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Overview & Recommendations

JOINT MEETING OF THE HABITAT ADVISORY PANEL AND CORAL ADVISORY PANEL

October 26-28, 2004

Francis Marion Hotel
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4) Deepwater Coral Habitat Research and Protection

Dr. Steve Ross of the University of North Carolina at Wilmington (UNCW) and John Reed of the Harbor Branch Oceanographic Institute (HBOI) made presentations on deepwater coral distribution and characterization in the South Atlantic Region. Andy Shepard, Director of the UNCW/NURC was contracted to coordinate the preparation of the reports for the Council. The presentations encompassed exploration and characterization conducted to date on deep water coral habitats in the South Atlantic region. The following reports developed for the Council summarize this information: *GENERAL DESCRIPTION OF DISTRIBUTION, HABITAT, AND ASSOCIATED FAUNA OF DEEP WATER CORAL REEFS ON THE NORTH CAROLINA CONTINENTAL SLOPE* (Ross, 2004); and *DEEP-WATER CORAL REEFS OF FLORIDA, GEORGIA AND SOUTH CAROLINA: A SUMMARY OF THE DISTRIBUTION, HABITAT, AND ASSOCIATED FAUNA* (Reed, 2004). Council staff provided an overview of the integration of new deepwater coral HAPCs into the Fishery Ecosystem Plan and Comprehensive Ecosystem Amendment development process. Panel

members discussed the information provided to further refine previous recommendations on the establishment of new deepwater coral HAPCs in the South Atlantic Region. In addition, Council staff provided an overview of the preliminary development of a deepwater coral research and monitoring plan

Proposed Deepwater Coral HAPCs

The excerpts below are from S. Ross' report and provide a more detailed description of each proposed site off North Carolina.

Proposed Cape Lookout Lophelia Bank HAPC:

Aside from a few maps there are no published data from this coral mound. Between summer 2000 and summer 2004 Ross et al. (unpubl. data) sampled this area extensively using a variety of methods throughout the water column. Their major method for collecting bottom data on the reef proper was the Johnson Sea Link (JSL) research submersible. Fifteen dives were made on coral mounds in this area and observations from these totaling nearly 33 hours (bottom time) are the basis of the descriptions of habitat and fauna below. Preliminary observations suggest that this area contains the most extensive coral mounds off North Carolina; however, it must be emphasized that data are lacking to adequately judge overall sizes and areal coverage. There appear to be several prominences capping a ridge system, thus, presenting a very rugged and diverse bathymetry, but there are also other mounds away from the main ridge sampled. The main mound system rises vertically nearly 80 m over a distance of about 1 km, and in places exhibits slopes in excess of 50-60 degrees. Sides and tops of these mounds are covered with extensive colonies of living Lophelia pertusa, with few other corals being observed. Dead colonies and coral rubble interspersed with sandy channels are also abundant. Extensive coral rubble zones surround the mounds for a large, but unknown, distance (exact area not yet surveyed), especially at the bases of the mounds/ridges, and in places seem to be quite thick. These topographic highs accelerate bottom currents which favor attached filterfeeders. Because fishes are somewhat disturbed by submersibles, data on the fish community has accumulated slowly; however, this group is quite diverse on the coral habitat. Ross et al. have so far identified over 43 benthic or benthopelagic fish species on and around these coral banks. Of the twenty five total fish species occurring on prime coral habitat of Bank A, nine dominate the data. Beryx decadactylus usually occurs in large aggregations moving over the reef, while most other major species occur as single individuals. Many of these species are cryptic, being well hidden deep in the corals (e.g., Hoplostethus occidentalis, Netenchelys exoria, Conger oceanicus). The morid, Laemonema melanurum, is one of the larger fishes abundant at every site with corals. This fish seems to rarely leave the prime reef area. Trash and entangled fishing gear were observed on this reef, suggesting some level of commercial fishing pressure. Initially the most impressive biological aspect of these coral mounds (aside from the corals themselves) was the well developed and abundant invertebrate fauna. We have not yet detected major differences in the invertebrate fauna among the three North Carolina banks; therefore, this paragraph is relevant to all three areas. Galatheid crabs (especially Eumunida picta) and the brisingid basket star (Novodinia antillensis) were particularly obvious, perching high in coral bushes to catch passing animals or filter in the currents. One very different aspect of the North Carolina deep

coral habitat compared to the rest of the South Atlantic Bight is the massive numbers of a brittle star (Ophiacantha bidentata) covering both dead and living coral colonies. These are perhaps the most abundant macroinvertebrate on these banks. In places the bottom is covered with huge numbers of several species of anemones. The abundance of filter feeders suggests a food rich habitat.

Cape Lookout Lophelia Bank B:

Except for a few maps there are no published data from this coral mound. Between summer 2001 and summer 2004 Ross et al. (unpubl. data) sampled this area using a variety of methods throughout the water column. The Johnson Sea Link (JSL) submersible was the major method for collecting bottom data on the reef proper. Five dives were made on coral mounds in this area, and observations from these totaling 10.4 hours form the basis of the descriptions of habitat and fauna below. The least amount of data are available for this area. Mounds appear to cover a smaller area than those described above, but here again better mapping data are needed. These mounds rise at least 53 m over a distance of about 0.4 km. There is a small mound away from the main system and in general these mounds were less dramatic than those described above. They appeared to be of the same general construction as Bank A, appearing to be built of coral rubble matrix that had trapped sediments. Extensive fields of coral rubble surrounded the area. Both living and dead corals were common on this bank, with some living bushes being quite large. Preliminary analyses (Ross et al. unpubl.) have identified 11 fish species from this bank, but it is clear that the species list would be much higher in this well developed habitat if there were more samples. The dominant fish species appears to be Helicolenus dactylopterus, followed by L. melanurum, H. occidentalis, L. barbatulum, and N. exoria. Although H. dactylopterus can be common on all habitats, it clearly occurs most often around structures. It is intimately associated with the coral substrate, and it is very abundant around this reef habitat. The invertebrate fauna on this reef system does not appear substantially different from Bank A

Cape Fear Lophelia Bank:

Aside from the map in EEZ-SCAN 87 Scientific Staff (1991) there are no published data from this coral mound and no indication that it was sampled before the studies initiated by Ross et al. (unpubl. data) between summer 2002 and summer 2004. Ross et al. located this bank based on estimated coordinates from the USGS survey (EEZ-SCAN 87 Scientific Staff 1991). As above, the JSL submersible was the major method for collecting bottom data on the reef proper. Seven dives were made on coral mounds in this area, and observations from these totaling 15.4 hours were used to describe the habitat and fauna. Sampling in this area was focused on a relatively small area, but data are lacking to accurately estimate the size and area covered by coral mounds or rubble zones. These mounds rise nearly 80 m over a distance of about 0.4 km, and exhibit some of the most rugged habitat and vertical excursion of any area sampled. This mound system also appears to be of the same general construction as Banks A and B, being built of coral rubble matrix with trapped sediments. Fields of coral rubble are common around the area. Both living and dead corals were common on this bank. The greatest numbers of large fishes were observed on this bank. Twelve total fish species were observed here, but as above, this list should increase with increasing sampling effort. As on Banks A and B,

decadactylus was the most common fish, followed closely by Polyprion americanus (wreckfish). So far, of the three North Carolina banks, this is the only area where wreckfish have been observed, and on some dives 8-10 large individuals were seen swimming slowly along the sides of the ridges. However, it is very likely that wreckfish occur on the other banks. As on the other two banks, L. melanurum was common here, always on prime reef habitat. Conger oceanicus (always large adults) and Myxine glutinosa were both frequently observed on this bank. The invertebrate fauna on this reef system does not appear substantially different from Banks A and B.

The following excerpts are from J. Reed's report for proposed HAPC sites off SC, GA and FL.

Proposed Stetson Reefs Coral HAPC (from Reed, 2002a; Reed et al., 2004b):
This site is on the outer eastern edge of the Blake Plateau, ~120 nm SE of Charleston, South Carolina, at depths of 640-869 m. Over 200 coral mounds up to 146 m in height occur over this 6174 km2 area that was first described by Thomas Stetson from echo soundings and bottom dredges (Stetson et al., 1962; Uchupi, 1968). These were described as steep-sloped structures with active growth on top of the banks. Live coral colonies up to 50 cm in diameter were observed with a camera sled. *Enallopsammia profunda* (=D. profunda) was the dominant species in all areas although *Lophelia pertusa* was concentrated on top of the mounds. Densest coral growth occurred along an escarpment in the Region. Stetson et al. (1962) reported an abundance of hydroids, alcyonaceans, echinoderms, actiniaria, and ophiuroids, but a rarity of large mollusks. The flabelliform gorgonians were also current-oriented. Popenoe and Manheim (2001) have made detailed geological maps of this Charleston Bump region which also indicate numerous coral mounds. Recent fathometer transects by the PI indicated dozens and possibly hundreds of individual pinnacles and mounds within the small region that we surveyed which is only a fraction of the Stetson Bank area. From our fathometer transects, two pinnacle regions were selected. Three submersible dives were made on “Pinnacle 3” and four dives on “Stetson’s Peak” which is described below. A small subset of the Stetson Bank area was first mapped during six fathometer transects covering ~28 nm2, in which six major peaks or pinnacles and four major scarps were plotted. The base depth of these pinnacles ranged from 689 m to 643 m, with relief of 46 to 102 m. A subset of this was further mapped with 70 fathometer transects spaced 250 m apart (recording depth, latitude and longitude ~ every 3 seconds), covering an area of 1 x 1.5 nm, resulting in a 3-D bathymetric GIS Arcview map of a major feature, which we named Stetson’s Pinnacle. Stetson’s Pinnacle was 780 m at the south base and the peak was 627 m. This represents one of the tallest *Lophelia* coral lithoherms known, nearly 153 m in relief. The linear distance from the south base to the peak was ~0.5 nm. The lower flank of the pinnacle from ~762 m to 701 m on the south face was a gentle slope of 10-30o with a series of 3-4 m high ridges and terraces that were generally aligned 60-240o across the slope face. These ridges were covered with nearly 100% *Lophelia* coral rubble, 15-30 cm colonies of live *Lophelia*, and standing dead colonies of *Lophelia*, 30-60 cm tall. Very little rock was exposed, except on the steeper exposed, eroded faces of the ridges. Some rock slabs, ~30 cm thick, have slumped from these faces. From 701 m to 677 m the slope increased from ~45o to 60o. From 671 m to the peak, the geomorphology was very complex and rugged, consisting of

60-90 degree rock walls and 3-9 m tall rock outcrops. Colonies of *Lophelia*, 30-60 cm tall, were more common, and some rock ledges had nearly 100% cover of live *Lophelia* thickets. The top edge of the pinnacle was a 30 cm thick rock crust which was undercut from erosion; below this was a 90o escarpment of 3-6 m. The peak was a flat rock plateau at 625- 628 m and was approximately 0.1 nm across on a S-N submersible transect. The north face was not explored in detail but is a vertical rock wall from the peak to ~654 m then grades to a 45o slope with boulders and rock outcrops. Dominant sessile macrofauna consisted of scleractinia, stylasterine hydrocorals, gorgonacea and sponges. The colonial scleractinia were dominated by colonies of *Lophelia pertusa* (30-60 cm tall) and *Enallopsammia profunda*, and *Solenosmilia variabilis* were present. Small stylasterine corals (15 cm tall) were common and numerous species of solitary cup corals were abundant. Dominant octocorallia consisted of colonies of Primnoidae (15-30 cm tall), paramuriceids (60-90 cm), Isididae bamboo coral (15-60 cm), stolonifera, and stalked Nephtheidae (5-10 cm). Dominant sponges consisted of Pachastrellidae (25 cm fingers and 25- 50 cm plates), Corallistidae (10 cm cups), Hexactinellida glass sponges (30 cm vase), Geodia sp. (15-50 cm spherical), and Leiodermatium sp. (50 cm frilly plates). Although motile fauna were not targeted, some dominant groups were noted. No large decapods crustaceans were common although some red portunids were observed. Two species of echinoids were common, one white urchin and one stylocidaroid. No holothurians or asteroids were noted. Dense populations of Ophiuroidea were visible in close-up video of coral clusters and sponges. No large Mollusca were noted except for some squid. Fish consisted mostly of benthic gadids and rattails. On the steeper upper flank, from 671 to 625 m the density, diversity, and size of sponges increased; 15- 50 cm macro sponges were more abundant. Massive Spongosorites sp. were common, Pachastrellidae tube sponges were abundant, and Hexactinellida glass sponges were also common. On the peak plateau the dominant macrofauna were colonies of Lophelia pertusa (30- 60 cm tall), coral rubble, Phakellia sp. fan sponges (30-50 cm), and numerous other demosponges were abundant. No large fish were seen on top.

Region C: Savannah Lithoherms, Blake Plateau (from Reed, 2002a; Reed et al., 2004b): A number of high-relief lithoherms occur within this region of the Blake Plateau ~90 nm east of Savannah, Georgia. Region C is at the base of the Florida-Hatteras Slope, near the western edge of the Blake Plateau, and occurs in a region of phosphoritic sand, gravel and rock pavement on the Charleston Bump (Sedberry, 2001). Wenner and Barans (2001) described 15-23 m tall coral mounds in this region that were thinly veneered with fine sediment, dead coral fragments and thickets of Lophelia and Enallopsammia. They found that blackbellied rosefish and wreckfish were frequent associates of this habitat. In general, the high-relief Lophelia mounds occur in this region at depths of 490-550 m and have maximum relief of 61 m. JSL-II dives 1690, 1697 and 1698 reported a coral rubble slope with <5% cover of 30 cm, live coral colonies (Reed, 2002a). On the reef crest were 30-50 cm diameter coral colonies covering ~10% of the bottom. Some areas consisted of a rock pavement with a thin veneer of sand, coral rubble, and 5-25 cm phosphoritic rocks. At Alvin dive sites 200 and 203, Milliman et al. (1967) reported elongate coral mounds, approximately 10 m wide and 1 km long, that were oriented NNE-SSW. The mounds had 25-37o slopes and 54 m relief. Live colonies (10-20 cm diameter) of E. profunda (=D. profunda) dominated and L. pertusa (=L. prolifera) was common. No rock outcrops were

observed. These submersible dives found that these lithoherms provided habitat for large populations of massive sponges and gorgonians in addition to the smaller macroinvertebrates which have not been studied in detail. Dominant macrofauna included large plate-shaped sponges (Pachastrella monilifera) and stalked, fan-shaped sponges (Phakellia ventilabrum), up to 90 cm in diameter and height. At certain sites (JSL-II dive 1697), these species were estimated at 1 colony/10 m2. Densities of small stalked spherical sponges (Stylocordyla sp., Hadromerida) were estimated in some areas at 167 colonies/10 m2. Hexactinellid (glass) sponges such as Farrea? sp. were also common. Dominant gorgonacea included Eunicella sp. (Plexauridae) and Plumarella pourtalessi (Primnoidae). Recent fathometer transects by the PI at Savannah Lithoherm Site #1 (JSL II-3327) extended 2.36 nm S-N revealed a massive lithoherm feature that consisted of five major pinnacles with a base depth of 549 m, minimum depth of 465 m, and maximum relief of 83 m (Reed and Pomponi, 2002b; Reed et al., 2002; Reed et al., 2004b). The individual pinnacles ranged from 9 to 61 m in height. A single submersible transect, south to north, on Pinnacle #4 showed a minimum depth of 499 m. The south flank of the pinnacle was a gentle 10-20o slope, with ~90% cover of coarse sand, coral rubble and some 15 cm rock ledges. The peak was a sharp ridge oriented, NW-SE, perpendicular to the prevailing 1 kn current. The north side face of the ridge was a 45o rock escarpment of about 3 m which dropped onto a flatter terrace. From a depth of 499 to 527 m, the north slope formed a series of terraces or shallow depressions, ~9-15 m wide, that were separated by 3 m high escarpments of 30-45\o. Exposed rock surfaces showed a black phosphoritic rock pavement. The dominant sessile macrofauna occurred on the exposed pavement of the terraces and in particular at the edges of the rock outcrops and the crest of the pinnacle. The estimated cover of sponges and gorgonians was 10% on the exposed rock areas. Colonies of Lophelia pertusa (15-30 cm diameter) were common but not abundant with ~1% coverage. Dominant Cnidaria included several species of gorgonacea (15-20 cm tall), Primnoidae, Plexauridae (several spp.), Antipathes sp. (1 m tall), and Lophelia pertusa. Dominant sponges included large Phakellia ventilabrum (fan sponges, 30-90 cm diameter), Pachastrellidae plate sponges (30 cm), Choristida plate sponges (30 cm), and Hexactinellid glass sponges. Motile fauna consisted of decapod crustaceans (Chaceon fenneri, 25 cm; and Galatheidae, 15 cm) and mollusks. Few large fish were observed but a 1.5 m swordfish, several 1 m sharks, and numerous blackbelly rosefish were noted. A fathometer transect by the PI at Savannah Lithoherm Site 2 extended 4.6 nm, SW to NE , mapped 8 pinnacles with maximum depth of 549 m and relief of 15-50 m. Submersible dives were made on Pinnacles 1, 5 and 6 of this group. Pinnacle 1 was the largest feature of this group; the base was 537 m and the top was 487 m. The south face, from a depth of 518 to 510 m, was a gentle 10o slope, covered with coarse brown sand and Lophelia coral rubble. A 3-m high ridge of phosphoritic rock, extended NE-SW, cropped out at a depth of 510 m. This was covered with nearly 100% cover of 15 cm thick standing dead Lophelia coral and dense live colonies of Lophelia pertusa (15-40 cm). From depths of 500 m to 495 m were a series of exposed rock ridges and terraces, that were 3-9 m tall with 45o slopes. Some of the terraces were ~30 m wide. Each ridge and terrace had thick layers of standing dead Lophelia, and dense live coral. These had nearly 100% cover of sponges (Phakellia sp., Geodia sp., Pachastrellidae, and Hexactinellida), scleractinia (Lophelia pertusa, Madrepora oculata), stylasterine hydrocorals, numerous species of gorgonacea

(Ifalukellidae, Isididae, Primnoidae), and 1 m bushes of black coral (Antipathes sp.). Deep deposits of sand and coral rubble occurred in the depressions between the ridges. The north face, from 500 m to 524 m was a gentle slope of 10o, that had deep deposits of coarse brown foraminiferal sand and coral rubble. Exposed rock pavement was sparse on the north slope, but a few low rises with live bottom habitat occurred at 524 m. Dominant mobile fauna included decapod crustaceans (Chaceon fenneri, 15 cm Galatheidae), rattail fish, and 60 cm sharks were common.

Region B: Florida Lophelia Pinnacles (from Reed, 2002a; Reed et al., 2004b)
Numerous high-relief Lophelia reefs and lithoherms occur in this region at the base of the Florida- Hatteras Slope and at depths of 670-866 m. The reefs in the southern portion of this region form along the western edge of the Straits of Florida and are 15-25 nm east of the Oculina coral banks Marine Protected Area (MPA). Along a 222-km stretch off northeastern and central Florida (from Jacksonville to Jupiter), nearly 300 mounds from 8 to 168 m in height (25- 550 ft) were recently mapped by the PI using a single beam echosounder (Fig. 11; Reed et al., 2004b). Between 1982 and 2004, dives with the Johnson-Sea-Link (JSL) submersibles and ROVs by the PI confirmed the presence of Lophelia mounds and lithoherms in this region (Reed, 2002a; Reed et al., 2002; Reed and Wright, 2004; Reed et al., 2004b). The northern sites off Jacksonville and southern Georgia appeared to be primarily lithoherms which are pinnacles capped with exposed rock (described in part by Paull et al., 2000), whereas the features from south of St. Augustine to Jupiter were predominately Lophelia coral pinnacles or mud mounds capped with dense 1-m-tall thickets of Lophelia pertusa and Enallopsammia profunda with varying amounts of coral debris and live coral. Dominant habitat-forming coral species were Lophelia pertusa, Madrepora oculata, Enallopsammia profunda, bamboo coral (Isididae), black coral (Antipatharia), and diverse populations of octocorals and sponges (Reed et al., 2004b). Paull et al. (2000) estimated that over 40,000 coral lithoherms may be present in this region of the Straits of Florida and the Blake Plateau. Their dives with the Johnson-Sea-Link submersible and the U.S. Navy's submarine NR-1 described a region off northern Florida and southern Georgia of dense lithoherms forming pinnacles 5 to 150 m in height with 30-60o slopes that had thickets of live ahermatypic coral (unidentified species, but photos suggest Lophelia and/or Enallopsammia). The depths range from 440 to >900 m but most mounds were within 500-750 m. Each lithoherm was ~100-1000 m long and the ridge crest was generally oriented perpendicular to the northerly flowing Gulf Stream current (25-50 cm s-1 on flat bottom, 50-100 cm s-1 on southern slopes and crests). Thickets of live coral up to 1 m were mostly found on the southern facing slopes and crests whereas the northern slopes were mostly dead coral rubble. These were termed lithoherms since the mounds were partially consolidated by a carbonate crust, 20-30 cm thick, consisting of micritic wackestone with embedded planktonic foraminifera, pteropods, and coral debris (Paull et al., 2000). A recent echosounder transect by the PI revealed a massive lithoherm, 3.08 nm long (N-S) that consisted of at least 7 individual peaks with heights of 30-60 m (Fig. 12; Reed and Wright, 2004; Reed et al., 2004b). The maximum depth was 701 m with total relief of 157 m. Three submersible dives (JSL II-3333, 3334; I-4658) were made on Peak 6 of pinnacle #204B which was the tallest individual feature of the lithoherm with maximum relief of 107 m and a minimum depth at the peak of 544 m (Reed et al., 2004b). The east

face was a 20-30o slope and steeper (50o) near the top. The west face was a 25-30o slope which steepened to 80o from 561 m to the top ridge. The slopes consisted of sand and mud, rock pavement and rubble. A transect up the south slope reported a 30-40o slope with a series of terraces and dense thickets of 30-60 cm tall dead and live Lophelia coral that were mostly found on top of mounds, ridges and terrace edges. One peak at 565 m had dense thickets of live and dead standing Lophelia coral (~20% live) and outcrops of thick coral rubble. Dominant sessile fauna consisted of Lophelia pertusa, abundant Isididae bamboo coral (30-60 cm) on the lower flanks of the mound, Antipatharia black coral, and abundant small octocorals including the gorgonacea (Placogorgia sp., Chrysogorgia sp, and Plexauridae) and Nephtheidae soft corals (Anthomastus sp., Nephthya sp.). Dominant sponges consisted of Geodia sp., Phakellia sp., Spongosorites sp. Petrosiidae, Pachastrellidae, and Hexactinellida. Further south off Cape Canaveral, echosounder transects by the PI on Lophelia Pinnacle #113 revealed a 61 m tall pinnacle with maximum depth of 777 m. The width (NW-SE) was 0.9 nm and consisted of at least 3 individual peaks or ridges on top, each with 15-19 m relief. One submersible dive (JSL II-3335) reported 30-60o slopes, with sand, coral rubble, and up to 10% cover of live coral. No exposed rock was observed. This appeared to be a classic Lophelia mud mound. The second dive site (JSL II-3336) at Pinnacle #151 was also a deep-water Lophelia coral reef comprised entirely of coral and sediment. Maximum depth was 758 m, with 44 m relief, and ~0.3 nm wide (N-S). The top was a series of ridged peaks from 713 to 722 m in depth. The lower flanks of the south face was a 10-20o slope of fine light colored sand with a series of 1-3 m high sand dunes or ridges that were linear NW-SE. The ridges had ~50% cover of thickets of Lophelia pertusa coral. The thickets consisted of 1 m tall dead, standing and intact, Lophelia pertusa colonies. Approximately 1-10% were alive on the outer parts (15-30 cm) on top of the standing dead bases. There was very little broken dead coral rubble in the sand and there was no evidence of trawl or mechanical damage. Most of the coral was intact, and the dead coral was brown. The sand between the ridges was fine and light colored, with 7-15 cm sand waves. The upper slope steepened to 45o and 70-80o slope near the upper 10 m from the top. The top of the pinnacle had up to 100% cover of 1-1.5 m tall coral thickets, on a narrow ridge that was 5-10 m wide. The coral consisted of both Lophelia pertusa and Enallopsammia profunda. Approximately 10-20% cover was live coral of 30-90 cm. The north slope was nearly vertical (70-80o) for the upper 10 m then consisted of a series of coral thickets on terraces or ridges. No exposed rock was visible and the entire pinnacle appeared to be a classic Lophelia mud mound. No discernable zonation of macrobenthic fauna was apparent from the base to the top. Corals consisted of Lophelia pertusa, Enallopsammia profunda, Madrepora oculata, and some stylasterine hydrocorals. Dominant octocoral gorgonacea included Primnoidae (2 spp.), Isididae bamboo coral (Isidella sp. and Keratoisis flexibilis), and the alcyonaceans Anthomastus sp. and Nephthya sp. Dominant sponges consisted of several species of Hexactinellida glass sponges, large yellow demosponges (60-90 cm diameter), Pachastrellidae, and Phakellia sp. fan sponges. Echinoderms included urchins (cidaroid and Hydrosoma? sp.) and comatulid crinoids, but no stalked crinoids. Some large decapod crustaceans included Chaceon fenneri and large galatheids. No mollusks were observed but were likely within the coral habitat that was not collected. Common fish were 2 m sharks, 25 cm eels, 25 cm skates, chimaera, and blackbelly rosefish.

The Miami Terrace Escarpment (summarized from Reed et al., 2004b)
The Miami Terrace is a 65-km long carbonate platform that lies between Boca Raton and South Miami at depths of 200-400 m in the northern Straits of Florida. It consists of high-relief Tertiary limestone ridges, scarps and slabs that provide extensive hard bottom habitat. At the eastern edge of the Terrace, a high-relief, phosphoritic limestone escarpment of Miocene age with relief of up to 90 m at depths of 365 m is capped with *Lophelia pertusa* coral, stylasterine hydrocoral (Stylasteridae), bamboo coral (Isididae), and various sponges and octocorals. Dense aggregations of 50-100 wreckfish were observed here by the PI during JSL submersible dives in May 2004. Previous studies in this region include geological studies on the Miami Terrace and dredge- and trawlbased faunal surveys in the 1970s primarily by the University of Miami. *Lophelia* mounds are also present at the base of the escarpment (~670 m) within the axis of the Straits of Florida, but little is known of their distribution, abundance or associated fauna. Using the Aluminaut submersible, researchers found thickets of *Lophelia*, *Enallopsammia*, and *Madepora* growing on elongate depressions, sand ridges and mounds. Large quantities of *L. pertusa* and *E. profunda* have also been dredged from 738-761 m. Recent JSL submersible dives and fathometer transects by the PI at four sites indicated the outer rim of the Miami Terrace to consist of a double ridge with steep rocky escarpments. At one Miami Terrace Site, the narrow N-S trending east ridge was 279 m at the top and had a steep 95 m. escarpment on the west face. The east and west faces of the ridges were 30-40 degree slopes with some near vertical sections consisting of dark brown phosphoritic rock pavement, boulders and outcrops. The crest of the east ridge was a narrow plateau ~10 m wide. Observations at a second site show the crest of the west ridge was 310 m and the base of the valley between the west and east ridges was 420 m. At a third site the echosounder transect showed a 13 m tall rounded mound at a depth of 636 m near the base of the terrace within the axis of the Straits of Florida. The profile indicated that it is likely a *Lophelia* mound. West of this feature the east face of the east ridge was a steep escarpment from 567 m to 412 m at the crest. The west ridge crested at 321 m. Total distance from the deep mound to the west ridge was The most southerly transect on the Miami Terrace indicated a double peaked east ridge cresting at 521 m, then a valley at 549 m, and the west ridge at 322 m. The east face of the west ridge consisted of a 155 m tall escarpment. There were considerable differences among the sites in habitat and fauna; however, in general, the lower slopes of the ridges and the flat pavement on top of the terrace were relatively barren. However, the steep escarpments especially near the top of the ridges were rich in corals, octocorals, and sponges. Dominant sessile fauna consisted of the following *Cnidaria*: small (15- 30 cm) and large (60-90 cm) tall octocoral gorgonacea (*Paramuricea spp., Placogorgia spp., Isididae* bamboo coral); colonial scleractinia included scattered thickets of 30-60 cm tall *Lophelia pertusa* (varying from nearly 100% live to 100% dead), *Madrepora oculata* (40 cm), and *Enallopsammia profunda*; stylasterine hydrocorals (15-25 cm); and Antipatharia (30-60 cm tall). Diverse sponge populations of *Hexactinellida* and *Demospongiae* included: *Heterotella sp., Spongosorites sp., Geodia sp., Vetulina sp., Leiodermatium sp., Petrosia sp., Raspailiidae, Choristida, Pachastrellidae*, and *Corallistidae*. Other motile invertebrates included *Asteroporpa sp. ophiuroids, Stylocidaris sp*. urchins, Mollusca, Actiniaria, and Decapoda crustaceans (*Chaceon fenneri* and *Galatheidae*). Schools of

~50-100 wreckfish (*Polyprion americanus*), ~60-90 cm in length, were observed on several submersible dives along with blackbelly rosefish, skates, sharks, and dense schools of jacks.

Portales Terrace Lithoherms (summarized from Reed et al., 2004a)
The Pourtalès Terrace provides extensive, high-relief, hard-bottom habitat, covering 3,429 km2 (1,000 nm2) at depths of 200-450 m. The Terrace parallels the Florida Keys for 213 km and has a maximum width of 32 km. Reed et al. (2004a) surveyed several deep-water, high-relief, hardbottom sites including the Jordan and Marathon deep-water sinkholes on the outer edge of the Terrace, and five high-relief bioherms on its central eastern portion. The JSL and Clelia submersibles were used to characterize coral habitat and describe the fish and associated macrobenthic communities. These submersible dives were the first to enter and explore any of these features. The upper sinkhole rims range from 175 to 461 m in depth and have a maximum relief of 180 m. The Jordan Sinkhole may be one of the deepest and largest sinkholes known. The high-relief area of the middle and eastern portion of the Pourtalès Terrace is a 55 km-long, northeasterly trending band of what appears to be karst topography that consists of depressions flanked by well defined knolls and ridges with maximum elevation of 91 m above the terrace. Further to the northeast of this knoll-depression zone is another zone of 40-m high topographic relief that lacks any regular pattern (Gomberg, 1976). The high-relief bioherms (the proposed HAPC sites within this region) lie in 198 to 319 m, with a maximum height of 120 m. A total of 26 fish taxa were identified from the sinkhole and bioherm sites. Species of potential commercial importance included tilefish, sharks, speckled hind, yellow-edge grouper, warsaw grouper, snowy grouper, blackbelly rosefish, red porgy, drum, scorpion fish, amberjack, and phycid hakes. Many different species of Cnidaria were recorded, including Antipatharia black corals, stylasterine hydrocorals, octocorals, and one colonial scleractinian (*Solenosmilia variabilis*).

Tennessee and Alligator Humps, Bioherms #1-4- Pourtalès Terrace (from Reed et al., 2004a) The Tennessee and Alligator Humps are among dozens of lithoherms that lie in a region called "The Humps" by local fishers, ~14 nm south of the Florida Keys and south of Tennessee and Alligator Reefs. Three dives were made by the PI on Bioherm #3 (Clelia 597, 598, 600; Aug. 2001), approximately 8.5 nm NE of Bioherm#2 (Fig. 15). Bioherm #3 consisted of two peaks 1.05 nm apart with a maximum relief of 62 m. The North Peak's minimum depth was 155 m and was 653 m wide at the base, which was 217 m deep at the east base and 183 m at the west side. The minimum depth of South Peak was 160 m and was about 678 m in width E to W at the base. The surrounding habitat adjacent to the mounds was flat sand with about 10% cover of rock pavement. From 213 m to the top, generally on the east flank of the mound, were a series of flat rock pavement terraces at depths of 210, 203, 198, 194, 183, and 171 m and the top plateau was at 165 m. Between each terrace a 30-45o slope consisted of either rock pavement or coarse sand and rubble. Below each terrace was a vertical scarp of 1-2 m where the sediment was eroded away leaving the edge of the terrace exposed as a horizontal, thin rock crust overhang of <1 m and 15-30 cm thick. The top of the bioherm was a broad plateau of rock pavement with 50-100% exposed rock, few ledges or outcrops, and coarse brown sand. Less time was spent on the western side, which was more exposed to the strong

bottom currents. The west side of South Peak sloped more gradually than the eastern side, had more sediment, and no ledges were observed.

Fish Communities (summarized from Reed et al., 2004a)
A total of 31 fish taxa, of which 24 were identified to species level, were identified from our submersible videotapes and were associated with the deep-water sinkholes and high-relief bioherms. Few studies have directly documented deep-water fish associations with deep-water reef habitats in the western Atlantic. Most of the work has concentrated on the Charleston Bump region of the Blake Plateau off Georgia and South Carolina (Sedberry, 2001). Ross (pers. comm.) reported the following species are common to both the deep-water Lophelia reefs on the Blake Plateau off the Carolinas and those of this study: Chloropthalmus agassizi, Helicolenus dactylopterus, Hoplostethus sp., Laemonema melanurum, Nezumia sp., and Xiphias gladius. Species most common to the high-relief bioherms included deepbody boarfish, blueline tilefish, snowy grouper, and roughtongue bass. Some species were common at both the sinkhole and bioherm sites and included snowy grouper, blackbelly rosefish, and mora. In addition to the moribund swordfish observed in the Jordan Sinkhole, a swordfish was observed from the NR-1 submersible on top of Pourtales Terrace. Species of potential commercial importance included tilefish, sharks, speckled hind, yellowedge grouper, warsaw grouper, snowy grouper, blackbelly rosefish, red porgy, drum, scorpionfish, amberjack, and phycid hakes. However, the fish densities that we saw at any of the sites were in insufficient numbers to suggest commercial or recreation harvest. In fact, any of the features, both sinkholes and bioherms, could be overfished very easily since only a few individuals of the larger grouper species were present at any one site.

Benthic Communities (summarized from Reed et al., 2004a)
The benthos at the bioherm sites was dominated by sponges, octocorals and stylasterids. A total of 21 taxa of Cnidaria were sampled or observed and 16 were identified to species level. These included 3 species of antipatharian black coral, 5 stylasterid hydrocorals, 11 octocorals with one possible new species, and 1 scleractinian (Solenosmilia variabilis). Eight species were associated only with the Pourtalès sinkholes and not the bioherms; these included two species of antipatharians; the octocorals Paramuricea placomus, Plumarella pourtalesii, Trachimuricea hirta; and the scleractinian Solenosmilia variabilis. Although Gomberg (1976) found evidence of skeletal remains of the colonial scleractinians Lophelia and Madrepora in sediment samples from the terrace, we did not see any colonies at our dive sites. Sponges identified from collections included 28 taxa. Five species of stylasterine hydrocorals were Distichopora foliacea, Pliobothrus echinatus, Stylaster erubescens, S. filogranus, and S. miniatus. On the flat pavement adjacent to the base of the mounds, stylasterids and antipatharian black coral bushes were common along with sea urchins and sea stars. The densities of sponges, stylasterid hydrocorals and octocorals were very high, especially on the plateaus and terraces of the bioherms on the Pourtalès Terrace. Maximum densities of sponges (>5 cm) on the plateaus ranged from 1-80 colonies m-2. Stylasterid coral densities ranged from 9-96 colonies m-2 and octocorals 16-48. Densities of sponges (1-2 colonies m-2) and stylasterids (1-20) also dominated the terraces and slopes of the bioherm sites but

generally in lower densities than the peak plateaus whereas the octocorals generally had higher densities on the flanks (1-80 colonies m-2).