Characteristics of Hard-bottom Assemblages for Resource Mapping of the Caicos Bank

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ABSTRACT

A marine community map of the eastern Caicos Bank was constructed from low-altitude aerial photographs and field surveys to collect baseline descriptions of hard-bottom communities. This area of the bank is utilized by local fishermen targeting lobster, conch and grouper. The major classes of hard-bottom communities were characterized in an area of low population density and low anthropogenic impact. The initial characterization of benthic communities was based on analysis of three taxa groups: sponges, stony corals and octocorals examining four parameters: (1. species presence/absence inventories, (2. density, (3. area coverage, and (4. mean size per colony or individual. Communities were grouped using a benthic community classification system for the tropical western Atlantic. Patch reefs were the dominant community class that occurred throughout the eastern platform margin and were utilized by lobster fishermen; these reef communities were examined in depth to explore changes in spatial patterning of benthos along environmental gradients. Patch reefs closer to South Caicos (northeastern end of platform) had higher numbers of species and higher densities of corals as well as sponges. Patch reefs at the southern end of the platform near Ambergris Cay showed a marked decrease in the number of species and density of both sponges and corals. Total area coverage of corals remained unchanged, but sponges virtually disappeared from southern sites. The surveys allowed for the correlation of community classes to photography features; this information can be used for photo-interpretation over the extent of the bank.

KEY WORDS: Classification, benthic, community similarity.

INTRODUCTION

The characterization of marine resources on the Caicos Bank is an initial step in utilizing remote sensing in fisheries resource management. This investigation outlines the process to first identify hard-bottom communities (*e g.* patch reefs, spur-and-groove reefs) that occur along the platform margin, and then describe changes along environmental gradients. The process of characterizing tropical hard-bottom communities relies on both species inventory lists and belt quadrat surveys.

Detecting spatial patterns and characteristics of reefs has long been a focus of coral reef ecological research. There is no ideal or universal reef survey methodology because different techniques are best suited for addressing different questions (Loya 1978; Weinberg 1981; Dodge *et al.*, 1982). Recent studies have used stony coral area coverage as a parameter to study reef structural dynamics (Porter *et al.*, 1981; Rogers *et al.*, 1983; Dustan and Halas 1987). In the absence of anthropogenic disturbances, natural fluctuations in reef populations and communities have been described but are not well understood (Dahl and Lamberts 1977; Bak and Luckhurst 1980; Davis 1982; Hughes and Jackson 1985).

The unique physiographic setting of the Caicos platform creates a mosaic of soft-sediment and hard-bottom communities. Hard-bottom communities dominate the platform margin, particularly along the more gently sloping margins of the southeast corner of the bank. This is an area of great importance to the conch and lobster fisheries. Along the platform margin a number of physical gradients create a continuum of reef communities that have very different benthic community structures and may vary in carrying capacity and recruitment of targeted species.

The Caicos platform covers approximately 7680 square kilometers, and is characterized by an island arc across the northern half and exposed shoals to the southern half of the bank. The bank represents the southern extent of the Bahamian archipelago, and is characterized by a steep margin plunging to abyssal depths (Wanless and Dravis 1989), with slumping and erosional scars at the southern margins.

The shallow bank has a tidal range of about one meter, with much of the currents on the banks driven by wind. Easterly winds are persistent from 15 to 20 knots year round. Hurricanes and tropical storms are important influences on both reef margin and bank habitats of the Caicos platform, with intense but localized storms frequenting the area on an average of once every five years (Neumann *et al.*, 1978). The location of the Caicos bank in the westward-flowing Antilles current, coupled with the location of islands along the northern half of the bank, results in east-to-west cross-bank circulation (Wanless and Dravis 1989).

Oceanic swell events are likely to be important at the windward southeast margin of the bank. These swells scour and transport sediment at the deep fore-reef areas of the platform margin (Adey, 1977). This deep fore-reef area is much broader at the southeastern end of the platform than anywhere else on the bank.

The examination of reefs from South Caicos to the Ambergris Cays indicates a gradient of environmental factors which are likely to influence benthic community structure: (1. the deeper (> 10 m) fore-reef is more extensive with a shallower slope at the southern end of the platform, (2. the lack of land and erosion at the southern end of the bank results in greater circulation around reefs with upwelling to stimulate algal growth, and (3. storms have recently passed over the southern end of the bank; this area has most recently been subjected to catastrophic disturbances.

The goal of this project is to provide a description of hard-bottom communities along the eastern platform margin of the Caicos bank with a particular focus on patch reefs. A protocol to sample benthic communities along environmental gradients and to provide the basis for describing spatial patterns in benthos is presented. The descriptions of these communities will help identify features that may influence recruitment, growth and density of mobile fauna targeted by fisheries.

MATERIALS AND METHODS

Site Selection

Natural-color aerial photography of the Caicos Bank was examined to determine the occurrence of hard-bottom communities and to select specific survey sites. Using a classification system for marine communities of the tropical western Atlantic, study sites were initially characterized as patch reefs, spur-and-groove reefs, transitional reefs and intermediate reefs (Table 1).

Hydrography and descriptions of physical gradients on reef communities are poorly understood but essential in understanding spatial patterns (Roberts *et al.*, 1975). The natural-color aerial photography used to select survey sites also was used to determine the placement of belt quadrats within each site. Visual assessment of the photographs was used to orient transects of belt quadrats across the reefs to capture the maximum spatial heterogeneity (*e.g.*, "splotchiness" in the photos) or the dominant physical gradient (*e.g.*, inshore to offshore).

Survey Methods

Survey methodologies are diverse in their application as well as goals (see review in Loya 1978; Weinberg 1981; Dodge *et al.*, 1982). The methodologies used in this study have been used in other investigations to examine a variety of

Table 1. Site classifications of selected hard-bottom communities on the eastern platform margin of the Caicos Bank. Within community classes, sites have been arranged from north to south.

Hard-Bottom Community Class	Latitude	Longitude	Maximum Depth (m)	Minimum Depth (m)
Patch Reefs				
Admirals Aquarium	21° 28.083' N	71° 32.491' W	1.5	1.0
Leeward Fish Cay Reef	21° 21.999' N	71° 37.068' W	3.9	0.9
Fish Cay Channel Reef	21° 21.730' N	71° 37.161' W	4.9	3.0
Ambergris Channel Reef	21° 20.509' N	71° 38.211' W	5.0	5.0
Ambergris Patch Reef	21° 19.829' N	71° 38.833' W	6.0	5.0
Spur and Groove Reefs				
Ambergris Reef #1	21° 21.003' N	71° 38.212' W	6.0	5.0
Ambergris Reef #2	21° 20.778' N	71° 38.218' W	6.5	5.0
Transitional Reefs				
Arch Platform Reef	21° 28.972' N	71° 31.120' W	10.0	6.0
Airplane Reef	21° 27.745' N	71° 32.282' W	17.1	15.0
Intermediate Reefs				
Arch Slope	21° 28.882' N	71° 31.119' W	13.7	12.2
Grotto Slope	21° 28.820' N	71° 32.070' W	14.7	11.1

reef types (barrier, fringing or patch) and zones within a particular type (*e.g.*, reef flat, reef crest, fore-reef).

Species Presence /Absence Inventories

Species inventory data were recorded for all taxa at all sites surveyed. Standard species checklists for conspicuous, field-identifiable species were developed from historical studies and from preliminary work by the authors. Some groups of organisms were identified only to species (*e.g.*, *Ceramium* spp. for macroalgae). Standard lists for taxa were developed for sponges, stony corals and octocorals. Other taxa groups, including echinoderms, molluscs, polychaetes, crustaceans and benthic algae, were surveyed, but the results are presented elsewhere. These lists were standardized to collect comparable information between sites, but were not intended to constitute a comprehensive species survey. Species that did not occur in the belt quadrat surveys were recorded during the presence / absence inventories. A typical 5- hectare reef site required two to three hours for inventory sampling. Sponges, stony corals (Scleractinia and Milleporina) and octocorals (Alcyonacea) were identified *in situ*. Stony corals that could not be identified were collected and subsequently identified based on skeletal morphology (Cairns, 1982; Zlatarski and Estalella, 1982). Octocorals that could not be identified were collected by cutting a small portion of a tertiary extension. Species were subsequently identified by colony growth morphology and spicule preparations (Bayer, 1961; Bayer, 1981). Sponges that could not be identified were collected and subsequently identified with spicule preparations (Wiedenmeyer, 1977). The collection of individuals was kept to a minimum to avoid bias in the sampling regime. All other taxa, including algal species, were identified in situ or collected for identification. For species presence / absence data, a qualitative coefficient (Jaccard) was utilized to observe similarity among survey sites in terms of sponges, stony corals and octocorals. Pair-wise comparisons were made among patch reef sites to analyze differences in species composition along the Caicos Bank based on sponge, stony coral and octocoral species composition (Hubalek, 1982). Jaccard coefficient values were utilized to construct dendrograms from similarity values using group average sorting (Pielou, 1977).

The overlap of occurrence of species between hard-bottom communities allows adjacent communities to be grouped into a broader system (*e.g.*, Bahamian archipelago). This overlap can be quantified by several indices of community similarity (see review in Legendre and Legendre, 1983).

Belt Quadrat Sampling

Belt quadrat sampling of reefs as used by Dana (1976) and Weinberg (1981) allows for the collection of detailed information on the spatial patterning of benthos. Benthos were identified to the taxa level, for example the stony corals (scleractinians and milleporid hydrocorals).

In addition to parameters that can be assessed using line transect or plotless techniques, plot methods allow for the direct measurement of individual or colony sizes. A 50-m traverse line was oriented along the major axis of the survey site identified from natural color aerial photographs. A series of six 20-m transect lines were placed perpendicular and were bisected by the traverse line. Transect lengths were determined to be appropriate utilizing species-transect length curves (Loya, 1972). Quadrats, measuring 1 m by 1 m, were systematically placed along the transect lines every third meter. This sampling scheme was chosen to assess the maximum variability across the study site. Sampling efficiency using quadrats was determined using species-area curves (Gleason, 1922).

A sponge individual or coral colony was defined as any individual or colony growing independently of its neighbors. In cases where a colony was clearly separated into two or more portions by the death of intervening parts, each living part was considered to be a separate individual (Loya, 1972). When branching colonies occurred in thickets, branches that could be traced to a common origin were considered to be part of a single colony (Dustan and Halas, 1987). Dimensions of sponge individuals and stony coral colonies were measured *in situ* with calipers to the nearest 0.5 cm.

Relative dimensions (length, width, radii) were measured to estimate the planar area coverage (cm^2) of each individual or colony utilizing appropriate areal formulas (*e.g.*, circle or rectangle). When a colony or individual partially lay in a quadrat, the individual or colony was included in the density calculations. The area in the quadrat was included in the area coverage and area per individual or colony calculations. Octocoral colonies were counted in each quadrat and measured for height per colony computations.

RESULTS

Community Descriptions

Spur and Groove Reefs. The Caicos bank is not noted for well developed spur and groove systems. Reefs are located in tidal passes where water is funneled onto and off of the bank. Spur and groove reefs are typically underdeveloped with little physiographic relief. The underlying framework is believed to be *Acropora palmata*, but little or no live *A. palmata* is present. Spurs are oriented from west to east along the eastern platform margin of the bank. This class of hard-bottom community is characterized by low sponge density (1.0 to 2.6 individuals m^{-2}) and area coverage (< 100 cm^2 m^{-2}), dominated by many species of encrusting and boring sponges (*e.g.*, *Mycale* spp., *Siphonodictyon siphonum*, *Chondrilla nucula*). Coral density is moderately high (1.5 to 4.0 colonies m^{-2}) with moderate area coverage (> 300 cm^2 m^{-2}) and is dominated by large *Montastrea annularis* colonies and smaller colonies of *Porites* spp. and *Millepora alcicornis.* Octocoral density is moderate (< 4 colonies m^{-2}) and is dominated by *Briareum asbestinum.*

Transitional Reefs. These low-relief hard-bottom communities are typically located seaward of a reef crest or buttress zone and could represent large areas of drowned or eroded spur and groove sites. Communities are characterized by lower relief and consist of a flat carbonate platform. These reefs may be influenced by strong wave energy (*e.g.*, surge) with little sediment accumulation on the substratum. Transitional reefs are characterized by significantly higher sponge density (> 5 individuals m^{-2}) and area coverage (> 300 cm^2 m^{-2}), and are typically dominated by large encrusting sponges (e.g., *Anthosigmaella varians* and *Hemectyon ferox*). Stony coral density (4.5 to 15 colonies m^{-2}) is dominated by *Porites* spp, *Agaricia* spp., *Favia fragum* and *Montastrea annularis.* Coral area coverage is low to moderate (150 to 650 cm^2 m^{-2}), with some large colonies (*e.g., M. annularis*), but typically dominated by smaller colonies. Octocoral density is the highest on transitional reefs (> 4 colonies m^{-2}) and is dominated by small (< 30 cm height) colonies of *Pseudopterogorgia* spp. and *Gorgonia flabellum.*

Deep Intermediate Reefs. Intermediate reefs are characterized by deeper depth (> 10 m) and higher relief compared to other hard-bottom community classes on the Caicos Bank (Table 1). These communities are located seaward of transitional reefs, and slope down to the drop-off on the bank approximately 100-150 m offshore. These reefs exhibit low sponge density (approximately two individuals m^{-2}) and moderate area coverage (> 100 cm^2 m^{-2}) resulting from the dominance of a few large species of sponges (*Agelas* spp., *Verongula gigantea*). Stony coral density is greatest on intermediate reefs (> 11 colonies m^{-2}) with high area coverage (> 400 cm^2 per m^2). Dominant species include *Siderastrea sidere, Montastrea annularis, Porites* spp. and *Millepora alcicornis.* Octocoral density is high (> 5 colonies m^{-2}) but is dominated exclusively by *Pseudopterogorgia* spp.

Patch Reefs. Patch reef communities vary in size (100 m^2 to > 10,000 m^2), depth (1.0 to 6.0 m) and shape (linear versus dome), are broadly distributed and very important to the bank fisheries. Northern linear patch reefs (Admirals Aquarium and Leeward Fish Cay Reef) are located on the leeward sides of islands. Southern dome patch reefs are located in tidal channels (Fish Cay Channel Reef, Ambergris Channel Reef and Ambergris Patch Reef). Sponge density and area coverage are variable with no clear dominance patterns. Stony coral density and area coverage are also variable and are dominated by *Montastrea annularis, Porites astreoides* and *P. porites*, and *Agaricia* spp.

Octocoral abundance is greatly reduced on linear patch reefs compared to dome patch reefs.

Species Presence / Absence Inventories

Fish Cay Channel Reef and Admirals Aquarium were the most speciose in terms of sponge species (21 and 20 respectively), while the southernmost patch reef sites have the least number (8) of species. Similarity (coefficient of Jaccard) is highest between Leeward Fish Cay Reef and Ambergris Channel Reef (60.0%), while Fish Cay Channel Reef and Ambergris Patch Reef are the least similar (14.8%) (Figure 1A). Overall similarity between sites based on sponge species presence / absence is low.

Stony coral species presence / absence exhibits the highest overall similarity among patch reef sites (approximately 50%) (Figure 1B). There is no clear northern to southern trend of similarity, but the northern sites (Admirals Aquarium, Leeward Fish Cay and Fish Cay Channel Reefs) are the most speciose. Octocoral species presence/absence is lowest overall among patch reef sites. Similarity (coefficient of Jaccard) decreased from north to south, except for the northernmost site (Admirals Aquarium), which was the least similar to other patch reefs (Figure 1C).

Belt Quadrat Surveys

Sponge species density was greatly reduced at the southern patch reef sites (Table 2). Sponge density and area coverage also followed a decreasing trend from north to south with the exception of Fish Cay Channel Reef. Southern patch reef sites were dominated by encrusting and boring sponges (*Mycale* spp., *Siphonodictyon* spp., *Chondrilla nucula*), while northern patch reefs did not exhibit clear species dominance patterns and were characterized by many functional forms (*e.g.* massive, tube, encrusting). Representative species include *Ircinia strobilina*, *Aplysina fistularis* and *Spinosella vaginalis*.

Stony coral species density and colony density on patch reefs decreased from northern to southern sites (Table 3). Area coverage is more variable, with Leeward Fish Cay Reef and Fish Cay Channel Reef exhibiting the highest area coverage. The sizes of colonies does not follow a clear trend, although southern patch reef sites were dominated by fewer but large coral colonies.

Octocoral species density and colony density do not follow a clear pattern (Table 4). Species density and colony density were highest at Fish Cay Channel Reef, and were lowest at the northernmost site (Admirals Aquarium). The heights of octocoral colonies increased from northern to southern patch reefs.

Northern patch reefs are more speciose and have higher densities of sponges and stony corals. Sponge cover is greatly reduced on the southern sites and is dominated by a few species of encrusting and boring sponges contrasted to the northern patch reefs with a co-dominance of massive and vase sponges. Stony

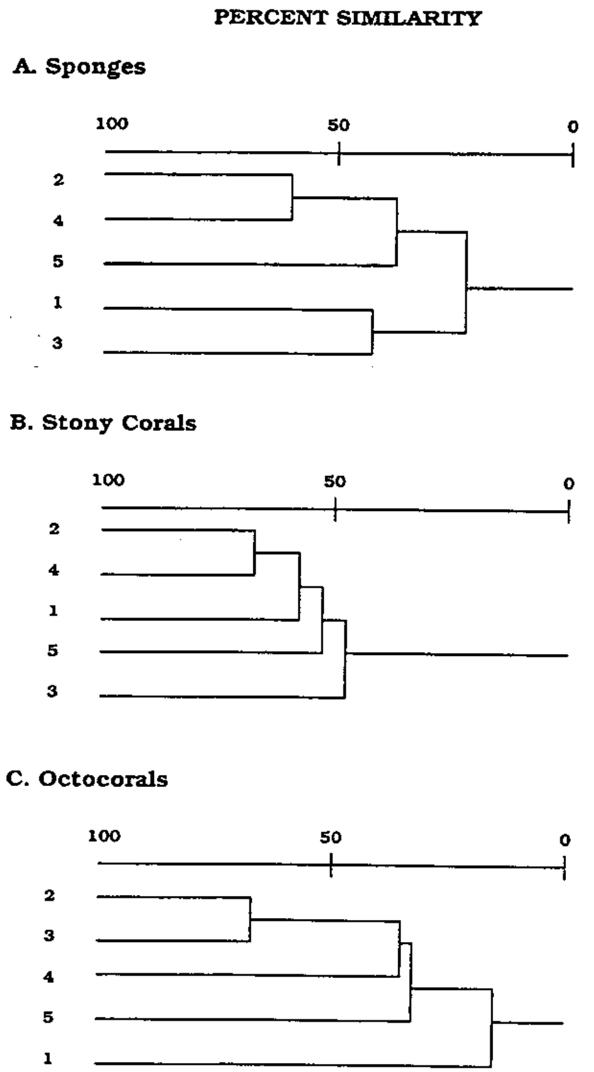

Figure 1. Cluster analysis (group average sorting) of species presence / absence data from patch reef sites along the Caicos Bank. Dendrograms have been constructed from similarity values computed from the coefficient of Jaccard for A: sponges, B: stony corals and C: octocorals. Site designations are as follows: (1) Admirals Aquarium, (2) Leeward Fish Cay Reef, (3) Fish Cay Channel Reef, (4) Ambergris Channel Reef and (5) Ambergris Patch Reef.

Table 2. Sponge taxa-level summary for selected patch reef sites along the eastern platform margin of the Caicos Bank. Survey sites have been arranged from north to south. The sampling effort is expressed as the total number of quadrats sampled (m^2). For each site, mean (± 1 SD) values are given for species, individuals, and area per m^2 and area (cm^2) per individual. Maximum and minimum values for each survey parameter are provided.

Size **Survey Parameter**	**1**	**2**	**3**	**4**	**5**
Sampling Effort (m^2)	36	18	18	24	46
No. Species m^{-2}	1.3 ± 1.3	0.4 ± 0.8	1.6 ± 1.2	0.2 ± 0.4	0.2 ± 0.6
Maximum	6	2	4	1	4
Minimum	1	1	1	-	1
No. Individuals m^{-2}	3.8 ± 3.7	0.4 ± 0.8	1.8 ± 1.4	0.2 ± 0.4	0.2 ± 0.8
Maximum	12	2	5	1	4
Minimum	1	1	1	-	1
Area Coverage (cm^2 m^{-2})	233.7 ± 273.0	4.0 ± 12.6	426.2 ± 1001.3	4.1 ± 15.4	3.1 ± 14.9
Maximum	931.7	48.0	3106.0	70.0	95.0
Minimum	3.1	12.0	2.0	21.0	1.0
Area per Individual (cm^2)	62.3 ± 78.7	30.0 ± 25.5	290.6 ± 729.3	45.5 ± 34.7	16.0 ± 30.5
Maximum	572.6	48.0	3105.0	70.0	95.0
Minimum	0.2	12.0	2.0	21.0	1.0

Site designations are as follows: (1) Admirals Aquarium, (2) Leeward Fish Cay Reef, (3) Fish Cay Channel Reef, (4) Ambergris Channel Reef, and (5) Ambergris Patch Reef.

Table 3. Stony coral taxa-level summary for selected patch reef sites along the eastern platform margin of the Caicos Bank. Survey sites have been arranged from north to south. The sampling effort is expressed as the total number of quadrats sampled (m^2). For each site, mean (± 1 SD) values are given for species, individuals, and area per m^2 and area (cm^2) per individual. Maximum and minimum values for each survey parameter are provided.

Size **Survey Parameter**	**1**	**2**	**3**	**4**	**5**
Sampling Effort (m^2)	36	18	18	24	46
No. Species m^{-2}	1.9 ± 1.9	1.6 ± 1.3	1.6 ± 2.0	0.4 ± 0.7	0.4 ± 1.1
Maximum	8	4	8	2	5
Minimum	1	1	1	1	1
No. Colonies m^{-2}	4.7 ± 5.7	4.7 ± 5.0	2.6 ± 4.2	0.6 ± 1.0	0.8 ± 2.4
Maximum	22	16	17	4	15
Minimum	1	1	1	1	1
Area Coverage (cm^2 m^{-2})	235.8 ± 445.4	596.2 ± 1131.9	530.1 ± 1105.7	40.9 ± 167.5	150.4 ± 501.0
Maximum	1945.0	4790.0	4386.0	824.0	2690.0
Minimum	2.0	20.0	72.0	2.0	7.1
Area per Colony (cm^2)	49.9 ± 130.9	127.8 ± 356.6	216.9 ± 688.6	81.9 ± 150.0	212.1 ± 526.8
Maximum	1500.0	3034.0	4386.0	525.0	2375.8
	0.3	1.0	4.0	2.0	0.8
Minimum	0.2	12.0	2.0	21.0	1.0

Site designations are as follows: (1) Admirals Aquarium, (2) Leeward Fish Cay Reef, (3) Fish Cay Channel Reef, (4) Ambergris Channel Reef, and (5) Ambergris Patch Reef.

Table 4. Octocoral taxa-level summary for selected patch reef sites along the eastern platform margin of the Caicos Bank. Survey sites have been arranged from north to south. The sampling effort is expressed as the total number of quadrats sampled (m^2). For each site, mean (± 1 SD) values are given for species, individuals, and area per m^2 and area (cm^2) per individual. Maximum and minimum values for each survey parameter are provided.

Size Survey Parameter	1	2	3	4	5
Sampling Effort (m^2)	36	18	18	24	46
No. Species m^{-2}	0.3 ± 0.2	0.4 ± 0.9	1.7 ± 1.5	0.2 ± 0.6	0.2 ± 0.4
Maximum	1	3	4	3	1
Minimum	-	1	1	1	-
No. Colonies m^{-2}	0.03 ± 0.17	0.67 ± 1.33	1.83 ± 1.65	0.46 ± 1.35	1.22 ± 3.60
Maximum	1	4	5	6	15
Minimum	-	2	1	1	2
Height per Colony (cm)	13.0	17.7 ± 13.1	24.9 ± 11.9	29.5 ± 23.1	30.7 ± 19.0
Maximum	13.0	45.0	49.0	100.0	70.0
Minimum	-	4.0	4.0	8.0	5.0

Site designations are as follows: (1) Admirals Aquarium, (2) Leeward Fish Cay Reef, (3) Fish Cay Channel Reef, (4) Ambergris Channel Reef, and (5) Ambergris Patch Reef.

coral colony density and area coverage are high at the northern sites, while density decreases to the south. Stony coral area coverage is high at the southern patch reefs and is dominated by a few large colonies. Octocorals were more abundant at the southern channel patch reefs and are greatly reduced at the northern sites.

DISCUSSION

The objectives in community characterization are three-fold: (1. to describe quantitatively the spatial patterns of benthos using parameters of both density and area measurements, (2. to identify survey sites belonging to a particular class of community based on structural and biological features, and (3. to relate measurable biological parameters to physical variables or gradients. The method of collecting information for characterizations includes both a reconnaissance step involving the interpretation of low- altitude aerial photography and a survey step involving identification, counting and measuring conspicuous benthos. This information provides some baseline information to begin analysis of fisheries catch as related to habitat type.

The results of the benthic surveys of reefs along the Caicos platform margin can first be described in terms of the physical setting of the platform. The Caicos Bank is characterized as a carbonate platform with tidal channels funnelling water onto and off of the bank. From the northern island arc seaward, the shelf-width is extremely narrow (100-200 m) before dropping to abyssal depths. Leeward hard-bottom communities are well-developed coral-dominated reefs to the north, where islands influence the tidal movement of water. To the south, reefs are less well-developed and are typically found in tidal passes. These physical differences related to higher levels of disturbance or storm frequency have resulted in patch reefs along the southwestern platform margin that have a surprisingly sparse sponge and coral assemblage. The reefs near Ambergris Cay are unique in the lack of massive and encrusting sponges, and low coral colony density.

Reef fisheries resources, such as reef fish and crustaceans, require 3-dimensional complexity in a reef, a feature that can be inferred from benthic diversity (Sullivan and Chiappone, 1992). There exists a need to understand both spatial and temporal patterns of reef communities as related to location and class of community. Patch reefs were the dominant reef class, but varied greatly in spatial patterning of benthos, unlike deeper reefs that remained somewhat similar along the platform margin. In some communities, it may be more difficult to quantify physical variables such as currents and upwelling than to orient sampling of biological parameters along a perceived gradient (Hutchinson, 1973; Andrew and Mapstone, 1987).

This study can provide some insights as to what parameters need to be measured to characterize a community, particularly to evaluate benthic structure change in response to environmental gradients. Results suggest that the measurement of density and area coverage parameters of sponges and corals is sufficient to characterize patch reef communities. Some type of major disturbance, in combination with gradients of current or exposure along the platform margin, has resulted in a depauperate reef benthos near the Ambergris Cays. Previous studies have demonstrated that small-scale changes in physical parameters (current, depth) have a significant impact on reef structure and morphology (Brown and Dunne, 1980). Benthic survey data are collected to provide insight into the environmental mechanisms influencing biotic distributions (Field *et al.*, 1982). These community characterizations can be compared to geo-referenced historical fisheries data; how does lobster catch vary across the bank at the different patch reef sites? With a better understanding of the relationship between benthic patterning, physical environments and imagery projections, a broader scale management of shallow-water marine systems may be feasible.

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