STATE OF DEEP CORAL ECOSYSTEMS IN THE CARIBBEAN REGION: PUERTO RICO AND THE U.S. VIRGIN ISLANDS

Steven J. Lutz[1,2] and Robert N. Ginsburg[1]

I. INTRODUCTION

This chapter summarizes published and unpublished information on deep corals in the wider Caribbean region (Caribbean Sea and Bahamian Archipelago) including those in the exclusive economic zone (EEZ) of United States Possessions. It summarizes the occurrences of the corals, associated species and their sea floor accumulations; it provides basic information on the geography, geology and oceanography of the region and how they interact to produce sea floor elevations; and it discusses stressors, including potential fisheries interactions.

For the purposes of this chapter deep corals are defined as those in waters below 100 m.

The territorial jurisdiction of the U.S. in the Caribbean is limited to the areas around Puerto Rico, the U.S. Virgin Islands and the uninhabited island of Navassa between Cuba and Hispaniola, illustrated in Figure 8.1. The EEZ of Puerto Rico and the U.S. Virgin Islands extends from the edge of the territorial waters to 200 nautical miles to the north and is bounded to the south by the EEZ of Venezuela, to the east by the British Virgin Islands and to the west by Dominican Republic. The EEZ of Navassa Island is bounded to the north by Cuba, to the west by Jamaica and to the east by Haiti.

As information on deep-sea corals in the U.S. Caribbean is limited, a consideration of the wider Caribbean enables a broader understanding of reported and potential deep water corals in the U.S. Caribbean.

[1]Ocean Research and Education Foundation
1300 Galiano St., Coral Gables, FL 33134

[2]Corresponding author addres: Marine Conservation Biology Institute, Public Policy Office
600 Pennsylvania Ave SE, Suite 210,
Washington DC 20003

Regional Deep-sea Research

Louis F. de Pourtalès first discovered deep-sea life in the region, including deep-water corals, in the 1860's. Pourtalès, a scientist aboard the Coast Survey steamer *Bibb*, found evidence of life off Cuba at 945 m (3,100 ft). He studied regional deep-sea corals and published comprehensive works (Pourtalès 1867, 1871). Pourtalès was also a pioneer of deep-sea dredging, a method that was used by later research cruises. These cruises were not focused on deep-sea corals and recovered specimens were incidental findings. Since the discoveries made by Pourtalès and the *Bibb* many research cruises have contributed to the understanding of deep-sea corals. Early cruises included voyages by the U.S. Coast Survey vessel *Blake* (late 1870's), U.S. Fish Commission *Albatross* (1880's) and the H.M.S. *Challenger* (1872-1876). Later research cruises included voyages by the R/V *Oregon* and R/V *Oregon II* (1950's to 1970's), R/V *Gerda* (1960's), R/V *Pillsbury* (1960's and 70's), the R/V *Eastward* (1970's), the R/V *Akademik Vernadski* (early 1970's); and R/V *Columbus Iselin* (1970's and 80's).

Beginning in the 1970's, dredging was supplemented by the use of research submersibles. These direct observations and photographs of deep-sea coral communities provided a major advance in understanding the occurrences, morphology and communities of deep-sea corals in the Straits of Florida and off the northeast slope of the Little Bahama Bank (Figure 8.1) (Neumann and Ball 1970; Neumann et al. 1977; Messing 1990; Reed et al. 2005). Other submersible research of the region includes the following: to 300 m (the "sub reef habitat") at Discovery Bay Jamaica (Lang 1974; Hartman 1973; Lang et al. 1975); to 300 m in Belize (Ginsburg and James 1979); research by Harbor Branch Oceanographic Institute (HBOI) to 1,000 m for sites in the Greater and Lesser Antilles and Netherlands Antilles (Reed pers. comm.).

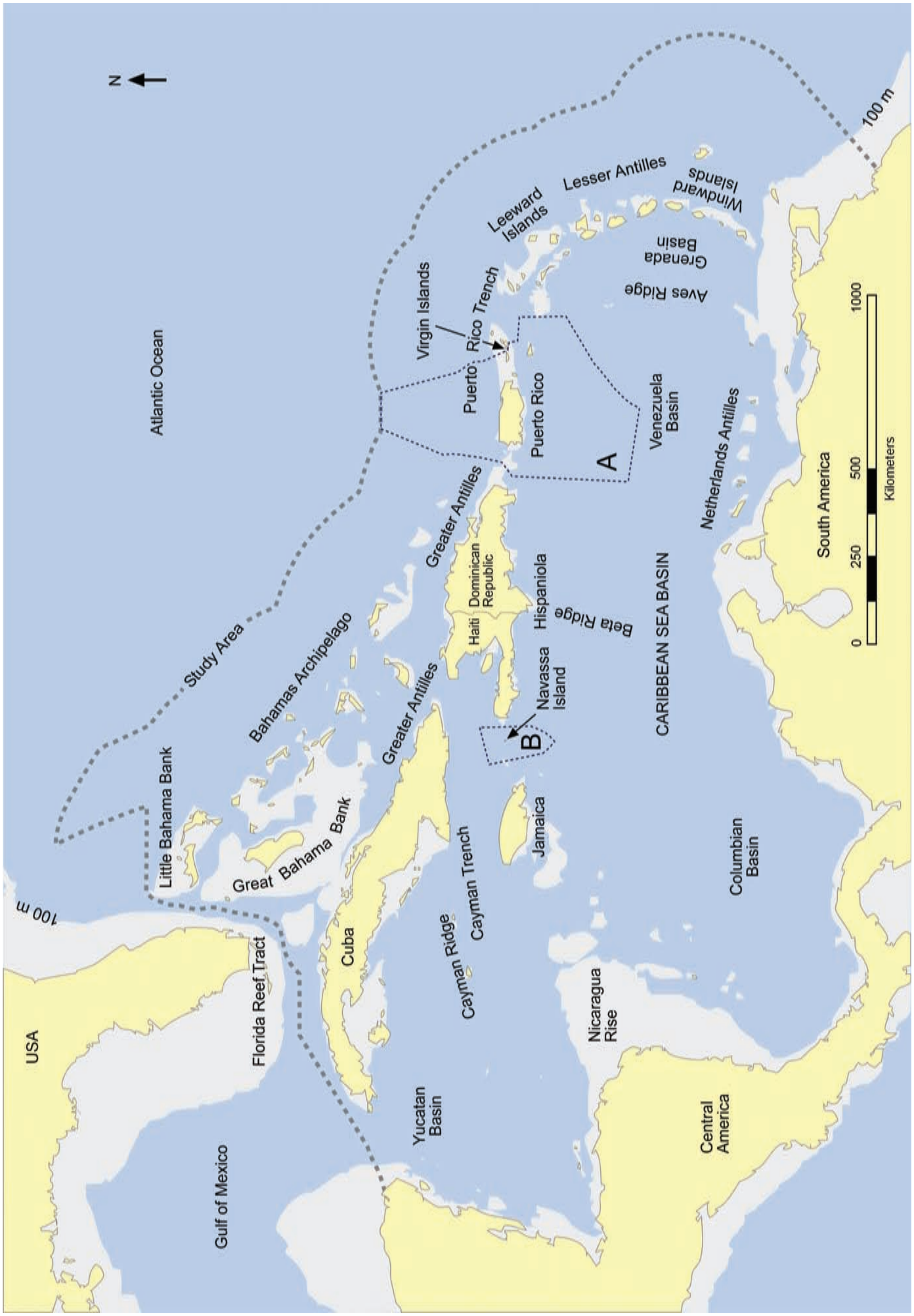


Figure 8.1. Study area showing geography and United States territories. The approximate boundaries of U.S. Caribbean EEZs are identified by the blue dashed line: A) Puerto Rico and the U.S. Virgin Islands; B) Navassa Island.

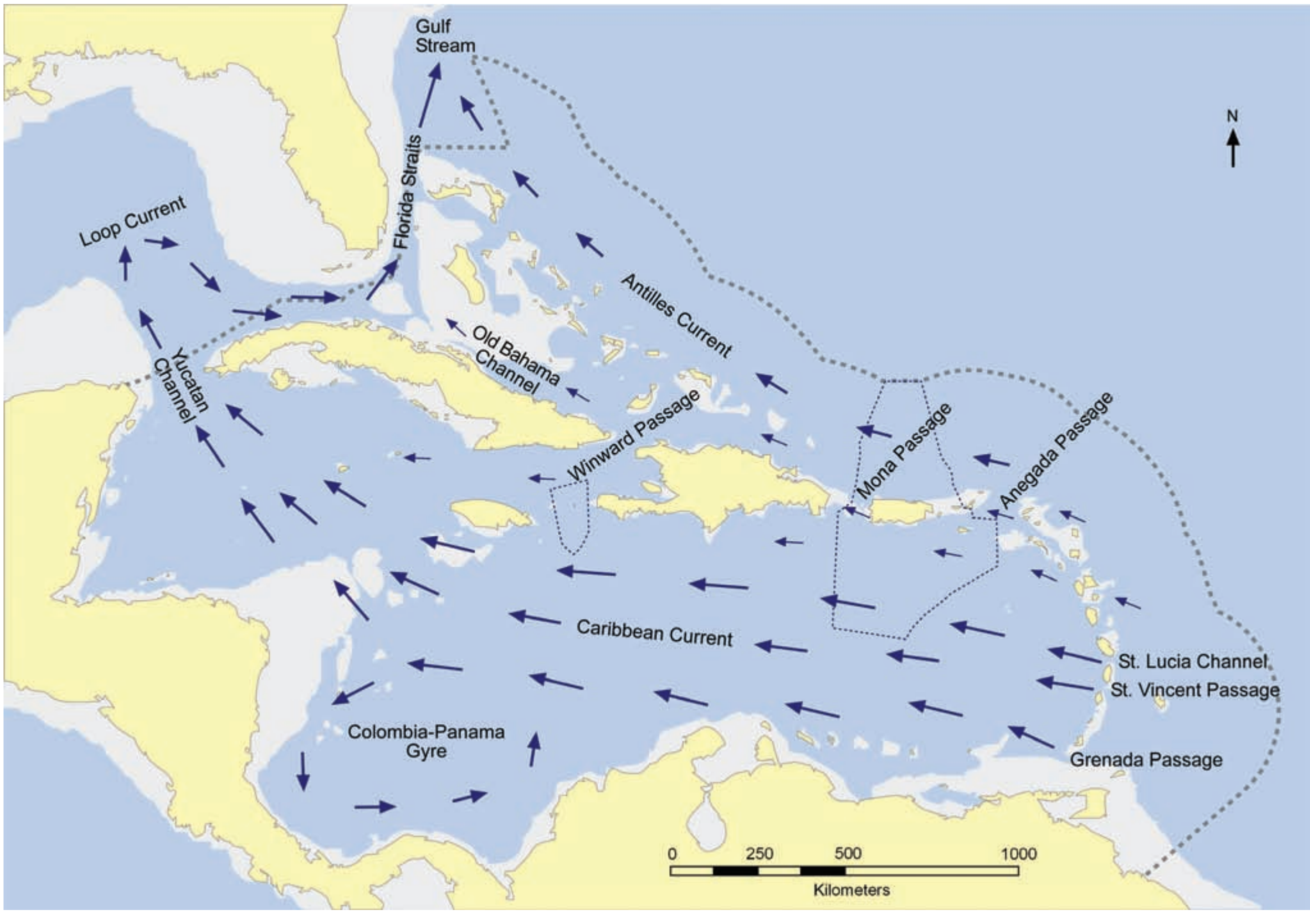


Figure 8.2. Regional currents, channels, and passages (adapted from Gyory et al. 2005a and b).

Submersible research for the U.S. Caribbean includes dives by HBOI and NOAA (Nelson and Appeldoorn 1985).

In 1979 Stephen Cairns published a seminal review of deep-water stony corals occurring in the Caribbean Sea and adjacent waters, examining eighty-eight species of deep-water corals (both solitary and colonial species) (Cairns 1979).

Recent regional deep-sea, coral related, investigations include the following: research on the distribution of deep water coral mounds in the Straits of Florida by the use of high-resolution multibeam sounding (Correa et al. 2006; McNeill 2006); continued private pharmaceutical research throughout the region and especially in the Straits of Florida interests (Reed pers. comm.); research on azooxanthellate coral communities in Colombia's Caribbean waters, off the San Bernardo-Rosario and Santa Marta Islands (Reyes et al. 2005; Santodomingo et al. 2006); and an ongoing effort to characterize seafloor habitats down to 1,000 meters within the U.S. Virgin Islands and Puerto (NOAA 2007).

II. GEOLOGICAL SETTING

The Caribbean Sea basin, the islands within it, and the Bahamas Archipelago, consisting of shallow banks and inter-bank depressions, make up this region (Figure 8.1). While most of the area is centered on the Caribbean plate several continental plates meet in this region, which are hotspots for seismic activity. Interactions between the Caribbean plate, North American plate and the South American plate produced the major topographic features and allow the Caribbean basin to be divided into four smaller basins; the Yucatan, Colombian, Venezuelan and Granada basins (Figure 8.1).

Both tectonic activity and biological activity produce features significant to deep water corals in this region. Tectonic activity is responsible for deep water trenches, ridges, basins and inter-island passages and channels (topographic features are detailed in section III). Products of biological activity include deep coral mounds and lithoherms (discussed in section IV).

III. OCEANOGRAPHIC SETTING

The Caribbean Sea is approximately 2,640,000 km^2 or 1,425,485 square nautical miles. It is a semi-enclosed basin, bounded on the west by Central America, on the south by Central and South America, on the east by the Lesser Antilles and on the north by the Greater Antilles. With a few exceptions, the Caribbean Sea generally exceeds 1,830 m (6,000 ft) in depth with many sections exceeding 3,660 m (12,000 ft) in depth. Its greatest known depth is 7,535 m (24,721 ft) below sea level in the Cayman Trench located between Cuba and Jamaica. The Puerto Rican Trench, the deepest area within the study region and deepest part of the Atlantic Ocean, lies north of Puerto Rico just outside the Caribbean, with a depth of 9,200 m (30,183 ft). The only notable extensive shallow areas are the Bahamas Banks and the Nicaragua Rise. Several gaps between islands on the north and east are major channels and passes for ocean currents connecting the Caribbean Sea with the Atlantic Ocean and Gulf of Mexico. Chief among these are the Windward Passage between Cuba and Hispaniola; the Mona Passage between Puerto Rico and Hispaniola; the Anegada Passage south of the Virgin Islands; smaller channels between islands in the Windward Island chain; and the Grenada Passage between the Lesser Antilles and the South American continent (Figure 8.2).

As a result of the exchanges with the open Atlantic, there is little seasonal variation in surface water temperatures, with a general range from 25.5^{o} C in the winter to 28^{o} C in the summer. Below the surface, water structure is highly stratified in the upper 1200 meters; weakly stratified between 1,200 and 2,000 meters and uniform below 2000 meters. This stratification is directly related to the shallow depth of passages between the Lesser Antilles. They act as sills and impede deep-water flow into the Caribbean (Gordon 1967; Gyory et al. 2005a).

Most water flows into the Caribbean Sea from the Atlantic through the Grenada, St. Vincent and St. Lucia Passages in the southeast (Figure 8.2) (Johns et al. 2002; Gyory et al. 2005a). From these passages, water flows clockwise across the Caribbean Sea basin as the Caribbean Current, the main surface circulation in the Caribbean Sea. It reaches high surface velocity (70 cm/sec) along the Netherlands Antilles and adjacent coastline of South America (Fratantoni 2001). The current then flows to the northwest, over the Colombian basin, towards the Nicaragua Rise and a trough southwest of Jamaica, with a branch forming an counterclockwise Panama-Colombia Gyre (where the current meets Central America). Strong flow (up to 60 cm/sec) has been recorded along the Panamanian and Colombian coasts (Gyory et al. 2005a).

Where currents are diverted by or constricted between landmasses, current velocities increase. The larger and deeper inter island spaces produce major seaways; the more numerous, smaller and shallower ones produce similar but smaller increases in velocity. Current velocities will also increase when water flow meets elevations of the sea floor, typically platforms or banks of calcareous deposits. For example, the passages between the large and long-lived platforms of the Bahamian Archipelago and the Florida Peninsula are sites of increased high flow.

At the Nicaragua Rise channel-like constrictions between shallow banks accelerate current. The flow and water is accelerated through the trough southwest of Jamaica and then turns west as it crosses the Cayman Ridge and enters Yucatan Channel as the Yucatan Current (Gyory et al. 2005d). Strong currents (170 cm/sec) have been reported in the Yucatan Channel (Pillsbury 1890; Gyory et al. 2005d). Water flow exits the Yucatan Channel into the Gulf of Mexico and doubles back as the Loop Current (Gyory et al. 2005c) before entering the Straits of Florida between Western Great Bahama Bank and the Florida Reef Tract where it is joined by waters passing through the Old Bahama Channel to form the Florida Current (Gyory et al. 2005b). Gyory et al. (2005b) reports strong surface flow in the Florida Current; “at times there is a 2 m/sec flow within a few miles of the (Florida) coast.” When this Florida Current exits the Straits it is joined by the Antilles Current and turns eastward and becomes the Gulf Stream *sensu stricto*.

The Antilles Current transports tropical waters from the Atlantic northwestward, flowing north of the Greater Antilles and joins the Gulf Stream off Florida past the outer Bahamas (Figure 8.2) (Rowe et al. 2005). Its waters are concentrated into a strong northward jet centered at 400 meters deep about 80-100 km wide (Lee et al. 1996). It is a considerable source of warm water for the

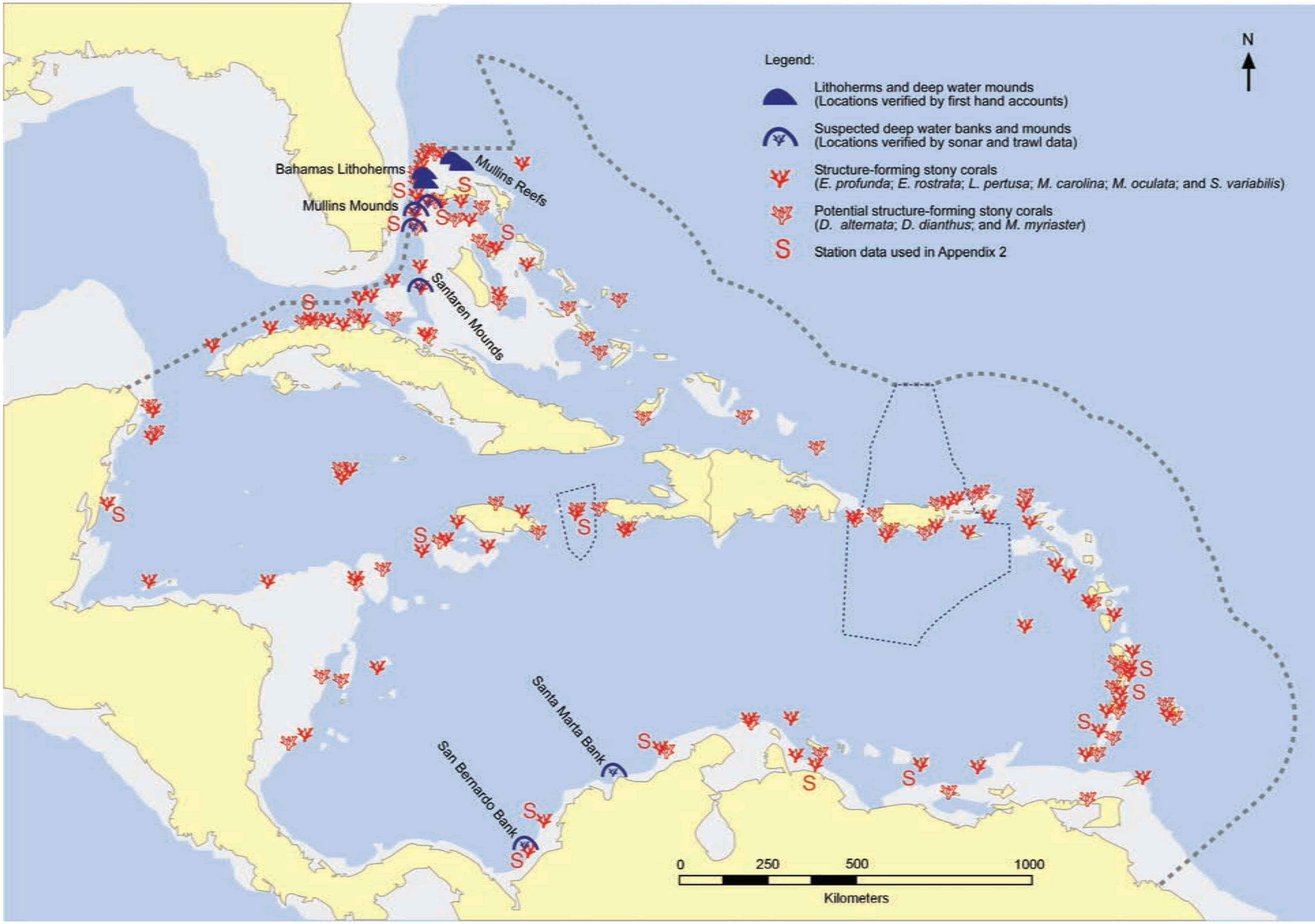


Figure 8.3. Distribution of major and potential structure-forming stony corals (scleractinia) and deep sea bio-buildups (lithoherms, mounds, and banks). The letter S identifies the locations of trawl stations referred to in Appendix 8.2 (some locations overlap). References are listed in Appendix 8.1.

CARIBBEAN

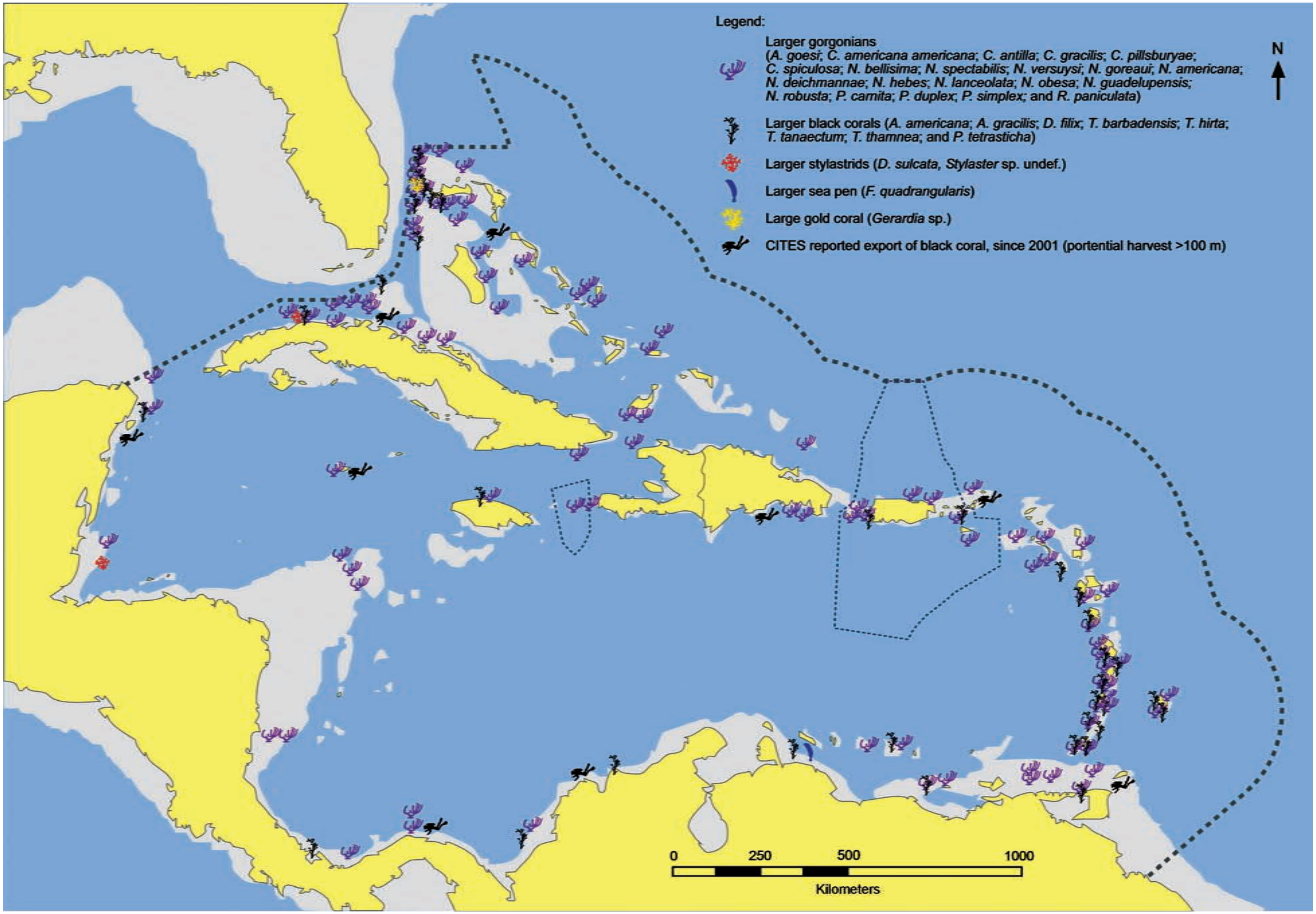


Figure 8.4. Reported distribution of potential habitat-forming corals (larger gorgonians, etc.). References include CITES 2007 and those listed in Appendix 8.1.

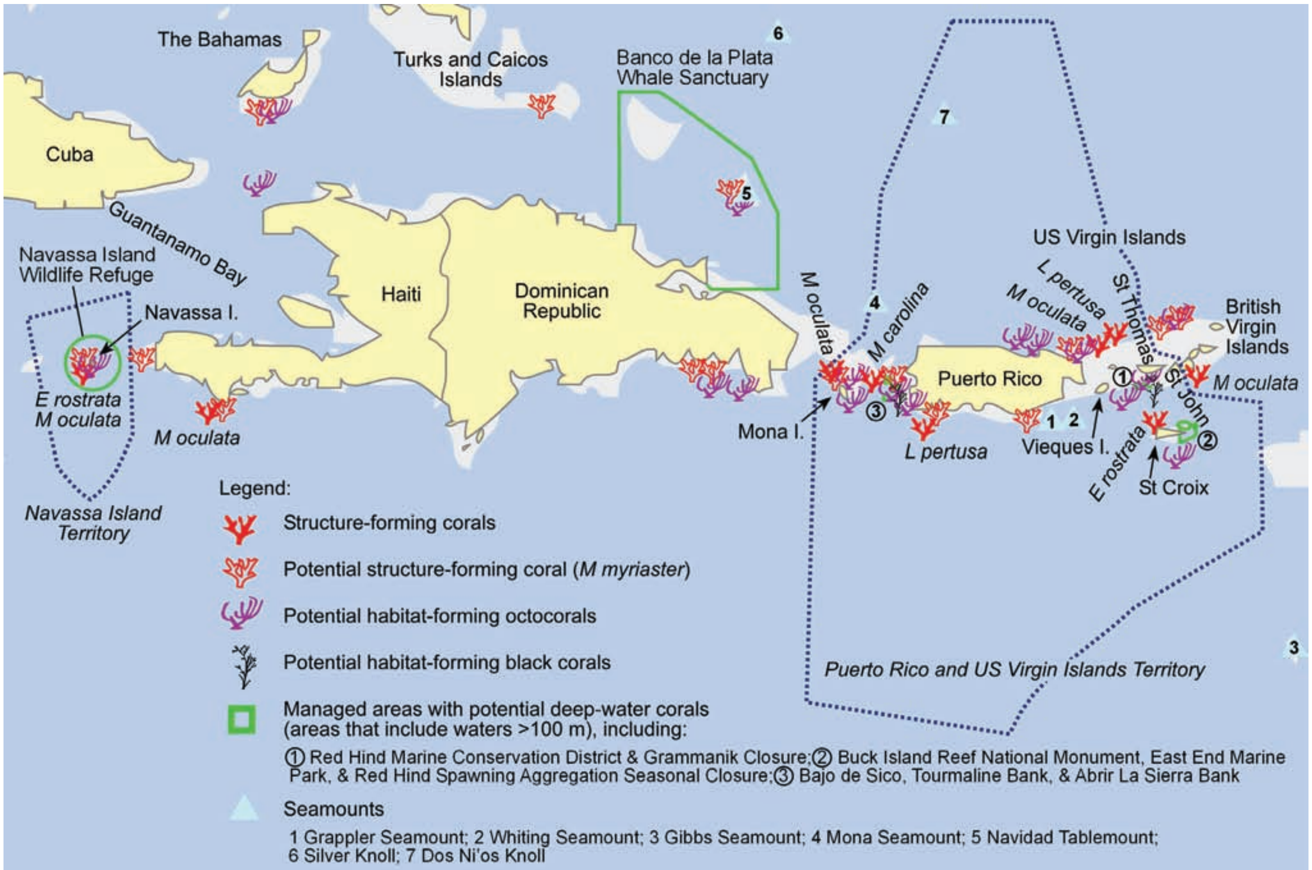


Figure 8.5. Distribution of deep water features and corals found in the U.S. Caribbean and adjacent area. References include EarthRef.org 2007 and those listed in Appendix 8.1.

Gulf Stream system. However, it occurs more as an eddy field along the Bahamas Archipelago rather than as a constant flow (Gunn and Watt 1982).

IV. STRUCTURE AND HABITAT-FORMING DEEP CORALS

A wide variety of deep-sea corals occur within the wider Caribbean region. These include stony corals, gorgonians, soft corals, stylasterids, black corals, lithotelestid coral and sea pens. The knowledge about the distribution of these corals is generally considered poor, greater for some groups than others. Cairns (1979) notes, with regard to deep-sea stony corals, that the southern coasts of the Greater Antilles (Cuba and Hispaniola) and Costa Rica are not well sampled and that the Straits of Florida (including the northwest coast of Cuba) and the Lesser Antilles are well sampled. Many species of deep-sea corals occur within the U.S. Caribbean. Species with an Antillian distribution (occurring within the Greater and Lesser Antilles) may also occur in U.S. Caribbean waters.

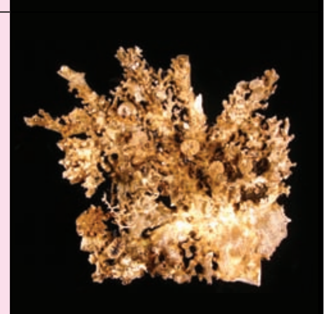
Deep-sea corals of interest to this chapter, are those termed “structure-forming” and “potential habitat-forming”. Structure-forming corals are associated with deep-sea coral habitat such as coral banks, bioherms and lithoherms. Both structure and non-structure forming corals occur within the study area (Figures 8.3, 8.4 and 8.5). Bayer (1961) describes the importance of octocorals (gorgonians and soft corals) in the reef building process and framework of shallow reefs. The importance of octocorals in deep water reefs is not yet understood but may be great in terms of contribution to framework and baffling of marine sediment, larger octocorals are expected to contribute and baffle more than smaller species. Appendix 8.1 details the attributes of each coral species including distribution.

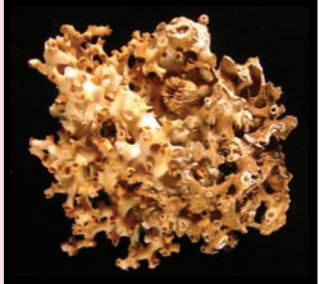
a. *Stony corals* (Class Anthozoa, Order Scleractinia)

Ninety-nine species of azooxanthellate hard corals are reported from the study area in depths below 100 m. Most are small single polyp species, shaped like cups, which often occur solitarily (e.g. Figure 8.6). Solitary corals are not reported to form significant structures. Nine species of structure-building and branched azooxanthellate hard corals are reported from the study area: *Dendrophyllia alternata*, *Desmophyllum dianthus* (also known as *Desmophyllum cristagalli*), *Enallopsammia profunda*, *Enallopsammia rostrata*, *Lophelia pertusa*, *Madracis myriaster*, *Madrepora oculata*, *Madrepora carolina* and *Solenosmilia variabilis* (Cairns pers. comm.). Table 8.1 and Figures 8.7 - 8.10 and 8.15 describe and illustrate structure-building corals.

Six species of azooxanthellate hard corals are regarded as the major structure-forming species: *E. profunda*, *E. rostrata*, *L. pertusa*, *M. carolina*, *M. oculata* and *S. variabilis*. Two genera (*Lophelia* and *Solenosmilia*) constitute two of

Table 8.1. Structure-forming deep water stony corals of the wider Caribbean region. The measurements given in brackets correspond to the approximate horizontal length for each specimen illustrated.

Species	Description	Illustration
Dendrophyllia alternata	*D. alternata* occurs throughout the North Atlantic. This coral forms bushy colonies up to 1 m in height and has been described as a reef builder. It occurs at depths of 279 - 900 m in the tropical western Atlantic. Regionally, it has been recorded with *M. oculata* and *M. myriaster* (Cairns 1979; Cairns and Stanley 1982; Le Goff-Vitry 2003). [30 cm, specimen recovered at 290.8 m off Curacao]	
Desmophyllum dianthus	*D. dianthus* (also known as *D. cristagalli*) forms densely branched colonies is reported to contribute to reef formation. It occurs globally to 2,460 m and in the tropical western Atlantic from 155 - 1,939 m. Regionally, it has been recorded with *E. profunda*, *L. pertusa*, *M. oculata*, and *S. variabilis (Cairns 1979; Cairns and Stanley 1982; Rogers 1999)*. [10.8 cm, specimen recovered at 597 m off the east coast of Florida]	
Enallopsammia profunda	*E. profunda* occurs globally and is endemic to the western Atlantic. It forms massive bushy colonies, up to 1 m thick, and is regarded a major structure-forming species. It occurs from 403 - 1,748 m and is often associated with *L. pertusa*, *M. oculata* and *S. variabilis (Cairns 1979; Cairns and Stanley 1982; Rogers 1999; Reed 2002; Freiwald et al. 2004)*. [30.7 cm, specimen recovered at 801 m in the Straits of Florida off Cuba]	
Enallopsammia rostrata	*E. rostrata* occurs in the U.S. Caribbean and globally. This coral forms massive bushy colonies and is regarded a major structure-forming species. It occurs from 300 - 1,646 m in the tropical western Atlantic. It is associated with *L. pertusa* on deep-water reefs in the north Atlantic and has been recorded with *S. variabilis*, *M. oculata*, and *E. profunda* in the wider Caribbean (Cairns 1979; Rogers 1999; Reed 2002; Freiwald et al. 2004). [31.4 cm, specimen recovered at 1,097 m off Bermuda. Specimen includes *L. pertusa* and *D. dianthus*]	
Lophelia pertusa	*L. pertusa* occurs in the U.S. Caribbean, globally, and is well known from the north Atlantic. This coral forms bushy colonies up to a meter in height and is regarded the most common reef-building deep/cold-water coal. It has been reported from waters as shallow as 25 m to as deep as 3,383 m. Regionally, it is most common between 500 - 800 m. *L. pertusa* is often found associated with *E. profunda* and has been recorded with *D. dianthus*, *M. carolina*, *M. oculata*, and *S. variabilis* in the wider Caribbean (Cairns 1979; Cairns and Stanley 1982; Rogers 1999; Dawson 2002; Reed 2002; Freiwald et al. 2004). [24.3 cm, specimen recovered at 793 m in the Straits of Florida off Cuba]	

Species	Description	Ilustration
Madracis myriaster	*M. myriaster* occurs in the U.S. Caribbean and throughout the wider Caribbean. It forms bushy colonies and is reported as a main framework builder of deep-water coral banks in Colombian waters. Regionally, it has been recorded with *M. carolina*. It occurs from 37 - 1220 m in the tropical western Atlantic (Cairns 1979; Reyes et al. 2005; Santodomingo et al. 2006). [30.2 cm, specimen recovered at 200 m off Jamaica]	
Madrepora carolina	*M. carolina* occurs in the U.S. Caribbean and throughout the tropical western Atlantic. This coral forms bush-like colonies with a thick base and is associated with cold-water reefs as a structure-forming species. It occurs from 53 - 801 m (most commonly between 200 - 300 m). Regionally, it has been recorded with *E. profunda*, *E. rostrata,* and *D. dianthus* (Cairns 1979; Dawson 2002; Freiwald et al. 2004). [27.6 cm, specimen recovered at 333 - 375 m in the northwest Providence Channel off Grand Bahama Island]	
Madrepora oculata	*M. oculata* occurs in the U.S. Caribbean and globally. This coral forms large bushy colonies and is regarded a major structure-forming species. It occurs from 55 - 1,950 m. It is commonly associated with *L. pertusa* in the eastern and northeastern Atlantic and Mediterranean Sea. Regionally, it has been recorded to occur with *E. profunda*, *E. rostrata, D dianthus, L. pertusa*, and *S. variabilis* (Cairns 1979; Rogers 1999; Dawson 2002; Reed 2002; Freiwald et al. 2004). [24.1 cm, specimen recovered at 634 m in the Gulf of Mexico]	
Solenosmilia variabilis	*S. variabilis* occurs globally. This coral forms bushy colonies and is regarded a major structure-forming species. It occurs from 220 - 2,165 m and is known from the northern slope of the Little Bahama Bank from 1,000 - 1,300 m, where it is associated with deep-water banks. It is often found associated with *L. pertusa*, *Madrepora* spp., and *E. profunda*, and has been recorded with *E. rostrata* and *D. dianthus* in the wider Caribbean (Cairns 1979; Mullins et al. 1981; Cairns and Stanley 1982; Rogers 1999; Freiwald et al. 2004). [20.7 cm, specimen recovered at 1,000 m in the North Atlantic Ocean]	

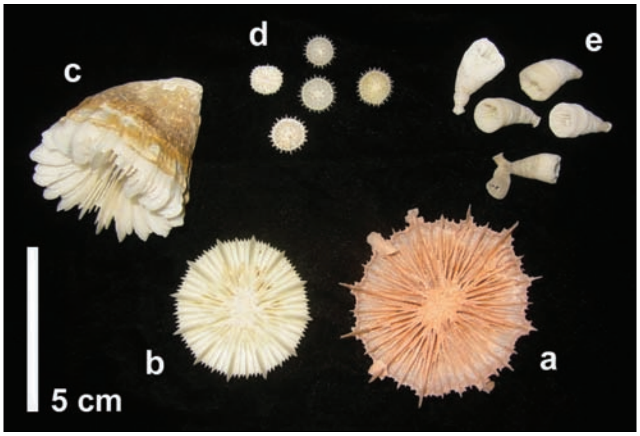


Figure 8.6. Assorted solitary deep water stony corals: a) *Stephanocyathus diadema*, from The Bahamas at 1,779 m; b) *S. laevifundus*, from St. Vincent at 576-842 m; c) *Caryophyllia ambrosia caribbeana*, from Surinam at 1,318-1,343 m; d) *Deltocyathus eccentricus*, from Jamaica at 457-558 m; e) *Bathypsammia tintinnabulum*, from the Straits of Florida at 689-699 m (*B. tintinnabulum* is not known from the region but is presented here for comparison).

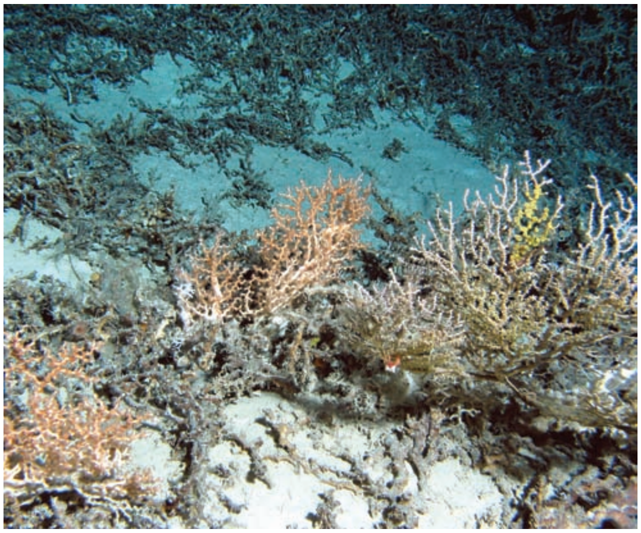


Figure 8.7. Deep sea coral habitat (*M. oculata* and *Paramuricea* sp.) at 2,230 m in the Bahamas (Straits of Florida off Cat Cay). Photo credit: Reed 2006.

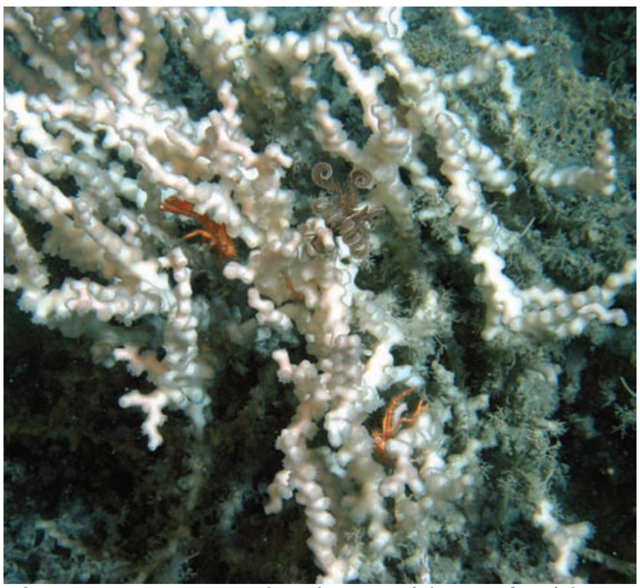


Figure 8.8. Structure-forming coral (*E. profunda*) providing habitat for unidentified crustaceans and a crinoid. Photographed from submersible at 2,721 m in Straits of Florida. Photo credit: Reed 2006

Figure 8.9. Close up of the potential structure-forming coral *D. alternata,* sampled by submersible, from the Netherlands Antilles, at 290.8 m.

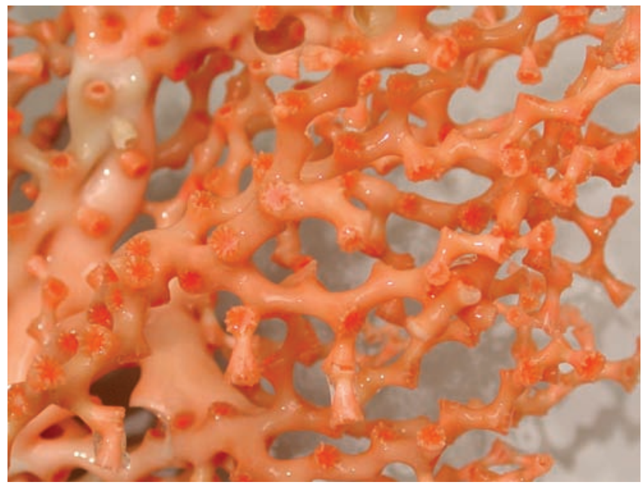


Figure 8.10. Close up of the major structure-forming coral *M. oculata*, sampled by submersible from the Straits of Florida at 746.4 m. Photo credit: Reed 2006.

the four major constituents of known world-wide deep-water coral banks at depths of 400 - 700 m (Cairns and Stanley 1982). Both *M. oculata* and *M. carolina* are regarded as minor constituents of coral banks in the Straits of Florida (Cairns 1979). *Solenosmilia* is the dominant structure-building coral found on deep coral banks north of the Little Bahama Bank (Reed 2002) (Table 8.2, Mullins Reefs), where *Madrepora* and *Enallopsammia* also occur. *Lophelia* and *Enallopsammia* are common components of the lithoherms east of the Little Bahama Bank in the Straits of Florida (Reed 2002) (Table 8.2, Bahamas Lithoherms). Four major structure-forming species *E. rostrata*, *L. pertusa*, *M. oculata* and *M. carolina* have been reported from the U.S. Caribbean.

Another major structure-forming species, *Oculina varicosa*, occurs throughout the Caribbean. *O. varicosa* is a facultative zooxanthellate species (i.e. it occurs with zooxanthellate in shallow water and without in deeper water). *O. varicosa* is reported to 152 m and forms bushy colonies several meters in height (commonly at 45 - 91 m). It is described as a main framework builder of deep-water banks off Florida's central eastern coast. However, as no deep water banks of *O. varicosa* have been reported from the wider Caribbean (only shallow water species) this species is not considered further.

Madracis myriaster, an azooxanthellate stony coral found throughout the wider Caribbean, is reported to form bushy shaped colonies and significantly contribute to habitat formation on

Table 8.2. Scleractinian-dominated coral habitats ("reefs") of the wider Caribbean. Locations are identified in Figure 8.3.

Location	Description
Mullins Reefs	This site is characterized by a region of deep coral mounds (bioherms) on the northern deep shelf edge of the Little Bahama Bank at depths of 1000-1300 m. Mounds 5-40 m in height are reported. The bioherms are dominated by the major structure forming deep water coral *Solenosmilia* sp., *Lophelia* is reportedly absent. An area of approximately 1500 km^2 is described. Site profiled via. submersible, seismic reflections, and dredges (Mullins et al. 1981; Reed 2002).
Bahamas Lithoherms	This site is characterized by a region of lithoherms on the western shelf edge of the Little Bahama Bank in the Straits of Florida at depths of 300-500 m. Pinnacles 30-50 m in height are reported. The lithoherms are dominated by the major structure forming deep water coral *L. pertusa*. *E. profunda* and *M. oculata* are also present. *D. alternata*, *A. fecunda*, and the larger black coral *Distichopathes filix* have been reported from the region. An idealized lithotherm from this site is illustrated in Figure 8.23. Wreckfish have been reported in association with these lithoherms. An area of approximately 330 km^2 is described. Site profiled via. submersible, seismic reflections, and dredges (Neumann and Ball 1970; Neumann et al. 1977; Messing et al. 1990; Reed 2002).
Mullins Mounds	Deep-water mounds (banks and lithoherms) and cemented hardgrounds are described off Bimini and entering the New Providence Channel. The mounds are described to continue northward and connect to the Bahamas Lithoherms. Site profiled via. coring and seismic reflections (Mullins and Neumann 1979).
Santaren Mounds	Deep water mounds are described at 500-800 m along the western shelf edge of the Great Bahama Bank, running from the Santaren Channel to the Straits of Florida. Mounds >30 m were reported. Site profiled via. multi-beam side scan sonar and drop camera (Correa et al. 2006; Grasmueck et al. 2006).
Santa Marta Bank	This site is described as a deep water coral bank on the northwestern shelf of Colombia at a depth of 200 m. The bank is dominated by the potential structure-forming deep water coral *M. myriaster. Anomocora fecunda*, *Coenosmilia arubuscula*, and *Polymyces fragilis* were reported abundant. Black corals and octocorals were reported numerous and include *Antipathes columnaris*, *Elatopathes abetina*, *Sticopathes* spp., *Chrysogorigia desbonni*, and *Nicella guadalupensis*. Site profiled via echosounding and dredges (Reyes et al. 2005).
San Bernardo Bank	This site is described as a deep water coral bank on the northern shelf of Colombia at a depth of 155-160 m. The bank is dominated by the potential structure-forming deep water coral *M. myriaster*. Other species considered to contribute to habitat include *A. fecunda*, *C. arubuscula*, *Eguchipsammia cornucopia*, *M. oculata*, *Javania cailleti*, *Caryophyllia berteriana*, *P. fragilis*, *Thalamophyllia riisei*, *Oxysmilia rotundifolia*, and other *Madracis* species. Flounder, basslets, and scorpionfish were the most abundant species of fish recovered. *Madracis* thickets and coralline mounds (up to 10 m in height) are reported. Site profiled via. echosounding, dredges, and grab sampling (Reyes et al. 2005; Santodomingo et al. 2006).

deep-water coral banks off Colombia (Reyes et al. 2005; Santodomingo et al. 2006). Investigations with sonar profiling and trawl and grab sampling suggest deep water banks from two locations off Columbia's continental shelf at depths of 155 - 200 m; Santa Marta and San Bernardo Banks. Table 8.2 details these locations. Relief, "suggestive of reef structures", was reported. *M. myriaster* occurs in the U.S Caribbean (Figure 8.5). Reyes et al. (2005) also report a shallower azooxanthellate coral community off Colombia at a depth of 70 m. *Cladocora debilis* was noted as the main matrix builder of this community. As this community occurs at less than 100 m in depth, *C. debilis* is not considered further.

Two other potential structure-forming species, *D. alternata* and *D. dianthus* are found throughout the wider Caribbean, but have not been reported from the U.S. Caribbean. *D. alternata* is found throughout the North Atlantic and forms bushy colonies to 1 m in height. It has been described as a reef builder (Le Goff-Vitry 2003) and has been recorded with *M. oculata* and *M. myriaster* in the wider Caribbean. *D. dianthus* is reported to form densely branched colonies and to "contribute to

Figure 8.11. Large deep-sea black coral (*Leiopathes glaberrima*) recovered from 304 m in the North Atlantic (approximately 116 cm in height).

Figure 8.12. Large deep water gorgonian (*Paracalyptrophora* sp.) and deep water sponge (*Pachastrellidae* sp.). Photographed from submersible at 2,193 m in The Bahamas (Straits of Florida) (gorgonian is approximately 53.5 cm in height). Photo credit: Reed 2006.

Figure 8.13. Bubblegum coral (*Paragorgia johnsoni*) sampled by submersible from 620 m west of the Little Bahama Bank in the area of Bahamas Lithoherms (approximately 51 cm in height). Photo credit: Amy Wolfrum.

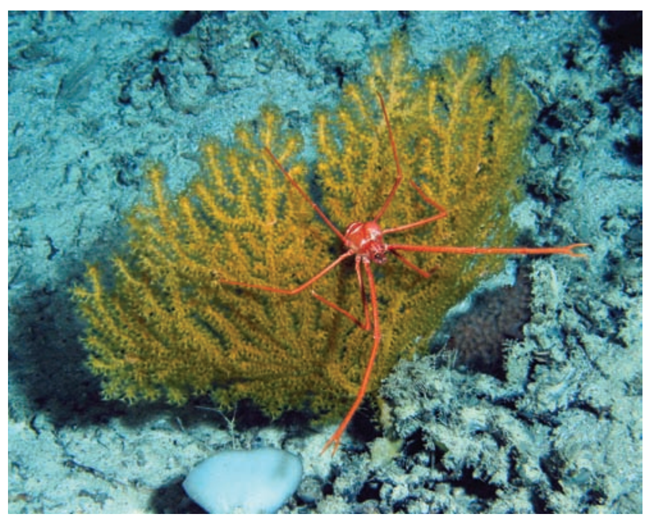


Figure 8.14. Large deep water gorgonian (*Paramuricea* sp.) providing habitat for an unidentified crustacean. Photographed from submersible at 2631 m in The Bahamas (Straits of Florida off Cat Cay) (gorgonian is approximately 33 cm in width). Photo credit: Reed 2006.

Figure 8.15. Bamboo coral (*Keratoisis flexibilis*) on deck and utilizing a deep water structure-forming coral (*E. profunda*) as substrate (bamboo coral is approximately 34 cm in height). Coral recovered from 806.5 m by submersible. Photo credit: Reed 2006.

Figure 8.16 Large deep water gorgonian *Nicella americana*, collected from 165 m off the Dominican Republic (approximately 53 cm in width).

reef formation" (Cairns and Stanley 1982). *D. alternata* and *D. dianthus* are detailed in Table 8.2.

The distribution of major and potential structure-forming species in the study area generally follows the Antillian arc and the margins of the continental shelves of South and Central America (Figure 8.3).

b. *Black corals* (Class Anthozoa, Order Antipatharia, Families Cladopathidae and Schizopathidae)

Approximately thirty-two species of antipatharia are reported from the wider Caribbean in depths below 100 m, with thirteen considered potentially important habitat-forming species. Eight species are reported from the U.S. Caribbean, with five considered potentially important habitat-forming species: *Antipathes americana*, *A. caribbeana*, *Plumapathes pennacea*, *Tanacetipathes hirta*, *Parantipathes tetrasticha*. Opresko and Sanchez (2005) list two regional black coral species of commercial importance: *A. atlantica* and *A. gracilis.* Both species are considered potentially habitat-forming. The maximum reported height of deep water antipatharians occurring in U.S. Caribbean waters is 61 cm (*P. tetrasticha*). Figure 8.11 illustrates a large deep-sea black coral.

c. *Gold corals* (Class Anthozoa, Order Zoanthidea)

One species of gold coral is reported from the Caribbean region. Messing et al. (1990) describe a large zoanthidean tentatively identified as *Gerardia* sp. in Bahamian waters. This species is considered habitat-forming as colonies 1 m tall and 1.5 m across were reported. *Gerardia* sp. was found in dense stands on lithoherm crests, where current flow was the greatest.

d. *Gorgonians* (Class Anthozoa, Order Gorgonacea)

Approximately one hundred and forty-seven species of gorgonians are reported from the wider Caribbean at depths below 100 m. Thirteen species are reported from the U.S. Caribbean (more are expected). Forty-four species are considered potential habitat-forming species, with twelve occurring in U.S. Caribbean waters: *Acanthogorgia goesi*, *Callogorgia americana Americana*, *Diodogorgia nodulifera*, *Ellisella barbadensis*, *E. elongata*, *Narella bellissima*, *N. pauciflora*, *N. deichmannae*, *N. obesa*, *N. guadelupensis*, *Riisea paniculata* and *Swiftia exserta*. The maximum reported height of a wider Caribbean deep water gorgonian is 300 cm (*Pseudoplexaura porosa*), and 244 cm for U.S. Caribbean waters (*E. barbadensis*). Two species of red or pink corals (family Coralliidae); 13 species of bamboo coral (family Isididae); one species of bubblegum coral (family Paragorgiidae); and 34 species of red tree coral (family Primnoidae) are known from the region. Detailed distribution data (beyond occurring in the western Atlantic) was available for only 54% (82) of known deep water gorgonians. Height and/or width data was available for 34% (50) of known deep water gorgonians. It is expected that many more gorgonians are potential habitat-forming species. Figures 8.12 - 8.16 and 8.17 illustrate deep-sea gorgonians.

Figure 8.17. Deep water coral habitat at 829.4 m in The Bahamas (Straits of Florida). A variety of deep-sea corals are illustrated, including the soft corals *Anthomastus agassizi* (red in color) and *Pseudodrifa nigra* (brown in color). Photo credit: Reed (2006).

Figure 8.18. Sea pens (*Renilla reniformis*), from Curacao, Netherlands Antilles (each approximately 2 cm in width). This species occurs to 108 m or more.

e. *True soft corals* (Class Anthozoa, Order Alcyonacea and Suborder Stolonifera)

Twenty species of true soft corals (Alcyonacea) are reported from the wider Caribbean in depths below 100 m. Only one is considered a potentially important habitat-forming species; *Neospongodes portoricensis*, with a maximum reported height of 30 cm. Only one is reported from the U.S. Caribbean: *Stereotelesto corallina*. Detailed distribution data was available for 35% (7) of known deep water alcyonaceans. Figure 8.17 illustrates a deep-sea soft coral.

f. *Pennatulaceans* (Class Anthozoa, Order Pennatulacea)

Pennatulaceans, or sea pens, live in soft-sediment and are known to form extensive groves in some areas (Morgan et al. 2006). Eight deep-water sea pens are reported from the wider Caribbean. One species is reported from the U.S.

Figure 8.19. Large deep water stylasterid (*Distichopora sulcata*) dredged off Havana, Cuba (approximately 33 cm in width).

Figure 8.20. Deep-sea stylasterid (*Stylaster miniatus*) providing substrate for a solitary deep water stony coral (*Paracyathus pulchellus*) and other unidentified invertebrates, the Straits of Florida, at 191 m (stylasterid is approximately 10 cm in width).

Caribbean: *Renilla reniformis*, with a maximum reported height of 6.5 cm it is not considered an important habitat-forming species (illustrated in Figure 8.18). It is bioluminescent. The maximum reported height of a deep water pennatulacean occurring in the wider Caribbean is 210 cm, for *Funiculina quadrangularis*. According to Picton and Howsen (2002) *F. quadrangularis* is often found in very large colonies. This order contains the deepest deep-sea corals, many occur below 1,000 m, with one species (*Umbellula magniflora*) reported from 6,300 m in the Caribbean Sea basin. Most deep water sea pens are found on basin floors, rises and trenches throughout the Caribbean region including the Caribbean Sea basin, Aves Ridge and Puerto Rico and Cayman Trenches. Height and width data were available for 25% (2) of known deep water sea pens.

g. *Stylasterids* (Class Hydrozoa, Order Anthoathecatae, family Stylasteridae)

Forty-one species of stylasterids are reported from the wider Caribbean at depths below 100 m. Only one is regarded as a potential habitat-forming species; *Distichopora sulcata* (Figure 8.19), with a maximum reported height of 25 cm and width of 30 cm, endemic to the waters off northwest Cuba. However, additional larger stylasterids are likely - during a submersible dive James and Ginsburg (1979) recorded a larger unidentified stylasterid measuring “about 30 cm across” growing out from a rock wall at 290 m off Belize Glovers Reef). Fifteen smaller (non habitat-forming) species (<25 cm in height or width) occur in U.S. Caribbean waters. All wider Caribbean stylasterids are referenced by Cairns (1986).

Puerto Rican waters contain two stylasterid species: *S. atlanticus* and *S. spatula*. Stylasterids have been recorded with many other species of deep water corals and can serve as substrate allowing invertebrates to gain a foothold (Figure 8.20).

Deep Coral Habitat Types

Deep sea corals often occur as individual and/or scattered colonies on the sea floor (Cairns 1979, 2000). More numerous colonies can form clumps or thickets of varying density (Mullins et al. 1981; Messing et al. 1990) (Figures 8.7, 8.8 and 8.10). These bush-like aggregations can form habitat on suitable substrate and contribute to the formation of deep sea bio-buildups through their skeletal debris and by trapping pelagic sediment. Two types of deep-sea bio-buildups are reported from the wider Caribbean region (deep coral mounds and lithoherms); their morphologies and compositions, and deep-sea coral banks are discussed below. Seamounts are also discussed.

Deep Coral Mounds

A variety of terms have been used for the unconsolidated sea floor elevations with which deep-sea corals occur. In general these structures are described as "capping mounds of unconsolidated sediment and coral rubble, which are often built on an underlying lithified substrate"

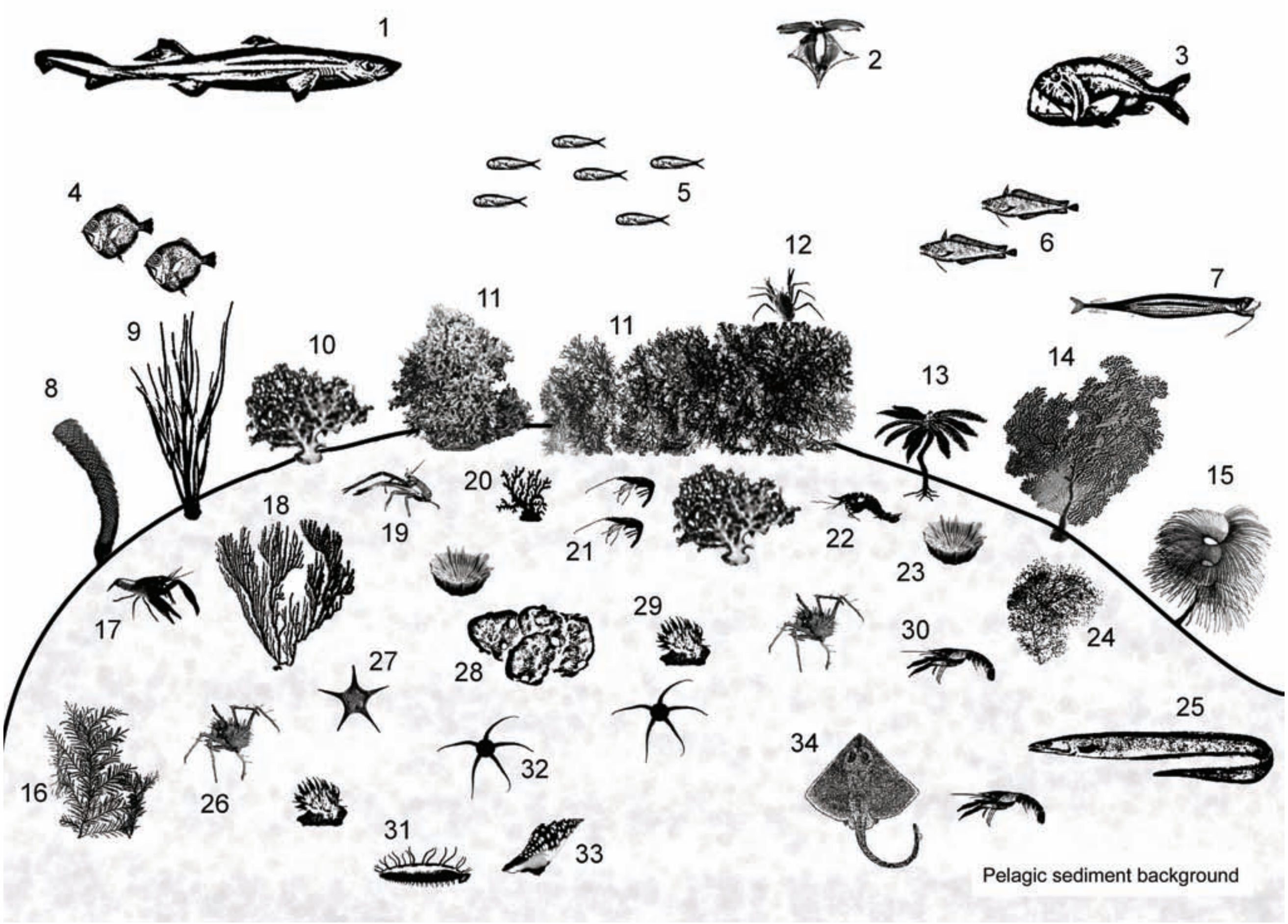


Figure 8.21. Idealized regional deep coral mound (not to scale). Associated benthos as follows: 1) *Etmopterus* sp. (dogfish sharks); 2) pteropods; 3) *Brotulid* sp. (fangtooths); 4) *Diretmus* sp. (dorys); 5) *Myctophid* sp. (lanternfish); 6) *Macrouid* sp. (grenadiers); 7) *Stomias* sp. (dragonfish); 8) *Hexactinelida* sp.; 9) *Cirripathes* sp.; 10) *S. varibilis*; 11) *M. oculata*; 12) *Galatheid* sp. (deep-sea crabs); 13) crinoids; 14) gorgonians; 15) *Iridogorgia* sp.; 16) *Antipathes* sp.; 17) *Macruan* sp.; 18) *Keratoisis* sp.; 19) *Munida* sp. (squat-lobsters); 20) *Stylasteria* sp.; 21) *Nematocarcinidae* sp. (deep-sea shrimp); 22) *Glyphocrangon* sp.; 23) solitary corals; 24) *Chrysogorgia* sp.; 25) *Synaphobranchus* sp.; 26) *Lithodid* sp.; 27) *Nymphaster* sp.; 28) porifera; 29) *Alcyonaria* sp.; 30) *Nephropsis rosea*; 31) *Holothurian* sp. 32) *Ophiuroid* sp.; 33) *Turrida* sp.; 34) *Cruriraja* sp. (skates). Sources listed in Appendix 8.2.

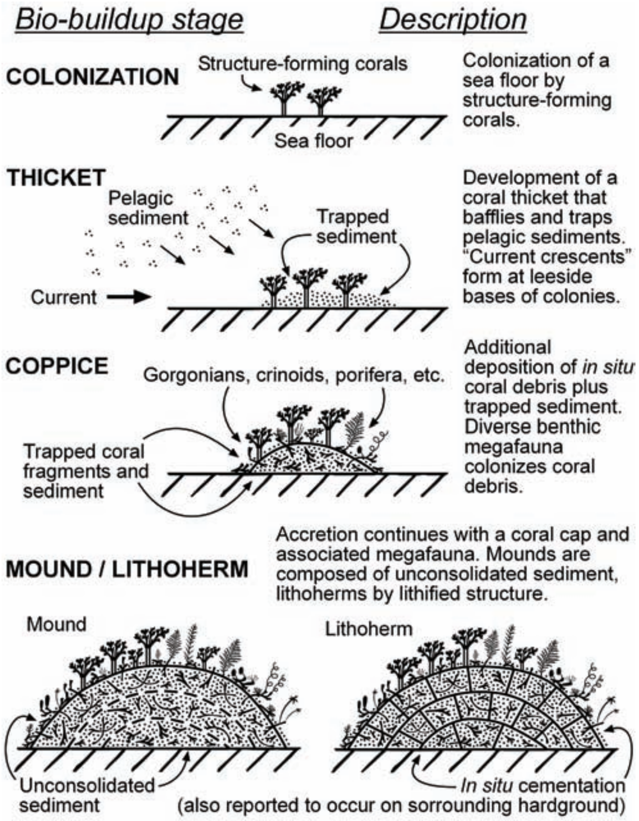


Figure 8.22. Hypothetical development sequence of deep coral mounds (not to scale). Figure adapted from Mullins et al. 1981, based in part on Squires 1964 and Neumann et al. 1977.

The most extensive known occurrence of deep coral mounds reported in the Caribbean is found on the northern slope of Little Bahama Bank at depths between 1,000 to 1,300 m (Mullins et al. 1981). Here, where bottom currents were reported to be as much as 50 cm/sec and temperatures of 4-6º C, numerous banks are inferred to occur in an area of 2,500 km^2 with relief over the surrounding sea floor ranging from 5-40 m (ibid). The surface sediments of these mounds consist predominantly of pelagic organisms such as planktonic foraminifera and pteropods, with small amounts of coral skeletal debris and other invertebrates in the coarser grain sizes (ibid). These mounds appear to be developed by the baffling action of the thickets of deep corals that traps pelagic sediments and build on unconsolidated mounds. Other coelenterates found on these mounds include gorgonians, alcyonaceans and antipatharians (Figure 8.21). Mullins et al. (ibid) present a useful schematic model of the sequential development of these mounds (Figure 8.22) based on previous publications (Squires 1964; Neumann et al. 1977). Figure 8.3 illustrates the distribution of deep coral mounds. Table 8.2 details these occurrences.

(Reed 2002). These structures have been called deep-water coral banks; deep-sea coral mounds; colony thickets; coral thickets; coral structures, deep-water coral reefs; and bioherms (Stetson et al. 1962; Squires 1964; Neumann et al. 1977; Mullins et al. 1981; Reed 2002). The accepted geological term for mounds rich in unbound skeletal debris is biostrome (Bates and Jackson 1987). In what follows we use "deep coral mounds" for this type of buildup.

In the study region these deep coral mounds occur in areas with strong currents and/or upwelling where they accrete by a combination of coral skeletal debris and trapped suspended sediment swept into coral structures (Mullins et al. 1981). The resulting structures range in height over the surrounding sea floor from a few meters to 50 m (Reed 2002).

Lithoherms

In contrast to the unconsolidated deep coral mounds, lithoherms (Neumann et al. 1977; Messing et al. 1990; Reed 2002) are composed of varied communities of benthic organisms growing on successive crust-like layers of friable limestone. Lithoherms have also been referred

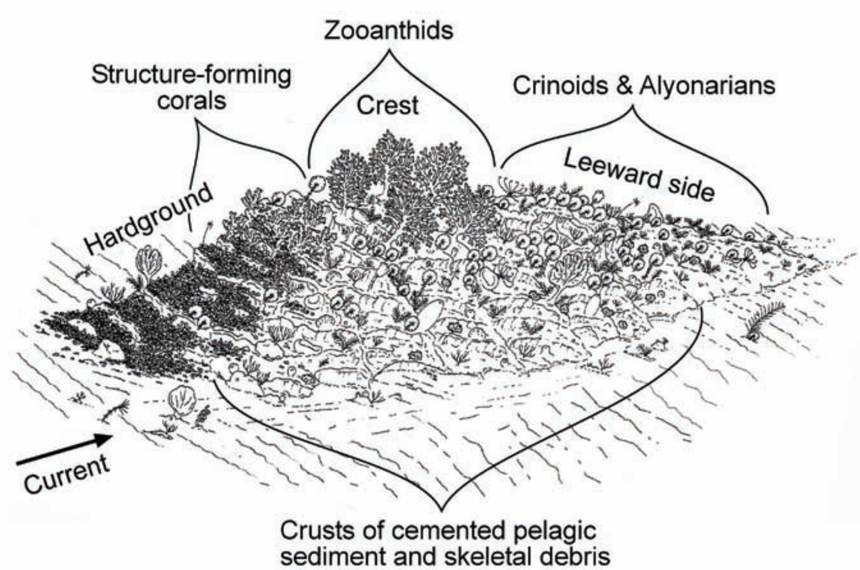


Figure 8.23. Idealized lithoherm of the Straits of Florida (not to scale). Figure adapted from Messing et al. 1990.

to as bioherms, deep-water biohermal buildups and muddy carbonate buildups (Neumann et al. 1977; Reed 2002). Regionally, they are reported only from the eastern side of the Straits of Florida at depths between 500 and 700 m below sea level. According to Messing et al. (1990) the lithoherms are elongate mounds up to 300 m long and 50 m high. Their surfaces show successive friable limestone layers composed of fine-grained carbonate skeletal sediment with variable amounts of coral debris. The cement of the crust-like layers of lithoherms is composed of magnesium calcite with 10-14 mole % magnesium (Wilbur and Neumann 1993).

Messing et al. (1990) describe and illustrate (Figure 8.23) a distinct, tripartite biozonation of one of these lithoherms, which they ascribe to variations in current velocity produced by the mounds, also described by Genin et al. (1986). On the steeper margin or side facing into the current (upcurrent margin) where velocities may reach 100 cm/sec, corals (*L. pertusa*) predominate ("corals" in Figure 8.23). A zone of zoanthids forms along the upcurrent crest (gold coral = "zoanthids" in Figure 8.23) and crinoids and alcyonarians occur behind this zone ("crinoids and alcyonarians" in Figure 8.23) and on the flanks of the lithoherms (Genin et al. 1986). Figure 8.3 illustrates the distribution of known lithoherms. Table 8.2 details these occurrences.

Deep-sea Coral Banks

Reyes et al. (2005) describes two azooxanthellate deep water coral habitats (banks) at depths greater than 100 m off Colombia's Caribbean shelf. Substrate included hard bottom limestone (fossilized reef) and metamorphic rocks. It is unclear to what extent these corals are building upon themselves (i.e. as with bio-buildups) or simply opportunistically taking advantage of suitable substrate (limestone platform). Reyes et al. (ibid) suggested similarities with shallow water reefs and stated a need for further investigations. Figure 8.3 illustrates the distribution of known deep water coral banks. Table 8.2 details these occurrences.

Seamounts

Deep sea corals are known as intimate associates of seamounts throughout the world (Freiwald et al. 2004; Clark et al. 2007). EarthRef.org (2007) lists four seamounts occurring within the U.S. Caribbean waters: Grappler Seamount; Whiting Seamount; Mona Seamount; and Dos Ni'os Knoll. Figure 8.5 illustrates their locations. The potential that seamounts throughout the region are home to deep water coral ecosystems deserves further attention.

Relevant Geological and Oceanographic Processes

Five processes play significant roles in the distribution and composition of bio-buildups: (1) foremost is amplification of current velocities by submarine topography; (2) the biological production of skeletal debris; (3) physical trapping and stabilization of sediment by thickets of corals, sponges and alcyonarians to build elevated accumulations; (3) availability of hard substrate for recruitment of corals; and (4) the submarine cementation that produces lithoherms. Process 3 is the most significant for deep water banks.

Increased current velocities appear essential for flourishing deep corals both because they can locally sweep away sediment to expose the hard substrate that encourages settlement of coral larvae and they provide a supply of plankton on which the corals feed. In addition, increased currents bring a continued supply of pelagic sediment to help build local relief (mounds and lithoherms).

Two kinds of submarine topography can accelerate current velocities. One, where water flow meets or is constricted between land masses, for example, the seaways or channels between islands of the Lesser Antilles or Windward Islands (Figure 8.2). The larger and deeper inter island spaces produce the major seaways; the more numerous, smaller and shallower ones produce similar but smaller increases in velocity. A second kind of topographic constriction occurs when water flow meets elevations of the sea floor, typically platforms or banks of calcareous deposits. The spaces between large and long-lived platforms of the Bahamian Archipelago and the Florida Peninsula are sites of increased flow velocities between adjacent platforms. A smaller scale example of topographic constriction of currents is present in the series of shallow banks of calcareous deposits, which have developed on the Nicaragua rise and channel flow from the Caribbean Sea contributing to the initiation of the swift Yucatan Current. Localized sediment accumulation, either physical or as a result of the trapping by thickets of erect invertebrates, is needed to produce sea floor relief.

The role of hard substrate in initiating coral settlement is ambiguous. On the one hand it is repeatedly cited as necessary for settlement of coral larvae (Freiwald et al. 2004, pp. 18, 21). However, in the same publication (ibid, pp 27-28) occurrences are cited of deep-sea corals on mounds, which presumably are unconsolidated sediment. Mullins et al. (1981) described and illustrated a compelling example of corals growing on mounds of unconsolidated pelagic sediment from the margin of Little Bahama Banks. One explanation for this apparent contradiction may be the minimal size of hard substrate required to promote settlement. If for example, something as small as a bivalve shell is sufficient then deep-sea corals could establish on mounds of unconsolidated sediments that included bivalve skeletons. Once a few corals are established their continued production of skeletal debris provides continually expanding hard substrate for larval settlement (Figures 8.15 and 8.20 illustrate the substrate use of deep-sea corals). Syndepositional, subsea cementation triggered perhaps by persistent strong currents (Straits of Florida) is required to produce current-resistant lithoherms and it may also be responsible for developing hard substrates on which deep coral mounds develop.

V. SPATIAL DISTRIBUTION OF CORAL SPECIES AND HABITAT

The distribution of deep water corals generally follows the Antilles and continental shelves of Central, South and North America (Figures 8.3 - 8.5). Dawson (2002) analyzed the distribution of 129 species of azooxanthellate (deep-sea) stony corals in the Caribbean and surrounding areas. His findings include the following: the greatest diversity of species occurs at around 200-350 m in depth; and the highest diversity of species is located at the northern islands of the Lesser Antilles.

To date, no significant deep scleractinian coral habitats have been discovered in the U.S. Caribbean. Deep-sea corals have been reported from submersible and ROV research, but only sporadically. However, deep-sea research for the region is still in its infancy. Previous research

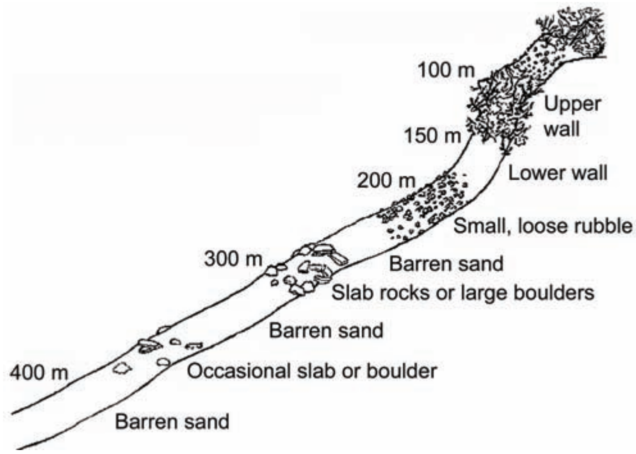


Figure 8.24. Cross-section of a “typical” continental slope for Puerto Rico and the U.S. Virgin Islands to approximately 400 m. Deep-sea research has been limited and, to date, deep corals have been only sporadically reported from the region. Figure adapted from Nelson and Appeldoorn 1985.

includes limited ROV and submersible work off Navassa Island (Littler and Littler 1999, Reed pers. comm.) and limited submersible work off Puerto Rico and the U.S. Virgin Islands (Nelson and Appeldoorn 1985). Figure 8.24 illustrates a cross section of a “typical” continental slope for Puerto Rico and the U.S. Virgin Islands, adapted from Nelson and Appeldoorn (1985). Intermittent zones of rubble, rocks and barren sand with occasional sponges, hydroids, soft corals, hard corals, crinoids and gorgonians attached to rocky substrate are described. “Sea whip” type gorgonians (*Ellisella sp.*), often wrapped with basket stars, were noted common at one location off the south coast of Puerto Rico. Rugged rock habitat, described as large, closely-packed boulders with little or no sand, was noted to primarily occur in the Mona Passage. Most notably, an abundance of the potential structure-forming coral *M. myriaster* was reported at a depth of 197-212 m on the shelf margin south of the southwest corner of Puerto Rico.

Ongoing deep water research in the U.S. Caribbean includes the exploration and characterization of seafloor habitats, with ROVs, down to 1,000 meters within the U.S. Virgin Islands and Puerto Rico by NOAA (NOAA 2007). This effort aims to characterize and map moderate to deep water coral reef ecosystem habitats within targeted study areas. Priority areas include the deep waters of the Buck Island Reef National Monument, the Escollo Grappler seamount to the southeast of Puerto Rico and the La Parguera region along the southwestern coast of Puerto Rico.

Inspection of regional unpublished research reports and dredge station sorting sheets illuminate interesting possibilities for deep coral habitat. Selected citations from dredge reports (individual station records) and notes include the following:

For the U.S. Caribbean: in Navassa Island waters two major structure forming corals (*M. oculata* and *E. rostrata*) were recovered, at 1,200 m, along with solitary corals (*Stephanocyathus laevifundus* and of the families *Deltocyathus* and *Desmophyllum*), gorgonians (of the genus *Acanella*, *Iridogorgia* and *Chrysogorigia*) and deep water fish (Staiger and Voss 1970).

For waters adjacent to the U.S. Caribbean: in British Virgin Islands waters, at 205 - 380 m, one potential structure-forming coral species (*M. myriaster*) was recovered from the same location in a trawl net "festooned with stalked crinoids". Deep water fish and crustaceans were also recovered (Staiger 1969); in Saba waters, in 512 m off the northern edge of the Saba Bank, a large deep water gorgonian (*C. multiflora*) was recovered along with deep water fishes (Anon. 1956); south of Hispaniola in 135-169 m, the potential structure forming coral species (*M. myriaster*) was recovered along with numerous sponges, gorgonians and other invertebrates in a net noted as "We had to use the crane to lift it aboard…. The catch was very good". Deep water fish and crustaceans were also recovered. Similar "excellent" and "magnificent" catches were also noted from two nearby trawl sets that also recovered *M. myriaster* (Staiger and Voss 1970; Voss 1971).

For waters throughout the region: in Venezuelan waters with *L. pertusa* at 406 m - "it was the best 10 ft. otter trawl tow I have seen in six years. There was a greater variety of organisms and a greater number than we usually get in a 41 ft. otter trawl tow" (Anon 1968); in the Straits of Florida, in waters just off just off Havana, Cuba, where *M. carolina*, *M. oculata*, and *M. myriaster* have been recovered - "the "pentacrinus grounds" [crinoid grounds] discovered by the *Blake* off Havana are world famous" (Voss 1966b); and in the Straits of Florida just southeast of the area of lithoherms on the Little Bahama Bank) with *L. pertusa*, *S. varibilis* and *E. profunda* at 738 m - "Tremendous amount of coral in net. Needed crane to lift it aboard. Good catch of fish and invertebrates" (Anon. 1973).

Though no direct information was found regarding the regional transport of deep coral larvae, the cosmopolitan distribution of shallow-water benthos of coral reefs as well as many deep water coral species (including the major structure-forming corals) indicates long term connectivity throughout the basin.

VI. SPECIES ASSOCIATIONS WITH DEEP CORAL COMMUNITIES

Fauna of deep-sea bio-buildups are among the least studied of marine assemblages. For example, the identification of deep-sea gorgonians, collected in the Caribbean and the Bahamas in the early 1960's, are, to date, being revised (e.g., Cairns 2007); deep-sea Gold corals collected on lithoherms in the Bahamas in the 1970's still await full identification (Messing pers. comm.), and crustaceans collected in the 1880's have long waited proper scientific descriptions (Larsen 1999).

Inspection of archival data and grey literature, including original station data sheets, cruise narratives and biological survey reports from 28 locations within the region identify a wide assortment of associated species occurring with the major structure-building deep-water corals; *E. profunda*, *L. pertusa*, *M. carolina*, *M. oculata* and *S. varibilis* (Appendix 8.2). Figure 8.21 illustrates several of these species in an idealized deep coral mound. Many of the reported associated species may grow to almost one meter in height (larger cnidarians and porifera).

Large deep sea sponges (phylum Porifera) are a potentially important megafauna component of deep sea coral habitats. Deep sea sponges have been recorded with structure-forming and potential habitat-forming corals (Appendix 8.2) and on deep water mounds, lithoherms and banks. It is unknown what habitat role they may play on deep water coral habitats. Colin (1978) reports that in some areas of shallow water reefs the biomass of sponges "can exceed that of any other group, including reef-building corals." Lang et al. (1975) reported that sponges (sclerosponges) can act as primary framework builders of reefs at depths of 70-105 m off Jamaica. Of primary interest are the larger calcareous sponges (class Calcarea), deep water glass sponges (class Hexatinellida), demosponges (class Demospongiae) and sclerosponges (class Sclerospongiae). Deep-sea sponges have been recorded up to 122 cm wide

Table 8.3. Potential fishing gear impacts on deep sea corals for the U.S. Caribbean.

	Measure of Impact					
Gear Type	Current Fishery Use in Region	Potential Severity of Impact	Potential Extent of Impact from Fishing Gear	Current Geographic Extent of Use in Region	Overlap of use with coral habitat	Overall Rating of Gear Impact
Bottom Trawl	None reported	High	High	NA	Uncertain	NA
Mid-water Trawl	None reported	Low	Low	NA	Uncertain	NA
Dredge	None reported	High	Low	NA	Uncertain	NA
Bottom-set Longline	to 109 m	Medium	Low	Unknown	Uncertain	Low
Bottom-set Gillnet	None reported	Medium	Medium	Unknown	Uncertain	Low
Longline traps or pots	to 183 m	High	Medium	To shelf edge	Uncertain	Low
Single pots	to 183 m	Low	Medium	To shelf edge	Uncertain	Low
Hook and line	to 600 m	Low	Low	Unknown	Uncertain	Low

at deep-sea coral depths in the Straits of Florida. Figure 8.12 illustrates a deep-sea sponge. Deep-sea sponges are subject of pharmacological investigations.

A number of fishes have been observed or collected in association with deep coral habitats. While most of these are demersal species (Appendix 8.2), certain commercially important pelagic species may also associate with deep-sea coral habitat. Swordfish (*Xiphias gladius*) have been encountered by submersibles visiting deep sea corals (*Lophelia*) in the Straits of Florida (Nizinski and Ross 2002) and in Bahamian deep waters at 600 m (Harbison and Janssen 1987). Larger deep coral mounds and lithoherms may play similar roles to seamounts, which are thought to attract pelagic fish because of an “enhanced primary productivity due to particular oceanographic conditions supporting a rich ecosystem” (Allain et al. 2006). In effect, seamounts influence oceanic currents in a way that promotes plankton to develop, acting as a feeding source for resident fish, attracting larger pelagic predators. These pelagic species are thought to use the seamounts unique underwater features primarily for food but also potentially as spawning grounds and/or nursery areas.

VII. STRESSORS ON DEEP CORAL COMMUNITIES

Serious potential threats to deep water coral communities found in other U.S. waters are not currently found in the U.S. Caribbean. No current examples were found of significant threats to deep water corals from the following: harvesting of precious coral, cable laying, oil and gas exploration, sedimentation, invasive species and destructive fishing practices (such as bottom trawling).

Fishing occurs to deep coral depths (>100 m) in the U.S. Caribbean and throughout the region. This activity is mainly focused on deep water snapper and grouper and includes commercial and recreational fishing effort. An extensive deep water fishery, primarily for snappers, occurs around Puerto Rico (Appeldoorn pers. comm.). Target species include black snapper (*Lutjanus griseus*), blackfin snapper (*L. buccanella*), vermilion snapper (*Rhomboplites aurorubens*) and silk snapper (*L. vivanus*) (FAO 1993; Kojis 2004; Cummings and Matos-Caraballo 2003).

Gear utilized in commercial deep water snapper and grouper fishing in the U.S. Caribbean includes vertical set line, bottom longline, handlines, electric or hydraulic reels and traps (Kojis 2004; Tobias 2004). Similar effort is reported throughout the region (FAO 1993). Figure 8.25 illustrates a typical commercial fishing vessel capable of fishing offshore for deepwater snapper and grouper in the U.S. Virgin Islands. The maximum reported depth for line fishing is 366 m (Swingle et al. 1970). The maximum reported depth for trap fishing is 183 m (Sheridan et al. 2006). During submersible observations, Nelson and Appeldoorn (1985) encountered ghost fishing traps at a depth of 121 m off the west end of St. Croix and a discarded longline at 236 m off the harbor entrance to San Juan, Puerto Rico.

Recreational fishing for deep water species in the U.S. Caribbean and throughout the region is termed "deep drop" fishing (also referred to as cannonball fishing). Gear includes expensive electric reels and heavy sash weights (commonly weighing 5 to 10 lbs) which allow fishing to potentially >600 m (Sword Fishing Central 2006). The Melton International Tackle Catalog (2007) lists electric deep drop reels up to $4,500 in price. Reels "capable of landing fish as deep as 500 fathoms [914 m]" are advertised (Melton 2007, pg 95). Heavy weights are needed for optimal deep drop fishing performance; to take the line straight down to the sea floor and keep the tackle as close to the bottom as possible, in a process called "bouncing," where the weight bounces up off the sea floor and the whole rig remains under the boat (Brooks 2007). Non-conventional weights, fashioned from pipes or other containers filled with concrete are also used. Deep drop fishing has recently gained in popularity with sport fishers, the 3nd annual 'Lords of the Deep' Fishing Tournament was held in September 2007 in Nassau, Bahamas. Figure 26 illustrates electric fishing reels utilized in deep-drop fishing. Such gear is available in the U.S. Caribbean. A small level of effort of deep-drop fishing is reported from the U.S. Caribbean and throughout the Caribbean region.

The association between deep-sea fishing and deep-sea coral habitat is unknown. However, a review of web-based fishing forums reveals that recreational sport fishers may be aware of and fishing on such:

> "You want to look for mounds, ridges, humps, etc. The key is learning the currents and exact location of your drop especially in very deep water (1000-2000 ft) [305-610 m]. You will find that on one particular mound, the peaks will hold one type of fish and the base of that same mound will hold another. Some deep water mounds in the Bahamas go up to a couple of hundred ft. [61 m] from the base. The Pomfret is one of my deep water favorites. We catch this species on the peaks of mounds. If your drop is off the mounds peak, you will have a tough time catching them." (Offshore Fishing Forum 2006).

Figure 8.26. Typical electric reels used in deep drop fishing. This gear is marketed in the U.S. Caribbean.

Table 8.3 details potential fishing gear impacts on deep-sea corals for the U.S. Caribbean with deep drop fishing included under "hook and line".

When compared to potential threats deep coral habitats experience in other U.S. waters (chiefly destructive bottom trawling) this effort does not currently pose a significant threat to deep corals. However, the potential for damage to deep corals from such fishing gear is well documented, and may increase as the amount of fishing effort increases (Chuenpagdee et al. 2003). Traps and weighted lines can crush structure-forming corals and entangle or snare softer octocorals. The potential impacts of regional commercial and recreational deep-sea fishing warrants further investigation. Additionally, the impact that the removal of large deep water predators may have on deep coral ecosystems is unknown. However, it is well documented that the overfishing of these species can have negative effects on shallow reef health (Dulvy et al. 2004; Steneck and Sala 2005; Mumby et al. 2006).

Figure 8.25. Bandit rigged boat - a type of commercial fishing vessel used to fish offshore for deepwater snapper and grouper in the U.S. Virgin Islands and capable of fishing to depths where deep water coral reside. Photo credit: Kojis 2005.

Current efforts to manage fisheries the Caribbean waters are exacerbated by a regional 'lack of capacity' in fisheries management (Haughton et al. 2004). Traditional management strategies (such as catch and release) may not work for deep-water species, as fish brought up from deep-sea coral depths expire en-route. Additionally, remoteness of location may play an important role with regard the management of deep-sea coral habitats. For example, the major structure forming corals *M. oculata* and *E. rostrata* have been found in the waters surrounding Navassa Island (Figure 8.5), an extremely remote uninhabited U.S. territory and illegal fishing activities are reported from Navassa's waters (Miller 2003). However, the closest inhabited United States territory, Guantanamo Bay Naval Base (Cuba), is located approximately 170 km distant.

Throughout the region, future fishing activities pose a significant potential threat, as shallow water fisheries resources are depleted and commercial and recreational effort moves into deeper water (Prado and Drew 1999; FAO 2000; Koslow et al. 2000; Roberts 2002). Inspection of research station sorting sheets and current literature reveal numerous fish species associated with deep corals that belong to taxa currently harvested in other regions and may be harvested in the Caribbean in the future. Fishes include targeted and by-catch deep-sea species such as deep-sea codfish, rattails or grenadiers, hake, dory, sea robins, wreakfish (*Polyprion americanus*) and sharks (Merrett and Haedrich 1997; Carpenter 2002; Freiwald 2004; Gordon 2004) (locations of these sites are illustrated in Figure 8.3, species are listed in Appendix 8.2). Wreakfish (Sedberry et al. 1994) and dogfish sharks are currently harvested in U.S. continental waters. Wreckfish and have been observed on deep coral habitat (mounds and lithoherms) in the Straits of Florida (Messing et al. 1990). Dogfish sharks are reported on deep coral mounds and lithoherms (Nizinski and Ross 2002) and associated with occurrences of structure-forming corals throughout the region (Appendix 8.2).

No significant threat of deep water trawling was found for the wider Caribbean. However, deep water shrimp trawlers are currently exploring fishing beyond 70 m in depth off Colombia (Gracia pers. comm.) and Reyes et al. (2005) note the need to asses the impacts of trawl fishing on the deep water coral banks off Colombia.

Oil and gas exploration does currently occur in the to U.S. Caribbean. However, this activity occurs in the southeast Caribbean, notably off Trinidad and Tobago, and in Straits of Florida waters off northwest Cuba. It is unknown what effect these activities have on deep coral communities. It is also unknown to what extent regional underwater cables and lines affect deep coral communities.

The harvest of precious corals, red and black corals, is prohibited in the U.S. Caribbean and there are no reports of current harvest activities. However, black coral jewelry, reportedly manufactured from corals harvested in the Cayman Islands, is available for purchase in the U.S. Virgin islands (Greenberg and Greenberg 2006; Bernard K. Passman Gallery, St. Thomas, pers. comm.). Black coral sold in the U.S. Caribbean is reportedly harvested in the western Caribbean from coral beds located at depths of 61-122 m (200-400 ft) (Bernard K. Passman Gallery, St. Thomas, pers. comm.). Regional countries listed by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) trade database as exporting black coral (*Antipatharia* spp.) since 2001 include the Bahamas, British Virgin Islands, Cayman Islands, Cuba, Colombia, Dominican Republic, Mexico, Panama, and Trinidad and Tobago (Figure 8.4, some locations may be transshipment points) (CITES 2007). The basil axis of black coral is used in the manufacture of jewelry (Opresko and Sanchez 2005).

VIII. CURRENT CONSERVATION AND MANAGEMENT ACTIVITIES

In the U.S. Caribbean deep-water corals and other marine resources are under the jurisdiction of territory (USVI: 0-3 nmi from shore), commonwealth (Puerto Rico: 0-12 nmi from shore) and federal management authorities (U.S. EEZ and the waters around Navassa Island). Fisheries in the U.S. EEZ around USVI and Puerto Rico are managed under fishery management plans developed by the Caribbean Fishery Management Council (CFMC), based in Puerto Rico. Deep sea coral language in the recently reauthorized Magnuson-Stevens Act includes an affirmation of the Council's authority designate zones to protect deep sea corals from physical damage from fishing gear as part of their fishery management plans, without having to prove that corals constitute essential fish habitat [as amended by the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (Public Law 109-479), see Chapter 1]. Navassa Island is managed by the U.S. Fish and Wildlife Service as a National Wildlife Refuge that includes a 12 mile radius of marine habitats around the island. Commonwealth and territorial management authorities include the Puerto Rico Department of Natural and Environmental Resources and the United States Virgin Islands Department of Planning and Natural Resources.

Current efforts to manage fisheries in Caribbean waters are focused on shallow-water coral reef areas and associated fisheries (conch, grouper, Caribbean spiny lobster, etc.) (Sala et al. 2001; Theile 2001; FAO 2003). However, the Territory of the U.S. Virgin Islands includes antipatharians (black corals) in its local Endangered Species Act (ESA), thus granting the authority to protect black corals (no matter the depth) within USVI territorial waters. Puerto Rico implements the Federal Endangered Species Act (Federal ESA) in local waters. However, currently, no deep coral species are listed under the Federal ESA. The Caribbean Council manages corals under the Corals and Reef Associated Invertebrates of Puerto Rico and the U.S. Virgin Islands Fishery Management Plan (Coral FMP) (Caribbean Fishery Management Council 1994). It lists many coral genera and species that are found in both shallow and deep waters. Those species found in deep water (including *Iciligorgia schrammi* (deep sea fan), *Telesto* spp., *Ellisella* spp. (sea whips) and antipatharians (black corals) would be protected under the Coral FMP. There are no conservation or management efforts specifically targeting deep-water corals for the U.S. Caribbean or the wider Caribbean region.

An assessment of regional deep-sea recreational and commercial fishing effort, especially deep drop fishing, would provide managers with information concerning the potential impact of this activity has on deep-sea corals. The collection of socioeconomic information and perceptions and attitudes to policy options, along with standard fisheries information (such as fishing effort, frequency of activity, landing and bycatch information, etc.), could help minimize any negative impacts of policies directed at the conservation of deep sea coral ecosystems

IX. REGIONAL PRIORITIES TO UNDERSTAND AND CONSERVE DEEP CORAL COMMUNITIES

Morgan et al. (2006) advocate that ecosystem-based management, research and mapping and a ban on destructive fishing practices in deep sea coral areas are necessary to provide sufficient protection for deep-sea coral ecosystems.

Ongoing projects that may generate information regarding the distribution deep coral communities include the previously mentioned benthic habitat characterization effort by NOAA (NOAA 2007) and a coral reef assessment and habitat mapping effort of Navassa Island National Wildlife Refuge by NOAA and the National Park Service (Miller pers. comm.). The Navassa Island effort, although currently focused on shallow water reefs, could include deep-water investigations. Currently, no activities in the U.S. Caribbean are focused on the biology and ecology of deep coral communities.

Mapping the locations of deep coral habitat would be a valuable component of any true ecosystem based management program for the U.S. Caribbean. Mapping the locations of coral habitats gives a crucial spatial framework for managers to better understand the effects of ocean uses on the environment. Figure 8.5 illustrates existing managed areas in the U.S. Caribbean and surrounding waters that have potential deep water coral habitat (waters >100 m). Navassa Island Wildlife Refuge is the only managed area that includes documented deep water structure-forming and potential habitat-forming scleractinian corals (*E. rostrata*, *M. oculata* and *M. myriaster*).

Examples of archival data awaiting further inspection include the following: video footage and photographs recorded during the submersible observations around Puerto Rico and the U.S. Virgin Islands reported by Nelson and Appeldoorn (1985), stored at the National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center in Pascagoula, Florida (Appeldoorn pers. comm.); video footage and dive records recorded during submersible observations at Navassa Island by the Center for Marine Conservation (now The Ocean Conservancy); station records from numerous research cruises kept on microfilm at the NMFS South East Fisheries Science Center in Miami, Florida; and cruise reports and other information kept at the academic institutions that carried out much original deep sea research - the University of Miami's Marine Invertebrate Museum in Miami, Florida, is one such location.

An assessment of regional deep-sea recreational and commercial fishing effort, especially deep drop fishing, would provide managers with information concerning the potential impact of this activity. The collection of socioeconomic information and perceptions and attitudes to policy options, along with standard fisheries information (such as fishing effort, frequency of activity, landing and bycatch information, etc.), could help minimize any negative impacts of policies directed at the conservation of deep sea coral ecosystems.

X. CONCLUSIONS

It is clear from this review that the U.S. Caribbean and the wider Caribbean region contain a huge diversity of deep water corals. However, information on regional distribution of deep corals is limited and needs great expansion if deep corals can be part of any meaningful ecosystem based management strategy. Nevertheless, the thorough description of deep coral mounds and lithoherms in the Bahamas and in the Straits of Florida and deep coral habitat off Colombia provides valuable information on the bathymetric and hydrographic conditions favoring the development of deep coral communities. From this information inferences may be made regarding the morphology, composition and organism zonation of regional deep coral communities and the potential for deep coral habitat in the U.S. Caribbean.

The lithoherms of the Straits of Florida are remarkable examples of the interaction of strong currents with a varied suite of benthos (corals, zoanthids, crinoids, alcyonarians, etc.) a rain of pelagic sediments and syndepositional cementation of the sediments and skeletal debris. This interaction produces current-resistant structures with a continual supply of new hard substrate for an attached and boring benthic community. It is these same interrelated processes that allow the development of ocean facing, wave-resistant shallow reefs. There are strong indications that the Straits of Florida contain undiscovered large areas of deep coral mounds and/or lithoherms and banks. Similarly, it seems likely that other areas throughout the Caribbean, including United States territories, with stronger currents may also have deep coral ecosystems. The possibility that deep-sea coral habitat in these areas harbor fish, which are exploitable (Appendix 8.2 and 8.3), deserves further attention.

Technical note

All images by Steven J. Lutz unless otherwise noted. Images may be modified for clarification.

XI. REFERENCES

Agassiz A (1888) Three cruises of the Blake. Houghton, Mifflin, N.Y., 314 pp

Allain V (2006) Seamounts and Pelagic Fisheries Interactions Under Study. South Pacific Commission Fisheries Newsletter 116: 3 pp

Anon. (1956) Sorting sheets and dredge station notes from R/V Oregon, Station O 2636. NOAA, Southeast Fishery Science Center (library). Uncatalogued microfiche

Anon. (1963) Sorting sheets and dredge station notes from R/V Gerda, Station G 118. Marine Invertebrate Museum Rosenstiel School of Marine and Atmospheric Science (RSMAS) University of Miami

Anon. (1964) Sorting sheets and dredge station notes from R/V Gerda, Station G 251. Marine Invertebrate Museum RSMAS University of Miami

Anon. (1965) Sorting sheets and dredge station notes from R/V *Gerda*, Stations G 503, G 636, G 691, G 692. Marine Invertebrate Museum RSMAS University of Miami

Anon. (1966) Sorting sheets and dredge station notes from R/V *Pillsbury*, Stations P 364, P 388. Marine Invertebrate Museum RSMAS University of Miami

Anon. (1968) Sorting sheets and dredge notes from R/V *Pillsbury*, Sta P 607, P 636, P 741, P 747, P 755, P 776. Marine Invertebrate Museum RSMAS University of Miami

Anon. (1969) Sorting sheets and dredge notes from R/V *Pillsbury*, Stations P 881, P 891, P 892, P 954. Marine Invertebrate Museum RSMAS University of Miami

Anon. (1970) Sorting sheets and dredge notes from R/V *Pillsbury*, Stations P 1187 and P 1262. Marine Invertebrate Museum RSMAS University of Miami

Anon. (1972a) Sorting sheets and dredge station notes from R/V *Gilliss*, Station GS 31. Marine Invertebrate Museum RSMAS University of Miami

Anon. (1972b) Sorting sheets and dredge notes from R/V *Columbus Iselin*, Station CI 6. Marine Invertebrate Museum RSMAS University of Miami

Anon. (1973) Sorting sheets and dredge notes from R/V *Columbus Iselin*, Station CI 140. Marine Invertebrate Museum RSMAS University of Miami

Anon. (1974) Sorting sheets and dredge notes from R/V *Columbus Iselin*, Stations CI 148, CI 246. Marine Invertebrate Museum RSMAS University of Miami

Armstrong RA, Singh H; Torres J; Nemeth RS; Can A; Roman C; Eustice R; Riggs L; Garcia-Moliner G (2006) Characterizing the deep insular shelf coral reef habitat of the Hind Bank marine conservation district (US Virgin Islands) using the Seabed autonomous underwater vehicle. Continental Shelf Research 26: 194–205

Bates R, Jackson J (eds) (1987) Glossary of Geology. Third Edition, American Geologic Institute, Alexandria, Virginia: 788 pp

Bayer FM (1952) New western Atlantic records of octocorals (Coelenterata: Anthozoa), with descriptions of three new species. Journal of the Washington Academy of Sciences 42: 183-189

Bayer FM (1961) The Shallow Water Octocorallia of the West Indian Region. Studies on The Fauna of Curacao and other Caribbean Islands 12: 377 pp

Bayer FM (1966) Dredging and trawling records of R/V John Elliot Pillsbury for 1964 and 1965. Studies in Tropical Oceanography 4 (1): 82-105

Bayer FM (2001) New species of Calyptrophora (Coelenterata: Octocorallia: Primnoidae) from the western part of the Atlantic Ocean. Proceedings of the Biological Society of Washington 114 (2): 365-378

Bayer FM, Muzik KM (1977) An Atlantic Helioporacean coral (Coelenterata: Octocorallia). Proceedings of the Biological Society of Washington 90 (4): 975-984.

Bayer FM, Muzik KM (1979) The correct name of the helioporan coral *Lithotelesto micropora* Bayer & Muzik. Proceedings of the Biological Society of Washington 92(4): 873-875

Bedford Institute of Oceanography (2003) Identification Sheets for Corals in Atlantic Canada. Marine Environmental Sciences Division, Bedford Institute of Oceanography, Department of Fisheries and Oceans, 8 pp

Brook G (1889) Zoology 80 LXXX: Report on the ANTIPATHARIA. By George Brook, F.L.S., F.R.S.E. Bound in Volume 32: 222 pp

Brooks R (2007) Deep drop fishing. Bass Pro Shops, OutdoorSite Library. Undated world wide web article, accessed August 2007. Available on-line at: <http://www.basspro.com/webapp/wcs/stores/servlet/CFPage?mode=article&objectID=31353&storeId=10151&catalogId=10001&langId=-1>

Cairns SD (1977) Guide to the commoner shallow-water gorgonians of South Florida, the Gulf of Mexico, and the Caribbean region. University of Miami Sea Grant Field Guide Series 6: 74 pp

Cairns SD (1979) The deep-water scleractinian of the Caribbean Sea and adjacent waters. Studies on the Fauna of Curacao and other Caribbean Islands 57: 1-341

Cairns SD (l986) A revision of the Northwest Atlantic Stylasteridae (Coelenterata: Hydrozoa). Smithsonian Contributions to Zoology 4l8: l3l pp

Cairns SD (1999) Species Richness of Recent Scleractinia. Atoll Research Bulletin 459: 13-46

Cairns SD (2000) A revision of the shallow-water azooxanthellate Scleractinian of the western Atlantic. Studies on the Natural History Caribbean Region 75: 321 pp

Cairns SD (2001) Studies on western Atlantic Octocorallia (Coelenterata: Anthozoa). Part 1. The genus *Chrysogorgia*. Proceedings of the Biological Society of Washington 114(3): 746-787

Cairns SD (2005) Western Atlantic Deep-Water (>200 m) Octocorallia. Unpublished list, dated 11/2005

Cairns SD (2007) Studies on western Atlantic Octocorallia (Gorgonacea: Elliseidae). Part 7: The genera *Riisea* Duchassaing & Michelotti, 1860 and *Nicella* Gray, 1870. Proceedings of the Biological Society of Washington 120 (1): 1-38

Cairns SD, Bayer FM (2002) Studies on western Atlantic Octocorallia (Coelenterata: Anthozoa). Part 2: The genus *Callogorgia* Gray, 1858. Proceedings of the Biological Society of Washington 115(4): 840-867

Cairns SD, Bayer FM (2003) Studies on western Atlantic Octocorallia (Coelenterata: Anthozoa). Part 3: The genus *Narella* Gray, 1870. Proceedings of the Biological Society of Washington 116(2): 617-648

Cairns SD, Bayer FM (2004a) Studies on western Atlantic Octocorallia (Coelenterata: Anthozoa). Part 4: The genus *Paracalyptrophora* Kinoshita, 1908. Proceedings of the Biological Society of Washington 117 (1): 114–139

Cairns SD, Bayer FM (2004b) Studies on western Atlantic Octocorallia (Coelenterata: Anthozoa). Part 5: The genera *Plumarella* Gray, 1870; *Acanthoprimnoa*, n. gen.; and *Candidella* Bayer, 1954. Proceedings of the Biological Society of Washington 117 (4): 447–487

Cairns SD, Bayer FM (2002) Studies on western Atlantic Octocorallia (Coelenterata: Anthozoa). Part 2: The genus *Callogoria* Grey, 1858. Proceedings of the Biological Society of Washington 115 (4): 840-867

Cairns SD, Bayer FM (2006) Studies on western Atlantic Octocorallia (Coelenterata: Anthozoa). Part 6. The genera *Primnoella* Gray, 1858; *Thouarella* Gray, 1870; *Dasystenella* Versluys, 1906. Proceedings of the Biological Society of Washington 119(2): 161-194

Cairns SD, Stanley G (1982) Ahermatypic coral banks: Living and fossil counterparts. Proceedings of the Fourth International Coral Reef Symposium, Manila (1981) 1: 611-618

Cairns SD, Zibrowius H (1997) Cnidaria Anthozoa: Azooxanthellate Scleractinia from the Philippine and Indonesian regions. In: Crosnier A, Bouchet P (eds) Resultats des campagnes MUSORSTOM, volume 16. Memoires du Museum national d'histoire naturelle 172: 27-243

Caribbean Fishery Management Council (1994) Fishery Management Plan, Regulatory Impact Review and Final Environmental Impact Statement for Corals and Reef Associated Plants and Invertebrates of Puerto Rico and the U. S. Virgin Islands, 60 FR 58221. Available on-line at: <www.caribbeanfmc.com/coralFMP.htm>

Carpenter KE (ed) (2002) The living marine resources of the Western Central Atlantic. Volume 1: Introduction, molluscs, crustaceans, hagfishes, sharks, batoid fishes, and chimaeras. In FAO Species Identification Guide for Fishery Purposes and American Society of Ichthyologists and Herpetologists Special Publication 5. FAO Rome, pp 1375-2127

Chuenpagdee R, Morgan LE, Maxwell S, Norse EA, Pauly D (2003) Shifting gears: Assessing collateral impacts of fishing methods in the U.S. waters. Frontiers in Ecology and the Environment 1(10): 517–524

CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) (2006). On-line species database of CITES-listed species. Accessed June 2006. Available on-line at: <http://sea.unep-wcmc.org/isdb/CITES/Taxonomy/?displaylanguage=eng>

CITES 2007. CITES trade database. On-line database. Accessed August 2007. Available on-line at: <http://www.unep-wcmc.org/citestrade/trade.cfm>

Clark MR, Tittensor D, Rogers AD, Brewin P, Schlacher T, Rowden A, Stocks K, Consalvey M (2006). Seamounts, deep-sea corals and fisheries: vulnerability of deep-sea corals to fishing on seamounts beyond areas of national jurisdiction. UNEPWCMC, Cambridge, UK. 86 pp

Colin P (1978) Caribbean Reef Invertebrates and Plants. Neptune City, New Jersey: T.F.H. Publications, Inc.: 512pp

Correa T, Grasmueck M, Eberli G, Rathwell G, Viggiano D (2006) Morphology and Distribution of Deep-Water Coral Reefs in the Straits of Florida. Project prospectus: 3 pp

Cummings NJ, Matos-Caraballo D (2003) Summarized reported commercial landings in Puerto Rico from 1969-2001 with specific notes on the Silk Snapper landings category. NOAA, NMFS, Caribbean Deepwater SEDAR Data Workshop Report 4 SEDAR DOC-5: 14 pp

Dawson JP (2002) Biogeography of azooxanthellate corals in the Caribbean and surrounding areas. Coral Reefs 21 (1): 27-40

Dulvy NK, Freckleton RP, Polunin NV (2004) Coral reef cascades and the indirect effects of predator removal by exploitation. Ecology Letters 7: (5): 410–416

EarthRef.org (2007) Seamount Catalog. World wide web digital archive, accessed August 2007. Available at: <http://earthref.org/cgi-bin/er.cgi?s=sc-s0-main.cgi>

FAO (Food and Agriculture Organization of the United Nations) (1993) Marine fishery resources of the Antilles: Lesser Antilles, Puerto Rico and Hispaniola, Jamaica, Cuba. FAO Fisheries Technical Paper 326: 235 pp

FAO (2000) Fishery Country Profile for the Republic of Trinidad and Tobago. FAO FID/CP/TRI Rev 2 May 2000. World wide web article, accessed April 2005. Available on-line at: <http://www.fao.org/fi/fcp/en/TTO/profile.htm>

FAO (2003) Report of the second Workshop on the Management of Caribbean Spiny Lobster Fisheries in the WECAFC Area. FAO Fisheries Report 715

Freiwald A, Fosså JH, Grehan A, Koslow T, Roberts JM (2004) Cold-water coral reefs. UNEP-WCMC, Cambridge, UK: 84 pp

Fratantoni DM (2001) North Atlantic surface circulation during the 1990's observed with satellite-tracked drifters. Journal of Geophysical Research 106: 22067-22093

Genin A, Dayton PK, Lonsdale PF, Spiess FN (1986) Coral on seamount peaks provide evidence of current acceleration over deep-sea topography. Nature 322: 59-61

Gordon AL (1967) Circulation of the Caribbean Sea. Journal of Geophysical Research 72: 6207-6223

Gordon J (2004) Deep-sea fisheries of the Atlantic Ocean. Presented at Deep-sea Fisheries: Ecology, Economics and Conservation (September 12-14, 2004) Woods Hole Oceanographic Institution and New England Aquarium. World wide web article, accessed August 2005 Available on-line at: <http://www.whoi.edu/institutes/oli/activities/symposia-deepsea-gordon.pdf>

Gosner KL (1978) Peterson Field Guides, Atlantic Seashore from the Bay of Fundy to Cape Hatteras, Houghton Mifflin, 336 pp

Greenberg H, Greenberg D (2006) The U.S. Virgin Islands Alive (second edition). Hunter Travel Guides, Hunter Publishing Inc, Edison, NJ: 322 pp

Gunn JT, Watt DR (1982) On the currents and water masses north of the Antilles/ Bahamas Arc. Journal of Marine Research 40: 1-48

Gyory J, Mariano AJ, Ryan EH (2005a) "The Caribbean Current" Ocean Surface Currents. World wide web article, accessed March 2005 Available on-line at: <http://oceancurrents.rsmas.miami.edu/caribbean/caribbean.html>

Gyory J, Rowe E, Mariano AJ, Ryan EH (2005b) "The Florida Current" Ocean Surface Currents. World wide web article, accessed March 2005 Available on-line at: <http://oceancurrents.rsmas.miami.edu/caribbean/florida.html>

Gyory J, Mariano AJ, Ryan EH (2005c) "The Loop Current" Ocean Surface Currents. World wide web article, accessed March 2005. Available on-line at: <http://oceancurrents.rsmas.miami.edu/caribbean/loop-current.html>

Gyory J, Mariano AJ, Ryan EH (2005d) "The Yucatan Current" Ocean Surface Currents. World wide web article, accessed March 2005. Available on-line at: <http://oceancurrents.rsmas.miami.edu/caribbean/yucatan.html>

Harbison GR, Janssen J (1987) Encounters with a Swordfish (*Xiphias gladius*) and Sharptail Mola (*Masturus lanceolatus*) at Depths Greater Than 600 Meters. Copeia 1987 (2): 511-513

Hartman WD (1973) Beneath Caribbean Reefs. Discovery 9: 13-26

Haughton M, Mahon R, McConney P, Kong GA, Mills A (2004) Establishment of the Caribbean Regional Fisheries Mechanism. Marine Policy 28: 351-359

Humann P (1993) Reef Coral Identification: Florida, Caribbean, Bahamas. Jacksonville, Florida: New World Publications, Inc.: 239 pp

James NP, Ginsburg RN (1979) The Seaward Margin of Belize Barrier and Atoll Reefs. Special Publication 3, International Association of Sedimentologists, Blackwell Science Publishing, Oxford, London, Edinburgh, Melbourne: 203 pp

Johns WE, Townsend TL, Fratantoni DM, Wilson WD (2002) On the Atlantic inflow to the Caribbean Sea. Deep-Sea Res I (49): 211–243

Kapela W, Lasker HR (1999) Size dependent reproduction in the Caribbean gorgonian *Pseudoplexaura porosa*. Marine Biology 135:107-114

Keller NB, Pasternak FA, Naumov DV (1975) Bottom deep-sea Coelenterata from the Caribbean Sea and Gulf of Mexico (from material from the 14th expedition of the `Akademik Kurchatov'). In: Scientific studies Caribbean Sea, Gulf of Mexico and adjacent waters. Transactions of the P.P. Shirshov Institute of Oceanology (Trudy Instituta okeanologii im. P.P. Shirshova) 100: 147-159 [in Russian with English summary]

Kojis B (2004) Census of the Marine Commercial Fishers of the U. S. Virgin Islands. U.S. Virgin Islands Division of Fish and Wildlife: 91 pp

Kojis B (2005) NOAA Fisheries - State Marine Fisheries Directors' Biennial Meeting 2005 - US Caribbean. 2005 State Directors' meeting, April 11-13, 2005. PDF presentation

CARIBBEAN

Koslow JA, Boehlert GW, Gordon JDM, Haedrich RL, Lorance P, Parin N (2000) Continental slope and deep-sea fisheries: implications for a fragile ecosystem. ICES Journal of Marine Science 57 (3): 548-557

Lang JC (1974). Biological zonation at the base of a reef. Amer. Sci., 62 (3): 272-281

Lang JC, Hartman WD, Land LS (1975). Sclerosponges: Primary framework constructors on the Jamaican fore-reef. Journal of Marine Research 33 (2): 952-959

Larsen K (1999) Deep-sea tanaidacean (Crustacea: Peracarida) from the Albatross cruises 1885-86, with keys to the suborder Neotanaidomorpha. Journal of Natural History 33 (8): 1107-1132

Lee TN, Johns WE, Zantopp R, Fillenbaum ER (1996) Moored observations of western boundary current variability and thermohaline circulation 26.5°N in the subtropical North Atlantic, Journal of Physical Oceanography 26: 962-963

Le Goff-Vitry MC (2003) Molecular ecology of the deep-sea coral *Lophelia pertusa* in the North East Atlantic. PhD thesis. University of Southampton.

Littler MM, Littler DS (1999) The First Oceanographic Expedition to Navassa Island. Reef Encounter 25: 26-30

Melton International Tackle 2006 Master Catalog (2007). Fishing tackle and accessories catalog, 182 pp

Messing CG, Neumann AC, Lang JC (1990) Biozonation of deep water lithoherms and associated hardgrounds in the northeastern Straits of Florida. Palaios 5: 15-33

Merrett NR, Haedrich RL (1997) Deep-Sea Demersal Fish and Fisheries. Chapman and Hall Great Britain: 296 pp

Miller MW (2003) Status of reef resources of Navassa Island: Cruise report Nov. 2002. NOAA Technical Memorandum NMFS-SEFSC-501: 119 pp

Morgan LE, Tsao CF, Guinotte JM (2006) Status of deep sea corals in U.S. waters, with recommendations for their conservation and management. Marine Conservation Biology Institute, Bellevue, Washington: 64 pp

Mullins HT, Newton CR, Heath K, Van Buren HM (1981) Modern deep-water coral mounds north of Little Bahama Bank; criteria for recognition of deep-water coral bioherms in the rock record. J Sed Res 51 (3): 999-1013

Mumby PJ, Dahlgren CP, Harborne AR, Kappel CV, Micheli F, Brumbaugh DR, Holmes KE, Mendes JM, Broad K, Sanchirico J, Buch K, Box S, Stoffle RW, Gill AB (2006) Fishing, Trophic Cascades, and the Process of Grazing on Coral Reefs. Science, Vol. 311 (5757): 98 – 101

McNeill D (2006) Dimensional Aspects of Deepwater Mounds, eastern Straits of Florida. Project prospectus, 3 pp

Nelson R, Appeldoorn DS (1985) A submersible survey of the continental slope of Puerto Rico and the U.S. Virgin Islands, Cruise Report, RV Seward Johnson, October 1–23: 76 pp

Neumann AC, Ball MM (1970) Submersible observations in the Straits of Florida: geology and bottom currents. Geological Society of America Bulletin 81: 2861-2874

Neumann AC, Kofoed JW, Keller GH (1977) Lithoherms in the Straits of Florida. Geology 5 (1): 4-10

Nizinski M, Ross S (2002) Views Forward, Views Aft, August 14, 2002. On-line research cruise log dated August 14, 2002. Accessed December, 2006, Available on-line at: <http://www.oceanexplorer.noaa.gov/explorations/02sab/logs/aug14/aug14.html>

NOAA (National Oceanic and Atmospheric Administration) (2005) Deep-Sea Coral Collection Protocols. NOAA Technical Memorandum. Deep-Sea Coral Panel of Experts. Draft dated January, 2005: 56 pp

NOAA (2007) Benthic Habitat Characterization and Bathymetry of Mid-water Habitats in the USVI and Puerto Rico (2007). Project on-line prospectus, accessed July 2007. Available on-line at: <http://www8.nos.noaa.gov/nccos/npe/projectdetail.aspx?id=402&fy=2007>

OBIS (Ocean Biogeographic Information System) (2006) On-line database, accessed July 2006. Available on-line at: <www.iobis.org>

Offshore Fishing Forum (2006) The Marlin Club, Offshore Fishing Forum. Message posted by WahooKing on January 13, 2005. Retrieved from the world wide web February 2006. Available on-line at: <http://www.marlinnut.com/cgi-bin/dcforum/dcboard.cgi?az=printer_format&om=639&forum=DCForumID3 >

Opresko DM (1972) Redescriptions of antipatharians described by L.F. Pourtales. Bulletin of Marine Science 22(4): 950-1017

Opresko DM (1974) A study of the classification of the Antipatharia (Coelenterata: Anthozoa), with redescriptions of eleven species. Ph.D. Dissertation, University of Miami: 149 pp

Opresko DM (1996) New species of black coral (Cnidaria: Anthozoa: Antipatharia) from the Caribbean, Bulletin of Marine Science 58: 289-300

Opresko DM (2002) Revision of the Antipatharia (Cnidaria: Anthozoa). Part II. Schizopathidae. Zoologische Mededelingen, Leiden. 76: 411–442

Opresko DM (2003) Revision of the Antipatharia (Cnidaria: Anthozoa). Part III. Cladopathidae. Zoologische Mededelingen, Leiden 77 (31): 495-536

Opresko DM (2006) Antipatherian Corals Reported from the Caribbean. Unpublished list

Opresko DM, Cairns SD (1994) Description of the new genus *Allopathes* (Cnidaria: Antipatharia) and its type species *Cirripathes desbonni*. Proceedings of the Biological Society of Washington 107(1): 185-192

Opresko DM, Sanchez JA (2005) Caribbean Shallow-water Black Corals (Cnidaria: Anthozoa: Antipatharia). Caribbean Journal of Science 41 (3): 492-507

Pasternak FA (1975) Deep-sea pennatularian genus Umbellula from the Caribbean Sea and Puerto-Rican Trench. In: Scientific studies Caribbean Sea, Gulf of Mexico and adjacent waters. Transactions of the P.P. Shirsov Institute of Oceanology 100: 160-173 [in Russian with English summary]

Peters EC, Cairns SD, Pilson MEQ, Wells JW, Jaap WC, Lang JC, Vasleski CE, St. Pierre Gollahon L (1988) Nomenclature and biology of *Astrangia poculata* (Ellis and Solander, 1786). Proceedings of the Biological Society of Washington 101(2): 234-250

Picton BE, Howson CM (eds) (2000) The species directory of the marine fauna and flora of the British Isles and surrounding seas. Ulster Museum and The Marine Conservation Society, Belfast and Ross-on-Wye. CD-ROM Edition. On-line photographic guide, page: *Funiculina quadrangularis* (Pallas, 1766). Accessed November 2006. Available on-line at: <http://www.seaslug.org.uk/marinelife/species.asp?item=D10500>

Pillsbury JE (1890) The Gulf Stream - A description of the methods employed in the investigation, and the results of the research. USCC-Geodetic Survey Silver Spring MD, pp 461-620

Pourtalès LF de (1867) Contributions to the Fauna of the Gulf Stream at great depths. Bulletin of the Museum of Comparative Zoology, Harvard, 1: 121-142

Pourtalès LF de (1871) Deep-sea corals. Illustrated catalogue of the Museum of Comparative Zoology at Harvard College 4: 93 pp

Pourtalès LF de (1874) Zoological results of the Hassler Expedition, deep-sea corals Illustrated Catalogue of the Museum of Comparative Zoology 8: 33-49

Pourtalès LF de (1880) Report on the results of dredging, under the supervision of Alexander Agassiz, in the Caribbean Sea, 1878-79, by the United States Coast Survey steamer "Blake". VI. Report on the corals and Antipatharia. Bulletin of the Museum of Comparative Zoology 6 (4): 95-120

Prado J, Drew S (1999) Research and Development in Fishing Technology in Latin America. FAO Fisheries Circular 944 FIIT/x2173

Reed JK (2002) Comparison of deep-water coral reefs and lithoherms off southeastern U.S.A. Hydrobiologia 471: 43-55

Reed JK, Shepard A, Koenig C, Scanlon K, Gilmore G (2005). Mapping, habitat characterization, and fish surveys of the deep-water Oculina coral reef Marine Protected Area: a review of historical and current research. In: Freiwald A, Roberts J (Eds), Cold-water Corals and Ecosystems. Proceedings of the 2nd International Symposium on Deep-Sea Corals Sept. 9-12 2003 Erlanger Germany. Springer-Verlag Berlin Heidelberg, 1243 pp

Reed JK (2006) Final Cruise Report, Bahamas-Florida Deep-Water Reef Expedition: Discovery and Exploration of Deep-Water Reefs in the Straits of Florida, May 22-30, 2006. Submitted to: The Bahamas Department of Fisheries- Ministry of Agriculture, Fisheries, and Local Government, DVD (Cruise Report and images)

Reyes J, Santodomingo N, Gracia A, Borrero-Pérez G, Navas G, Ladino LM, Bermúdez A, Benavides M (2005) Southern Caribbean azooxanthellate coral communities off Colombia. In: Freiwald A, Roberts J (Eds) Cold-water Corals and Ecosystems Proceedings of the 2nd International Symposium on Deep-Sea Corals Sept. 9-12 2003 Erlanger Germany. Springer-Verlag Berlin Heidelberg, 1243 pp

Rezek R, Bright TJ, McGrail DW (1985) Reefs and banks of the northwestern Gulf of Mexico. Their geological, biological, and physical dynamics. John Wiley and Sons, New York: 259 pp

Roberts CM (2002) Deep impact: the rising toll of fishing in the deep sea. Trends in Ecology & Evolution 17: 242-245

Rogers AD (1999) The biology of *Lophelia pertusa* and other deep-water reef-forming corals and impacts from human activities. International Review of Hydrobiology 84 (4): 315-406

Rowe E, Mariano AJ, Ryan EH (2005) "The Antilles Current" Ocean Surface Currents. World wide web article, accessed April 2005. Available on-line at: <http://oceancurrents.rsmas.miami.edu/atlantic/antilles.html>

Sala E, Ballesteros E, Starr RM (2001) Rapid decline of Nassau grouper spawning aggregations in Belize: fishery management and conservation needs. Fisheries 26: 23-30

Santodomingo N, Reyes J, Gracia A, Martínez A, Ojeda G, García G (2006) Madracis coral communities off San Bernardo Islands (Colombian Caribbean). Bulletin of Marine Science, *in press*, manuscript received November 2006, 29 pp

Sedberry GR, Ulrich GF, Applegate AJ (1994) Development and status of the fishery for wreckfish (*Polyprion americanus*) in the southeastern United States. Proceedings of the Gulf and Caribbean Fishery Institute 43: 168-192

Sheridan P, Hill R, Kojis B (2006) Trap Fishing in the U.S. Virgin Islands: How and Where Effort is Exerted. Proceedings of the Gulf and Caribbean Fisheries Institute 57: 175-188

South Atlantic Fishery Management Council (1998) Final Habitat Plan for the South Atlantic Region: Essential Fish Habitat Requirements for Fishery Management Plans of the South Atlantic Fishery Management Council. 457 pp. Available on-line at: <http://www.safmc.net/Default.aspx?tabid=80>

Spalding MD (2004) A guide to the Coral reefs of the Caribbean. University of California Press: 256 pp

Squires DF (1964) Fossil coral thickets in Wairarapa, New Zealand: Journal of Paleontology 30 (5): 904-915

Staiger JC (1968a) Narrative of the Cruise p-6802 to the Northwestern Caribbean, March 11-26, 1968. Processed Report Marine Invertebrate Museum RSMAS University of Miami: 24 pp

Staiger JC (1968b) Narrative of the Cruise p-6806 to the Southern Caribbean, July 6 - August 3, 1968. Processed Report Marine Invertebrate Museum RSMAS University of Miami: 71 pp

Staiger JC (1969) Narrative of the Cruise p-6806 - Antillean Arc, June 27 - July 31, 1969, 1968. Processed Report, RSMAS, University of Miami, 65 pp

Staiger JC (1971) Narrative of the Cruise p-7101 - Central America, January 20 - 5 February 1971. Processed Report Marine Invertebrate Museum RSMAS University of Miami: 31pp

Staiger JC, Voss GL (1970) Narrative of the Cruise p-7006 - Hispaniola and Jamaica, June 26 - July 23, 1970. Processed Report Marine Invertebrate Museum RSMAS University of Miami: 57 pp

Steneck RS, Sala E (2005). Large Marine Carnivores: Trophic Cascades and Top-Down Controls in Coastal Ecosystems Past and Present. In: Large Carnivores and the Conservation of Biodiversity, Ray JC, Redford KH, Steneck RS, Berger J (Eds). Island Press: 512 pp

Stetson TR, Squires DF, Pratt RM (1962) Coral Banks Occurring in Deep Water on the Blake Plateau. American Museum Novitates 2114: 1-39

Sword Fishing Central (2006) SFC Fishing Forums Deep Dropping sub forum. Deep drop weights? Discussion thread. Retrieved from the world wide web November 2006. Available on-line at: <http://www.swordfishingcentral.com/forum/deep-dropping/6194-deep-drop-weights.html>

Swingle WE, Dammann AE, Yntema JA (1970) Survey of the Commercial Fishery of the Virgin Islands of the United States. Proceedings of the Gulf and Caribbean Fisheries Institute 22:110-121.

Theile S (2001) Queen Conch fisheries and their management in the Caribbean. Technical Report to the CITES Secretariat. Brussels, TRAFFIC Europe, 95 pp

Tobias W (2004) Status of the Reefs: Reef Fish Resources. U.S. Virgin Islands Department of Planning and Natural Resources, Division of Fish and Wildlife: 11 pp

UNEP-WCMC (United Nations Environment Programme-World Conservation Monitoring Centre) (2003) Checklist of fish and invertebrates listed in the CITES appendices and in EC Regulation 338/97. 6th Edition. JNCC Report 341

van der Land J, Opresko DM (2001) Antipatharia, in: Costello MJ et al. (eds.) (2001). European register of marine species: a check-list of the marine species in Europe and a bibliography of guides to their identification. Collection Patrimoines Naturels 50: 109 pp

Voss GL (1966a) Narrative of the Cruise p-6607 to the Southwestern Caribbean, July 7 - 22. Processed Report, RSMAS, University of Miami: 38 pp

Voss GL (1966b) Biological Survey the Southwestern Caribbean. Processed Report, RSMAS, University of Miami: 36 pp

Voss GL (1971) Narrative of the Cruise p-7106 to the Nares Abyssal Basin and Puerto Rico Trench, 26 June - 13 July 1971. Processed Report, RSMAS, University of Miami: 32 pp

Veronique PT (1987) Annotated Checklist of the Gorgonacea from Martinique and Guadeloupe Islands (F.W.I.). Atoll Research Bulletin 303: l-16.

Viada ST, Cairns SD (1987) Range extensions of ahermatypic Scleractinia in the Gulf of Mexico. Northeast Gulf Science 9 (2): 131-134

Watling L, Auster PJ (2005) Distribution of deep-water Alcyonacea off the Northeast coast of the United States. In: Freiwald A, Roberts JM (eds) Cold-Water Corals and Ecosystems, Springer-Verlag: 259-276

Warner GF (1981) Species descriptions and ecological observations of black corals (Antipatharia) from Trinidad. Bulletin of Marine Science 31: 147-163

Wilber JR, Neumann AC (1993) Effects of submarine cementation on microfabrics and physical properties of carbonate slope deposits, Northern Bahamas. In: Rezak R, Lavoie DL (eds). Carbonate Microfabrics, Springer, New York: 79-94

Wilkinson C (ed) (2004) Status of coral reefs of the world: 2004. Volume 2. Australian Institute of Marine Science, Townsville, Queensland, Australia: 301 pp

Appendix 8.1. Deep-sea corals of the wider Caribbean region, including those located in the U.S. Caribbean
▲ Bold denotes major and potential structure-forming scleractinia (species associated with deep water banks, lithoherms, etc.) and potential habitat-forming antipatharia, octocorallia, pennatulacea, and hydrozoa (species greater than or equal to 25 cm species greater than or equal to 25 cm in height or width
♠ Bold denotes distribution including U.S. Caribbean territories
‡ For material examined: HBOI = Harbor Branch Oceanographic Institute; USNM = United States National Museum

Higher Taxon	Family	Species ▲	Distribution ♠	Depth Range	Reference ‡
Phylum Cnidaria					
Class Anthozoa					
Subclass Hexacorallia (Zoantharia)					
Order Scleractinia					
	Caryophyllidae	*Anomocora fecunda*	Widespread Caribbean and Bahamas, including the **U.S. Virgin Islands**	37-640	Cairns 1979, 2000, UNEP-WCMC 2003; Reyes et al. 2005
	Caryophyllidae	*Anomocora marchadi*	Straits of Florida, southern Caribbean	35-229	Cairns 1979, 2000; Cairns and Zibrowis 1997
	Caryophyllidae	*Anomocora prolifera*	Straits of Florida, southern Caribbean, Lesser Antilles	30-329	Cairns 1979, 2000; Reyes et al. 2005
	Anthemiphylliidae	*Anthemiphyllia patera*	Straits of Florida, Bahamas, Lesser Antilles	500-700	Cairns 1979
	Rhizangiidae	*Astrangia poculata*	Throughout Caribbean, including **Puerto Rico**	0-263	Cairns 1999, 2000
	Dendrophylliidae	*Balanophyllia bayeri*	Mexico, Colombia	274-311	Cairns 1979; Reyes et al. 2005
	Dendrophylliidae	*Balanophyllia cyathoides*	Straits of Florida, Yucatan Channel, Lesser Antilles; Venezuela	45-494	Cairns 1979, 2000; Reyes et al. 2005
	Dendrophylliidae	*Balanophyllia dineta*	Southeastern Caribbean, Lesser Antilles	27-274	Cairns 2000
	Dendrophylliidae	*Balanophyllia floridana*	Straits of Florida, southeastern and western Caribbean	13-220	Cairns 2000
	Dendrophylliidae	*Balanophyllia hadros*	Only off Nicaragua	238-274	Cairns 1979
	Dendrophylliidae	*Balanophyllia palifera*	Bahamas, Antilles, Yucatan Channel, Colombia	53-708	Cairns 1979, 2000; Reyes et al. 2005

Higher Taxon	Family	Species ▲	Distribution ♠	Depth Range	Reference ‡
	Dendrophylliidae	*Balanophyllia wellsi*	Bahamas, Cuba, Grenada, Jamaica, Colombia	412-505	Cairns 1979, UNEP-WCMC 2003; Reyes et al. 2005
	Dendrophylliidae	*Bathypsammia fallosocialis*	Straits of Florida, St. Lucia	244-805	Cairns 1979
	Caryophyllidae	*Caryophyllia ambrosia caribbeana*	Widespread Caribbean, Bahamas, including **U.S. territories**	183-1646	Cairns 1979; Reyes et al. 2005
	Caryophyllidae	*Caryophyllia antillarum*	Straits of Florida, Bahamas, Antilles, including **US territories**	150-730	Cairns 1979, 2000
	Caryophyllidae	*Caryophyllia barbadendis*	Barbados; Colombia	129-249	Cairns 1979, 2000; Reyes et al. 2005
	Caryophyllidae	*Caryophyllia berteriana*	Widespread Caribbean, Bahamas, including **U.S. territories**	99-1033	Cairns 1979, 2000; Reyes et al. 2005
	Caryophyllidae	*Caryophyllia corrugata*	Antilles, Virgin Islands to Cuba, including **U.S. territories**	183-380	Cairns 1979
	Caryophyllidae	*Caryophyllia crypta*	Bahamas and Caribbean, Greater Antilles, southern and western Caribbean, including **U.S. territories**	12-183	Cairns 2000
	Caryophyllidae	*Caryophyllia parvula*	Antilles, Venezuela	97-399	Cairns 1979
	Caryophyllidae	*Caryophyllia paucipalata*	Lesser Antilles, including **U.S. territories**	714-843	Cairns 1979
	Caryophyllidae	*Caryophyllia polygona*	Straits of Florida, Antilles	700-1817	Cairns 1979
	Caryophyllidae	*Caryophyllia zopyros*	Antilles	73-618	Cairns 1979, 2000
	Caryophyllidae	*Cladocora debilis*	Straits of Florida, eastern and southern Caribbean, including **Puerto Rico**	32-480 (common 50-100)	Cairns 2000; UNEP-WCMC 2003; Reyes et al. 2005
	Dendrophylliidae	*Cladopsammia manuelensis*	Straits of Florida, St. Lucia	70-366	Cairns 1979, 2000
	Caryophyllidae	*Coenocyathus caribbeana*	Bahamas and Caribbean	5-100	Cairns 2000

Higher Taxon	Family	Species ▲	Distribution ♠	Depth Range	Reference ‡
	Caryophyllidae	*Coenocyathus parvulus*	Bahamas and Caribbean, including **U.S. territories**	97-399	Cairns 1979, 2000; Reyes et al. 2005
	Caryophyllidae	*Coenosmilia arbuscula*	Widespread Caribbean, Bahamas, including **U.S. territories**	74-622	Cairns 1979, 2000; Reyes et al. 2005
	Caryophyllidae	*Colangia immersa*	Throughout Caribbean, Bahamas, including **U.S. territories**	0.5-347	Cairns 2000
	Caryophyllidae	*Concentrotheca laevigata*	Straits of Florida, Yucatan Channel	183-800	Cairns 1979
	Turbinoliidae	*Cylicia inflata*	Only off Havana, Cuba	183-443	Cairns 1979
	Caryophyllidae	*Dasmosmilia lymani*	Straits of Florida, Cuba, Grenada, Venezuela	37-366	Cairns 1979, 2000, UNEP-WCMC 2003
	Caryophyllidae	*Dasmosmilia variegata*	Straits of Florida, southern Lesser Antilles	110-421	Cairns 1979, 2000
	Turbinoliidae	*Deltocyathoides stimpsonii*	Straits of Florida, Lesser Antilles	110-553	Cairns 1979, 2000
	Caryophyllidae	*Deltocyathus agassizii*	Straits of Florida, Anguilla	494-907	Cairns 1979
	Caryophyllidae	*Deltocyathus calcar*	Widespread Caribbean, Bahamas, including **U.S. territories**	81-675	Cairns 1979, 2000; Reyes et al. 2005
	Caryophyllidae	*Deltocyathus eccentricus*	Widespread Caribbean, Bahamas, including **U.S. territories**	183-907	Cairns 1979
	Caryophyllidae	*Deltocyathus italicus*	Widespread Caribbean, Bahamas, including **U.S. territories**	403-2634	Cairns 1979
	Caryophyllidae	*Deltocyathus moseleyi*	Straits of Florida, Belize, Lesser Antilles	201-777	Cairns 1979
	Caryophyllidae	*Deltocyathus pourtalesi*	Straits of Florida, Bahamas	311-567	Cairns 1979
	Dendrophylliaidae	***Dendrophyllia alternata***	Antilles, Bahamas	276-900	Cairns 1979
	Caryophyllidae	***Desmophyllum dianthus*** (=*D. cristagalli*)	Straits of Florida, Bahamas, Martinique, **U.S. Virgin Islands**	155-2200	Cairns 1979, 2000, UNEP-WCMC 2003
	Caryophyllidae	*Desmophyllum striatum*	Greater Antilles, Bahamas, including **U.S. territories**	277-823	Cairns 1979, 2000
	Dendrophylliaidae	*Eguchipsammia cornucopia*	Bahamas, Straits of Florida, Yucatan Channel, southeastern Caribbean	93-300	Cairns 1979, 2000; Reyes et al. 2005
	Dendrophylliaidae	*Eguchipsammia gaditana*	Yucatan Channel, Venezuela	97-505	Cairns 1979, 2000

Higher Taxon	Family	Species ▲	Distribution ♠	Depth Range	Reference ‡
	Dendrophylliaidae	***Enallopsammia profunda***	Straits of Florida, St. Lucia	403-1748	Cairns 1979
	Dendrophylliaidae	***Enallopsammia rostrata***	Straits of Florida, Bahamas, Antilles, western Caribbean, Antilles, including **U.S. Virgin Islands**	300-1646	Cairns 1979, UNEP-WCMC 2003
	Flabellidae	*Flabellum (pavoninum) atlanticum*	Bahamas, Cuba	357-618	Cairns 1979, UNEP-WCMC 2003
	Flabellidae	*Flabellum floridanum*	Western Straits of Florida, Mexico, Panama	80-366	Cairns 1979, 2000; UNEP-WCMC 2003
	Flabellidae	*Flabellum moseleyi*	Widespread Caribbean, including **U.S. territories**	216-1097	Cairns 1979
	Fungiacyathidae	*Fungiacyathus marenzelleri*	Bahamian archipelago	1450-2745	Cairns 1979
	Fungiacyathidae	*Fungiacyathus pusillus*	Straits of Florida, Yucatan, Lesser Antilles	285-439	Cairns 1979
	Fungiacyathidae	*Fungiacyathus symmetricus*	Widespread Caribbean, Bahamas.	183-1664	Cairns 1979
	Gardineriidae	*Gardineria minor*	Throughout Caribbean, Bahamas	2-146	Cairns 1979, 2000
	Gardineriidae	*Gardineria paradoxa*	Antilles, Yucatan Channel, Straits of Florida	97-700	Cairns 1979, 2000
	Gardineriidae	*Gardineria simplex*	Bahamas, Antilles, Yucatan Channel	46-241	Cairns 2000
	Guyniidae	*Guynia annulata*	Bahamas, Straits of Florida, western Caribbean, Antilles	30-653	Cairns 1979, 2000
	Flabellidae	*Javania cailleti*	Widespread Caribbean, Bahamas, including U.S. territories	30-1809	Cairns 1979, 2000; Reyes et al. 2005
	Flabellidae	*Javania pseudoalabastra*	Bahamas, Jamaica	1089-1234	Cairns 1979
	Caryophyllidae	*Labyrinthocyathus langae*	Straits of Florida, Bahamas, Antilles, western Caribbean	695-810	Cairns 1979
	Micrabaciidae	*Leptopenus discus*	Only off south east Cuba	2842-3475	Cairns 1979
	Caryophyllidae	***Lophelia pertusa***	Straits of Florida, Bahamas, southern Caribbean, Antilles, including **Puerto Rico and U.S. Virgin Islands**	146-1200	Cairns 1979, 2000, UNEP-WCMC 2003
	Pocilloporidae	*Madracis asperula*	Widespread Caribbean, including **U.S. territories** (absent Bahamas)	24-311	Cairns 2000; Reyes et al. 2005
	Pocilloporidae	*Madracis brueggemanni*	Southern Caribbean	51-130	Cairns 2000

Higher Taxon	Family	Species ▲	Distribution ♠	Depth Range	Reference ‡
	Pocilloporidae	***Madracis myriaster***	Widespread Caribbean, Bahamas, including **Puerto Rico and U.S. Virgin Islands**	20-1220	Cairns 1979, 2000, UNEP-WCMC 2003
	Pocilloporidae	*Madracis* pharensis forma *pharensis*	Widespread Caribbean, Bahamas, including U.S. territories	11-333	Cairns 2000; Reyes et al. 2005
	Oculinidae	***Madrepora carolina***	Greater Antilles, Bahamas, Tobago, western Caribbean, including **Puerto Rico and U.S. Virgin Islands**, Venezuela	53-801 (common 100-300)	Cairns 1979, 2000; UNEP-WCMC 2003; Reyes et al. 2005
	Oculinidae	***Madrepora oculata***	Widespread Caribbean, Bahamas, including **Puerto Rico and U.S. Virgin Islands**	144-1391	Cairns 1979
	Oculinidae	*Oculina tenella*	Straits of Florida, Cuba	25-159 (common 40-60)	Cairns 2000; UNEP-WCMC 2003
	Caryophyllidae	*Oxysmilia rotundifolia*	Widespread Caribbean, Bahamas, including **U.S. territories**	46-640	Cairns 1979, 2000; Reyes et al. 2005
	Caryophyllidae	*Paracyathus pulchellus*	Widespread Caribbean, including **U.S. territories**	17-250	Cairns 1979, 2000; Reyes et al. 2005
	Turbinoliidae	*Peponocyathus folloculus*	Straits of Florida, Antilles	284-457	Cairns 1979
	Caryophyllidae	*Phacelocyathus flos*	Bahamas, Antilles, western Caribbean	20-355	Cairns 1979, 2000
	Flabellidae	*Placotrochides frusta*	Lesser Antilles	497-907	Cairns 1979
	Caryophyllidae	*Polycyathus mayae*	Straits of Florida, Bahamas, northern Caribbean, including **U.S. territories**, Barbados	137-309	Cairns 2000; Reyes et al. 2005
	Caryophyllidae	*Polycyathus senegalensis*	Disjunct distribution, Florida, southern Caribbean	12-143	Cairns 2000
	Flabellidae	*Polymyces fragilis*	Straits of Florida, Bahamas, western and southern Caribbean, southern Lesser Antilles	75-822	Cairns 1979, 2000; Reyes et al. 2005
	Guyniidae	*Pourtalocyathus hispidus*	Straits of Florida, Bahamas, Antilles, including **U.S. territories**	349-1200	Cairns 1979
	Caryophyllidae	*Premocyathus cornuformis*	Straits of Florida, Bahamas, northern and eastern Caribbean	137-931	Cairns 1979, 2000

Higher Taxon	Family	Species ▲	Distribution ♠	Depth Range	Reference ‡
	Dendrophylliaidae	*Rhizopsammia goesi*	Lesser Antilles, Colombia, Bahamas, including **U.S. Virgin Islands**	4.5-119	Cairns 1977, 2000, UNEP-WCMC 2003
	Caryophyllidae	*Rhizosmilia gerdae*	Straits of Florida, Bahamas, Yucatan Channel, northeastern Antilles, including **U.S. territories**	123-549	Cairns 1979, 2000
	Caryophyllidae	*Rhizosmilia maculata*	Widespread Caribbean, Bahamas, including **U.S. territories**	0.5-508	Cairns 2000
	Guyniidae	*Schizocyathus fissilis*	Straits of Florida, Bahamas, western Caribbean, Antilles (from **Puerto Rico** to Grenada)	88-640	Cairns 1979, 2000
	Caryophyllidae	***Solenosmilia variabilis***	Straits of Florida, Lesser Antilles, Jamaica, southern Caribbean	220-1383	Cairns 1979
	Guyniidae	*Stenocyathus vermiformis*	Straits of Florida, western Caribbean, Bahamas, Antilles, including **U.S. territories**	165-835	Cairns 1979, 2000
	Caryophyllidae	*Stephanocyathus coronatus*	Throughout Caribbean, Bahamas, including **U.S. territories**	543-1250	Cairns 1979
	Caryophyllidae	*Stephanocyathus diadema*	Widespread Caribbean, including **U.S. territories**	795-2113	Cairns 1979
	Caryophyllidae	*Stephanocyathus laevifundus*	Antilles, Panama, Straits of Florida, and off **Navassa Island**	300-1158	Cairns 1979
	Caryophyllidae	*Stephanocyathus paliferus*	Widespread Caribbean, Bahamas	299-715	Cairns 1979
	Caryophyllidae	*Tethocyathus cylindraceus*	Straits of Florida, Jamaica, Bahamas, Barbados.	155-649	Cairns 1979
	Caryophyllidae	*Tethocyathus recurvatus*	Yucatan Channel	320-488	Cairns 1979
	Caryophyllidae	*Tethocyathus variabilis*	Straits of Florida, Yucatan, Jamaica, including **U.S. territories**	320-488	Cairns 1979
	Caryophyllidae	*Thalamophyllia gombergi*	Only from Pourtales Terrace, Florida	155-220	Cairns 1979
	Caryophyllidae	*Thalamophyllia riisei*	Bahamas, Antilles, including **U.S. territories, Colombia**	4-914	Cairns 1979, 2000; Reyes et al. 2005
	Dendrophylliidae	*Thecopsammia socialis*	Gerogia to FL Keys, Bahamas	214-878	Cairns 1979; UNEP-WCMC 2003
	Turbinoliidae	*Trematotrochus corbicula*	Only northwest Cuba	400-576	Cairns 1979

Higher Taxon	Family	Species ▲	Distribution ♠	Depth Range	Reference ‡
	Caryophyllidae	*Trochocyathus fossulus*	Bahamas, Virgin Islands, including **U.S. territories**	205-380	Cairns 1979
	Caryophyllidae	*Trochocyathus rawsonii*	Widespread Caribbean, Bahamas, including **U.S. territories**	55-700	Cairns 1979, 2000
	Dendrophylliaidae	*Trochopsammia infundibulum*	northwestern Cuba, Lesser Antilles	532-1372	Cairns 1979
Order Zoanthidea					
	Gerardiidae	*Gerardia sp.*	Bahamas (Straits of Florida)	>100 (~580-630)	Messing et al. 1990
Order Antipatharia					
	Aphanipathidae	*Acanthopathes humilis*	Bahamas, Barbados, Cuba, Grenada, Mexico, Montserrat, Saint Vincent and the Grenadines	129 - 491	Opresko 1972; UNEP-WCMC 2003; Opresko 2006
	Aphanipathidae	*Acanthopathes thyoides*	Cuba, Saint Vincent and the Grenadines	~40-240	Opresko 1972; UNEP-WCMC 2003; Opresko 2006
	Antipathidae	***Allopathes desbonni***	Barbados, Cuba, Guadeloupe, Montserrat	129-161	Opresko and Cairns 1994; UNEP-WCMC 2003; Opresko 2006
	Antipathidae	***Antipathes americana?***	**U.S. Virgin Islands**, Grenada, Netherlands Antilles	37-532	Brook 1889; Opresko 1972; Warner 1981; OBIS 2006
	Antipathidae	***Antipathes atlantica***	Colombia, Jamaica, Mexico, Trinidad and Tobago	10 - 115	Warner 1981; UNEP-WCMC 2003; Reyes et al. 2005; Opresko 2006
	Antipathidae	***Antipathes caribbeana***	Bahamas, Colombia, **Puerto Rico**, Greater and Lesser Antilles	11->100 (common 30-60)	Opresko 1996; UNEP-WCMC 2003; Opresko and Sanchez 2005
	Antipathidae	*Antipathes columnaris*	Greater and Lesser Antilles, including **U.S. Virgin Islands**, Venezuela	73 - 567	Opresko 1974; UNEP-WCMC 2003; Reyes et al. 2005; Opresko 2006
	Antipathidae	*Antipathes lenta*	Straits of Florida, Cuba, Saint Vincent and the Grenadines, Trinidad and Tobago, Barbados, Honduras, Panama, Colombia, Venezuela	50-200	Opresko 1972; UNEP-WCMC 2003; Opresko and Sanchez 2005; Reyes et al. 2005; OBIS 2006; Opresko 2006

Higher Taxon	Family	Species ▲	Distribution ♠	Depth Range	Reference ‡
	Antipathidae	***Antipathes gracilis***	from Colombia north throughout the Caribbean, including Panama, Trinidad and Tobago, and Colombia	20-160	Brook 1889, Warner 1981, STRI 2006; Reyes et al. 2005
	Antipathidae	*Antipathes rhipidion?*	**U.S. Virgin Islands**	Unk	UNEP-WCMC 2003
	Antipathidae	*Antipathes tristis?*	Barbados, Guadeloupe, Martinique, Montserrat, Saint Lucia	Unk	UNEP-WCMC 2003
	Aphanipathidae	*Aphanipathes pedata*	Widespread Caribbean	~60-310	Opresko 1974; Opresko 2006
	Aphanipathidae	*Aphanipathes salix*	Guadeloupe, Colombia	107-333	Opresko 1972; UNEP-WCMC 2003; Reyes et al. 2005; Opresko 2006
	Schizopathidae	*Bathypathes alternata*	Straits of Florida (Bahamas), Yucatan Channel	~100-5000	Brook 1889 ; Opresko 1974; Opresko 2002; Opresko 2006
	Schizopathidae	*Bathypathes patula*	Mexico, **Puerto Rico**, Saint Kitts and Nevis, Caribbean Sea Basin, Cayman Trench, Yucatan Basin	100-5000	Brook 1889; Opresko 1974; Keller, et al. 1975; Opresko 2002; UNEP-WCMC 2003; OBIS 2006; Opresko 2006
	Cladopathidae	*Chrysopathes sp.*	Widespread Caribbean	>100	Opresko 2006
	Antipathidae	*Cirrhipathes spiralis?*	Barbados, Cuba, Martinique, Montserrat, St. Vincent and the Grenadines		UNEP-WCMC 2003
	Aphanipathidae	*Distichopathes disticha*	Martinique, Mexico	95-190	Opresko 2004; CITES 2006; Opresko 2006
	Aphanipathidae	***Distichopathes filix***	Bahamas, Barbados, Cuba, Dominica, Guadeloupe, Martinique, Montserrat, Saint Vincent and the Grenadines	~175-450	Opresko 2006; Opresko 1972; UNEP-WCMC 2003
	Aphanipathidae	*Elatopathes abietina*	Bahamas, Barbados, Cuba, Martinique, Mexico, Nicaragua, Saint Vincent and the Grenadines; Colombia	31 - 310	Opresko 1972; Rezak et al. 1985; UNEP-WCMC 2003; Reyes et al. 2005; Opresko 2006
	Cladopathidae	*Heliopathes americana*	Widespread Caribbean	>100	Opresko 2003; Opresko 2006
	Leiopathidae	***Leiopathes glaberrima***	Straits of Florida, Jamaica, Mexico; Venezuela, Bahamas	176 - 549	Opresko 1974; UNEP-WCMC 2003; Opresko 2006; Material examined USNM 1026305

Higher Taxon	Family	Species ▲	Distribution ♠	Depth Range	Reference ‡
	Schizopathidae	***Parantipathes tetrasticha***	Cuba, Guyana, Mexico, **Puerto Rico**, Saint Lucia	175 - 428	Opresko 1972; Opresko 2002; UNEP-WCMC 2003; Opresko 2006
	Schizopathidae	*Phanopathes rigida*	Bahamas, Barbados, Colombia, Cuba, Guadeloupe, Venezuela	64 - 640	Opresko 1972; Opresko 2002; UNEP-WCMC 2003; Opresko 2006
	Myriopathidae	***Plumapathes pennacea***	Throughout Caribbean, including **U.S. Virgin Islands & Puerto Rico**	3-229	Opresko 1974; Colin 1978; UNEP-WCMC 2003, CITES 2006; Opresko 2006
	Antipathidae	*Stichopathes lutkeni*	Barbados, Colombia, Dominican Republic, Trinidad and Tobago	~14-115	Brook 1889; Humann 1993; UNEP-WCMC 2003; Reyes et al. 2005; Opresko 2006
	Antipathidae	*Stichopathes occidentalis*	Caribbean region	~20-160	Brook 1889; Opresko 2006; Reyes et al. 2005
	Antipathidae	*Stichopathes pourtalesi*	Barbados, Colombia, Cuba, Grenada, Martinique, Montserrat, Saint Vincent and the Grenadines	>100	Pourtalès 1874, 1880; Brook 1889; Reyes et al. 2005; CITES 2006; Opresko 2006
	Myriopathidae	***Tanacetipathes barbadensis***	Barbados, Trinidad and Tobago	~60-345	Brook 1889; van der Land and Opresko 2001; Warner 1981; UNEP-WCMC 2003; Opresko 2006
	Myriopathidae	***Tanacetipathes hirta***	Throughout Caribbean, including **Puerto Rico**	13 - 357	Opresko 1972; Colin 1978; Warner 1981; UNEP-WCMC 2003; Opresko 2006
	Myriopathidae	***Tanacetipathes tanacetum***	Throughout Caribbean, including Puerto Rico	46 - 915	UNEP-WCMC 2003; OBIS 2006; Opresko 2006
	Myriopathidae	***Tanacetipathes thamnea***	Trinidad and Tobago	~45-345	Opresko 1970; Warner 1981; UNEP-WCMC 2003; Opresko 2006
Subclass Octocorallia					
Order Alcyonacea					
	Alcyoniidae	*Alcyonium digitatum*	Western Atlantic	>200	Cairns 2005
	Alcyoniidae	*Anthomastus agassizi*	Straits of Florida, Bahamas	320-3186	Cairns 2005

Higher Taxon	Family	Species ▲	Distribution ♠	Depth Range	Reference ‡
	Alcyoniidae	*Anthomastus robusta* var. *delta*	Western Atlantic	>200	Cairns 2005
	Alcyoniidae	*Bellonella rubistella*	Throughout Caribbean	24-329	Cairns 2005
	Clavulariidae	*Carijora* (=*Telesto*?) *operculata*	Straits of Florida (off Havana, Cuba), probably throughout Antilles	60-298	Cairns 2005
	Nephtheidae	*Drifta glomerata*	Western Atlantic	>200	Cairns 2005
	Nephtheidae	*Duva florida*	Western Atlantic	>200	Cairns 2005
	Nephtheidae	*Gersemia rubiformia*	Western Atlantic	>200	Cairns 2005
	Nephtheidae	***Neospongodes portoricensis***	Bahamas, Caribbean	37-503	Humann 1993
	Nidaliiae	*Nidalia deichmannae*	Western Atlantic	>200	Cairns 2005
	Nidaliiae	*Nidalia dissidens*	Western Atlantic	>200	Cairns 2005; Reyes et al. 2005
	Nidaliiae	*Nidalia occidentalis*	Throughout Caribbean	37-311	Cairns 2005; Reyes et al. 2005
	Nidaliiae	*Nidalia rubrapunctata*	Western Atlantic	~82->200	Cairns 2005
	Nephtheidae	*Pseudodrifa capnella nigra*	Straits of Florida (off Havana, Cuba), Bahamas	60-878	South Atlantic Fishery Management Council 1998; Cairns 2005; Reed 2006
	Clavulariidae	*Scleranthelia rugosa rugosa*	Throughout Caribbean	175-586	Cairns 2005
	Nephtheidae	*Stereonepthya portoricensis*	Western Atlantic	>200	Cairns 2005
	Clavulariidae	*Stereotelesto* (=*Telesto*) *corallina*	Bahamas, Antilles, including **Puerto Rico**	23-188	Bayer 1961; Humann 1993
	Clavulariidae	*Telesto nelleae*	Straits of Florida (off Havana, Cuba), Bahamas	27-1153	Bayer 1961; South Atlantic Fishery Management Council 1998; Cairns 2005
	Clavulariidae	*Telesto septentrionalis*	Western Atlantic	>200	Cairns 2005
	Nephtheidae	*Trachythela rudis*	Western Atlantic	805	Cairns 2005
Order Gorgonacea					
	Isididae	*Acanella arbuscula*	Western Atlantic	>200	Cairns 2005
	Isididae	*Acanella eburnea*	Western Atlantic	>200	Cairns 2005
	Plexauridae	*Acanthactis austera*	Western Atlantic	>200	Cairns 2005

Higher Taxon	Family	Species ▲	Distribution ♠	Depth Range	Reference ‡
	Plexauridae	*Acanthactis scabra*	Western Atlantic	>200	Cairns 2005
	Acanthogorgiidae	*Acanthogorgia armata*	Western Atlantic	>200	Cairns 2005
	Acanthogorgiidae	*Acanthogorgia aspera*	Throughout Caribbean, including **Puerto Rico**	>183	Watling and Auster 2005; Bayer 1961
	Acanthogorgiidae	*Acanthogorgia schrammi*	Straits of Florida; Guadeloupe; Colombia	>200	Veronique 1987; Watling and Auster 2005; Reyes et al. 2005
	Primnoidae	***Acanthoprimnoa goesi***	Straits of Florida, Bahamas, **Puerto Rico**, Virgin Islands, including **U.S. Virgin Islands**	137-595	Cairns and Bayer 2004b; Cairns 2005
	Primnoidae	*Acanthoprimnoa pectinata*	northeastern Yucatan, lesser Antilles, Straits of Florida	194-686	Cairns and Bayer 2004b; Cairns 2005
	Anthothelidae	*Anthothela bathybius*	Western Atlantic	>200	Cairns 2005
	Anthothelidae	*Anthothela grandiflora*	Western Atlantic	>200	Cairns 2005
	Anthothelidae	*Anthothela grandiflora sensu*	Western Atlantic	>200	Cairns 2005
	Plexauridae	*Bebryce cinerea*	Western Atlantic	>200	Cairns 2005
	Plexauridae	*Bebryce grandis*	Western Atlantic	>200	Cairns 2005
	Plexauridae	*Bebryce parastellata*	Western Atlantic	>200	Cairns 2005
	Plexauridae	*Caliacis nutans*	Western Atlantic	>200	Cairns 2005
	Primnoidae	***Callogorgia americana americana***	Straits of Florida, Lesser Antilles, including **U.S. territories**	183-732	Cairns & Bayer 2002; Cairns 2005
	Primnoidae	***Callogorgia gracilis***	Throughout Caribbean, Bahamas, Antilles	82-514	Cairns & Bayer 2002; Cairns 2005
	Primnoidae	*Callogorgia linguimaris*	Only Bahamas	1116	Cairns & Bayer 2002; Cairns 2005
	Primnoidae	***Calyptrophora antilla***	Windward Passage	1399	Bayer 2001; Cairns 2005
	Primnoidae	*Calyptrophora gerdae*	Straits of Florida	229-556	Bayer 2001; Cairns 2005
	Primnoidae	***Calyptrophora pillsburyae***	Lesser Antilles	686-1125	Bayer 2001; Cairns 2005
	Primnoidae	*Calyptrophora trilepis*	Straits of Florida, Bahamas	593-911	Bayer 2001; Cairns 2005
	Primnoidae	***Candidella imbricata***	Straits of Florida, Bahamas, Antilles	514-2063	Cairns and Bayer 2004b; Cairns 2005; Watling and Auster 2005; Cairns personal Comm.

Higher Taxon	Family	Species ▲	Distribution ♠	Depth Range	Reference ‡
	Isididae	*Caribisis simplex*	Western Atlantic	>200	Cairns 2005
	Chrysogorgiidae	*Chalcogorgia pellucida*	Western Atlantic	>200	Cairns 2005
	Isididae	*Chelidonisis aurantiaca mexicana*	Western Atlantic	>200	Cairns 2005
	Chrysogorgiidae	*Chrysogorigia agassizii*	Western Atlantic	>200	Cairns 2005
	Chrysogorgiidae	*Chrysogorigia desbonni*	Greater and Lesser Antilles, Bahamas, Guadeloupe, Martinique, Colombia	155-595	Veronique 1987; Cairns 2001; Cairns 2005; Reyes et al. 2005
	Chrysogorgiidae	*Chrysogorigia elegans*	Southeastern Caribbean, Lesser Antilles, Martinique	128-1716	Cairns 2001; Cairns 2005
	Chrysogorgiidae	*Chrysogorigia fewkesii*	Antilles, Caribbean	403-1200	Cairns 2001; Cairns 2005
	Chrysogorgiidae	***Chrysogorigia multiflora***	Antilles, Bahamas, Straits of Florida	320-1354	Cairns 2001; Cairns 2005
	Chrysogorgiidae	***Chrysogorigia spiculosa***	Gulf of Mexico, Lesser Antilles	914-2256	Cairns 2001; Cairns 2005
	Chrysogorgiidae	*Chrysogorigia squamata*	Antilles, Yucatan	431-1046	Cairns 2001; Cairns 2005
	Chrysogorgiidae	*Chrysogorigia thrysiformis*	Greater and Lesser Antilles, Bahamas	146-526	Cairns 2001; Cairns 2005
	Coralliidae	*Corallium medea*	Straits of Florida	>200	Bayer 1961; Cairns 2005; Watling and Auster 2005
	Coralliidae	*Corallium niobe*	Straits of Florida	659-677	Bayer 1961; Cairns 2005; Watling and Auster 2005
	Ellisellidae	*Ctenocella* (*Ellisella*) *atlantica*	Western Atlantic	>200	Cairns 2005
	Primnoidae	*Dasystenella acanthina*	Western Atlantic	>200	Cairns 2005
	Dendrobrachiidae	*Dendrobrachia multispina*	Western Atlantic	>200	Cairns 2005
	Anthothelidae	***Diodogorgia nodulifera?***	Throughout Caribbean, including **Puerto Rico**, Bahamas, Guadeloupe	14-183	Veronique 1987; Bayer 1961; Humann 1993
	Chrysogorgiidae	*Distichogorgia sconsa*	Straits of Florida	>200	Cairns 2005; Watling and Auster 2005
	Plexauridae	*Echinomuricea atlantica*	Western Atlantic	>200	Cairns 2005
	Ellisellidae	***Ellisella barbadensis***	Striats of Florida, Antilles, including **U.S. Virgin Islands**	20-488	Bayer 1961; Veronique 1987; Humann 1993; Cairns 2005; Armstrong et al. 2006

Higher Taxon	Family	Species ▲	Distribution ♠	Depth Range	Reference ‡
	Ellisellidae	***Ellisella elongata***	Antilles, **Puerto Rico**, Bahamas, southeastern Caribbean	15-219	Humann 1993; Bayer 1961; Caribbean Fishery Management Council 2004; Cairns 2005
	Ellisellidae	*Ellisella funiculina*	Western Atlantic	>200	Cairns 2005
	Ellisellidae	*Ellisella grandiflora*	Guadeloupe	350	Veronique 1987; Cairns 2005
	Ellisellidae	*Ellisella grandis*	Western Atlantic	>200	Cairns 2005
	Ellisellidae	*Ellisella nivea*	Western Atlantic	92~>200	Cairns 2005
	Ellisellidae	*Ellisella rosea*	Western Atlantic	52~>200	Cairns 2005
	Ellisellidae	*Ellisella schmitti*	Western Atlantic	61~>200	Cairns 2005
	Gorgoniidae	*Eunicella albatrossae*	Western Atlantic	>200	Cairns 2005
	Gorgoniidae	***Eunicella modesta***	Straits of Florida, Bahamas	274-3236	Watling and Auster 2005; Reed 2006
	Gorgoniidae	*Eunicella tenuis*	Western Atlantic	>200	Cairns 2005
	Plexauridae	***Hypnogorgia pendula***	Guadeloupe, Martinique	176	Veronique 1987; Cairns 2005; Material examined HBOI 26-V-06-1-17 (Reed 2006)
	Anthothelidae	***Iciligorgia schrammi***	Straits of Florida, Antilles, southeastern Caribbean	11-366	Humann 1993; Cairns 1977; Cairns 2005
	Chrysogorgiidae	*Iridogorgia pourtalesi*	Guadeloupe	1343	Cairns 2005; Veronique 1987
	Isididae	*Isidella longiflora?*	Straits of Florida	to 667	Reed 2006
	Ellisellidae	*Junceella antillarum*	Western Atlantic	>200	Cairns 2005
	Isididae	***Keratoisis flexibilis***	Straits of Florida, Bahamas, Mexico, Guadeloupe, Colombia, Venezuela	170-878	Cairns 2005; Watling and Auster 2005
	Isididae	***Keratoisis ornata***	Straits of Florida, Bahamas, Cuba	274-3236	Bedford Institute of Oceanography 2003; Cairns 2005; Watling and Auster 2005
	Isididae	*Keratoisis siemensii*	Western Atlantic	>200	Cairns 2005
	Isididae	*Keratosis simplex*	Martinique	611	Cairns 2005; Veronique 1987
	Isididae	*Lepidisis caryophyllia*	Martinique, Guadeloupe	607-1067	Cairns 2005; Veronique 1987
	Isididae	*Lepidisis longiflora*	Straits of Florida, Caribbean	743-1125	Cairns 2005; Watling and Auster 2005

Higher Taxon	Family	Species ▲	Distribution ♠	Depth Range	Reference ‡
	Gorgoniidae	*Leptogorgia euryale?*	Southern Lesser Antilles	1060-3000	Bayer 1952; Keller et al. 1975
	Gorgoniidae	*Leptogorgia stheno?*	Southern Lesser Antilles	1060-3000	Bayer 1952; Keller et al. 1975
	Gorgoniidae	*Lophogorgia cardinalis*	Straits of Florida (Cuba)	26-123	Bayer 1961; South Atlantic Fishery Management Council 1998; Cairns 2005
	Chrysogorgiidae	*Metallogorgia splendens*	Western Atlantic	>200	Cairns 2005
	Plexauridae	***Muricea laxa***	Straits of Florida, Bahamas, Antilles	18-128	Bayer 1961; Cairns 1977; Humann 1993; Cairns 2005
	Plexauridae	*Muriceides (=Trachymuricea) hirta*	Western Atlantic	>200	Cairns 2005
	Plexauridae	*Muriceides kukenthali*	Western Atlantic	>200	Cairns 2005
	Plexauridae	*Muriceopsis petila*	Florida, Bahamas, Guadeloupe	67-455	Cairns 2005; Bayer 1961; Veronique 1987
	Primnoidae	***Narella bellissima***	Straits of Florida, Bahamas, Lesser Antilles, including **U.S. territories**	161-792	Cairns and Bayer 2003; Cairns 2005
	Primnoidae	***Narella pauciflora***	Straits of Florida, Antilles, **Puerto Rico**, Bahamas, Mexico	738-1473	Cairns and Bayer 2003; Cairns 2005
	Primnoidae	*Narella regularis*	Straits of Florida, Lesser Antilles and Bahama.	366-792	Veronique 1987; Cairns and Bayer 2003; Cairns 2005; Watling and Auster 2005
	Primnoidae	***Narella spectabilis***	Only Bahamas.	1485	Cairns and Bayer 2003; Cairns 2005
	Primnoidae	***Narella versluysi***	Straits of Florida, Cuba.	677-900	Cairns and Bayer 2003; Cairns 2005
	Ellisellidae	***Nicella goreaui***	Bahamas and southern Caribbean	45-146	Cairns 2007
	Ellisellidae	***Nicella americana***	Bahamas, Antilles, southern Caribbean	62-237	Cairns 2007
	Ellisellidae	***Nicella deichmannae***	Bahamas, northweatern Caribbean, Antilles, incluuding **U.S. territories**	27-403	Cairns 2007
	Ellisellidae	***Nicella hebes***	Western Atlantic, including Bahamas and southern coast of Caribbean to Nicaragua	27-327	Cairns 2005; Cairns 2007
	Ellisellidae	***Nicella lanceolata***	Only Grand Cayman Island	229-244	Cairns 2007

Higher Taxon	Family	Species ▲	Distribution ♠	Depth Range	Reference ‡
	Ellisellidae	***Nicella obesa***	Bahamas, Antilles from Cuba to Barbados, incluuding **U.S. territories**, Venezuela	174-819	Cairns 2007; Cairns 2005; Veronique 1987
	Ellisellidae	***Nicella guadelupensis***	Bahamas, Antilles, including **U.S. territories**, Venezuela	27-395	Cairns 2007
	Ellisellidae	*Nicella* sp. A.	Western Atlantic	55-329	Cairns 2007
	Ellisellidae	*Nicella gracilis*	Bahamas, Antilles, Venezuela	60-481	Cairns 2007
	Ellisellidae	***Nicella robusta***	Bahamas, Caribbean	110-259	Cairns 2007
	Primnoidae	***Paracalyptrophora carinata***	Only St. Lucia	514	Cairns and Bayer 2004a; Cairns 2005
	Primnoidae	***Paracalyptrophora duplex***	Straits of Florida, Cuba, Antilles, and Bahamas	374-555	Cairns and Bayer 2004a; Cairns 2005
	Primnoidae	***Paracalyptrophora simplex***	Straits of Florida, Bahamas, Yucatan	165-706	Cairns and Bayer 2004a; Cairns 2005
	Paragorgiidae	***Paragorgia*** (=*boschmai*) ***johnsoni***	Straits of Florida, Bahamas	522-608	Watling and Auster 2005; material examined USNM 35928; Cairns personal comm.
	Plexauridae	*Paramuricea echinata*	Western Atlantic	>200	Cairns 2005
	Plexauridae	*Paramuricea grandis*	Western Atlantic	>200	Cairns 2005
	Plexauridae	*Paramuricea multispina*	Western Atlantic	>200	Cairns 2005
	Plexauridae	*Paramuricea placomus*	Straits of Florida, Cuba (off Havana)	247-805	Cairns 2005
	Plexauridae	*Placogorgia mirabilis*	Western Atlantic	>200	Cairns 2005
	Plexauridae	*Placogorgia rudis*	Western Atlantic	>200	Cairns 2005
	Plexauridae	*Placogorgia tenius*	Western Atlantic	>200	Cairns 2005; Reyes et al. 2005
	Plexauridae	*Placogorgia tribuloidea*	Western Atlantic	>200	Cairns 2005
	Primnoidae	*Plumarella aculeata*	Bahanas and northern Straits of Florida	400-900	Cairns and Bayer 2004b; Cairns 2005
	Primnoidae	*Plumarella aurea*	Straits of Florida, Cuba	310-878	Cairns and Bayer 2004b; Cairns 2005
	Primnoidae	*Plumarella dichotoma*	Straits of Florida	494-1065	Cairns and Bayer 2004b; Cairns 2005

Higher Taxon	Family	Species ▲	Distribution ♠	Depth Range	Reference ‡
	Primnoidae	*Plumarella pellucida*	Straits of Florida, Bahamas	549-1160	Cairns and Bayer 2004b; Cairns 2005
	Primnoidae	***Plumarella pourtalesii* typical**	Straits of Florida, Cuba	196-882	Cairns and Bayer 2004b; Cairns 2005
	Primnoidae	***Plumarella pourtalesii var. obtusa***	Straits of Florida	183-743	Cairns and Bayer 2004b; Cairns 2005; Cairns personal comm.
	Primnoidae	***Plumarella pourtalesii* var. *robusta***	Straits of Florida	183-850	Cairns and Bayer 2004b; Cairns 2005
	Primnoidae	***Primnoa resedaeformis***	Western Atlantic	>200	Cairns 2005
	Primnoidae	*Primnoella delicatissima*	Western Atlantic	>200	Cairns 2005
	Primnoidae	*Primnoella divaricata*	Western Atlantic	>200	Cairns 2005
	Primnoidae	*Primnoella polita*	Western Atlantic	>200	Cairns 2005
	Isididae	*Primnosis rigida*	Western Atlantic	>200	Cairns 2005
	Plexauridae	***Pseudoplexaura porosa?***	Straits of Florida, Antilles, southeastern Caribbean	3-283	Cairns 1977; Kapela and Lasker 1999
	Chrysogorgiidae	***Radicipes gracilis***	Straits of Florida, southern Lesser Antilles	>200	Keller, et al. 1975; Bedford Institute of Oceanography 2003; Watling and Auster 2005; Cairns 2005
	Ellisellidae	***Riisea paniculata***	Bahamas, Caribbean, including **U.S. territories**	110-704	Cairns 2007
	Plexauridae	*Scleracis guadelupensis*	Guadeloupe, Martinique	176-350	Veronique 1987; Cairns 2005
	Plexauridae	*Scleracis petrosa*	Guadeloupe, Martinique	275-1607	Veronique 1987; Cairns 2005
	Isididae	*Stenisis humilis*	Western Atlantic	>200	Cairns 2005
	Plexauridae	*Swiftia casta*	Straits of Florida, Cuba (off Havana), Yucatan Channel	40-1953	Cairns 2005
	Plexauridae	***Swiftia exserta***	Straits of Florida, Bahamas, **Puerto Rico**, Mexico, Panama, southern Caribbean	18-494	Veronique 1987; Cairns 2005
	Plexauridae	*Swiftia koreni*	Straits of Florida, Guadeloupe	221-858	Veronique 1987; Cairns 2005

Higher Taxon	Family	Species ▲	Distribution ♠	Depth Range	Reference ‡
	Plexauridae	***Swiftia pallida*** (=*Thesa nivea*)	Straits of Florida, Guadeloupe	23-366	Humann 1993; Veronique 1987; Cairns 2005
	Plexauridae	*Swiftia pourtalesii*	Straits of Florida	>200	Cairns 2005; Watling and Auster 2005
	Plexauridae	*Swiftia sp. Sensu*	Western Atlantic	>200	Cairns 2005
	Keroeididae	*Thelogorgia longiflora*	Western Atlantic	>200	Cairns 2005
	Keroeididae	*Thelogorgia studeri* (=*Lingnella richardii*)	Saint Vincent, Guadeloupe, Barbados	180->200	Veronique 1987; Bayer 1961; Cairns 2005
	Keroeididae	*Thelogorgia vossi*	Western Atlantic	>200	Cairns 2005; Reyes et al. 2005
	Plexauridae	*Thesea antiope*	Western Atlantic	>200	Cairns 2005
	Plexauridae	*Thesea bicolor*	Western Atlantic	>200	Cairns 2005
	Plexauridae	*Thesea gracilis*	Western Atlantic	>200	Cairns 2005
	Plexauridae	*Thesea grandiflora*	Western Atlantic	>200	Cairns 2005
	Plexauridae	*Thesea grandiflora* var. *rugulosa*	Western Atlantic	>200	Cairns 2005
	Plexauridae	*Thesea grandulosa*	Western Atlantic	>200	Cairns 2005
	Plexauridae	*Thesea guadelupensis*	Guadeloupe	>200	Cairns 2005; Veronique 1987
	Plexauridae	*Thesea hebes*	Guadeloupe	275	Cairns 2005; Veronique 1987
	Plexauridae	*Thesea parviflora*	Western Atlantic	>200	Cairns 2005
	Plexauridae	*Thesea rugosa*	Western Atlantic	>200	Cairns 2005
	Plexauridae	*Thesea solitaria*	Western Atlantic	>200	Cairns 2005
	Plexauridae	*Thesea sp. Sensu*	Western Atlantic	>200	Cairns 2005
	Primnoidae	*Thouarella bipinnata*	Western Atlantic	>200	Cairns 2005; Cairns and Bayer 2006
	Primnoidae	*Thouarella diadema*	Western Atlantic	>200	Cairns 2005; Cairns and Bayer 2006
	Primnoidae	*Thouarella grasshoffi*	Western Atlantic	>200	Cairns 2005; Cairns and Bayer 2006

Higher Taxon	Family	Species ▲	Distribution ♠	Depth Range	Reference ‡
	Anthothelidae	***Titanideum frauenfeldii*** (=*T. suberosum*)	Straits of Florida, Cuba	15-238	South Atlantic Fishery Management Council, 1998; Cairns 2005
	Chrysogorgiidae	*Trichogorgia n. sp.*	Western Atlantic	>200	Cairns 2005
	Plexauridae	*Villogorgia antillarum*	Western Atlantic	>200	Cairns 2005
	Plexauridae	*Villogorgia n. sp.*	Western Atlantic	>200	Cairns 2005
	Plexauridae	***Villogorgia nigrescens***	Martinique, Guadeloupe, Colombia	176-275	Veronique 1987; Cairns 2005; Reyes et al. 2005
Order Helioporacea					
	Lithotelestidae	*Epiphaxum micropora*	Barbados	50-400	Bayer & Muzik 1977, 1979
Order Pennatulacea					
	Anthoptilidae	*Anthoptilum grandiflorum*	Southern Lesser Antilles	1600	Keller et al. 1975
	Funiculinidae	***Funiculina quadrangularis***	Venezuela	~30-4000	Keller et al. 1975; Picton and Howsen 2002
	Kophobelemnidae	*Kophobelemnon irregulatus*	Southeastern Caribbean Sea Basin	4160	Keller et al. 1975
	Renillidae	*Renilla reniformis*	Throughout Caribbean, including **Puerto Rico**	to 108 or more	Gosner 1978; Bayer 1961; NOAA 2005
	Umbellulidae	*Umbellula thomsoni*	Puerto Rico Trench Caribbean Sea Basin, Cayman Islands	1336-6200	Pasternak 1975
	Umbellulidae	*Umbellula durissima*	Southeastern Caribbean (Venezuela)	~1012-4400	Pasternak 1975; Keller et al. 1975
	Umbellulidae	*Umbellula hemigymna*	Southern Lesser Antilles, Caribbean Sea Basin	~2610-3500	Pasternak 1975
	Umbellulidae	*Umbellula magniflora*	Caribbean Sea Basin	~100-6300	Pasternak 1975; Keller et al. 1975
Class Hydrozoa					
Order Stylasterina					
	Stylasteridae	*Crypthelia glossopoma*	Straits of Florida, Yucatan Channel, Lesser Antilles, including **U.S. territories**	198-864	Cairns 1986
	Stylasteridae	*Crypthelia insolita*	Southernmost Lesser Antilles	159-720	Cairns 1986
	Stylasteridae	*Crypthelia papillosa*	Lesser Antilles	161-545	Cairns 1986

Higher Taxon	Family	Species ▲	Distribution ♠	Depth Range	Reference ‡
	Stylasteridae	*Crypthelia peircei*	Greater and Lesser Antilles, including **U.S. territories**	159-837	Cairns 1986
	Stylasteridae	*Crypthelia tenuisepata*	Lesser Antilles, including **U.S. territories**	761-1061	Cairns 1986
	Stylasteridae	*Distichopora anomala*	Lesser Antilles	139-311	Cairns 1986
	Stylasteridae	*Distichopora barbadensis*	Southernmost Lesser Antilles	102-311	Cairns 1986
	Stylasteridae	*Distichopora cervina*	Lesser Antilles, **Puerto Rico**	68-384	Cairns 1986
	Stylasteridae	*Distichopora contorta*	Only off Havana	125-368	Cairns 1986
	Stylasteridae	*Distichopora foliacea*	Straits of Florida, Yucatan Channel	183-366	Cairns 1986
	Stylasteridae	*Distichopora rosalindae*	Western Caribbean	165-198	Cairns 1986
	Stylasteridae	***Distichopora sulcata***	Only off Havana, Cuba	1097	Cairns 1986
	Stylasteridae	*Distichopora uniserialis*	Only off Havana, Cuba	333-366	Cairns 1986
	Stylasteridae	*Distichopora yucatanensis*	Western Caribbean	39-261	Cairns 1986
	Stylasteridae	*Errina altispina*	Only Yucatan Channel	198-309	Cairns 1986
	Stylasteridae	*Errina cochleata*	Straits of Florida, Bahamas	194-534	Cairns 1986
	Stylasteridae	*Lepidopora biserialis*	Straits of Florida	196-370	Cairns 1986
	Stylasteridae	*Lepidopora carinata*	Only off Havana	60-494	Cairns 1986
	Stylasteridae	*Lepidopora clavigera*	Only off Barbados	150-282	Cairns 1986
	Stylasteridae	*Lepidopora decipiens*	Lesser Antilles	270-670	Cairns 1986
	Stylasteridae	*Lepidopora glabra*	Only off Havana	267-1170	Cairns 1986
	Stylasteridae	*Lepidotheca brochi*	Dominica, Martinique, Montserrat, Saint Kitts and Nevis	545-864	Cairns 1986
	Stylasteridae	*Lepidotheca pourtalesi*	Straits of Florida	123-368	Cairns 1986
	Stylasteridae	*Pliobothrus echinatus*	Lesser Antilles and Mona Passage, including **Puerto Rico**	164-708	Cairns 1986
	Stylasteridae	*Pliobothrus symmetricus*	Throughout Caribbean, including **Puerto Rico**	150-400	Cairns 1986
	Stylasteridae	*Pliobothrus tubulatus*	Antilles, including **U.S. territories**	419-708	Cairns 1986
	Stylasteridae	*Stenohelia pauciseptata*	Only off St. Lucia	300-514	Cairns 1986

Higher Taxon	Family	Species ▲	Distribution ♠	Depth Range	Reference ‡
	Stylasteridae	*Stylaster antillarum*	Lesser Antilles and the Mona Passage, including **Puerto Rico**	174-653	Cairns 1986
	Stylasteridae	*Stylaster atlanticus*	Only off **Puerto Rico** (Isla de Culebra)	823	Cairns 1986
	Stylasteridae	*Stylaster auranticus*	Greater Antilles, off Cuba	112-377	Cairns 1986
	Stylasteridae	*Stylaster complanatus*	Straits of Florida, Antilles, including **U.S. territories**	183-707	Cairns 1986
	Stylasteridae	*Stylaster corallium*	Barbados, Dominica, Grenada, Martinique, Saint Lucia	13-298	Cairns 1986
	Stylasteridae	*Stylaster duchassaingi*	Widespread Caribbean, including **U.S. Virgin Islands**, Bahamas	42-692 (common 200-400)	Cairns 1986
	Stylasteridae	*Stylaster erubescens*	Continental slopes of the southeasetern United States to the Yucatan Peninsula	146-965	Cairns 1986
	Stylasteridae	*Stylaster filogranus*	Straits of Florida	183-274	Cairns 1986
	Stylasteridae	*Stylaster inornatus*	Only off the Yucatan Peninsula	198-309	Cairns 1986
	Stylasteridae	*Stylaster laevigatus*	Straits of Florida, Yucatan Channel	123-759 (common 300-400)	Cairns 1986
	Stylasteridae	*Stylaster miniatus*	Straits of Florida	146-530	Cairns 1986
	Stylasteridae	*Stylaster profunda*	Lesser Antilles, including **Puerto Rico**	159-2021 (common 200-650)	Cairns 1986
	Stylasteridae	*Stylaster roseus*	Widespread Caribbean, including **Puerto Rico**	0.5-373 (common 0.5-30)	Cairns 1986
	Stylasteridae	*Stylaster spatula*	Only off southeastern **Puerto Rico**	384-549	Cairns 1986

Appendix 8.2. An aggregate inventory of the benthos associated with the major structure-forming corals *E. profunda*, *L. pertusa*, *M. carolina*, *M. oculata*, and *S. varibilis* throughout the wider Caribbean. Benthos is grouped by coral species. Sources include station data from 28 locations in the wider Caribbean, sampled by the following research vessels: R/V *Pillsbury* (14 Stations); R/V *Columbus Iselin* (5 Stations); R/V *Gerda* (6 Stations); R/V *Gilliss* (1 Station); Submersible Alvin (multiple station); and R/V *Eastward* (multiple stations) (Anon 1963; 1964, 1965, 1966, 1968, 1969, 1970, 1972a, 1972b, 1973, 1974; Bayer 1966; Staiger 1968a, 1968b, 1969, 1971; Voss 1966a and 1966b). Locations are identified in Figure 3 by the letter S (some station locations overlap). *Please note that many species noted were first identifications and spelling is presented as it appears on the original station sorting sheets.

Potential structure and habitat- forming species	Other coelenterata	Crustacean (deep-seas crabs, shrimp and lobsters)	Fish	Echinoderms	Mollusks	Other
E. profunda						
L. pertusa; *S. varibilis*; gorgonians; hydroids; octocorals	"Solitary corals"; "Medusae"	*Homolodramia paradoxa*; *Galatheid* sp.; *Pylocheles scutata*; *Glyphocrangon longleyi*; *Nephropsis rosea*; *Plesionika acanthonotus*; *Pasiphaeidae* sp.; *Stylirostris* sp.; *Nematocarcinua cursor*; isopods	*Benthobatis* sp.; *Breviraja plutonia* (ray); *Cruriraja* sp. (skates); *Etmopterus* sp. (dogfish sharks); *Laemonema* sp. (hake); *Synaphobranchus* sp.; *Nettastomatidae* sp. (eels)		Gastropods; pelecypods; scaphopods; brachiopods	Polychaetes; porifera; pyncnogonids
L. pertusa						
S. varibilis; *E. profunda*; gorgonians; "corals"	"Solitary corals"; actinarians	*Aristaeomorpha* sp.; *Bathyplax* sp.; *Benthochascon* sp.; *Crangonidae* sp.; *Galatheid* sp.; *Hymenopenaeus* sp.; *Munida* sp.; *Munidopsis* sp.; *Nephropsis* sp.; *Palicus* sp.; *Phoberus* sp.; *Polycheles* sp.; *Raninoides* sp.; *Rochinia* sp.; *Stereomastis* sp.; *Stylirostris* sp.; *Xanthidae* sp.	*Bathyclupea* sp. (deepsea herring); *Bembrops* sp.; *Benthobatis* sp.; *Breviraja plutonia* (ray); *Brotulid* sp. (fangtooths); *Chaunax pictus* (anglerfish); *Chlorophthalmus* sp.; *Cruriraja* sp. (skates); *Dibranchus* sp. (batfishes); *Etmopterus* sp. (dogfish shark); *Gadidae* sp (cod) ; *Galeus* sp. (benthic sharks); *Laemonema* sp. (hake); *Macrourid* sp. (grenadiers); *Merluccius* sp. (hake); *Moridae* sp. (deepsea codfishes); *Neoscopelus* sp. (lanternfish); *Nettastomid* sp.; *Promyllanter schmitti*; *Synaphobranchus* sp.	Holothurians (sea cucumbers); Nymphaster sp.; Ophiuroids; Phormosoma sp.; Zoroaster sp.	Arca sp.; Columbarium sp.; Gastropods; Gaza sp.; Natica sp.; Turridae sp.; Voluta sp.; Xenophora sp.	Polychaetes; porifera

CARIBBEAN

Potential structure and habitat- forming species	Other coelenterata	Crustacean (deep-seas crabs, shrimp and lobsters)	Fish	Echinoderms	Mollusks	Other
M. carolina						
"Corals"; *Antipatharia* sp. (black corals); *Stylasterina* sp. (hydrocorals)	"Solitary corals"; *Actiniaria* sp. (anemones); *Alcyonaria* sp. (soft corals); Hydroids; *Urochordata* sp. (encrusting gorgonians); zoanthids	*Anomalothir furcillatus*; *Brachyura* sp.; *Cancellus oratus*; *Cirripedia* sp.; *Clibanarius anomalus*;; *Galatheid* sp.; *Homaridae* sp.; *Iliacantha subglobosa*; *Leucosiidae* sp.; *Majidae* sp.; *Munida irrasa*; *Munida schroederi* ; *Myropsis quinquespinosa*; *Nephropsis aculeate*; *Paguristes spinipes; Pandalidae sp.; Plesionika acanthonotus; Podochela curvirostris ; Pyromia cuspidate; Sicyonia stimpsoni; stomatopods; Sympagurus pictus*	*Calamopteryx goslinei*; elasmobranch egg cases	Asteroidea; crinoids; echinoids; holothurians (sea cucumbers); ophiuroids; starfish; brittle stars; urchins	Gastropods; pelecypods; brachiopods	Algae; "Large sponge 18" across"; oolite chunk; polychaetes; bryozoans; tunicates

Potential structure and habitat- forming species	Other coelenterata	Crustacean (deep-seas crabs, shrimp and lobsters)	Fish	Echinoderms	Mollusks	Other
M. oculata						
S. varibilis; "pink gorgonians"; "various coelenterates"; *Acanella* sp. (bamboo corals); *Bathypathes patula*; *Calytrophora pourtalesi* (sea fan / sea whip); *Chrysogorgia* sp. (sea fan / sea whips); *Cirripathes* sp. (sea whips); gorgonians; *Iridogorgia* sp. (spiral corals); *Keratoisis* sp.; *Plumarella* sp.	"Solitary corals"; Deltocyathus sp.; Desmophyllum sp.; Hydroids; Odontocyathus coronatus; Pennatulidae sp. (sea pens); Stephanocyathus diadema; Telestula sp. (anemones); aoanthids	"Various crustaceans"; *Acanthephyra* sp.; *Amphipods*; *Aristaeinae* sp.; *Aristeus* sp.; *Axiidae* sp.; *Bathymunida* sp.; *Bathypalaemonella* sp.; *Bathyplax* sp.; *Bathysquilla* sp.; *Galatheid* sp.; *Gennadas* sp.; *Glyphocrangon* sp.; *Gnathophausia* sp.; *Heterocarpus* sp.; isopods; *Lithodid* sp.; *Majidae* sp.; *Munida* sp.; *Munidopsis* sp.; *Nematocarcinus* sp.; *Nephropsis* sp.; *Oplophorus* sp.; *Pandalidae* sp.; *Parapagurus* sp.; *Plesiopenaeus* sp.; *Polycheles crucifer*; *Polychelidae* sp.; *Pontophilus* sp.; *Prionocrangon* sp.; *Scalpellum* sp.; *Sergestes* sp.; *Spongicoloides* sp.; *Stereomastis* sp.; *Stylodactylus* sp.; *Uroptychus nitidus*; *Uroptychus* sp; *Uroptychus* sp.; *Verrucomorphs* sp.	*Acanthurus* sp. (surgeonfish); *Alepocephalus* sp.; *Apristurus* sp. (cat sharks); *Barathronus* sp. (cusk-eels); *Bathypterois* sp. (tripod fish); *Benthobatis* sp.; *Brotulid* sp. (fangtooths); *Chaunax pictus* (anglerfish); *Diaphus* sp. (headlightfish); *Dibranchus atlanticus* (Atlantic batfish) ; *Dibranchus* sp. (batfishes); *Dicrolene intronigra; Diretmus sp. (dorys); Gonostomatidae sp. (bristlemouth); Halosaurs sp.; Hariotta sp. (chimaera); Ilyophis sp. (eels); Macrourid sp. (grenadiers); Monomitopus sp. (cusk-eels); Myctophid sp. (lanternfish); Myxini sp. (hagfish); Neoscopelus sp. (lanternfish); Nesiarchus sp. (scabbardfish); Notacanthid sp. (spiny eel); Oxygadus sp. (rattails); Promyllantor schmitti; Saurida sp. (lizardfish); Searsid sp.; Sternoptychidae sp. (hatchetfish); Stomias sp. (dragon fish); Synaphobranchus oregoni Synaphobranchus sp.*	"Pancake urchin"; "Soft urchin"; asteroids; *Benthopectinids; Crinoids; Goniaster sp.; holothurians (sea cucumbers); Molpadia sp. (sea cucumbers); Nymphaster sp.; ophiuroids; Phormosoma sp. (sea biscuts); Psilaster squameus; Zoroaster fulgens*	"Squid, unidentified"; *Acesta* sp. (Clams); *Arenatus* sp.; *Gaza superba*; *Leptothyra* sp.; *Leucosyrinx* sp.; *Limopsis* sp.; *Melongena* sp; *Mitra* sp.; *Pseudamusium dallil* (bivalve, clam?); scaphopods; *Solariella* sp.; solenogaster (shelless mollusk); *Spirula spirula*; *Turridae* sp.	"Grapefruit sponges"; *Cladorhiza* sp (potato sponges); *Hexactinellida* sp. (glass sponges); *Hyalonema* sp.; polychaetes

Potential structure and habitat- forming species	Other coelenterata	Crustacean (deep-seas crabs, shrimp and lobsters)	Fish	Echinoderms	Mollusks	Other
S. varibilis						
M. oculata; L. *pertusa*; *E. profunda*; "corals"; *Acanella sp.* (bamboo corals); *Callogorgia* sp.; *Chrysogorgia* sp. (sea fan / sea whips)*; Keratoisis* sp. (bamboo corals); *Nicella* sp.; octocorals; Primnosis sp.	"Solitary corals"; *Odontocyathus coronatus*; *Stephanocyathus diadema*; *Telestula* sp. (anemones); *Clavulariidae* sp.	*Acanthephyra* sp.; amphipods; *Aristaeinae* sp.; *Axiidae* sp.; *Chirostylus* sp.; *Galatheid* sp.; *Gennadas* sp.; *Glyphocrangon aculeate*; *Glyphocrangon alispina*; *Glyphocrangon* sp.; *Heterocarpus* sp.; isopods; *Lithodid* sp.; *Majidae* sp.; *Mixtopagurus paradoxus*; *Munida* sp.; *Munidopsis* sp.; *Nematocarcinus* sp.; *Nephropsis* sp.; *Oplophorus* sp.; *Paguristes* sp.; *Penaeid* sp.; *Polycheles crucifer*; *Polychelidae* sp.; *Prionocrangon* sp.; *Processa* sp.; *Pylopagurus* sp; *Rochinia* sp.; *Sergestes* sp.; *Spongicoloides* sp.; *Stereomastis* sp.; *Stylodactylus* sp.; *Systellaspis* sp.; *Uroptychus* sp.	*Brotulid* sp. (fangtooths); *Callionymus* sp.; *Chaunax* sp. (Anglerfish); *Chlorophthalmus* sp.; *Dibranchus atlanticus* (Atlantic batfish); *Gadomus longifilis* (Bathygadid family); *Hymenocephalus* sp. (rattails); *Macrourid* sp. (grenadiers); *Monomitopus* sp. (cusk-eels); *Peristedion* sp. (sea robins); *Promyllantor schmitti*; *Saurida* sp. (lizardfish)	*Ceramaster elongatus* (Cookie starfish); *Ceramaster* sp.; cidarids; *Circeaster americanus*; *Lophaster verrilli*; *Nymphaster* sp.; *Ophidiaster* sp.; *Solaster caribbea*; *Spatangoids*; *Zoroaster ackleyi*	"Finned octopod"; "unidentified squid"; *Acesta* sp. (Clams); brachiopods; *Dentalium* sp.; *Naticidae* sp.; *Ornithoteuthis antillarum* ; *Propeamusium dalli*; pteropods; scaphopods; *Solariella* sp.; *Solenogaster* sp.; *Turridae* sp.	Cladorhiza sp. (potato sponges); polychaetes; pyncnogonids

Appendix 8.3. Commercially important deep-sea fish of the wider Caribbean (FAO 1993).

Species	Depth (m)
Snappers:	
Apsilus dentatus (black snapper)	70 – 290
Etelis oculatus (queen or green snapper)	180 – 463
Lutjanus buccanella (blackfin snapper)	80 – 180
L. vivanus (silk snapper)	60 – 210
Rhomboplites aurorubens (vermilion snapper)	80 – 230
Sharks:	
Centrophorus granulosus (gulper shark)	to 210
Eugomphodus taurus (grey nurse shark)	to 210
Hexanchus vitulus (bigeyed sixgill shark)	to 250
Mustelus canis (smooth dogfish)	to 250
Scyliorhinus boa (catshark)	to 270
Sphyma lewini (scalloped hammerhead shark)	to 170
Squalus cubensis (Cuban dogfish)	to 300
Promthicthys Prometheus (rabbit-fish)	to 170
Groupers & hinds:	
Epinephelus adscensionis (rock hind)	0 – 120
E. flavolimbatus (yellowedge grouper)	to 132
E. fulvus (coney)	0 – 230
E. guttatus (red hind)	0 – 200
E. morio (red grouper)	to 174
E. mystacinus (misty grouper)	180 – 270
Mycteroperca phenax (scamp)	to 174
Neoscombrops sp.	to 190
Other:	
Erythrocles monody (Atlantic rubyfish)	to 300
Gephyroberix darwini	to 310
Ostichthys trachypoma (bigeye soldierfish)	to 290
Polymixia lowel (beardfish)	to 260
Pristipomoides sp. (jobfish)	180 – 300+