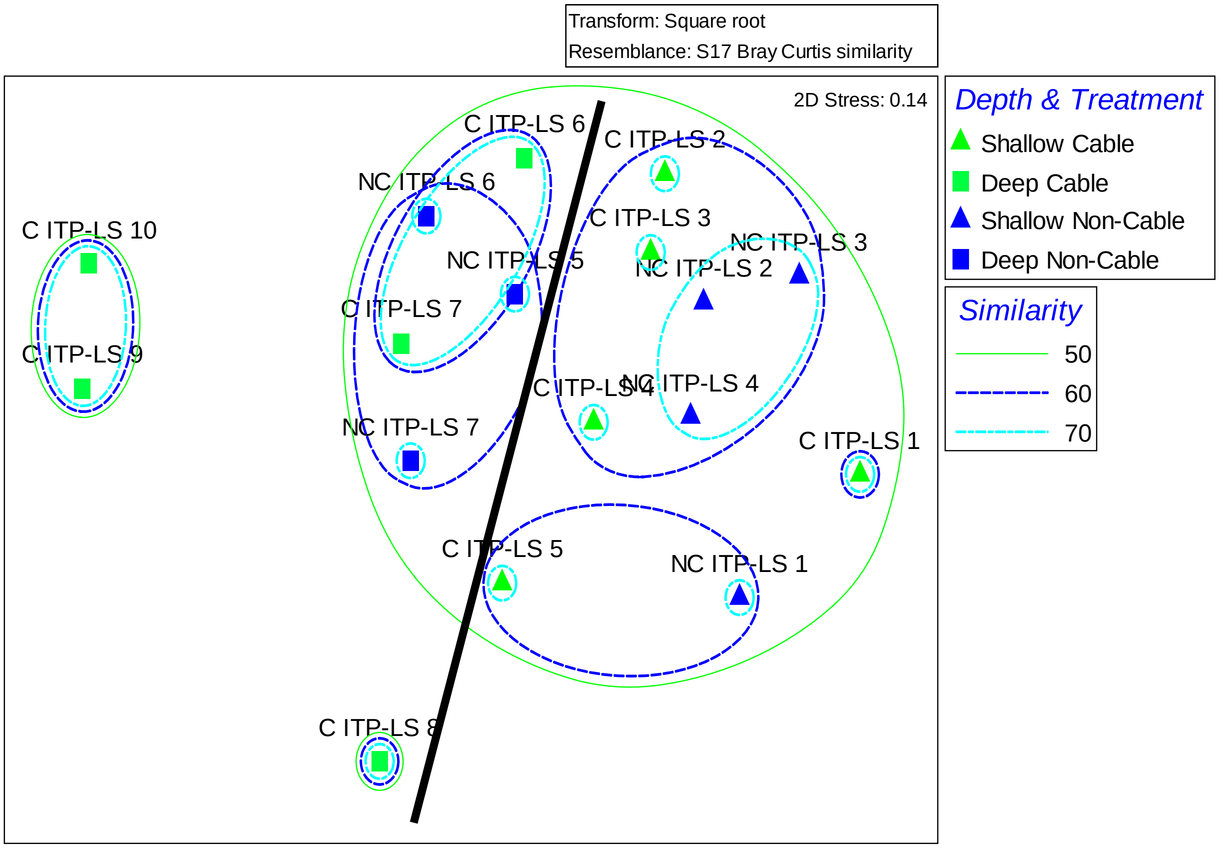

Figure 4-38. MDS plot of density data for all Inner Terrace Platform Low Slope Hardbottom habitat photostations. Stations are color coded by Cable and Non-Cable. Triangles indicate shallower (<275 m) photostations and squares indicate deeper (>275 m) ones. Circles indicate percent similarity from the cluster analysis.

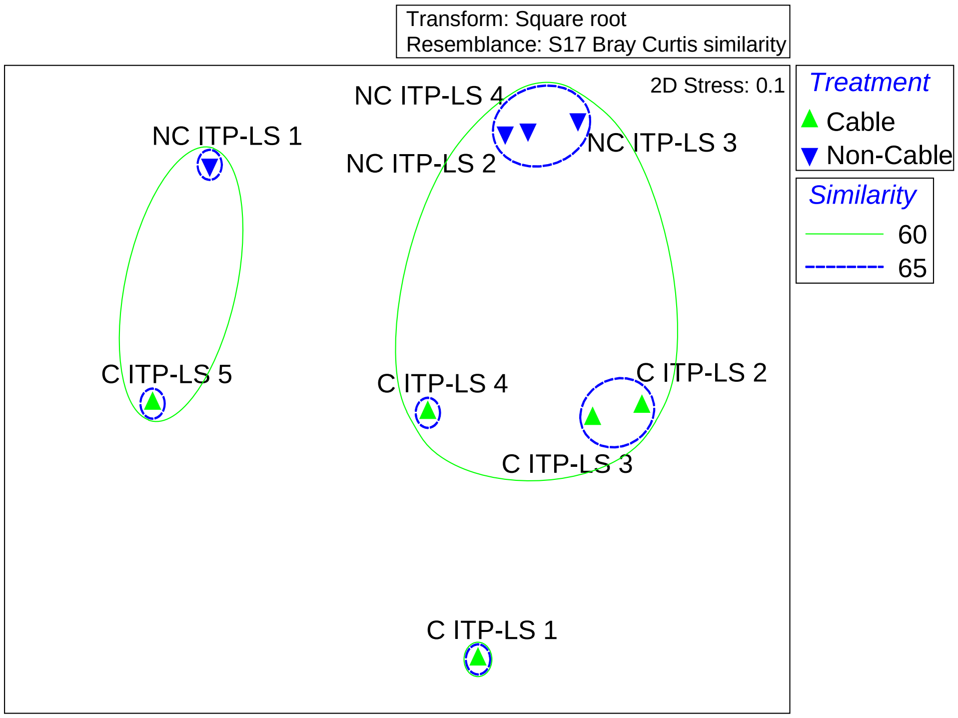

Figure 4-39. MDS plot of density data for all Inner Terrace Platform Low Slope Hardbottom habitat photostations in <275 m depth. Stations are color coded by Cable and Non-Cable. Circles indicate percent similarity from the cluster analysis.

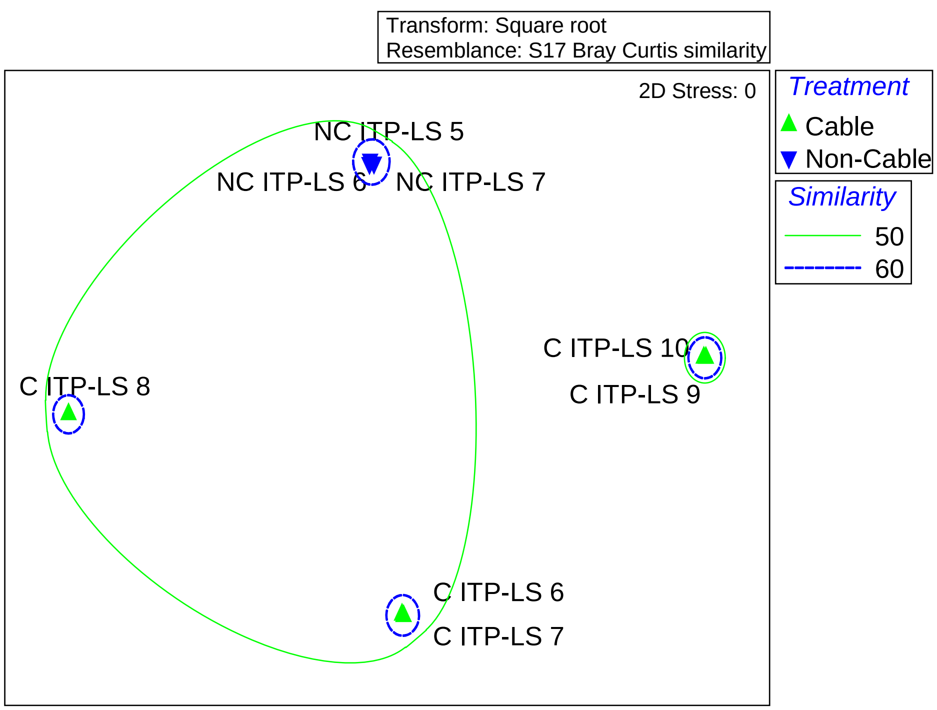

Figure 4-40. MDS plot of density data for all Inner Terrace Platform Low Slope Hardbottom habitat photostations in >275 m depth. Stations are color coded by Cable and Non-Cable. Circles indicate percent similarity from the cluster analysis.

Outer Terrace Platform - Low Slope Hardbottom (Tables 4-30 – 4-31; Figures 4-41 – 4-43)
Sediment substrates dominated at all five stations, ranging from 52.1 to 88.7% of cover. Maximum cover by living organisms was 2.14% (station 5). Deep-sea coral habitat, chiefly as coral rubble, accounted for a small percentage of cover at stations C OTP LS 1 and 4.

Table 4-30. Percent cover data for all Cable Outer Terrace Platform Low Slope Hardbottom habitat photostations.

Cable - Outer Terrace Platform - Low Slope	C OTP-LS 1	C OTP-LS 2	C OTP-LS 3	C OTP-LS 4	C OTP-LS 5	MEAN	Std.Dev.	Std.Err.
CORAL (COR)	0.032	0	0	0.059	0	0.018	0.027	0.012
Coral Rubble (CR)	0.03	0.00	0.00	0.03	0.00	0.012	0.017	0.008
Solitary Coral (SC)	0.00	0.00	0.00	0.03	0.00	0.006	0.013	0.006
ARTHROPODA (ART)	0.127	0	0	0	0	0.025	0.057	0.025
CHORDATA (CHO)	0	0	0.027	0.030	0	0.011	0.016	0.007
CNIDARIA NON SCLERACTINIA (CNI)	0.668	0.447	0.327	0.207	0.536	0.437	0.179	0.080
ECHINODERMATA (ECH)	0.159	0.112	1.391	0.474	0.875	0.602	0.536	0.240
ECHIURA (ECR)	0	0.028	0.055	0	0.028	0.022	0.023	0.010
PORIFERA (POR)	0.796	0.279	0.218	0.444	0.649	0.477	0.244	0.109
UNIDENTIFIED ORGANISM (UND)	0.032	0	0	0	0.056	0.018	0.026	0.011
SOFT BOTTOM SUBSTRATE (SB)	67.187	52.108	88.707	86.264	72.340	73.321	14.940	6.681
HARD BOTTOM SUBSTRATE (HB)	30.968	46.858	9.056	12.256	24.922	24.812	15.247	6.819
CABLE (CB)	0.032	0.168	0.164	0.266	0.480	0.222	0.167	0.074
HUMAN DEBRIS (HUM)	0	0	0.055	0	0.113	0.033	0.050	0.022
TAPE, WAND, SHADOW, PHOTO EFFECT (TWS)	1.782	0.500	3.526	3.486	2.905	2.440	1.293	0.578
Sum (excluding tape+shadow+wand)	100	100	100	100	100			

Variations among living organism densities and composition were too small to contribute to differences between Cable and Non-Cable station groups. The MDS plot revealed no significant effect of cable on percent substrate cover (Figure 4-41).

Organism densities ranged from 2.13 m^{-2} at station 4 to 6.96 m^{-2} at station 1. The identified taxa that contributed the most to faunal density were *Eunicella* sp. (mean 0.73 m^{-2} and 14%) and *P. nigra* (mean 0.56 m^{-2} and 12%) (Table 4-31, Figure 4-42), the same two as at the Non-Cable Outer Terrace Platform Low-Slope photostations. Both were substantially more common at stations 1 and 2 than at the remaining stations. By contrast, unidentified Porifera accounted for almost half of organism density at station 5 (Figure 4-42A). Mean density was lower at Non-Cable (3.67 m^{-2}) than Cable photostations (4.67 m^{-2}), although individual photostation densities overlapped widely: 1.67-9.44 m^{-2} at Non-Cable stations and 2.13-6.96 m^{-2} at Cable stations (Table 4-31). The primary overall faunal density difference between Non-Cable and Cable photostations was the substantially greater density of sponges (recorded as Unidentified Demospongiae and Unidentified Hexactinellida) at Cable photostations and the somewhat greater contribution to mean densities by *Eunicella* sp. and *Pseudodrifa nigra* at Non-Cable photostations (Figure 4-42B).

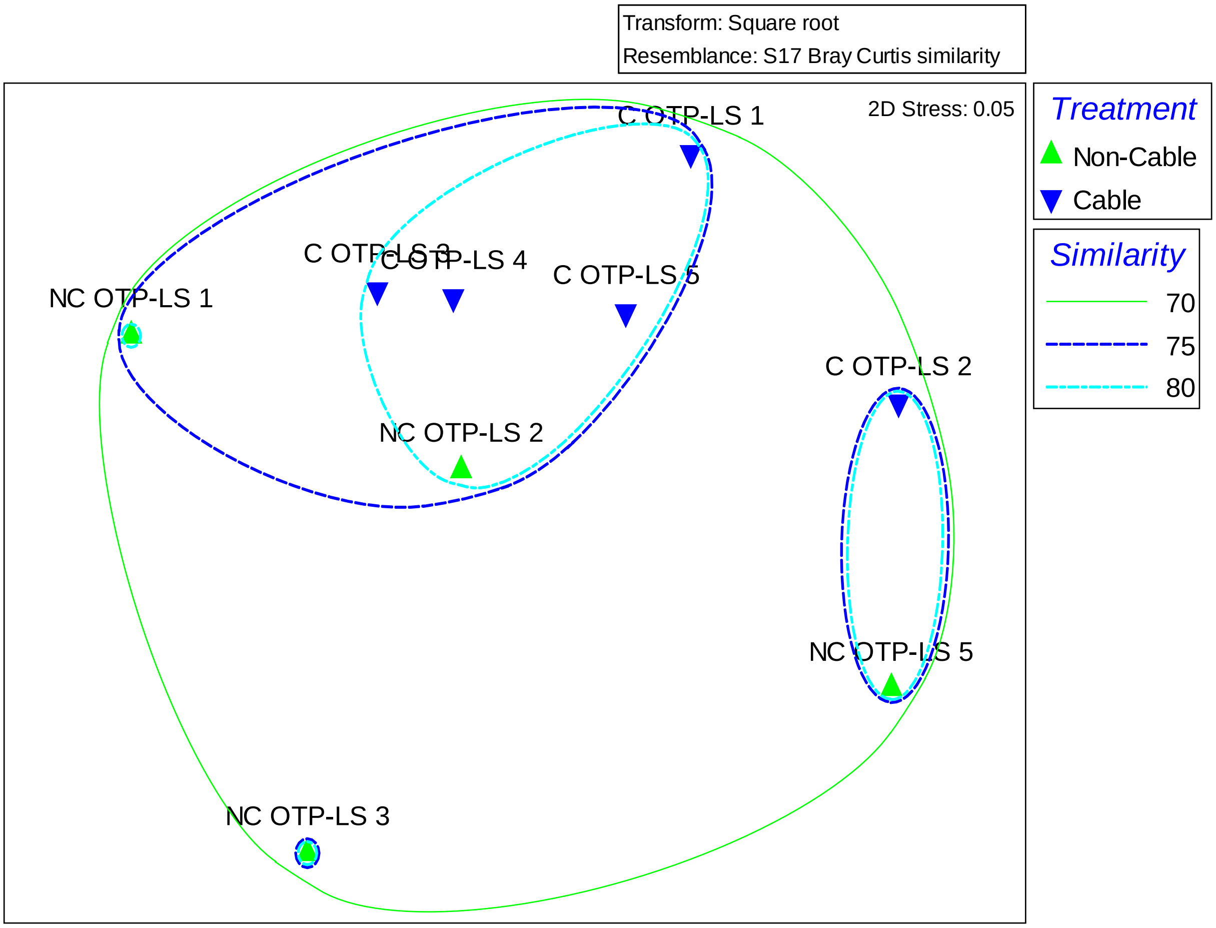

Figure 4-41. MDS plot of percent cover data for all Outer Terrace Platform Low-Slope Hardbottom habitat photostations. Stations are coded by Cable and Non-Cable. Station NC OTP-LS 4 was removed from analysis as an outlier [as noted above, likely due to its high percentage of hard substrate (86%) and coral rubble (9%) relative to the other stations in this habitat (0% coral rubble and no more than 37.4% hard substrate]. Circles indicate percent similarity from the cluster analysis.

An ANOSIM showed no significant differences between Cable and Non-Cable station groups. Their distribution appears to be mostly geographic: NC OTP LS stations 1, 2 and 5 all lie on the western side, whereas C OTP LS stations 3, 4 and 5, and NC OTP LS 3 are all in close proximity along a similar longitude. NC OTP LS 4 is again an outlier, grouping at a distance with C OTP LS stations 1 and 2 (Figure 4-43).

Table 4-31. Density data for all Non-Cable and Cable Outer Terrace Platform Low-Slope Hardbottom habitat photostations.

	Non-Cable Outer Terrace Platform Low-Slope									Cable Outer Terrace Platform Low-Slope								
	1	2	3	4	5	TOT	MEAN	STD.DEV.	STD.ERR.	1	2	3	4	5	TOT	MEAN	STD.DEV.	STD.ERR.
PORIFERA																		
DEMOSPONGIAE																		
Astrophorida					0.008	0.008	0.002											
Demospongiae unident.		0.124	0.017		0.053	0.194	0.039	0.052	0.028	0.944	0.848	0.559	0.397	0.088	2.835	0.567	0.346	0.245
Desmacellidae	0.076		0.035	0.241	0.038	0.390	0.078	0.095	0.055	0.256	0.245			0.058	0.560	0.112	0.129	0.091
Geodiidae		0.017		0.010		0.027	0.005	0.008	0.004									
Lithistida 1		0.008				0.008	0.002											
Pachastrellidae	0.019	0.008	0.069	0.060		0.157	0.031	0.031	0.022	0.020		0.027	0.125	0.175	0.347	0.069	0.077	0.054
Phakellia sp.	0.019	0.166	0.225	0.020	0.015	0.445	0.089	0.099	0.063	0.236	0.089	0.080	0.146	0.146	0.697	0.139	0.062	0.044
Raspailiidae				0.473		0.473	0.095				0.022	0.027	0.042	0.029	0.120	0.024	0.015	0.011
HEXACTINELLIDA																		
Aphrocallistes beatrix	0.171		0.017			0.188	0.038	0.075	0.027									
Euritidae/Farreidae	0.076	0.017	0.121	0.020	0.008	0.241	0.048	0.049	0.034	0.315	0.089	0.080	0.042	0.058	0.584	0.117	0.112	0.079
Hexactinellida unident.	0.076	0.050	0.035	0.010	0.181	0.351	0.070	0.066	0.050	0.629	0.312	0.692	0.376	0.643	2.652	0.530	0.173	0.122
Porifera unident.	0.114		1.159	0.594		1.867	0.373	0.503	0.264	0.020				2.104	2.124	0.425	0.939	0.664
CNIDARIA																		
HEXACORALLIA																		
?Actinauge sp.					0.030	0.030	0.006											
Actiniaria 2											0.022				0.022	0.004		
Actiniaria unident.	0.437	0.008		0.181	0.113	0.739	0.148	0.178	0.105	0.413	0.134	0.027	0.042		0.615	0.123	0.170	0.120
Actinoscyphia sp.				0.080	0.008	0.088	0.018	0.035	0.012	0.216	0.022				0.239	0.048	0.095	0.067
Antipatharia unident.				0.010		0.010	0.002			0.039				0.029	0.069	0.014	0.019	0.014
Corallimorphidae		0.008		0.010		0.018	0.004	0.005	0.003	0.059					0.059	0.012		
Liponema sp.	0.209	0.332	0.052	0.161	0.475	1.228	0.246	0.163	0.174	0.059	0.089	0.399	0.146		0.693	0.139	0.155	0.109
Lophelia pertusa				0.141		0.141	0.028											
Madrepora sp.			0.017			0.017	0.003											
Sagartiidae				0.050	0.030	0.080	0.016	0.023	0.011	0.020	0.045				0.064	0.013	0.020	0.014
Zoanthidea	0.646	0.017			0.008	0.670	0.134	0.286	0.095	0.079					0.079	0.016		
OCTOCORALLIA																		
Anthomastus sp.		0.017				0.017	0.003					0.027			0.027	0.005		
Eunicella sp.	0.114	0.041	0.294	2.827	0.354	3.631	0.726	1.181	0.513	1.317	0.848	0.266	0.251	0.351	3.032	0.606	0.467	0.330
Isididae			0.017	0.010	0.008	0.035	0.007	0.007	0.005		0.045			0.117	0.162	0.032	0.051	0.036
Octocorallia unident.		0.008				0.008	0.002											
Pennatulacea	0.057	0.041			0.023	0.121	0.024	0.025	0.017									
Primnoidae											0.179				0.179	0.036		
Pseudodrifa nigra	0.057	0.232		2.103	0.384	2.776	0.555	0.878	0.393	1.081	1.004	0.213	0.251	0.175	2.724	0.545	0.456	0.323
STYLASTERIDAE	0.152	0.373	0.035	0.151	0.279	0.990	0.198	0.131	0.140	0.511	1.272	0.027	0.063	0.292	2.165	0.433	0.508	0.359

Table 4-31, continued. Density data for all Non-Cable and Cable Outer Terrace Platform Low-Slope Hardbottom habitat photostations.

	Non-Cable Outer Terrace Platform Low-Slope									Cable Outer Terrace Platform Low-Slope								
	1	2	3	4	5	TOT	MEAN	STD.DEV.	STD.ERR.	1	2	3	4	5	TOT	MEAN	STD.DEV.	STD.ERR.
ANNELIDA														0.029	0.029	0.006		
ECHIURA			0.069		0.023	0.092	0.018	0.030	0.013	0.098	0.112	0.053	0.042		0.305	0.061	0.045	0.032
MOLLUSCA		0.025	0.017	0.020		0.062	0.012	0.012	0.009	0.020			0.021		0.041	0.008	0.011	0.008
BRACHIOPODA				0.010		0.010	0.002			0.039		0.027		0.029	0.095	0.019	0.018	0.013
BRYOZOA													0.042		0.042	0.008		
ARTHROPODA	0.019	0.025	0.069	0.141	0.128	0.382	0.076	0.057	0.054	0.020	0.045		0.021	0.029	0.114	0.023	0.016	0.011
ECHINODERMATA																		
ASTEROIDEA																		
Asteroidea unident.	0.038		0.035	0.101	0.015	0.188	0.038	0.038	0.027	0.059	0.022		0.042		0.123	0.025	0.026	0.018
Goniasteridae		0.025				0.025	0.005							0.029	0.029	0.006		
Sclerasterias sp.		0.008				0.008	0.002											
ECHINOIDEA																		
Cidaridae	0.114	0.066	0.121	1.368	0.030	1.700	0.340	0.576	0.240	0.138	0.223	0.053	0.021	0.321	0.756	0.151	0.123	0.087
Gracilechinus sp.	0.019	0.008		0.020	0.008	0.055	0.011	0.008	0.008	0.059	0.045				0.104	0.021	0.029	0.020
CRINOIDEA																		
Comatulida	0.019	0.017		0.513	0.143	0.692	0.138	0.217	0.098	0.177	0.022		0.021	0.058	0.279	0.056	0.071	0.050
OPHIUROIDEA																		
Euryalidae		0.008		0.070		0.079	0.016	0.031	0.011		0.022				0.022	0.004		
HOLOTHUROIDEA																		
Psolidae				0.010		0.010	0.002			0.039	0.067		0.021		0.127	0.025	0.028	0.020
UNKNOWN ANIMAL	0.019	0.017	0.035	0.030		0.100	0.020	0.014	0.014	0.098	0.022	0.027	0.021	0.058	0.227	0.045	0.033	0.024
TOTAL	2.450	1.667	2.439	9.437	2.359	18.352	3.670	3.240	2.595	6.960	5.847	2.580	2.129	4.822	22.338	4.468	2.078	1.469

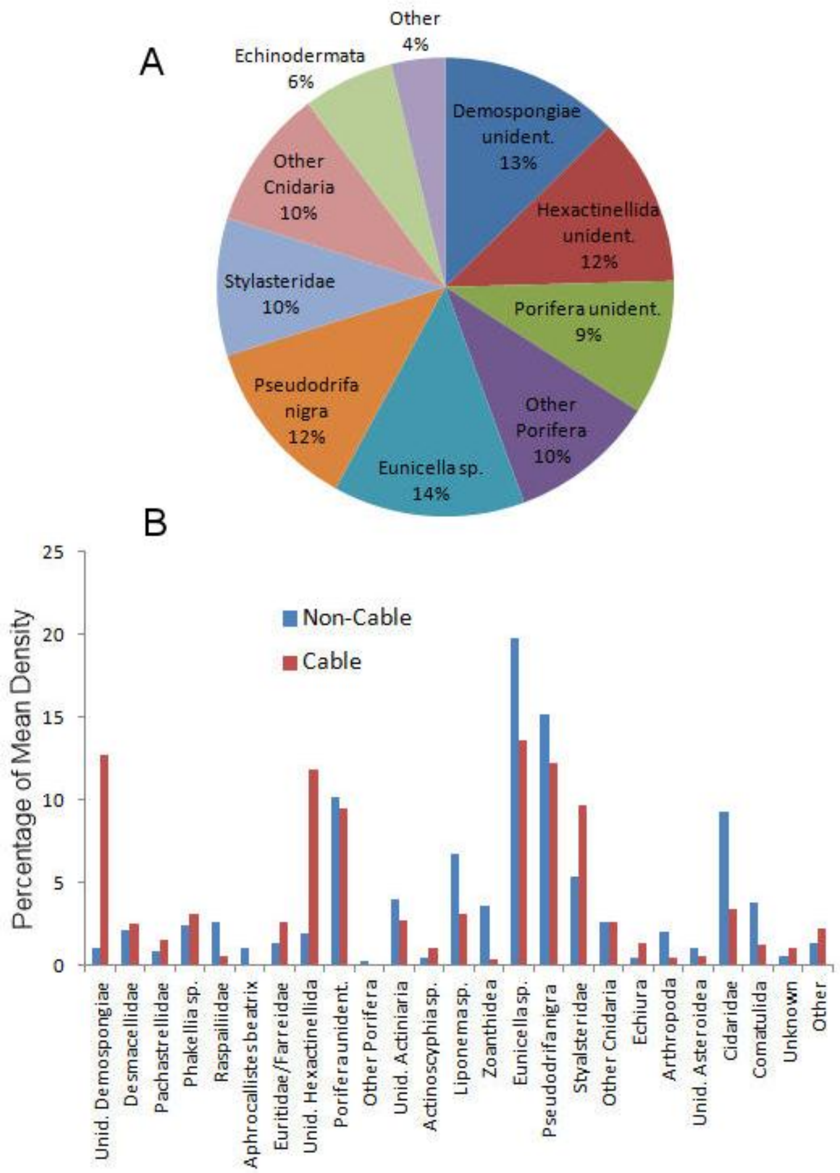

Figure 4-42. A. Macrofaunal organism densities (in m^{-2}) at the five Cable Outer Terrace Platform Low-Slope photostations expressed as percentages of the total of mean organism densities. Other Porifera includes identified demosponge and hexactinellid taxa, each of which occurs at <1 m^{-2}. B. Comparison of percentage contributions to organism densities at Cable vs. Non-Cable OTP L-S photostations. Data summarized from Table 4-31.

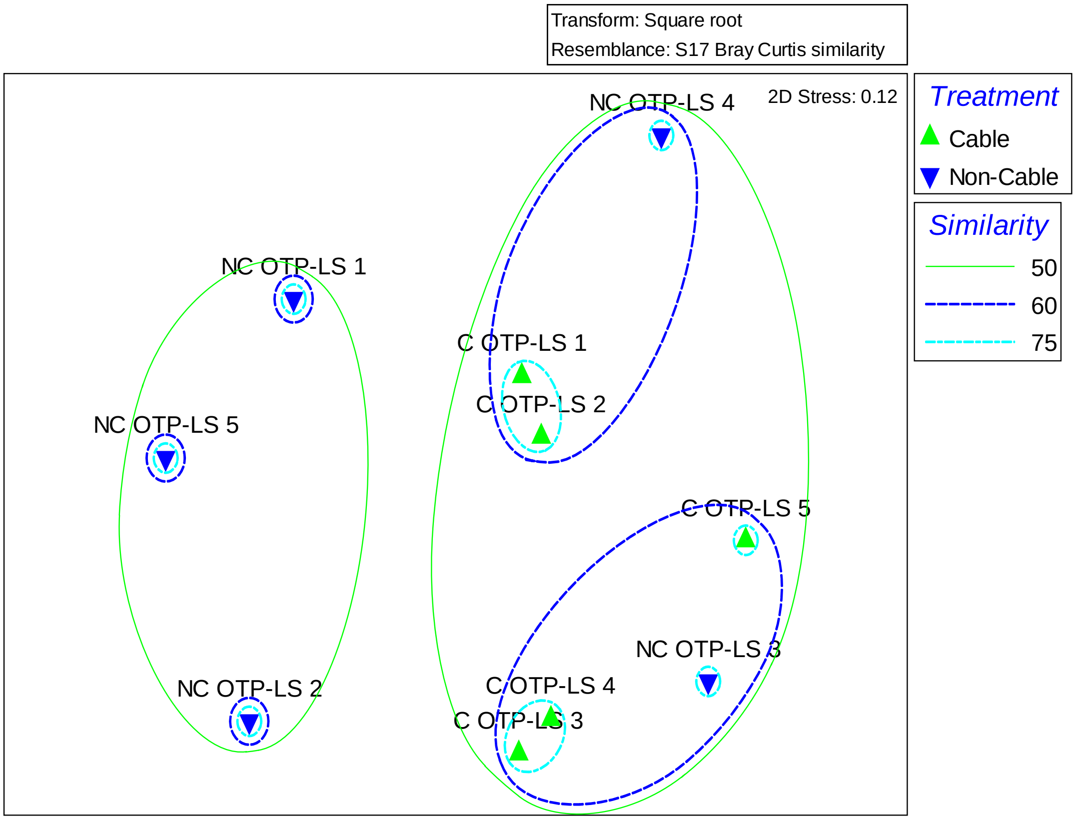

Figure 4-43. MDS plot of density data for all Outer Terrace Platform Low Slope Hardbottom habitat photostations. Stations are coded by Cable and Non-Cable. Station NC OTP-LS 4 was not removed from analysis as an outlier. Circles indicate percent similarity from the cluster analysis.

Outer Terrace Platform - High Slope Hardbottom (Tables 4-32 – 4-33; Figures 4-44 – 4-46)
Percent cover of hard substrates varied widely, ranging from 3.1% at C OTP HS 1 to 76.5% at C OTP HS 2. Cover by living organisms ranged from 0.843 (station 4) to 3.567% (station 3). Sponges accounted for most of living cover at stations 2 and 3, whereas echinoderms accounted for most at station 1. C OTP LS 3 also recorded a total deep-sea coral habitat cover of 0.43% including 0.028% living coral (*Lophelia pertusa*).

Again, the MDS plot of relative cover reflected percentages of hard versus soft substrates; living organism cover was too low to contribute significantly to any distinctions, and there were no significant differences based on Cable versus Non-Cable stations. The 95.3% sediment cover at station C OTP HS 1 generated its outlying position in the MDS plot in Figure 4-44.

Table 4-32. Percent cover data for all Cable Outer Terrace Platform High Slope Hardbottom habitat photostations.

Cable - Outer Terrace Platform - High Slope	C OTP-HS 1	C OTP-HS 2	C OTP-HS 3	C OTP-HS 4	MEAN	Std. Dev.	Std. Err.
CORAL (COR)	0.000	0.000	0.425	0.000	0.106	0.212	0.106
Colonial Dead Coral (DC)	0.000	0.000	0.227	0.000	0.057	0.113	0.057
Coral Rubble (CR)	0.000	0.000	0.170	0.000	0.042	0.085	0.042
Lophelia (LOP)	0.000	0.000	0.028	0.000	0.007	0.014	0.007
ARTHROPODA (ART)	0.000	0.000	0.057	0.158	0.054	0.074	0.037
CHORDATA (CHO)	0.000	0.032	0.000	0.000	0.008	0.016	0.008
CNIDARIA NON SCLERACTINIA (CNI)	0.169	0.223	0.821	0.316	0.382	0.299	0.149
ECHINODERMATA (ECH)	1.124	0.128	0.396	0.000	0.412	0.503	0.251
ECHIURA (ECR)	0.000	0.000	0.028	0.000	0.007	0.014	0.007
MOLLUSCA (MOL)	0.000	0.000	0.142	0.000	0.035	0.071	0.035
PORIFERA (POR)	0.000	1.563	2.067	0.316	0.987	0.987	0.494
UNIDENTIFIED ORGANISM (UND)	0.000	0.032	0.028	0.053	0.028	0.022	0.011
SOFT BOTTOM SUBSTRATE (SB)	95.278	20.772	48.343	32.859	49.313	32.655	16.327
HARD BOTTOM SUBSTRATE (HB)	3.092	76.452	47.352	66.140	48.259	32.432	16.216
CABLE (CB)	0.112	0.734	0.113	0.158	0.279	0.304	0.152
HUMAN DEBRIS (HUM)	0.056	0.064	0.028	0.000	0.037	0.029	0.015
NATURAL DETRITUS (DET)	0.169	0.000	0.198	0.000	0.092	0.107	0.053
TAPE, WAND, SHADOW, PHOTO EFFECT (TWS)	1.167	0.508	0.535	0.053	0.566	0.458	0.229
Sum (excluding tape+shadow+wand)	100	100	100	100			

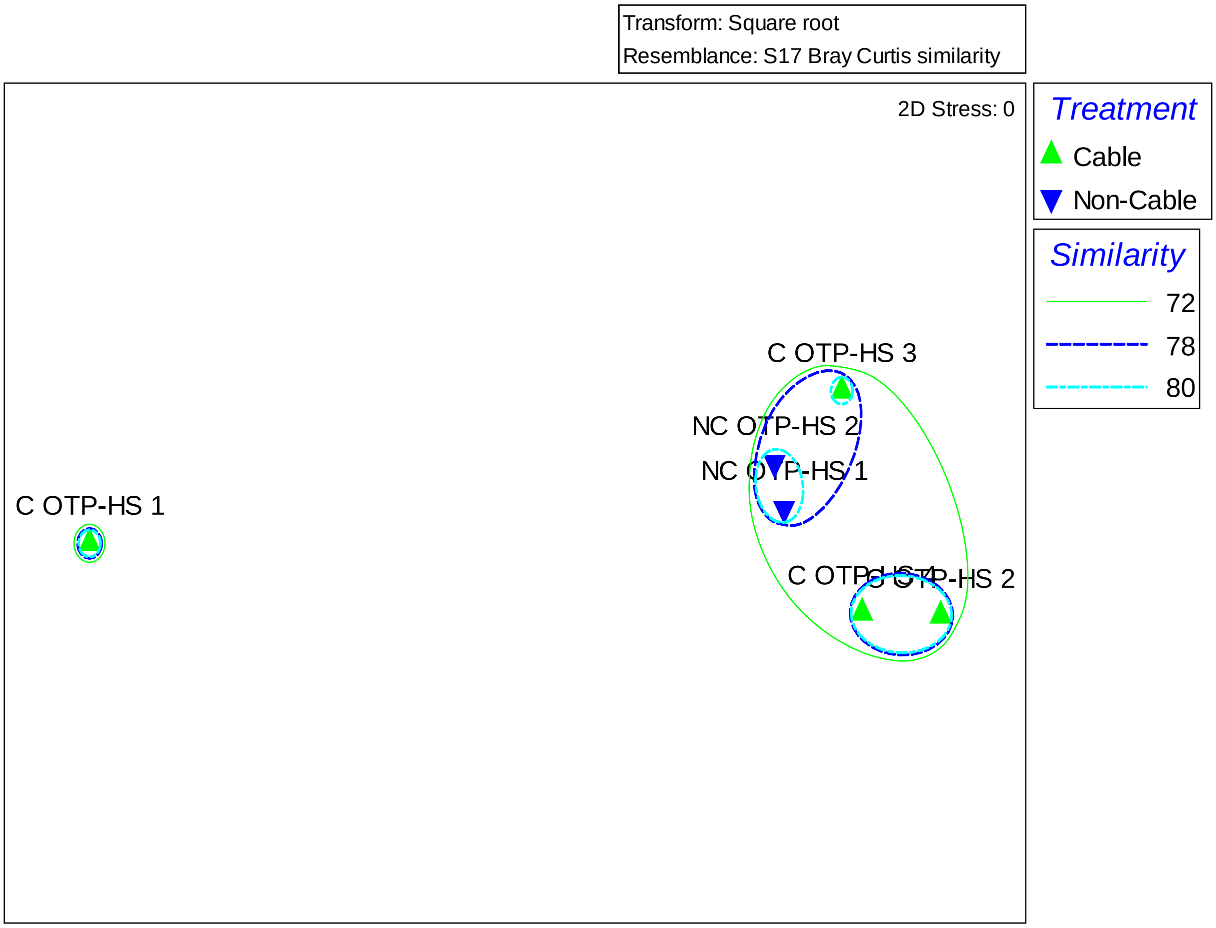

Figure 4-44. MDS plot of percent cover data for all Outer Terrace Platform High Slope Hardbottom habitat photostations. Stations are coded by Cable and Non-Cable. Circles indicate percent similarity from the cluster analysis.

Organism densities ranged widely across the four stations, from 1.87 to 9.51 organisms m^{-2} (Table 4-33). Mean and maximum densities were substantially greater at the Cable photostations, perhaps at least in part because there were twice as many; both Non-Cable and Cable recorded one station each with similarly low densities (1.32 m^{-2} at NC OTP H-S 1 and 1.87 m^{-2} at C OTP H-S 1). The blue encrusting sponge in the family Desmacellidae was the most abundant taxon at the Cable photostations, accounting for 21% of organism density (mean 1.42 m^{-2}), much more than at the Non-Cable photostations (Figure 4-45). All other sponges together accounted for 27% of organism density, similar to the 30% accounted for by all sponges at the Non-Cable photostations. Again, sponge groups varied between Non-Cable and Cable stations as a result of the difficulty in identifying taxa from photographs (or video) in this group, i.e., chiefly unidentified demosponges and hexactinellids at Non-Cable versus *Phakellia* sp. and unidentified Porifera at Cable photostations (Figure 4-45B) *Pseudodrifa nigra* (mean 0.87 m^{-2} and 13%) accounted for the next greatest contribution to mean density, similar to that at the Non-Cable OTP High-Slope stations. The greater density of primnoid octocorals at NC OTP H-S 2 (0.46 m^{-2}) may have resulted from local exposure to stronger or more consistent near benthic flow.

Table 4-33. Density data for all Cable Outer Terrace Platform High-Slope Hardbottom habitat photostations.

	Non-Cable Outer Terrace Platform High-Slope						Cable Outer Terrace Platform High-Slope							
	1	2	TOT	MEAN	STD.DEV.	STD.ERR.	1	2	3	4	TOT	MEAN	STD.DEV.	STD.ERR.
PORIFERA														
DEMOSPONGIAE														
Demospongiae unident.	0.333	0.352	0.685	0.342	0.013	0.009	0.818	0.101	0.675	0.014	1.607	0.402	0.403	0.285
Desmacellidae	0.121	0.054	0.175	0.088	0.047	0.033		2.242	2.513	0.941	5.695	1.424	1.171	0.828
Geodiidae	0.015	0.014	0.029	0.014	0.001	0.001		0.020		0.014	0.034	0.009	0.010	0.007
Lithistida 1									0.017	0.014	0.031	0.008	0.009	0.006
Pachastrellidae	0.015	0.054	0.069	0.035	0.028	0.019		0.040	0.202	0.041	0.284	0.071	0.090	0.063
Phakellia sp.		0.041	0.041	0.020			0.196	1.333	0.253	0.028	1.810	0.452	0.595	0.421
Raspailiidae		0.095	0.095	0.047				0.384	0.219	0.055	0.658	0.165	0.173	0.123
HEXACTINELLIDA														
Euritidae/Farreidae		0.041	0.041	0.020				0.020	0.067	0.083	0.171	0.043	0.039	0.028
Hexactinellida unident.		0.271	0.271	0.135			0.098				0.098	0.025		
Porifera Unident.	0.015		0.015	0.008			0.164	0.646	0.354	1.328	2.492	0.623	0.510	0.361
CNIDARIA														
HEXACORALLIA														
Actiniaria 2								0.020			0.020	0.005		
Actiniaria unident.	0.106	0.027	0.133	0.066	0.056	0.039		0.061	0.202	0.097	0.360	0.090	0.085	0.060
Actinoscyphia sp.	0.015	0.014	0.029	0.014	0.001	0.001		0.202	0.556	0.221	0.980	0.245	0.231	0.163
Antipatharia	0.030		0.030	0.015				0.020		0.014	0.034	0.009	0.010	0.007
Cerianthidae										0.028	0.028	0.007		
Corallimorphidae		0.027	0.027	0.014						0.055	0.055	0.014		
Liponema sp.		0.162	0.162	0.081				0.081	0.034	0.055	0.170	0.042	0.034	0.024
Lophelia pertusa		0.014	0.014	0.007										
Sagartiidae		0.014	0.014	0.007					0.067	0.249	0.316	0.079	0.118	0.083
Zoanthidea								0.040	0.084		0.125	0.031	0.040	0.028
OCTOCORALLIA														
Eunicella sp.	0.015	0.135	0.150	0.075	0.085	0.060	0.229		0.455	0.775	1.459	0.365	0.330	0.234
Octocorallia unident.	0.045		0.045	0.023										
Pennatulacea									0.017		0.017	0.004		
Primnoidae		0.460	0.460	0.230						0.055	0.055	0.014		
Pseudodrifa nigra	0.030	0.717	0.747	0.374	0.486	0.343	0.065	1.030	0.658	1.729	3.482	0.871	0.697	0.493
STYLASTERIDAE	0.151	0.893	1.044	0.522	0.524	0.371		0.040	1.450	0.705	2.196	0.549	0.682	0.482
ANNELIDA										0.290	0.290	0.073		
ECHIURA							0.033	0.020		0.014	0.067	0.017	0.014	0.010
MOLLUSCA	0.015	0.041	0.056	0.028	0.018	0.013		0.020			0.020	0.005		
BRACHIOPODA										0.014	0.014	0.003		
ARTHROPODA	0.015	0.014	0.029	0.014	0.001	0.001	0.033		0.185	0.124	0.343	0.086	0.085	0.060
ECHINODERMATA														
ASTEROIDEA														
Asteroidea unident.	0.045	0.027	0.072	0.036	0.013	0.009	0.033	0.121	0.017	0.041	0.212	0.053	0.047	0.033
Coronaster briareus										0.014	0.014	0.003		
Goniasteridae										0.014	0.014	0.003		
Novodinia sp.	0.015		0.015	0.008										
ECHINOIDEA														
Araeosoma sp.									0.017		0.017	0.004		
Cidaridae	0.030	0.149	0.179	0.090	0.084	0.059	0.033	1.111	0.438	0.249	1.831	0.458	0.466	0.329
Coelopleurus floridanus		0.014	0.014	0.007										
Gracilechinus sp.								0.020			0.020	0.005		
CRINOIDEA														
Comatulida	0.272	0.027	0.299	0.150	0.173	0.123		0.020	0.860	0.235	1.115	0.279	0.402	0.284
OPHIUROIDEA														
Euryalidae								0.020	0.067	0.014	0.101	0.025	0.029	0.021
Gorgonocephalidae										0.014	0.014	0.003		
HOLOTHUROIDEA														
Psolidae	0.015		0.015	0.008			0.033		0.051	0.028	0.111	0.028	0.021	0.015
UNKNOWN ANIMAL	0.015	0.027	0.042	0.021	0.008	0.006	0.131	0.202	0.051	0.083	0.466	0.117	0.066	0.047
TOTAL	1.316	3.680	4.996	2.498	1.672	1.182	1.865	7.816	9.511	7.635	26.826	6.707	3.337	2.359

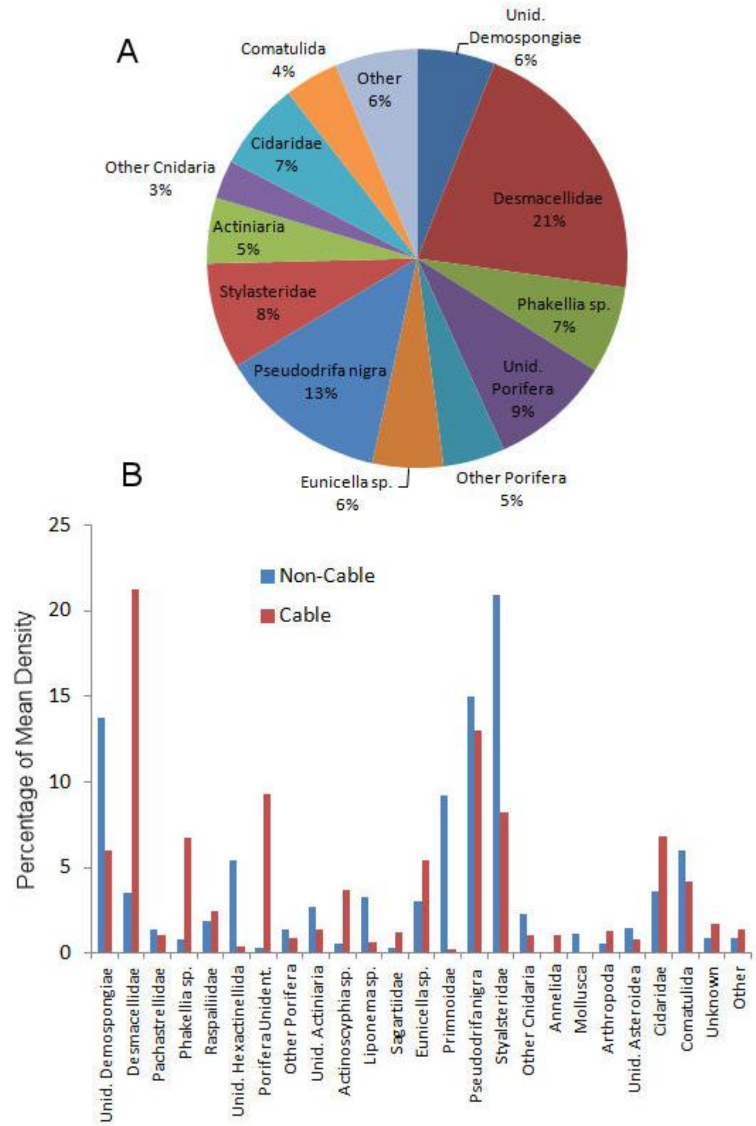

Figure 4-45. A. Macrofaunal organism densities (in m^{-2}) at the four Cable Outer Terrace Platform High-Slope photostations expressed as percentages of mean benthic organism abundance. Other Porifera includes identified demosponges and hexactinellids, each of which occurs at <1 m^{-2}. B. Comparison of percentage contributions to organism densities at Cable vs. Non-Cable OTP H-S photostations. Data summarized from Table 4-33.

The MDS plot of density data showed no significant difference attributable to the presence versus absence of cable (Figure 4-46). Station distributions appeared to be chiefly geographic; the three cable stations C OTP HS 2, 3 and 4 all grouped closely together but also with NC OTP HS 2 at >50% similarity. The two outlying stations in the plot, C OTP HS 1 and NC OTP HS 1, both recorded far lower organism densities than at any of the other stations in this habitat, both Cable and Non-Cable.

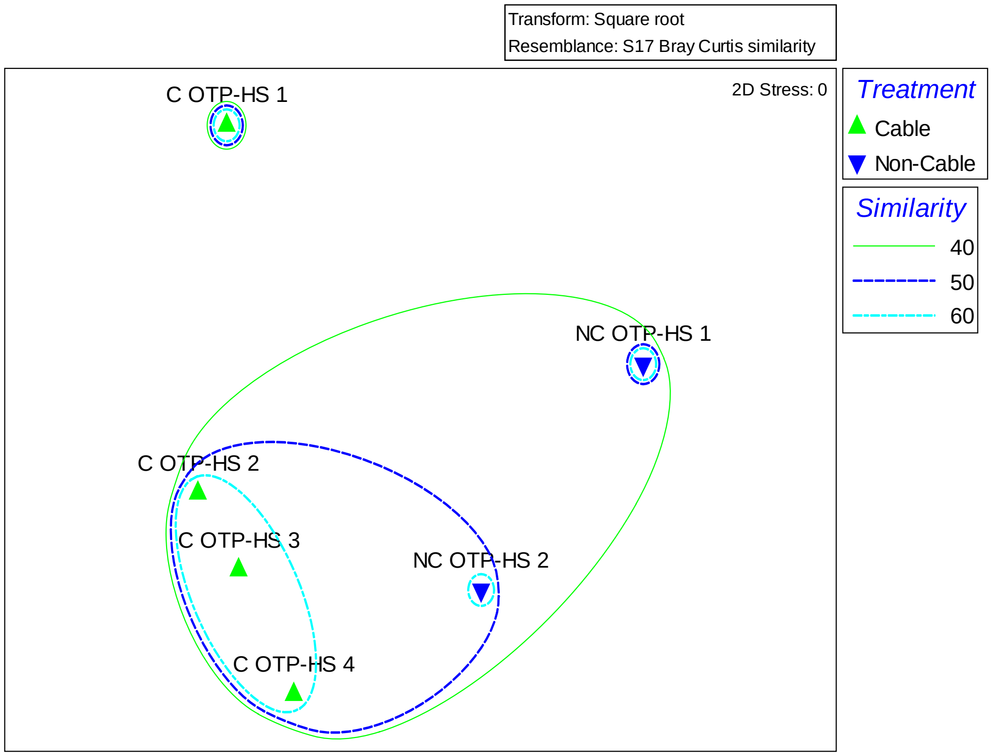

Figure 4-46. MDS plot of density data for all Outer Terrace Platform High Slope Hardbottom habitat photostations. Stations are coded by Cable and Non-Cable. Circles indicate percent similarity from the cluster analysis.

Outer Terrace Ridge - Low Slope Hardbottom (Table 4-34 – 4-35; Figure 4-47)

Percent cover at the single cable station in this habitat was roughly split between hard and soft substrates, with 1.6% deep-sea coral habitat (chiefly coral rubble) and living organisms contributing 1.39% (Table 4-34).

Table 4-34. Percent cover data for all Cable Outer Terrace Ridge Low Slope Hardbottom habitat photostations.

Cable - Outer Terrace Ridge - Low Slope	**C OTR-LS 1**
CORAL (COR)	1.602
Colonial Dead Coral (DC)	0.092
Coral Rubble (CR)	1.510
CNIDARIA NON SCLERACTINIA (CNI)	0.370
ECHINODERMATA (ECH)	0.247
PORIFERA (POR)	0.770
SOFT BOTTOM SUBSTRATE (SB)	41.726
HARD BOTTOM SUBSTRATE (HB)	55.193
CABLE (CB)	0.062
HUMAN DEBRIS (HUM)	0.031
TAPE, WAND, SHADOW, PHOTO EFFECT (TWS)	4.531
Sum (excluding tape+shadow+wand)	100

Both densities and major faunal components were similar at Non-Cable (mean 7.44 m^{-2}) and Cable (5.11 m^{-2}) photostations (Table 4-35). Sponges dominated at both, but with most recorded as Unidentified Porifera at NC stations and as Unidentified Demospongiae at the Cable photostation. The next most abundant taxa, *Eunicella* sp. and Stylasteridae, accounted for similar proportions of density at both sets of stations (Figure 4-47B).

Table 4-35. Density data for all Outer Terrace Ridge Low Slope Hardbottom habitat photostation. C OTR L-S refers to the single Cable Outer Terrace Ridge Low-Slope photostation.

	Non-Cable Outer Terrace Ridge Low-Slope						C OTR L-S
NC OTR LS	1	2	TOT	MEAN	STD.DEV.	STD.ERR.	1
PORIFERA							
DEMOSPONGIAE							
Astrophorida	0.012	0.126	0.138	0.069	0.080	0.057	
Demospongiae unident.	0.143	0.597	0.740	0.370	0.321	0.227	0.901
Desmacellidae	0.059	0.024	0.083	0.042	0.025	0.018	0.171
Geodiidae		0.016	0.016	0.008			
Lithistida 1	0.309	0.063	0.372	0.186	0.174	0.123	0.140
Lithistida 2	0.024	0.094	0.118	0.059	0.050	0.035	
Pachastrellidae	0.143	0.047	0.190	0.095	0.068	0.048	0.047
Phakellia sp.	0.036	0.346	0.381	0.191	0.219	0.155	0.047
Raspailiidae	0.238	0.157	0.395	0.197	0.057	0.040	0.016
Spongosorites sp.	0.095	0.016	0.111	0.055	0.056	0.040	0.062
HEXACTINELLIDA							
Aphrocallistes beatrix	0.012		0.012	0.006			
Euritidae/Farreidae	0.202	0.024	0.226	0.113	0.126	0.089	
Hexactinellida unident.	0.059	0.471	0.531	0.265	0.291	0.206	0.264
Hyalonema sp.		0.008	0.008	0.004			
Vazella sp.		0.008	0.008	0.004			
Porifera unident.	2.248		2.248	1.124			0.171
CNIDARIA							
HEXACORALLIA							
Actiniaria unident.	0.048	0.228	0.275	0.138	0.127	0.090	0.140
Actinoscyphia sp.							0.078
Corallimorphidae	0.012		0.012	0.006			0.016
Liponema sp.	0.095	0.079	0.174	0.087	0.012	0.008	0.016
Lophelia pertusa							0.016
Zoanthidea		0.024	0.024	0.012			
OCTOCORALLIA							
Eunicella sp.	2.866	0.118	2.984	1.492	1.944	1.374	1.040
Isididae		0.094	0.094	0.047			
Plexauridae		0.039	0.039	0.020			0.124
Primnoidae	0.095	0.267	0.362	0.181	0.122	0.086	0.202
Pseudodrifa nigra	0.071	0.016	0.087	0.044	0.039	0.028	0.031
STYLASTERIDAE	0.856	1.948	2.804	1.402	0.772	0.546	0.885
ANNELIDA	0.012		0.012	0.006			
ECHIURA	0.012		0.012	0.006			0.016
MOLLUSCA	0.012	0.016	0.028	0.014	0.003	0.002	
BRYOZOA	0.036	0.024	0.059	0.030	0.009	0.006	0.031
BRACHIOPODA	0.012		0.012	0.006			
ARTHROPODA	0.071	0.024	0.095	0.047	0.034	0.024	0.031
ECHINODERMATA							
ASTEROIDEA							
Asteroidea unident.	0.059	0.008	0.067	0.034	0.036	0.026	
Goniasteridae	0.012	0.008	0.020	0.010	0.003	0.002	
Linckia sp.		0.008	0.008	0.004			
ECHINOIDEA							
Cidaridae	0.393	0.385	0.777	0.389	0.005	0.004	0.311
Coelopleurus floridanus		0.016	0.016	0.008			
Echinoidea unident.							
Gracilechinus sp.							
CRINOIDEA							
Comatulida	1.070	0.149	1.220	0.610	0.651	0.461	0.311
OPHIUROIDEA							
Euryalidae		0.008	0.008	0.004			
Gorgonocephalidae							
HOLOTHUROIDEA							
Psolidae	0.024		0.024	0.012			
UROCHORDATA							0.047
UNKNOWN ANIMAL	0.059	0.024	0.083	0.042	0.025	0.018	
TOTAL	9.396	5.474	14.870	7.435	2.774	1.961	5.109

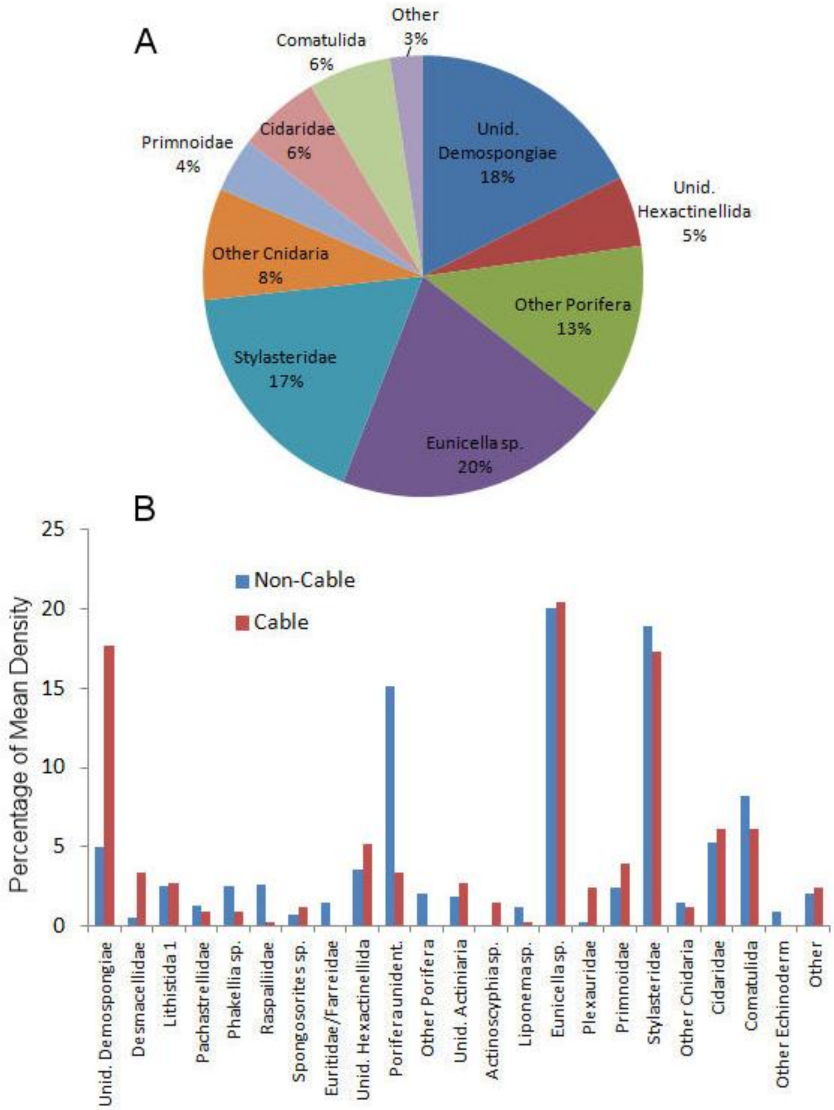

Figure 4-47. A. Macrofaunal organism densities (in m^{-2}) at the Cable Outer Terrace Ridge Low-Slope photostation expressed as percentages of benthic organism abundance. Other Porifera includes identified demosponges and unidentified Porifera, each of which occurs at <1 m^{-2}. B. Comparison of percentage contributions to organism densities at Cable vs. Non-Cable OTR L-S photostations. Percentage values for Non-Cable stations are based on mean densities of the two stations; there was only one Cable station. Data summarized from Table 4-37.

Outer Terrace Ridge - High Slope Hardbottom (Tables 4-36 – 4-37 ; Figures 4-48 – 4-50)

Percent cover of hard substrates varied considerably but remained greater than 50% at all five photostations: 58.7-91.8% (Table 4-36). Deep-sea coral habitat contributed 0.18 to 0.54% at four stations, but accounted for 9.87% at C OTR HS 5. Living *L. pertusa* accounted for all of the deep-sea coral at C OTR HS 4. Non-coral living organisms contributed at most 2.93% (at C OTR HS 4).

Table 4-36. Percent cover data for all Cable Outer Terrace Ridge High Slope Hardbottom habitat photostations.

Cable - Outer Terrace Ridge - High Slope	C OTR-HS 1	C OTR-HS 2	C OTR-HS 3	C OTR-HS 4	C OTR-HS 5	MEAN	Std.Dev.	Std.Err.
CORAL (COR)	0.184	0.041	0.236	0.544	9.874	2.176	4.307	1.926
Colonial Dead Coral (DC)	0.074	0	0.157	0	3.678	0.782	1.620	0.725
Coral Rubble (CR)	0	0	0	0	6.045	1.209	2.704	1.209
Lophelia (LOP)	0	0	0	0.544	0	0.109	0.243	0.109
Solitary Coral (SC)	0.110	0.041	0.079	0	0.151	0.076	0.059	0.026
CHORDATA (CHO)	0	0.041	0	0	0	0.008	0.019	0.008
CNIDARIA NON SCLERACTINIA (CNI)	0.037	0.083	0.394	1.306	0.453	0.454	0.510	0.228
ECHINODERMATA (ECH)	0.037	0.207	0.787	0.326	0.756	0.423	0.335	0.150
BRYZOA (BRY)	0	0	0.079	0	0	0.016	0.035	0.016
PORIFERA (POR)	0.258	0.703	1.181	1.306	0.605	0.810	0.431	0.193
UNIDENTIFIED ORGANISM (UND)	0	0	0	0	0.252	0.050	0.113	0.050
SOFT BOTTOM SUBSTRATE (SB)	7.548	17.377	19.606	37.758	22.015	20.861	10.929	4.888
HARD BOTTOM SUBSTRATE (HB)	91.826	81.547	77.638	58.651	66.045	75.141	13.042	5.832
CABLE (CB)	0.110	0	0.079	0.109	0	0.060	0.056	0.025
TAPE, WAND, SHADOW, PHOTO EFFECT (TWS)	3.000	1.307	2.308	8.100	3.171	3.577	2.633	1.177
Sum (excluding tape+shadow+wand)	100	100	100	100	100			

An MDS plot (Figure 4-48) of percent cover data for all OTR HS habitat photostations showed overlap of Cable and Non-Cable stations at the 70% similarity level, except outlying NC OTR HS 2. Living components again represented too small a contribution of percent cover to generate any significant difference between Cable and Non-Cable groups of stations. The presence versus absence of cable did not significantly affect substrate type.

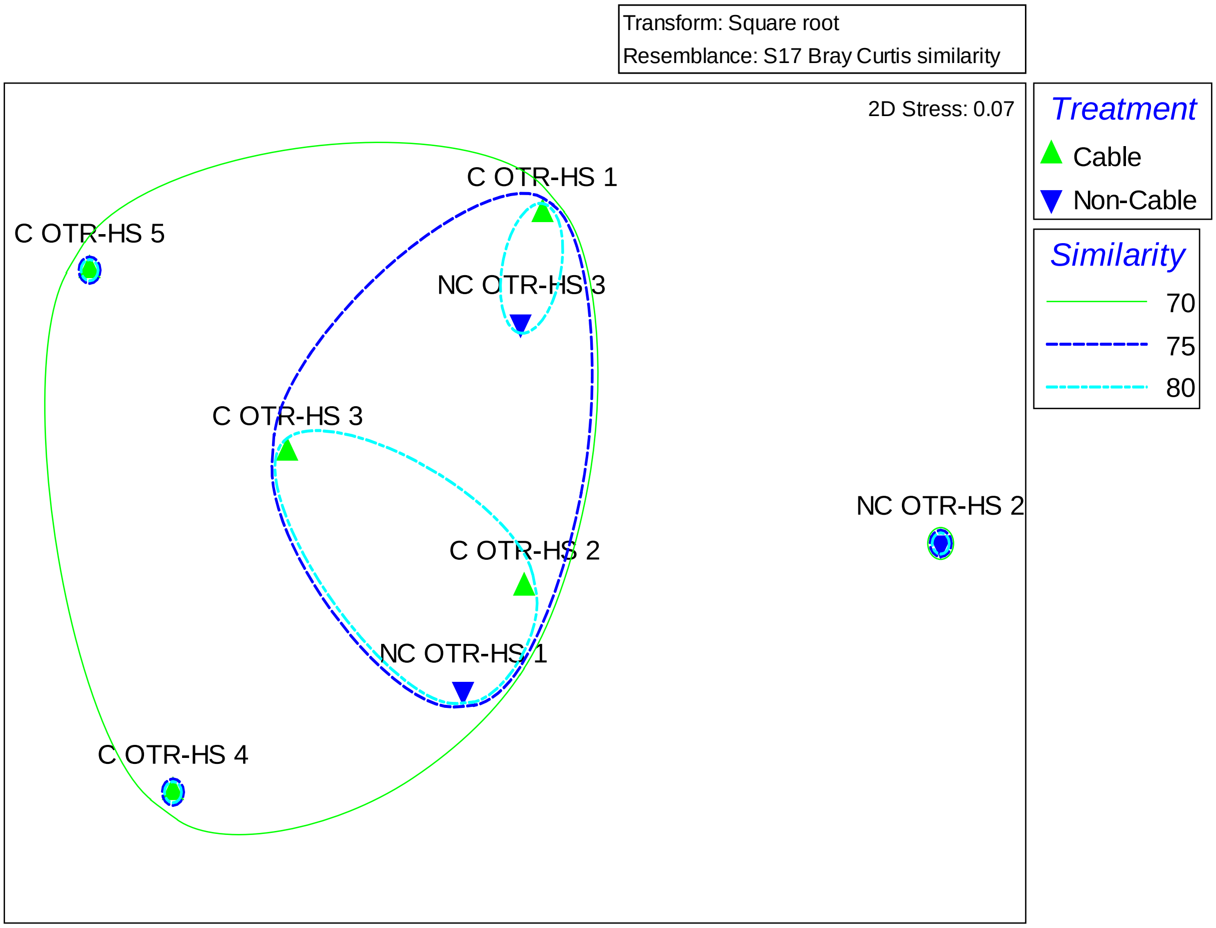

Figure 4-48. MDS plot of percent cover data for all Outer Terrace Ridge High Slope Hardbottom habitat photostations. Stations are coded by Cable and Non-Cable. Circles indicate percent similarity from the cluster analysis.

Organism densities varied substantially, increasing progressively westward upslope toward the ridge crest, from 1.40 m^{-2} at C OTR HS 1 to 9.26 m^{-2} at C OTR HS 5, a possible reflection of increasing exposure to near-bottom current (Table 4-37). All sponges combined accounted for 44% of total density (Figure 4-49A), substantially greater than the 27% at the Non-Cable OTR High-Slope stations, and chiefly recorded as Unidentified Porifera. *Eunicella* sp., Primnoidae and *P. nigra* were again important identified components as at the NC OTR HS stations. *Eunicella* sp. was again the greatest contributor to mean density (mean 2.27 m^{-2} and 13%), but not nearly as great a percentage as at the Non-Cable photostations (40%) (Figure 4-49B). As at the Non-Cable photostations, high densities of major identified contributors did not occur at all stations, e.g., *P. nigra* was only observed at C OTR HS 5.

Table 4-37. Density data for all Cable Outer Terrace Ridge High Slope Hardbottom habitat photostations.

	Non-Cable Outer Terrace Ridge High-Slope							Cable Outer Terrace Ridge High-Slope								
	1	2	3	TOT	MEAN	STD.DEV.	STD.ERR.	1	2	3	4	5	TOT	MEAN	STD.DEV.	STD.ERR.
PORIFERA																
DEMOSPONGIAE																
Astrophorida										0.063	0.068		0.131	0.026	0.036	0.025
Demospongiae unident.	0.754	0.532	0.534	1.820	0.607	0.127	0.090	0.548	1.635	1.200	1.627	0.271	5.281	1.056	0.624	0.441
Desmacellidae	0.017	0.099		0.116	0.039	0.053	0.038	0.010	0.036	0.032	0.316	0.109	0.502	0.100	0.126	0.089
Geodiidae	0.008			0.008	0.003							0.018	0.018	0.004		
Leiodermatium sp.			0.031	0.031	0.010											
Lithistida 1	0.215	0.054	0.016	0.285	0.095	0.106	0.075	0.020			0.226		0.246	0.049	0.099	0.070
Pachastrellidae	0.025	0.036	0.016	0.077	0.026	0.010	0.007	0.040	0.018	0.032	0.068	0.181	0.338	0.068	0.066	0.047
Phakellia sp.	0.099	0.180	0.110	0.390	0.130	0.044	0.031	0.259	0.320	0.379	0.023		0.980	0.196	0.174	0.123
Raspailiidae	0.240	0.694	0.031	0.966	0.322	0.339	0.240	0.040	0.551	0.442	0.090	0.090	1.214	0.243	0.236	0.167
Spongosorites sp.	0.008			0.008	0.003					0.032	0.045	0.036	0.113	0.023	0.021	0.015
HEXACTINELLIDA																
Aphrocallistes beatrix		0.009		0.009	0.003											
Euritidae/Farreidae	0.099	0.099		0.199	0.066	0.057	0.041					0.109	0.109	0.022		
Hexactinellida unident.	0.215	0.135	0.252	0.602	0.201	0.060	0.042		0.053	0.411	0.158		0.622	0.124	0.172	0.122
Vazella sp.	0.008		0.031	0.040	0.013	0.016	0.012	0.010	0.071		0.023		0.104	0.021	0.030	0.021
Porifera unident.									0.071	1.074	0.520	1.302	2.967	0.593	0.584	0.413
CNIDARIA																
HEXACORALLIA																
Actiniaria 2	0.008		0.031	0.040	0.013	0.016	0.012									
Actiniaria unident.	0.025	0.108		0.133	0.044	0.057	0.040	0.050	0.018		0.023	0.054	0.144	0.029	0.023	0.016
Bathypathes alternata	0.008		0.031	0.040	0.013	0.016	0.012									
Corallimorphidae	0.025	0.036	0.016	0.077	0.026	0.010	0.007					0.036	0.036	0.007		
Liponema sp.	0.083	0.207	0.016	0.306	0.102	0.097	0.069	0.010	0.142	0.063		0.018	0.233	0.047	0.059	0.041
Lophelia pertusa	0.008			0.008	0.003			0.010				0.018	0.028	0.006	0.008	0.006
Madrepora sp.			0.016	0.016	0.005											
Sagartiidae	0.008	0.009		0.017	0.006	0.005	0.004					0.072	0.072	0.014		
Zoanthidea										0.032			0.032	0.006		
OCTOCORALLIA																
Anthomastus sp.											0.023		0.023	0.005		
Eunicella sp.	2.153	4.606	0.047	6.806	2.269	2.282	1.613	0.010	0.160	0.884	1.356	2.188	4.598	0.920	0.895	0.633
Isididae		0.009	0.063	0.072	0.024	0.034	0.024	0.080	0.124	0.063	0.023		0.290	0.058	0.049	0.035
Octocorallia unident.	0.008	0.009	0.283	0.300	0.100	0.158	0.112		0.018		0.023		0.040	0.008	0.011	0.008
Pennatulacea	0.008			0.008	0.003											
Primnoidae	0.066		1.037	1.104	0.368	0.581	0.411	0.189	0.018	0.095	0.768	0.904	1.974	0.395	0.410	0.290
Pseudodrifa nigra	0.091	0.388		0.479	0.160	0.203	0.143					1.157	1.157	0.231		
STYLASTERIDAE	0.091	0.388		0.479	0.160	0.203	0.143	0.050	0.089	0.632	1.379	0.543	2.691	0.538	0.538	0.380
MOLLUSCA	0.017	0.009		0.026	0.009	0.008	0.006	0.010					0.010	0.002		
BRYOZOA	0.017	0.018	0.016	0.050	0.017	0.001	0.001		0.071	0.158	0.023	0.018	0.270	0.054	0.064	0.045
ARTHROPODA	0.033	0.018	0.031	0.083	0.028	0.008	0.006		0.107	0.063		0.054	0.224	0.045	0.045	0.032
ECHINODERMATA																
ASTEROIDEA																
Asteroidea unident.	0.116	0.153		0.269	0.090	0.080	0.057			0.032	0.023	0.036	0.090	0.018	0.017	0.012
Goniasteridae	0.025		0.016	0.041	0.014	0.013	0.009									
Linckia sp.		0.009		0.009	0.003											
Sclerasterias sp.	0.008			0.008	0.003											
Tremaster mirabilis	0.017			0.017	0.006											
ECHINOIDEA																
Cidaridae	0.373	0.568		0.941	0.314	0.289	0.204				0.633	0.416	1.049	0.210	0.297	0.210
Echinoidea unident.	0.008			0.008	0.003				0.018				0.018	0.004		
Gracilechinus sp.	0.033			0.033	0.011			0.010					0.010	0.002		
CRINOIDEA																
Comatulida	0.613	0.370	0.126	1.108	0.369	0.244	0.172		0.373	0.726	0.181	1.447	2.727	0.545	0.571	0.404
OPHIUROIDEA																
Euryalidae												0.036	0.036	0.007		
Gorgonocephalidae											0.023		0.023	0.005		
HOLOTHUROIDEA																
Psolidae									0.018			0.018	0.036	0.007	0.010	0.007
UROCHORDATA		0.072	0.016	0.088	0.029	0.038	0.027			0.063			0.063	0.013		
UNKNOWN ANIMAL								0.060	0.089	0.189	0.226	0.127	0.691	0.138	0.069	0.049
TOTAL	5.532	8.815	2.767	17.114	5.705	3.028	2.141	1.404	3.999	6.663	7.866	9.259	29.191	5.838	3.144	2.223

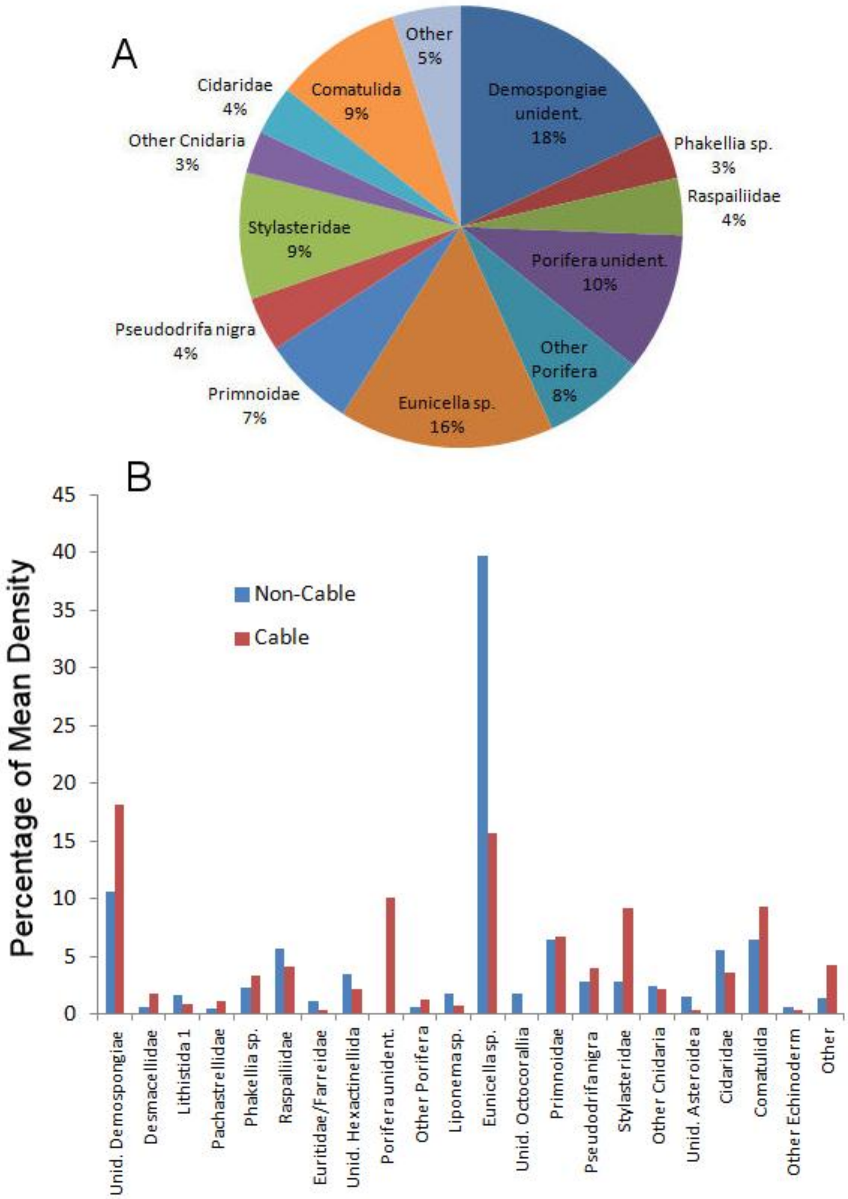

Figure 4-49. A. Macrofaunal organism densities (in m^{-2}) at the five Cable Outer Terrace Ridge High-Slope photostations expressed as percentages of mean benthic organism abundance. B. Comparison of percentage contributions to organism densities at Cable vs. Non-Cable OTR H-S photostations. Data summarized from Table 4-37.

No cable impacts were evident in a cluster analysis of density data from Cable versus Non-Cable OTR HS stations. Relationships among stations make sense in terms of location. Geographically close stations were more similar as were stations on similar longitudes. C OTR HS 1 and NC OTR HS 3 both lay along the same longitude on the deeper edge of the Outer Terrace Ridge; three pairs of stations were adjacent to each other physically and in the MDS plot: NC OTR HS 1 and 2, C OTR HS 2 and 3 and COTR HS 4 and 5 (Figure 4-50).

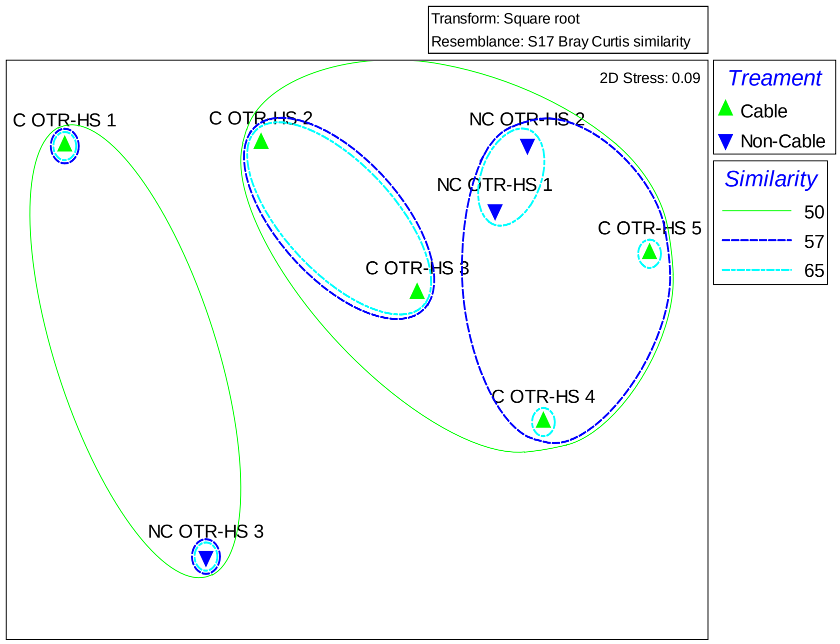

Figure 4-50. MDS plot of density data for all Outer Terrace Ridge High Slope Hardbottom habitat photostations. Stations are coded by Cable and Non-Cable. Circles indicate percent similarity from the cluster analysis.

Lower Terrace - High Slope Hardbottom (Tables 4-38 – 4-39; Figure 4-51)
The single station in this habitat was chiefly soft bottom (80.3%) but with a substantial percentage of deep-sea coral habitat as Colonial Dead Coral (9.25%). Living organisms contributed only 1.05% of cover (Table 4-38).

Total organism density was twice as great at the single Cable photostation (7.61 m^{-2}) relative to that at the Non-Cable photostation (3.79 m^{-2}). Octocorals accounted for 74.8% of density (5.69 m^{-2}) at the Cable photostation, greater than the 56.8% (2.15 m^{-2}) at the Non-Cable photostation in this habitat (Table 4-39). Primnoid octocorals contributed the greatest percentage of any individual taxon to density at both Non-Cable (1.21 m^{-2} and 31%) and Cable photostations (2.67 m^{-2} and 35%); *Eunicella* sp. and Unidentified Octocorals accounted for most of the remainder of octocoral density at the Cable (2.22 m^{-2} and 29%) and Non-Cable photostations (0.45 m^{-2} and 23%), respectively (Table 4-39, Figure 4-51). *Eunicella* sp. is a small octocoral not always easily identified.

Table 4-38. Percent cover data for the Cable Lower Terrace High Slope Hardbottom habitat photostation.

Cable - Lower Terrace - High Slope	C LT-HS 1
CORAL (COR)	9.25
Colonial Dead Coral (DC)	9.25
CNIDARIA NON SCLERACTINIA (CNI)	0.95
UNIDENTIFIED ORGANISM (UND)	0.10
SOFT BOTTOM SUBSTRATE (SB)	80.27
HARD BOTTOM SUBSTRATE (HB)	9.44
TAPE, WAND, SHADOW, PHOTO EFFECT (TWS)	0.10
Sum (excluding tape+shadow+wand)	100

Table 4-39. Density data for the Non-Cable and Cable Lower Terrace High-Slope habitat photostations.

	NC-1	**C-1**
PORIFERA		
DEMOSPONGIAE		
Demospongiae unident.	0.090	0.050
Phakellia sp.	0.045	
Spongosorites sp.		0.101
HEXACTINELLIDA		
Hexactinellida unident.	0.560	0.101
Porifera unident.		0.202
CNIDARIA		
HEXACORALLIA		
Actiniaria unident.	0.067	0.202
Actinoscyphia sp.		0.050
Antipatharia unident.		0.151
Corallimorphidae	0.112	0.050
Lophelia pertusa	0.022	
Madrepora sp.	0.090	
Sagartiidae	0.090	
Zoanthidea	0.022	0.101
OCTOCORALLIA		
Anthomastus sp.		0.050
Eunicella sp.	0.022	2.217
Isididae	0.022	0.151
Octocorallia unident.	0.874	0.453
Primnoidae	1.210	2.671
Pseudodrifa nigra	0.022	0.151
STYLASTERIDAE	0.359	
BRYOZOA		0.101
MOLLUSCA	0.090	
ARTHROPODA	0.045	0.050
ECHINODERMATA		
CRINOIDEA		
Comatulida	0.045	
Crinoidea (stalked)		0.050
UNKNOWN ANIMAL		0.705
TOTAL	3.787	7.608

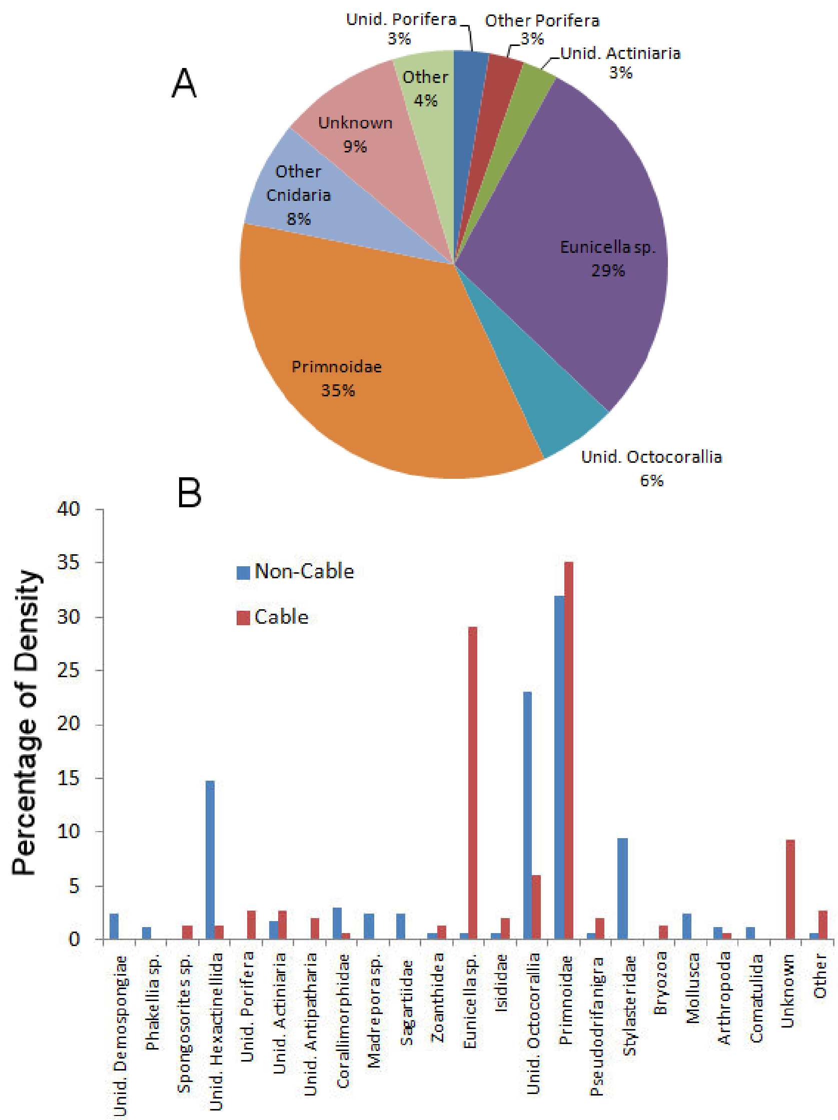

Figure 4-51. A. Macrofaunal organism densities (in m^{-2}) at the Cable Lower Terrace High-Slope photostation expressed as percentages of benthic organism abundance. B. Comparison of percentage contributions to organism densities at Cable vs. Non-Cable LT H-S photostations. Data summarized from Table 4-39.

Lower Terrace - Sinkhole Hardbottom (Tables 4-40 – 4-41; Figures 4-52 – 4-53)

Percent cover at this station was almost evenly divided between hard and soft substrates, with a 2.56% contribution from deep-sea coral (rubble and colonial dead coral) (Table 4-40). As at the Non-Cable Lower Terrace Sinkhole station, Primnoidae accounted for the greatest percentage of organism density (69%) (Figure 4-52). Here, the great majority of octocorals were identified as Primnoidae; at the Non-Cable Sinkhole station, half of octocoral density was unidentified, but much of it was likely Primnoidae, which would make the percent contributions to density by Primnoidae at the two stations much more similar. Most of the sponges at the Cable photostation were recorded as Unidentified Porifera (13%), whereas at the Non-Cable photostation, most were recorded as Hexactinellida (8.7%).

Table 4-40. Percent cover data for all Cable Lower Terrace Sinkhole Hardbottom habitat photostations.

Cable - Lower Terrace - Sinkhole	C LT-SH 1
CORAL (COR)	2.56
Colonial Dead Coral (DC)	0.18
Coral Rubble (CR)	2.38
ARTHROPODA (ART)	0.04
CNIDARIA NON SCLERACTINIA (CNI)	0.65
MOLLUSCA (MOL)	0.04
PORIFERA (POR)	0.04
UNIDENTIFIED ORGANISM (UND)	0.04
SOFT BOTTOM SUBSTRATE (SB)	49.69
HARD BOTTOM SUBSTRATE (HB)	46.95
TAPE, WAND, SHADOW, PHOTO EFFECT (TWS)	2.70
Sum (excluding tape+shadow+wand)	100

Table 4-41. [Left] Density data for the Cable Lower Terrace Sinkhole Hardbottom habitat photostation.

	NC-1	C-1
PORIFERA		
DEMOSPONGIAE		
Demospongiae unident.		0.015
Phakellia sp.		0.029
HEXACTINELLIDA		
Aphrocallistes beatrix	0.013	
Hexactinellida unident.	0.281	
Porifera Unident.	0.128	0.483
CNIDARIA		
HEXACORALLIA		
Actiniaria unident.	0.026	0.015
Actinoscyphia sp.	0.013	
Antipatharia unident.	0.013	0.015
Cerianthidae	0.038	
Corallimorphidae	0.013	0.015
Lophelia pertusa	0.051	0.029
OCTOCORALLIA		
Isididae		0.073
Octocorallia unident.	1.290	0.132
Primnoidae	1.277	2.520
STYLASTERIDAE	0.089	0.015
MOLLUSCA	0.013	
ARTHROPODA	0.026	0.073
ECHINODERMATA		
ASTEROIDEA		
Asteroidea unident.	0.013	0.015
ECHINOIDEA		
Echinoidea unident.	0.013	
OPHIUROIDEA		
Euryalidae		0.015
UNKNOWN ANIMAL	0.077	0.234
TOTAL	3.372	3.677

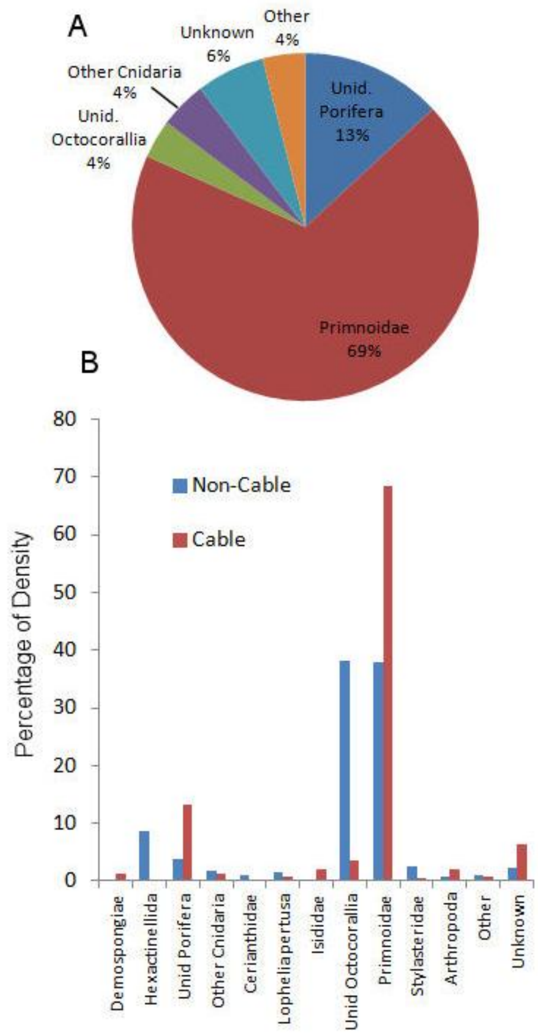

Figure 4-52. [Right above] A. Macrofaunal organism densities (in m^{-2}) at the Cable Lower Terrace Sinkhole photostation expressed as percentages of benthic organism density. B. Comparison of percentage contributions to organism densities at Cable vs. Non-Cable LT SH photostations. Data summarized from Table 4-41.

An MDS plot of a cluster analysis comparing Non-Cable and Cable Lower Terrace High-Slope and Sinkhole photostations (Figure 4-53) showed that the habitat distinctions were stronger than any Cable versus Non-Cable differences. However, the sample size (one of each habitat and treatment) was too low to determine any impact.

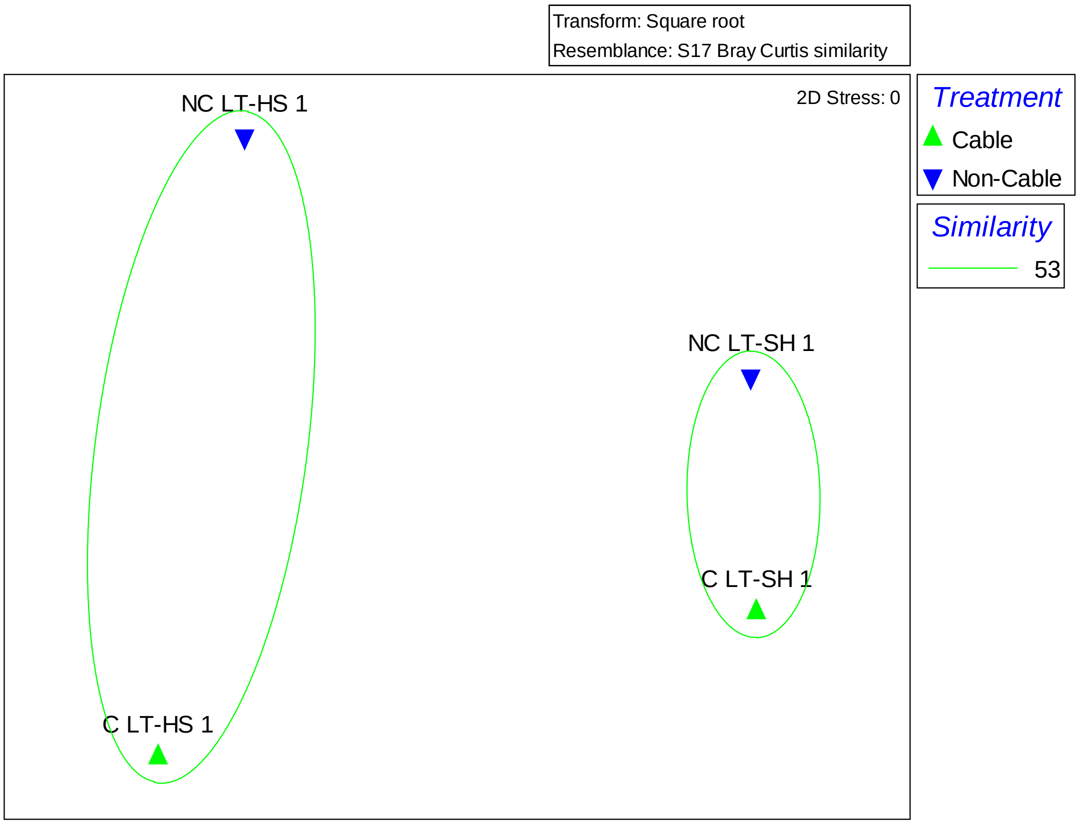

Figure 4-53. MDS plot of density data for all Lower Terrace Hardbottom habitat photostations. Stations are coded by Cable and Non-Cable. SH = Sinkhole, HS = High Slope. Circles indicate percent similarity from the cluster analysis.

Analysis of similarity

An analysis of similarity (ANOSIM) was performed for each habitat analysis with more than two Cable and Non-Cable stations to determine the significance of the Cable and Non-Cable categories within habitats. The ANOSIM is a permutation-based hypothesis test analogous to univariate ANOVAs that tests for differences between groups of (multivariate) samples from different experimental treatments. The closer the R statistic is to 1, the stronger the categorical groups. Its strength is dependent on the number of samples per category which defines the number of possible permutations. A low number of stations in a category limits the strength of the results. None of the Analyses of Similarity (ANOSIM) tests showed any significant groupings between Cable and Non-Cable stations. Global R must be close to 1 and significance level must be high to reflect any significant relationship. The cases with the highest R values here were with the result of low statistical power as indicated by the limited number of possible permutations.

Table 4-42. ANOSIM results of density data testing between cable and Non-Cable photostations.

ANOSIM Results - Density Subcategories - Cable v. Non-Cable	OTR-HS	OTP-LS	OTP-HS	ITP-LS_All	ITP-LS <275 m	ITP-LS >275 m	All Stations
Sample statistic (Global R)	0.046	0.188	0.464	0.059	0.306	0.159	0.062
Significance level of sample statistic	37.50%	12.70%	13.30%	23.40%	6.30%	25.00%	3.40%
Number of permutations	56 (All possible)	126 (All possible)	15 (All possible)	999	126 (All possible)	56 (All possible)	999
Number of permuted statistics greater than or equal to Global R	21	16	2	233	8	14	33

4.3.3 Cable Impact Assessment Summary

1) All three shallow transects (A, An, As) from ~30 to 90 m traversed cables. No similar habitat without cables was available, thus no statistical comparisons were performed.
2) A total of 109 identified colonies of stony corals (Scleractinia) was observed in 83 of 845 images taken between 30 m and 63 m, the deepest in 38-43 m. Most were <10 cm in maximum diameter. None exhibited any recognizable impacts (dislodged, abraded or shaded).
3) The only direct cable impact on macrobenthos observed in the video and photographic record in this depth range appeared at 26°05.249'N, 80°04.713'W, in 43 m along Transect An, where a cable appeared to have split a large sponge, which continued to survive.
4) Other effects associated with cable in 30-63 m included fouling of cables by cyanobacterial mat and chiefly encrusting sponges.
5) Organisms growing on cable at depths >90 m were initially dominated by hydroids and anemones (Actiniaria), accompanied at greater depths by zoanthids, demosponges, hexactinellid sponges, octocorals (e.g., *Pseudodrifa nigra*), antipatharians, stony coral (*Lophelia pertusa*), and the crinoid *Comatonia cristata*.
6) Although observations were made of cable coiled on the seafloor, the lack of catenary in cable suspended up to ~7 m above bottom between seafloor elevations, the growth of delicate colonies of *L. pertusa* on suspended cable, and the presence of large, old antipatharian colonies, as well as a wide diversity of other attached invertebrate macrofauna immediately adjacent to cable, suggest that substantial lengths of cable have not been subject to any appreciable post-deployment lateral movement.
7) On sediment-veneered pavement, exposure of hard substrate via current scour around cable generated space under the cable utilized by the crab *Bathynectes longispina*, the urchin *Cidaris* ?*rugosa*, and the codling *Laemonema* sp.
8) Percent cover, overall organism density and densities of individual taxa often varied widely within habitats along both Cable and Non-Cable transects, although both Cable and Non-Cable stations exhibited similar major faunal trends associated with habitat, e.g., the high contributions to density by the octocorals *Pseudodrifa nigra* and *Eunicella* sp. at Terrace Platform stations and Primnoidae at Lower Terrace stations.
9) Benthic habitats based on geomorphology (e.g., Inner Terrace Platform, Lower Terrace Sinkhole) and slope derived from geophysical multibeam data (Low versus High) are driving the regional (between-habitat) differences among groups of stations rather than the presence of cable. If any cable impacts exist, they are less than the differences among habitats.
10) Statistical analyses revealed no patterns in percent substrate cover or organism density within habitats that might be attributed to the presence of cable. Living organisms contributed too little to percent cover to drive any distinction, and the presence of cable had no effect on percent cover by non-living (hard versus soft) substrates. Organism density was not significantly affected by the presence of cable.

5 DISCUSSION

5.1 Introduction

This effort provided a benthic habitat characterization of the Essential Fish Habitat (EFH) areas within the SFOMF OP AREA south and southeast of the Port Everglades Entrance Channel, Broward County, Florida, along a series of cable and non-cable transects using remote technology at depths from 30 to ~550 m, and described impacts to EFH resources from cable deployments along the same transects. EFH in the study area consisted of Artificial Reef (spoil), Tilefish Habitat, Hardbottom and Deep-sea Coral. It is not clear whether any natural shallow Coral Reef EFH was exposed in the shallow survey where spoil overlaid the natural substrate.

Tilefish habitat was the only non-hard-substrate EFH recorded during this project, in the form of burrows in sediment. Although blueline tilefish (*Caulolatilus microps)* is included under the SAFMC Snapper-Grouper Fishery Management Plan (FMP), the habitat requirements of this species differ substantially from other fishes under this FMP. As a result, the SAFMC through the Comprehensive Ecosystem-Based Amendment 2 for the South Atlantic Region (CE-BA 2; SAFMC 2011a) has proposed an EFH-HAPC for blueline tilefish under the Snapper Grouper FMP "to include irregular bottom habitats along the shelf edge in 45-65 meters depth; shelf break; or upper slope along the 100-fathom contour (150-225 meters); hardbottom habitats characterized as rock overhangs, rock outcrops, manganese-phosphorite rock slab formations, or rocky reefs in the South Atlantic Bight; and the Georgetown Hole (Charleston Lumps) off Georgetown, SC" (SAFMC 2011b). With the exception of the apparent spoil habitat in <90-93 m, hard bottom EFH encountered in this survey was restricted to depths >245 m and thus fell outside the tilefish EFH-HAPC.

Surveys that necessarily rely on remote technology, in this case an ROV, are inherently difficult tasks. Water depths >30 m and current pose significant challenges to the study of such environments. As a result, our view of the seafloor is only a snapshot of the larger seascape, both temporally and spatially. For these reasons, mapping deep-water biological communities to the level of detail and accuracy as shallow-water systems is not currently feasible. Deep-water benthic habitat mapping is limited to broad categories of geological, topographical, and biological zonation.

The following discussion first outlines the major limitations of the study in terms of biological and habitat information, and design and instrumentation constraints, followed by alternative cable routes, quantitative analyses, and assessment of cable impacts to EFH.

5.2 Study Limitations - Biological and Habitat Data

Limited understanding of the population dynamics, growth rates, longevities and reproductive patterns of the living components of these biological communities presents obstacles to recognizing the effects of specific environmental factors such as cables. The organisms of interest are those associated chiefly with hard substrates. The local hard-substrate habitats are combinations of exposed hard-bottoms and variable-sized unconsolidated materials from slabs and boulders through cobbles to gravel. These hardbottoms span a continuum from completely exposed to fully buried. Partially exposed substrates range from pavements with small pools of sediment in depressions to scattered rubble or gravel clasts on otherwise buried hardbottoms.

Broad expanses of rippled sediment, many typically raised 10-30 cm above surrounding smooth, weakly bioturbated sediment areas, attest to the mobility of unconsolidated substrates under the influence of near-bottom flow. Hard substrates may be thus exposed or buried by moving bodies of sediments for undetermined lengths of time, depending on short- or long-term variations in bottom currents. Such natural environmental perturbations may potentially obscure or mask effects of cables or other anthropogenic installations on benthic fauna. However, the frequency (or rarity) and extent of burial and exposure of hard substrates and associated organisms in the deep habitats in this study remain unknown. At least limited adaptation to mobile sediments may exist as evidenced by growth of some attached fauna (i.e., some sponges and octocorals) on sediment-veneered hard substrates, although conditions permitting larval settlement and survival also remain unknown.

No information currently exists about the longevities of local benthic macrofauna, particularly relative to periods of exposure or burial of their substrates. However, radiocarbon measurements of a specimen of *Leiopathes glaberrima*—a Hawaiian black coral congeneric with local *Leiopathes* sp.—with a basal radius of 11.6 mm returned a growth rate of $<10\ \mu m\ yr^{-1}$ and an age of 2,377±15 y (Roark et al. 2006). *Leiopathes* sp. was widespread but widely scattered and infrequent in the current study, commonly occurring on low-relief, sediment-veneered pavements. Local colonies with basal diameters similar to that of the Hawaiian specimen are likely also centuries old (Figure 4-8). Although the (rare) observation of *Leiopathes* sp., as well as *Phakellia* sp. fan sponges adjacent to cables imply that at least some of these deep cables have not moved appreciably if at all since deployment, we cannot determine what if any adverse effects deployment generated.

The great majority of benthic macrofauna observed in our survey consisted of sessile or semi-sessile, suspension-feeding organisms (e.g., sponges, octocorals, antipatharians, stony and lace corals, and crinoids) that depend on ambient water movement for a sustained source of suspended food particles. Variations in organism assemblages attest to general broad-scale variations in near-bottom flow, e.g., broad, almost barren low-relief pavements and rubble fields on the Terrace Platform and barren high-relief boulders below the lips of sinkholes reflect little water movement, whereas dense assemblages of sponges, crinoids, octocorals and stylasterids on projecting high-relief ledges reflect exposure to consistently stronger flow. However, although the Florida Current has been subject to extensive modeling and observational studies, the detailed physical characteristics of its complex benthic boundary layer remain largely unknown (see Introduction- Background - Physical Setting section) as do the hydrodynamic requirements of resident organisms.

An additional layer contributing to variations in assemblage composition and organism densities among, and particularly within, habitats is the wide range of reproductive and developmental patterns found within the taxonomic groups represented in the survey area. Sponges, anemones and octocorals all exhibit both sexual and asexual reproduction that may generate wide variations in population sizes, genetic composition and dispersal. Asexual reproduction via pedal laceration in sea anemones serves a wide range of possible advantages including competitive ability and differential growth of locally successful genotypes (Clayton 1985). Brooded octocoral larvae likely have more limited dispersal abilities than broadcast larvae, and members of the family Nephthyidae, to which *Pseudodrifa nigra* belongs, commonly reproduce asexually (Simpson

2009). Adaptive strategies that include asexual reproduction and brooding, both of which may restrict dispersal of offspring, may contribute to observed organism patchiness within habitats in the absence of obvious environmental cues, e.g., why a cluster of bamboo corals or sagartiid anemones grows in one place that appears identical in substrate composition, relief, percent cover and slope to another that lacks the organism. Still, the current state of knowledge, with its lack of any substantial temporal or broad spatial data, or information on the biological processes associated with resident fauna, makes it extremely difficult to identify Non-Cable environmental factors. Even the most obvious associations are imperfectly understood. It is clear, for example, that numerous primnoid octocorals *Plumarella* sp. growing uniform orientation along the edges of projecting ledges are taking advantage of mean current flow; but it remains unclear why only on some ledges and not others nearby, and why they occasionally appear in large numbers on low-relief pavements. Such variations may derive from either local topography that modifies near-bottom flow, or patterns of reproduction, or some combination of both.

Small-scale benthic faunal and substrate variability notwithstanding, large-scale patterns emerged in the data that supported the benthic habitat map categorizations. Multivariate analyses of organism density showed clustering of photostation similarities by benthic habitats (Figure 4-24) and depth (e.g., Figure 4-37). Subtler patterns were also evident with organism densities in the MDS plots where the arrangement of the plot appeared to be driven by the cross-shelf organization of benthic habitats. These same plots did not show any clustering of Cable and Non-Cable photostations (e.g., Figures 4-33, 4-38); therefore, the data indicate that the presence of cable does not appreciably affect the regional-scale differences among the stations. In other words, the differences between stations is mostly determined by the geomorphology and slope along the shelf and any cable impacts, if present, are weaker than the influence of habitat. This is not surprising as previous studies have qualitatively described the change in communities across the terrace's geologic formations from the platform to the outer ridge (Mullins and Neumann, 1979; Reed et al. 2004). Furthermore seafloor slope has been recognized as an important factor in deep-water benthic community structure (Messing et al., 2008).

5.3 Study Limitations – Design and Instrumentation

As noted in the Introduction, this project was carried out at depths greater than recreational scuba diving limits (30 m) using a Remotely Operated Vehicle (ROV) under narrow time constraints based on available shiptime and funds. An ROV offers a much narrower observational field relative to scuba and thus limits the data that can be collected.

The limits of identification from ROV photographs may affect results. Whereas organisms such as the anemone *Liponema* sp. and the soft coral *Pseudodrifa nigra* represent single taxa and were easily identified wherever visible in images, sponges and some other anemones (and fewer examples of other organisms) often defied identification because of poor image resolution (due to distance, lighting, or size), angle of observation, or partial view, which almost certainly placed known taxa in one of several "unidentified" categories (e.g., Unidentified Porifera, Unidentified Demospongiae and Unidentified Actiniaria) that almost certainly included multiple taxa. As examples, the sponges recorded as Unidentified Porifera at a station may actually have included some Raspailiidae, Pachastrellidae, or Lithistida, which were identified and enumerated in other images from the same station. At another station, all sponges may have been identified, so the category Unidentified Porifera was absent from the analysis. Two red and white jointed legs protruding from under a rock might belong to either the squat lobster *Eumunida picta* or the crab *Bathynectes longispina*, requiring that the observation be recorded as Unidentified Crustacea, even though both species were recorded in other images from the station. Many, if not all, of the unidentified octocorals at the Sinkhole Non-Cable station, which accounted for 38% of density, were likely the primnoid octocoral *Plumarella* sp. Adding these unidentified colonies to those identified as primnoids at the station gave a total of 78%, close to the 69% contribution by primnoids at the Cable Sinkhole station (Figures 4-30, 4-50). Categories such as Unidentified Porifera were used out of necessity. We avoided combining all sponges, for example, in a single higher-level category, which would have obscured the great diversity of such organisms in these habitats. The more taxonomically refined the classification, the more accurate our appraisal of variations among stations. Finally, current understanding of local deep-water benthic macrofaunal taxonomy is imperfect at best, and some taxa require microscopic examination for identification.

As mentioned above, many species exhibited patchiness throughout the study area as exemplified by their variations in numbers and resulting densities among replicate stations within given habitats. The sources of such spatial variability may be rooted in a variety of biological and ecological processes such as response to local hydrodynamic conditions, reproductive strategy, and substrate preferences, rather than to the presence or absence of cable.

This study was designed before the habitat map was created and therefore utilized equal numbers of photostations within pre-defined depth zones whenever possible. Although not perfect, these depth zones corresponded closely with the habitat designations. Having the habitat map, beforehand would likely have affected data collection, e.g., by allowing us to target more of certain smaller habitats (particularly high slope) to more evenly distribute photostations per habitat. Also the northern Non-Cable transect was outside of the area mapped in detail, making it more difficult to discern habitat type. Because slope can be a determinant of organism density, and slope cannot be determined along this transect, it is difficult to know if high-slope habitats were included in some of the low-slope Non-Cable photostations.

5.4 Alternate Routes

Two north-south transects, each ~610 m long, were run to investigate potential alternate routes for future cables. The original plan called for one along the crest of the Miami Terrace escarpment (East N-S Transect E) and one near the EEZ along the deep-water coral thickets habitat. The second was abandoned as being far eastward of any current Navy cables and was replaced by another, termed West N-S Transect (D), along the border of the Inner and Outer Terrace Platforms along apparent high slope based on multibeam topography. Both north-south transects traversed several cables each.

Because most of the length of West N-S Transect (D) lay outside the multibeam survey area, where the only available seafloor data was NOAA’s low-resolution bathymetry, no depth profile was mapped. The initial portion of the transect, in 274-278 m, ran from the beginning of the transect at 26°04.902’N, 79°53.003’W, to 26°04.72’N, 79°53.013’W, a distance of ~350 m, over chiefly sediment-veneered hardbottom with areas of gravel and rubble. The dominant organisms were the anemone *Liponema* sp., the small soft coral *Pseudodrifa nigra*, pencil urchins (*Cidaris* ?*rugosa*) and abundant ophiuroids. This segment is the longest portion of the transect characterized by relatively low biological complexity. Beyond this, organism diversity and qualitative abundance, and substrate relief increased and included a variety of sponges, stylasterids, and black corals. Short stretches of gravel and rubble sometimes supported numerous sea pens.

The East North-South Transect (E) reflects the great variation in topography along the Outer Terrace Ridge of the Miami Terrace within the OP AREA. Much of this transect traversed relatively steep slopes characterized by series of rugged ledges with vertical relief up to 2 m, and boulders up to 1 m tall interspersed with pavement, rubble patches and areas of coral rubble, and with biologically diverse assemblages that included numerous sponges, Stylasteridae, large antipatharians (*Leiopathes* sp.) and living colonies of the deep-water reef-building coral *Lophelia pertusa* to 1 m across. The gently sloping to flat seafloor between peaks at the northern and southern ends of the transect still included up to 1-m ledges, narrow rock ridges, and boulders with a variety of sponges.

We found no alternative routes along which cables could be deployed without impacting hardbottom habitat. Many habitats were composed of varying proportions of sediment; however, this sediment overlays existing hardbottom and can shift due to prevailing bottom currents (as evidenced by ripple marks and sediment shadows). We observed no expansive cross-shelf areas of sediment devoid of hardbottom. However, Vinick et al. (2012), in a study designed to site hydrokinetic turbine arrays to utilize the energy of the Florida Current, identified cross-shelf areas north of the Miami Terrace suitable for avoiding impacts to hardbottom communities.

5.5 Cable Impact Assessment

Because cluster analysis is affected by all stations in the dataset and site similarity was affected by benthic habitats, analyses of organism density were performed on stations within each habitat (with two or more photostations per group) to determine if Cable stations clustered apart from Non-Cable stations without such inter-habitat influences. In all cases, Cable and Non-Cable stations did not significantly cluster separately. None of the Analyses of Similarity (ANOSIM) tests showed any significant distinctions between Cable and Non-Cable stations. In other words, there was no statistical difference in the biological communities (organism types and densities) between Cable and Non-Cable photostations.

Table 5-1 summarizes percent cover by hard and soft bottoms to illustrate the wide variations in proportional coverage by these substrates within given habitats, as well as the frequently similar mean values between Non-Cable and Cable photostations for given habitats. Thus, as examples, minimum and maximum values for percent hard and soft bottoms varied widely among individual stations at ITP LS, OTP LS, OTP HS and OTR HS habitats, but the mean values were similar for both Non-Cable and Cable photostations in each of these habitats. In fact, excepting those habitats represented by single stations, mean values for hard and soft bottoms differed substantially between Non-Cable and Cable photostations only in the OTR LS habitat (Table 5-1).

Table 5-1. Summary of minimum, maximum and mean values for percent cover by hard and soft bottoms at Non-Cable versus Cable photostations. Asterisks indicate single values rather than means for habitats represented by single stations. There were no stations in the Cable ITP HS habitat.

	Non-Cable							Cable						
		% Hard Bottom			% Soft Bottom				% Hard Bottom			% Soft Bottom		
	No. sta.	Min	Max.	Mean	Min	Max.	Mean	No. sta.	Min	Max.	Mean	Min	Max.	Mean
ITP LS	7	17.4	49.82	38.13	49	81.98	61.21	10	9.3	55.84	38.37	41.91	83.74	59.49
ITP HS	1			70.21*			27.02*							
OTP LS	5	2.54	86.11	30.01	2.24	96.74	67.03	5	9.06	46.86	24.81	52.11	88.71	73.32
OTP HS	2	44.81	52.68	48.75	46.15	54.51	50.33	4	3.09	76.45	48.26	20.77	95.28	49.31
OTR LS	2	56.06	87.89	71.97	11.10	40.42	25.76	1			55.19*			41.73*
OTR HS	3	83.04	95.03	87.31	3.00	15.92	11.06	5	58.65	91.83	75.14	7.55	37.76	20.86
LT HS	1			24.30*			60.48*	1			9.44*			80.27*
LT SH	1			72.18*			19.08*	1			46.95*			46.69*

Similarly, minimum and maximum total organism densities usually varied widely among stations within a habitat and treatment (Table 5-2). Mean organism density (and total density for habitats with single stations) was at least slightly greater at Cable photostations than Non-Cable photostations in all habitats except OTR LS. However, this habitat only included two Non-Cable and one Cable photostation, and the lowest density at the former (5.474 m^{-2}) and the one value at the latter (5.109 m^{-2}) were similar. Nevertheless, mean densities did not differ substantially between most Non-Cable and Cable photostations with multiple stations due to the wide range of densities at individual photostations, with the exception of OTP HS where mean Cable station organism densities were much higher.

Table 5-2. Summary of minimum, maximum and mean values plus standard deviations and standard errors for organism density (in m^{-2}) at Non-Cable versus Cable photostations. Asterisks indicate single values rather than means for habitats represented by single stations. Abbreviations as in Table 5-1. There were no stations in the Cable ITP HS habitat.

	Non-Cable						Cable					
	No. sta.	Min	Max.	Mean	StDev	StErr	No. sta.	Min	Max.	Mean	StDev	StErr
ITP LS	7	2.161	5.689	3.870	1.393	0.985	10	3.030	17.153	5.883	3.106	2.196
ITP HS	1			*3.672								
OTP LS	5	1.667	9.437	3.670	3.240	2.595	5	2.129	6.960	4.468	2.078	1.469
OTP HS	2	1.316	3.680	2.498	1.672	1.182	4	1.865	9.511	6.707	3.337	2.359
OTR LS	2	5.474	9.396	7.435	2.774	1.961	1			*5.109		
OTR HS	3	2.767	8.815	5.705	3.028	2.141	5	1.404	9.259	5.838	3.144	2.223
LT HS	1			*3.787						*7.608		
LT SH	1			*3.372						*3.677		

This does not mean that cables have not and are not affecting the benthos. As noted in the Introduction, cable-associated EFH impacts may occur during cable deployment and continuously over the time cable remains on the seafloor. However, this project was not designed to and could not distinguish among impacts associated with deployment and those that have occurred since deployment, e.g., lateral movement. Given the length of time since deployment, adverse effects associated with deployment, e.g., mortality resulting from burial by resuspended sediment, were highly unlikely to be observed. Similarly, as a one-time set of observations, this study could neither observe nor measure several of the impacts considered adverse effects by EFH rules, such as indirect impacts to fecundity and predator/prey interactions, and cumulative and synergistic consequences of actions.

Our assessment of impacts via video and still photographic examination of substrates between and adjacent to cables was limited to potential direct adverse effects on attached benthic macrofauna, i.e., sponges, octocorals, lace corals (Stylasteridae), black corals (Antipatharia) and stony corals (Scleractinia) associated with the post-deployment presence of the cable on the seafloor:

- Physical dislodgment resulting from lateral movement, likely resulting in complete mortality.
- Abrasion caused by direct contact, which may cause mortality, partial mortality or increased susceptibility to predation/grazing.
- Shading fauna or hard substrates suitable for settlement by attached macrofauna. This adverse effect is restricted in the study area to a depth of ~90 m. Below this depth, EFH essentially disappears and only reappears in ~245 m, a depth at which light and shading are no longer significant factors in community development and function.
- Covering hard substrates suitable for settlement by attached macrofauna.
- Scouring adjacent substrate via lateral movement, which may limit organism settlement, growth, and assemblage stability; increase mortality of organisms previously in contact with cable, and continue dislodgement and abrasion.

Apart from enumerating observed examples of dislodgement, abrasion, shading or scouring, the remote method used in this survey precluded quantification of habitat-wide impacts. Because cable was only intermittently visible in quantitative images, effects such as areal coverage of EFH by cable could not be extrapolated to entire photostations. Similarly, because cable was not in view along the entire cable transect, and was intermittently buried along patchy EFH, extrapolating cable area projected on the seafloor over the length of the transect on EFH would not provide an accurate measure of areal coverage of EFH by cable.

As noted in the shallow-water component of this project (Gilliam and Walker 2012), this survey effort was not designed to and could not estimate EFH impacts associated with cable deployment activities or distinguish deployment impacts from those that have occurred since deployment. Impacts to attached organisms in the deep-water component that occur during deployment include physical dislodgment or burial by resuspended sediment, which will likely result in complete mortality, and physical abrasion, which may cause mortality, partial mortality (in the case of sponges and colonial invertebrates), or increased susceptibility to predation/grazing. Some impacts may continue for the life of the cable on or over all EFH considered here. Shading of attached fauna by suspended cable is a potential adverse effect only from the shallow end of the deep-water component to a depth of ~90 m. Below this depth, hard-bottom EFH only reappears in ~245 m, a depth at which light and shading are no longer significant factors in community development and function. All other potential effects remain in force regardless of depth. Continuous direct contact with attached organisms could also potentially cause mortality. Cable movement on the seafloor can augment impacts by scouring additional substrate, which further limits organism settlement, growth, and assemblage stability; increasing mortality of organisms previously in contact with cable, and continuing dislodgement and abrasion.

Apart from hardbottom EFH, note that, although blueline tilefish is included under the SAFMC Snapper-Grouper Fishery Management Plan (FMP), the habitat requirements of this species differ substantially from other fishes under this FMP. As a result, SAFMC through the Comprehensive Ecosystem-Based Amendment 2 for the South Atlantic Region (CE-BA 2; SAFMC 2011a) has proposed an EFH-HAPC for blueline tilefish under the Snapper Grouper FMP "to include irregular bottom habitats along the shelf edge in 45-65 meters depth; shelf break; or upper slope along the 100-fathom contour (150-225 meters); hardbottom habitats characterized as rock overhangs, rock outcrops, manganese-phosphorite rock slab formations, or rocky reefs in the South Atlantic Bight; and the Georgetown Hole (Charleston Lumps) off Georgetown, SC" (SAFMC 2011b).

Cables may also affect local communities via fouling and attraction of organisms to cable as localized complex physical habitat. Although we did not specifically distinguish or quantify organisms attached to cables relative to those on surrounding substrates, a few species, e.g., the Venus flytrap anemone *Actinscyphia* sp., appeared to occur in substantially greater numbers on cable, often where it was suspended well above the seafloor between adjacent elevations. Also, in traversing extensive areas of sediment-veneered hard substrates, particularly pavements characterized by qualitatively low macrofaunal abundances (areas not included in quantitative photostations), bottom flow often scoured sediment from below cable, exposing underlying hard substrate and depositing a narrow sediment shadow parallel to the cable on the downcurrent side. Such scour appeared to result from water movement around the cable rather than any cable movement. Organisms such as the crab *Bathynectes longispina*, the urchin *Cidaris* ?*rugosa*, and the codling *Laemonema* sp., were observed apparently sheltering in the resulting space exposed beneath the cable. It is unknown whether potential shelter offered by the cable in otherwise open areas significantly increases numbers of predators such as crabs and fish that may have an impact on surrounding habitats.

Similarly, exposed cables may represent a corridor for the expansion of taxa into otherwise unavailable habitats. Organisms characteristic of Miami Terrace hard substrates, such as *Pseudodrifa nigra*, *Eumunida picta* and zoanthids began to appear on or in association with the cable in as little as 230 m, west of the initial exposure of natural hard substrates (Figure 4-6). It is unknown, however, whether fouling populations make any significant contribution to recruitment onto natural substrates. Colonies of the stony coral *Lophelia pertusa* often took advantage of suspended portions of the cable (Figure 4-9C), growing above otherwise undesirable substrates. However, this species is widely established elsewhere on the Terrace as well as in many locations all along the southeastern U.S. continental margin (e.g., Reed 2004, Partyka et al. 2007, Messing et al. 2008, Reed et al. 2006, and in press).

Apart from the communities growing on cable, which varied with benthic habitat, qualitative observations of potential interactions between benthic macrofauna and cable were extremely limited. As noted above, the only direct effect on macrobenthos observed in the video and photographic record and attributable to cable appeared in 43 m along the North Parallel Transect (An), where a cable appeared to have split a large sponge, which, however, continued to survive. In deeper water, several detached fan sponges (*Phakellia* sp.) and several dead stumps of bamboo octocoral (*Isidella* sp.) were seen chiefly where no cable was observed. Although not tested here, the deep-water cable exhibited no indication of lateral movement. The great majority of cable was apparently deployed under great tension, as evidenced by the long stretches of cable suspended without apparent catenary between elevations. The two instances where cable lay in multiple loops, which might permit lateral movement following deployment, were both on sediment substrates outside EFH. A 45° bend in the cable on a sediment and rubble substrate in 331 m was not accompanied by any evidence of lateral movement. We observed no indication of substrate scoured by cable or repeatedly impacted organisms. In fact the presence of *Lophelia pertusa* on the suspended cable and long-lived black coral immediately adjacent to cable on the seafloor leads us to conclude that they are moving little if at all. *L. pertusa* is a delicate hard coral that would likely break free of its attachment on the cable without much force.

Movement, retrieval, or removal of deep-water cables is not recommended. It is clear that any attempt to remove any of the existing cables, whether in shallow or deep water, will have important repercussions. Apart from the destruction of the communities growing on the cable (which include some protected coral species), removal will produce lateral cable movement, which will have the opportunity to damage or destroy benthic organisms, some of which are long-lived components of their communities and important contributors to habitat complexity (e.g., Figures 4-5B,C, 4-8F, 4-17A).

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