

THE QUANTITATIVE ASSESSMENT OF REEF
COMMUNITIES
AND
POTENTIAL SPORT DIVER EFFECTS
ON SELECTED SITES
ON CAYMAN BRAC AND LITTLE CAYMAN

A report for the Sister Island Tourism Association

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May 1993

INTRODUCTION

The Sister Islands, Cayman Brac and Little Cayman (Fig. 1) have been the unspoiled jewels of the Cayman Islands for nearly 15 years. The variety and abundance of live-animal cover make these reefs a popular location for sport divers; in fact, the percent live-animal cover at most of the sites in this study is among the highest in the Caribbean. These islands' remote locations and controlled development have limited man-induced disturbance to their surrounding reef systems. Yet, as development and tourism increase, so too, will the pressures placed on these limited natural resources. The establishment of a quantitative baseline that describes the reef communities on these islands is an important first step in the proper management of these valuable resources.

The objectives of this study were to:

- 1) Gather data on the species composition of reef/dive sites on Cayman Brac and Little Cayman to establish a baseline of reef health.
- 2) Design and implement a system to evaluate and monitor the impact of divers visiting those reef/dive sites.

This project (September through December, 1992) is the first such endeavor, either government or private, to evaluate a majority of the dive sites on these islands. The need for this kind of assessment was established by Ogden (Ogden and Ogden, 1991) and Fenner (Fenner, in press.), who emphasized the need for a large number of study sites. The present investigation examined 45 dive sites; 33 sites on Cayman Brac and 12 sites on Little Cayman (Fig. 2a-b). This represents 72% of the active sites around Cayman Brac and 71% of the sites around Little Cayman. (Focus was placed on the Bloody Bay/Jackson Bight area of Little Cayman.)

There are many forces that shape reef communities, and monitoring the effects of these forces is important, yet difficult. Natural processes such as storms, diseases, and oceanographic effects eventually run their natural course. Although the effects of man (including unplanned development, improper waste disposal, silt and chemical runoff) may seem small in comparison, they can have dramatic effects on the underwater environment. This study attempted to evaluate the relative importance of natural versus man-induced impacts.

The evaluation of the physical impact by SCUBA divers is a relatively new and poorly understood subject. This project was the first to design and implement a system for the classification and quantification of diver impacts on Cayman reefs. A

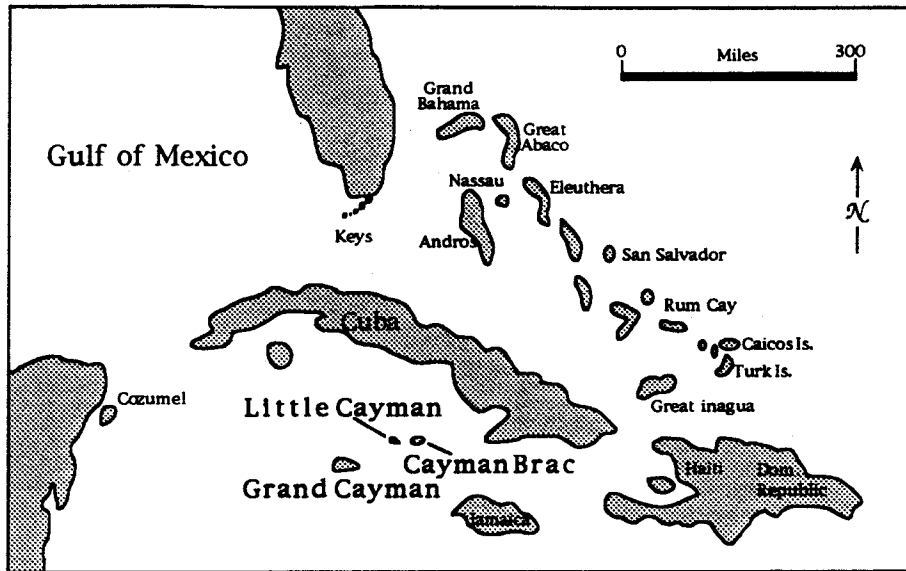


Figure 1. Location Map for Cayman Brac and Little Cayman.

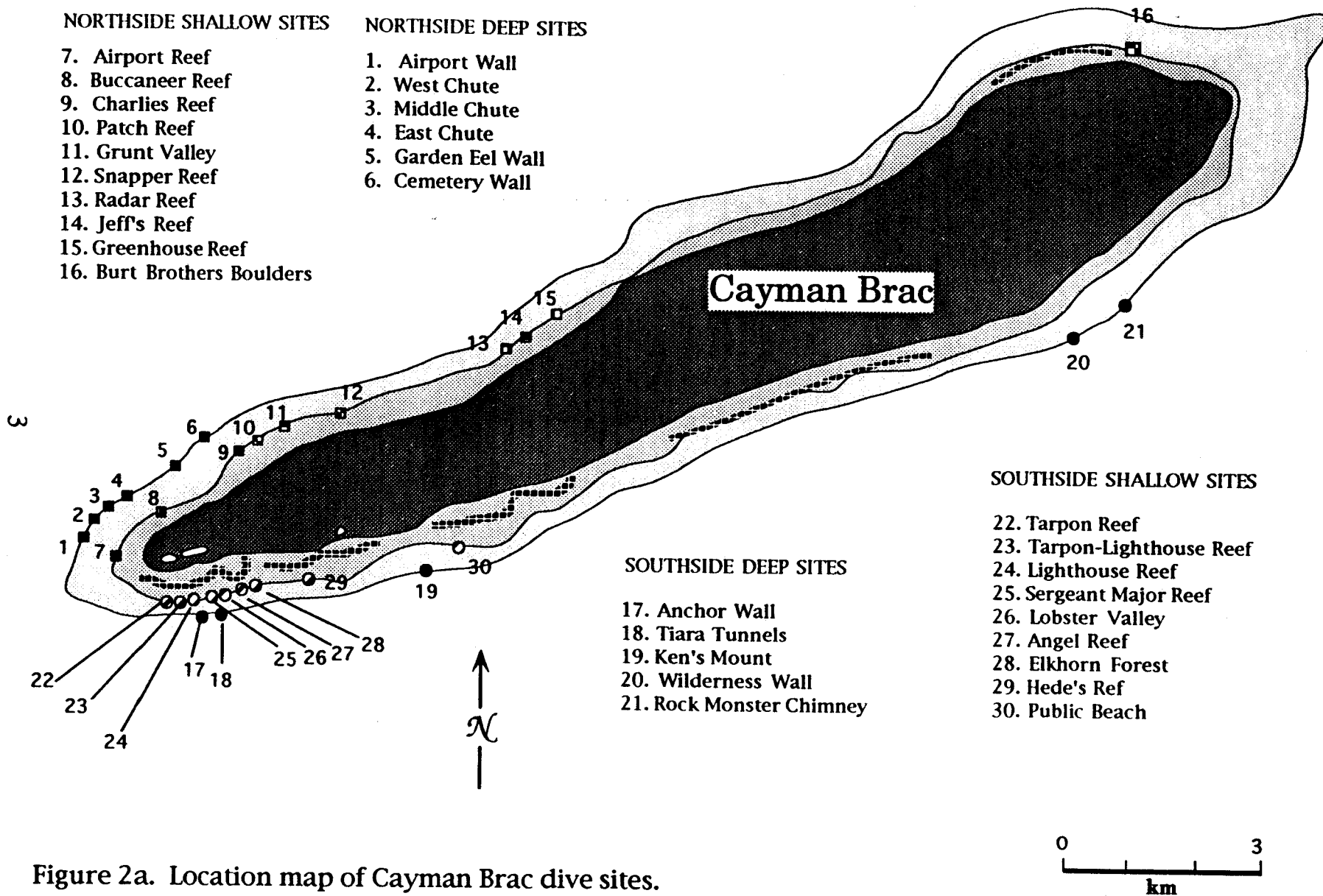
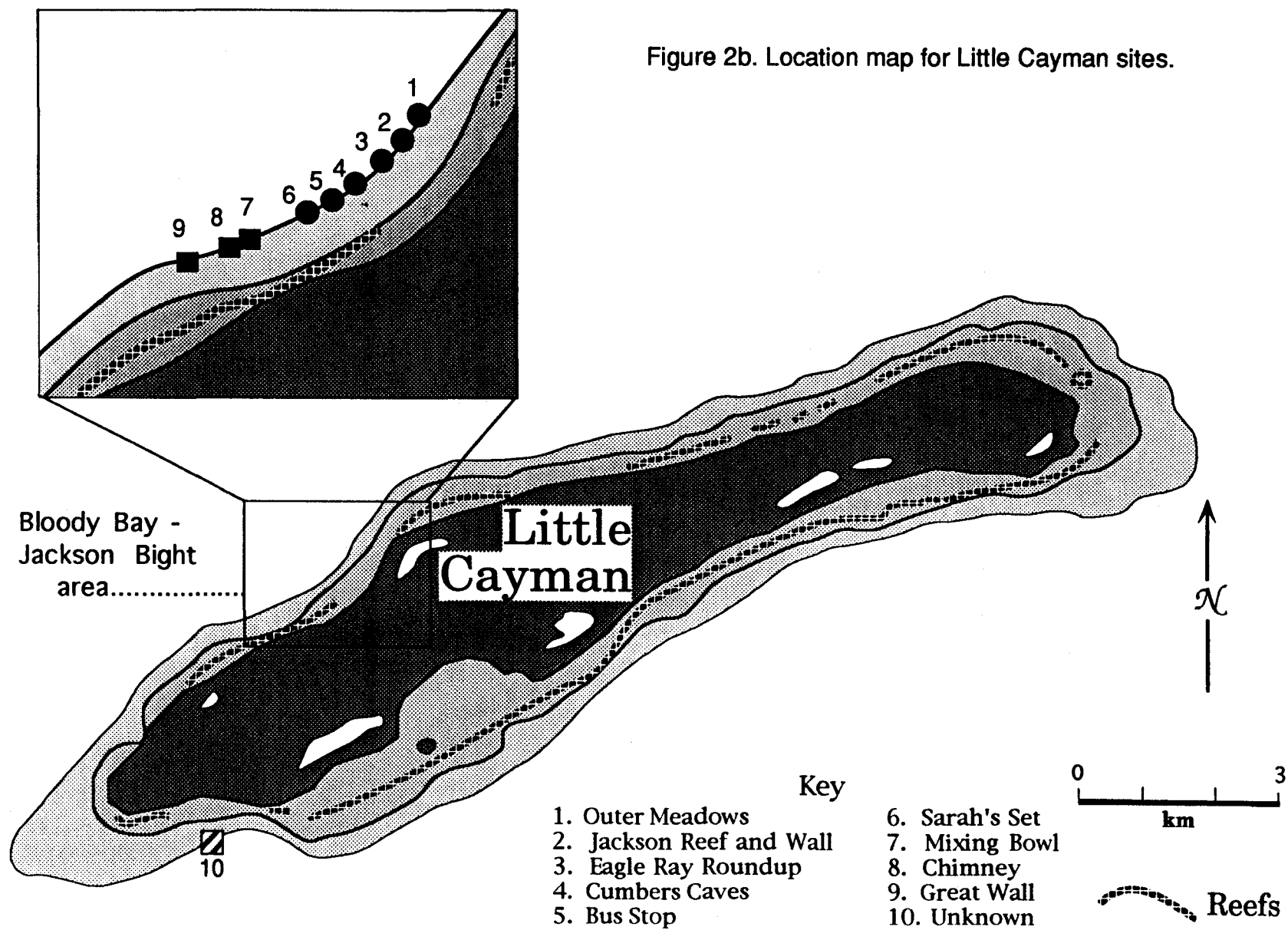


Figure 2a. Location map of Cayman Brac dive sites.



data-collection system was introduced to gather information concerning the number of divers visiting each site on a yearly basis. A unique program to quantify and qualify direct diver-reef contacts was developed, and introduced to the area dive staff for implementation.

While the primary goal of this study was to develop a resource-management plan, parallel efforts were undertaken to interact with the island community and resort divers. Educational programs and guided dives, emphasizing natural history, were given to enhance the ecological awareness of both target groups, and their knowledge of the efforts being undertaken in their behalf by the Hotel and Tourism Association. In this manner, the cost of the study was offset by increased dive revenue (immediate) and resort-destination promotion (long-term). This combination produced benefits for the resort (resource management and promotion), the island (community education and activities) and the diver (increased awareness and knowledge).

METHODS

The data collection utilized standard scientific techniques that were chosen for their ability to meet the following criteria:

- 1) non-intrusive techniques (nothing attached to the bottom)
- 2) lightweight, portable equipment (for use with sport dive boats)
- 3) large sample areas (entire dive site should be considered)
- 4) reproducible techniques (for comparative analysis over time)

Which methods most effectively describe reef communities have been the subject of much debate within the scientific community. The techniques used in this study are commonly accepted, (Bythell et al., 1992; Rogers unpub. data) and can, therefore, be realistically compared with data from other Caribbean locations.

Data Collection

A quadrat was constructed from 3/8" P.V.C. pipe measuring one meter on each side. The perimeter was marked with duct tape every 10 centimeters to aid in size estimation. The quadrat was placed by swimming a random number of fin kicks and dropping the frame over the shoulder to avoid bias in the survey. At each site, 20 quadrats were generally measured. At Airport Reef, separate measurements were taken on the "reef" and in the intervening sand/rubble areas (pavement).

Within each one-meter square, the percent cover by live animals, sand/rubble and algae were estimated. Small species were estimated to the closest 0.25%.

Otherwise, cover was estimated to the nearest whole number percent. Taxonomic identifications were based on the following criteria:

- 1) Hard Corals: defined to genus and species
- 2) Soft Corals: defined as "Gorgonians"
- 3) Sponges, tunicates and zoanthids were listed as such, with no further taxonomic clarification.
- 4) Sand and Rubble were recorded as such and could include dead coral if it was covered with sand.
- 5) Algae: included macro, turf and encrusting algae.

Scientific and common names, for the surveyed organisms, as well as abbreviations used in data tables, are summarized in Table 1.

Point count and photo transects were also taken. They are not included in the discussion, however, and therefore, the methods are not described here. Data are available if the need arises and funding for future analyses becomes available.

Most study sites were established near permanent mooring buoys that have been installed and maintained as a part of the Marine Park System (Table 2a-b). Absolute location was determined using a Furuno Navigator GP-70, Global Positioning System. Each site encompassed an area 50 meters by 50 meters. At some sites, sampled areas were chosen based on physical characteristics. These include Cemetery Wall (Brac, Northside deep sampled from 104' to 74') and terrace site (sampled on top of the wall), and two locations on Little Cayman (Jackson Wall and Mixing Bowl: sampled on top of the wall and the wall face).

In addition to the main survey sites, two "control" sites were examined for comparisons with more-heavily visited locations. The Lobster Valley site has no mooring and is not usually dived. The Tarpon-lighthouse site is between Tarpon Reef and Lighthouse Reef, and relatively few divers cover this large distance underwater.

Data on the numbers of divers visiting each site were gathered using the boat logs from Dive Tiara during the period January 1992-November 1992 (Table 3). Dive Tiara is one of the two dive operators on Cayman Brac, so these logs represent approximately one half of the divers that visit the study sites. The percentage of divers taken to the different reef sites is likely similar to the other operation (Brac Aquatics). These numbers are not actual total diver visitations, yet they are probably good approximations of the relative diver frequency.

TABLE 1.

SCIENTIFIC, COMMON NAMES AND ABBREVIATIONS FOR TAXONOMIC GROUPS

Genus and species	Abbreviation	Common Names *
<i>Acropora cervicornis</i>	A. cerv.	Staghorn Coral
<i>Acropora palmata</i>	A. palm.	Elkhorn Coral
<i>Acropora prolifera</i>	A. pro.	Fused Staghorn Coral
<i>Agaricia agaricites</i>	Ag. ag.	Lettuce Coral
<i>Agaricia grahamae / lamarchi</i>	Ag. graham.	Graham's Sheet Coral
<i>Colpophyllia natans/breviserialis</i>	Col. nata.	Boulder Brain Coral
<i>Dendrogyra cylindrus</i>	Dendro.	Pillar Coral
<i>Dichocoenia stokesi/stellaris</i>	Dicho.	Elliptical Star Coral
<i>Diploria clivosa</i>	Dip. cliv.	Knobby Brain Coral
<i>Diploria labyrinthiformis</i>	D. lab.	Grooved Brain Coral
<i>Diploria strigosa</i>	Dip. strig.	Symmetrical Brain Coral
<i>Eusmilia fastigiata</i>	Eus. fast.	Smooth Flower Coral
<i>Favia fragum</i>	Favia	Golf Ball Coral
Gorgonian	Gorg.	Sea Fans, Rods or Whips
<i>Isophyllastrea rigida</i>	Iso. rig.	Rough Star Coral
<i>Isophyllia sinuosa</i>	Iso. sino.	Sinuuous Cactus Coral
<i>Leptoseris (Helioseris) cucullata</i>	Lepto.	Sunray Lettuce Coral
<i>Madracis decactis</i>	Mad. dec.	Knobby Finger Coral
<i>Madracis formosa</i>	Mad. form.	Eight-Ray Finger Coral
<i>Madracis mirabilis</i>	Mad. mir.	Yellow Pencil Coral
<i>Manicinia areolata</i>	Manicinia.	Rose Coral
<i>Meandrina meandrites</i>	Mean. mean.	Maze Coral
<i>Millepora alcicornis</i>	Mil. alc.	Branching Fire Coral
<i>Millepora complanata</i>	Mil. comp.	Blade Fire Coral
<i>Montastrea annularis</i>	M. ann.	Boulder Coral
<i>Montastrea cavernosa</i>	M. cav.	Great Star Coral
<i>Mussa angulosa</i>	Mussa	Spiny Flower Coral
<i>Mycetophyllia aliciae</i>	Mycet. aliciae.	Knobby Cactus Coral
<i>Mycetophyllia danaana</i>	Mycet. dan.	Lowridge Cactus Coral
<i>Mycetophyllia ferox</i>	Mycet. ferox.	Rough Cactus Coral
<i>Mycetophyllia lamarckiana</i>	Mycet. lam.	Rigged Cactus Coral
<i>Mycetophyllia reesi</i>	Mycet. reesi.	Ridgeless Cactus Coral
<i>Porites asteroides</i>	P. ast.	Mustard Hill Coral
<i>Porites divaricata</i>	P. div.	Thin Finger Coral
<i>Porites furcata</i>	P. fur.	Branched Finger Coral
<i>Porites porites</i>	P. por.	Finger Coral
<i>Scolymia cubensis</i>	Scolyo.	Artichoke Coral
<i>Siderastrea radians</i>	Sid. rad.	Lesser Starlet Coral
<i>Siderastrea siderea</i>	Sid. sid.	Massive Starlet Coral
Sponge	sponge	Sponge
<i>Stephanocoenia michelinii</i>	Steph.	Blushing Coral
Tunicate	Tunicate	Tunicate
Zoanthid	Zoo.	Zoanthid
Algae	Algae	"green stuff"
Sand / Rubble	S/R	"other stuff"

* Common names are referenced from REEF CORAL IDENTIFICATION by Paul Humann, 1993

TABLE 2a.

CAYMAN BRAC SITE INFORMATION

NORHTSIDE DEEP SITES

	GPS location	quads per site	depth range
Airport Wall	19:41.44 N 79:53.77 W	15	54-69 ft.
Cemetery Wall (deep)	19:41.91 N 79:52.68 W	20	74-106 ft.
Cemetery Wall (terrace)	same as above	20	50-77 ft.
East Chute	19:41.54 N 79:53.49 W	20	51-64 ft.
Garden Eel Wall	19:41.84 N 79:52.83 W	20	55-85 ft.
Middle Chute	19:41.53 N 79:53.61 W	20	53-75 ft.
West Chute	19:41.48 N 79:53.69 W	20	52-77 ft.

NORTHSIDE SHALLOW SITES

Airport Reef (Pavement)	19:41.26 N 79:53.65 W	20	27-44 ft.
Airport Reef (Reef)	same as above	20	21-35 ft.
Buccaneer Reef	19:41.60 N 79:53.04 W	20	25-34 ft.
Burt Brothers Boulders		14	22-38 ft.
Charlies Reef	19:41.83 N 79:52.66 W	20	21-34 ft.
Greenhouse Reef	19:43.21 N 79:49.70 W	15	18-31 ft.
Grunt Valley	19:42.12 N 79:52.48 W	20	26-36 ft.
Jeff's Reef	19:43.04 N 79:49.94 W	20	17-34 ft.
Patch Reef	19:41.95 N 79:52.56 W	20	26-36 ft.
Radar Reef	19:42.95 N 79:50.05 W	15	24-34 ft.
Snapper Reef	19:42.39 N 79:51.24 W	20	22-37 ft.

SOUTHSIDE DEEP SITES

Anchor Wall	19:40.66 N 79:53.02 W	20	58-76 ft.
Eden Wall	19:41.37 N 79:50.51 W	20	58-71 ft.
Ken's Mount	19:41.27 N 79:50.76 W	12	52-63 ft.
Rock Monster Chimney		10	50-68 ft.
Tiara Tunnels	19:40.69 N 79:52.85 W	20	65-91 ft.
Wilderness Wall		16	49-64 ft.

SOUTHSIDE SHALLOW SITES

Angel Reef	19:40.88 N 79:52.44 W	20	22-35 ft.
Elkhorn Forest	19:40.93 N 79:52.15 W	20	25-34 ft.
Hede's Reef		12	23-32 ft.
Lighthouse Reef	19:40.79 N 79:53.25 W	20	19-36 ft.
Lobster Valley	19:40.86 N 79:52.71 W	20	24-36 ft.
Public Beach/ Fry Caves	19:41.41 N 79:50.68 W	20	14-26 ft.
Sargent Major Reef	19:40.85 N 79:52.97 W	20	20-41 ft.
Tarpon Reef	19:40.77 N 79:53.37 W	20	21-36 ft.
Tarpon-Lighthouse Reef	19:40.79 N 79:53.27 W	20	20-37 ft.

TABLE 2b.

LITTLE CAYMAN SITE INFORMATION

JACKSON BIGHT SITES

Bus Stop/School Bus Wall	19:41.32 N 80:04.26 W	20	44-52 ft.
Cumber's Caves	19:41.37 N 80:04.22 W	20	38-43 ft.
Eagle Ray Round-up	19:41.49 N 80:04.15 W	20	31-42 ft.
Jackson Reef and Wall	19:41.45 N 80:04.12 W	20	31-41 ft.
Jackson Wall (Deep)	same as above	20	90-60 ft.
Outer Meadows		15	30-38 ft.
Sarah's Set	19:41.26 N 80:04.38 W	10	57-69 ft.

BLOODY BAY SITES

Chimney/Randy's Gazebo	19:41.00 N 80:05.01 W	20	28-37 ft.
The Great Wall	19:40.99 N 80:05.07 W	20	38-71 ft.
Mixing Bowl (Terrace)	19:41.09 N 80:04.69 W	6	28-34 ft.
Mixing Bowl (Deep)	same as above	20	44-67 ft.

SOUTHSIDE SITE

Unknown name	19:39.39 N 80:05.32 W	7	50-57 ft.
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TABLE 3.

FREQUENCY OF DIVERS AT DIVE SITES

RANK	SITE	JAN	FEB	MCH	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL	RELATIVE %
1	Snapper Reef	64	138	140	90	70	152	169	168	123	93	133	1340	8.73
2	Cemetery Wall	55	115	126	137	115	185	148	131	52	88	120	1272	8.29
3	East Chute	85	151	44	132	121	127	169	123	53	76	83	1164	7.58
4	Charlies Reef	80	127	78	125	132	92	135	122	87	45	93	1116	7.27
5	Patch Reef	25	89	50	115	87	149	122	110	42	42	81	912	5.94
6	Greenhouse Reef	57	46	59	96	77	95	67	60	96	66	82	801	5.22
7	Grunt Valley	39	70	45	61	59	84	131	167	19	47	78	800	5.21
8	Garden Eel Wall	32	57	42	82	59	105	115	50	57	81	66	746	4.86
9	Radar Reef	17	8	158	7	39	115	113	67	48	58	92	722	4.70
10	Jeff's Reef/Plymouth Rock	14	68	89	55	40	118	0	101	71	87	71	714	4.65
11	Middle Chute	0	0	36	48	62	39	95	119	70	22	94	585	3.81
12	Rock Monster Chimney	73	0	72	77	64	12	16	90	55	56	63	578	3.77
13	Wilderness Wall	88	43	71	92	83	0	18	36	41	22	53	547	3.56
14	Sgt. Major Reef	65	25	53	131	86	5	6	36	16	39	81	543	3.54
15	Angel Reef	85	24	60	18	104	0	27	14	34	39	84	489	3.19
16	Tarpon Reef	74	3	56	46	79	12	14	43	34	56	58	475	3.09
17	West Chute	0	36	0	37	27	26	11	79	17	38	108	379	2.47
18	Airport Reef/End of Island	24	24	11	59	12	29	17	44	35	22	83	360	2.35
19	Elkhorn Forest	55	17	28	43	91	0	0	16	12	18	63	343	2.23
20	Lighthouse Reef	51	18	33	25	101	0	0	15	16	44	15	318	2.07
21	Buccaneer Reef	40	33	34	0	49	89	0	0	0	0	0	245	1.60
22	Tiara Tunnels	13	6	36	27	24	2	15	0	0	29	16	168	1.09
23	Public Beach/Fry Cave	50	30	0	48	19	0	0	0	0	0	0	147	0.96
24	Eden Wall	20	5	29	27	15	0	14	0	0	0	32	142	0.93
25	Anchor Wall	51	0	18	9	0	0	0	27	0	11	24	140	0.91
26	Ken's Mount	0	0	0	15	10	25	15	0	16	26	19	126	0.82
27	Airport Wall	0	0	0	0	0	8	28	15	0	26	16	93	0.61
28	Hede's Reef	6	15	24	28	0	0	0	0	12	0	0	85	0.55

TOTAL
DIVERS:

1163 1148 1392 1630 1625 1469 1445 1633 1006 1131 1708 15350

Statistical Analysis

Data were tabulated in three formats, and are provided in the Appendices. Percent cover by each bottom type (coral species, other kinds of animals, sand/rubble, and algae) are summarized in Appendix I. Means and standard deviations for these groups are provided in Appendix II. Appendix III tabulates the frequency of occurrence of each major group in quadrats (i.e., the number and percent of quadrats in which each bottom type was encountered).

Two statistical analyses were performed on the quadrat data to compare the sites with respect to species composition and diversity. K-dominance curves were used to show differences in species diversity of two or more sites, independent of sample size. The higher the curve, the less diverse the sites. K-dominance curves that do not cross, indicate differences in species diversity. Similarity is defined by the amount and variety of different corals occurring at each site and not by the actual species involved (e.g., two "similar" sites with similar percent cover by 12 species of coral each may not have the same 12 species in common). This allows us to compare the general "health" of different sites which are exposed to different natural stresses and would, therefore, be expected to have different types of corals present (e.g., branching corals in shallow water versus platy corals in deeper water).

Multi-dimensional scaling ordination (MDS) was carried out to compare the mean abundance values of the taxa surveyed from site to site. Calculations were made using SYSTAT for the Macintosh computer (Version 5.2). Statistical details aside, the method plots the sites on x-y axes such that similar sites group together. The resulting graph allows for the simple analysis of complex sites by grouping those with similar characteristics. The more distant the points, the greater the difference between them.

MDS calculation were based on the Pearson correlation matrix and Kruskal's stress formula with a monotonic function. Plotting was carried out in two dimensions, with the linear distances between points (sites) being related to the degree of similarity between them. MDS plots evaluate each species using its presence as well as its percent cover for the basis of comparison. Being a multivariate statistic, all taxonomic categories were used when making the calculations.

Separate MDS analyses were run for animal groups only (i.e.: with algae and sand/rubble removed). With the dead cover and algae removed, a clearer pattern of

the live-animal cover emerges. Calculations were repeated to include algae, sand/rubble, along with animal cover. With all substrate types included, a comparison can be made of the amount of live versus dead cover.

It is of interest to note that in most scientific evaluations of reef communities, "live cover" can include items that are of little interest to the average diver, such as algae. Algae are major players in the balance of life on the reef and their presence is quite important. Photosynthetic processes of plants convert the sun's energy into food that can be utilized by the corals and other invertebrates on the reef. In this study, algae are treated as a separate category. Confusion can also occur when divers and others assume that soft corals (gorgonians) or sea fans are plants because they look like bushes or shrubs and overlook the fact of their true animal identity.

RESULTS

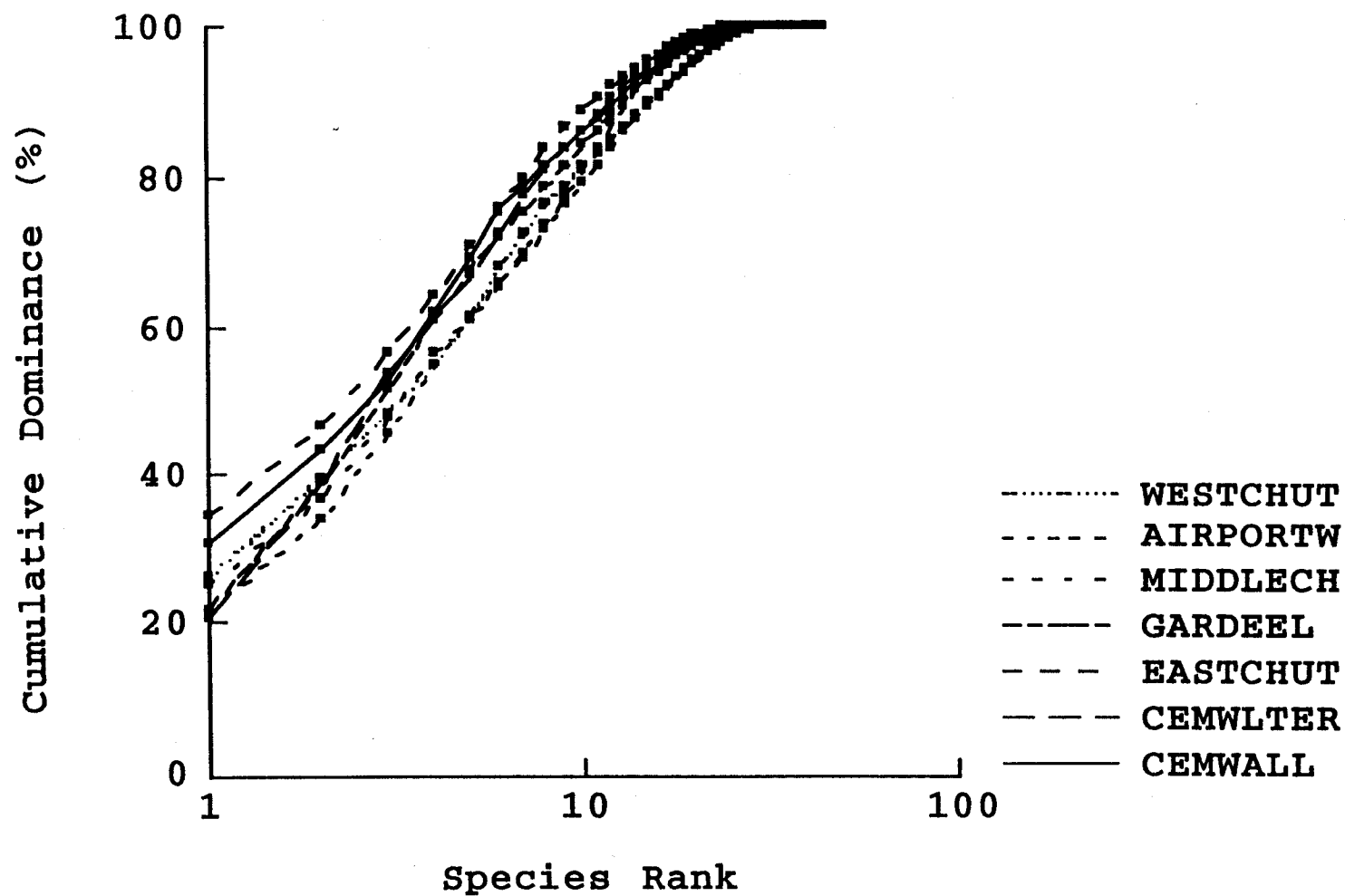
Coral Cover At Cayman Brac Sites

Live-animal cover was high at most study sites. This consistency suggests either low or even pressures upon the reef communities and perhaps a dominance of natural processes over the impact of divers. The following section briefly describes the results from each site. The reader is referred to the appendices for the raw data.

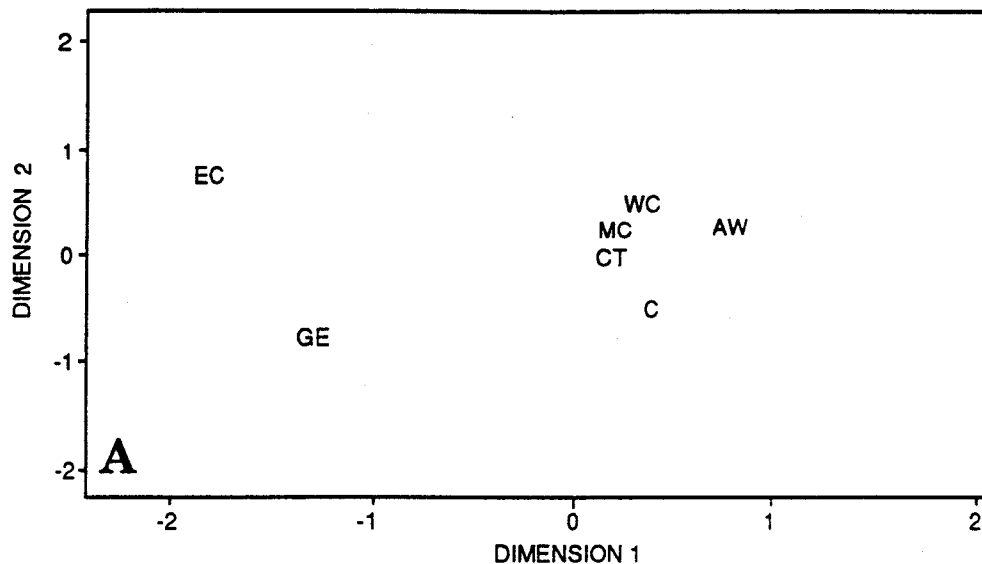
Northside Deep - K-dominance curves (Fig. 3) showed no significant dissimilarities among sites although East Chute showed slightly higher levels of species dominance, and the highest percent live-animal cover (=42.05%). MDS analyses of all bottom cover (Fig. 4a) separated Cemetery Wall Deep (d=74'-106') slightly from the main grouping due to the relatively high percentages of *Agaricia agaricities* and sponges, and lack of *Diploria* species. The even greater separation Garden Eel Wall and East Chute from all remaining sites (Cemetery Wall Terrace, Middle, West Chutes and Airport Wall), was observed. Based on MDS analyses of live-animal cover only (Fig. 4b), Airport Wall was dissimilar to all other sites, as was Garden Eel Wall and Cemetery Wall Deep. West Chute was slightly distant from the main group containing Cemetery Wall Terrace, East and Middle Chutes. The percent live-animal cover of the main group is approximately 31%.

Northside Shallow - K-dominance curves in this area were broken into two groups for legibility. West End Sites (Fig. 5a): Include Airport Reef, Buccaneer Cut, Patch Reef, Charlies Reef and Grunt Valley (See Fig. 2 for locations). Sites showed similar species diversity with the exception of Charlies Reef which had a lower diversity. Stake Bay Sites (Fig. 5b) include Snapper Reef, Radar Reef, Jeff's Reef,

Fig. 3. C. Brac Northside Deep



Dive Site	Plot	Dimension	
		1	2
Cemetary Wall	CW	0.54	-0.69
Cemetary Wall Terrace	CT	0.33	-0.03
East Chute	EC	-1.54	0.65
Garden Eel	GE	-1.06	-0.85
Middle Chute	MC	0.36	0.24
Airport Wall	AW	0.89	0.20
West Chute	WC	0.48	0.48



Dive Site	Plot	Dimension	
		1	2
Cemetary Wall	CW	-2.09	0.12
Cemetary Wall Terrace	CT	-0.08	0.33
East Chute	EC	1.05	0.27
Garden Eel	GE	-0.34	-0.35
Middle Chute	MC	0.48	0.24
Airport Wall	AW	0.37	-0.56
West Chute	WC	0.61	-0.05

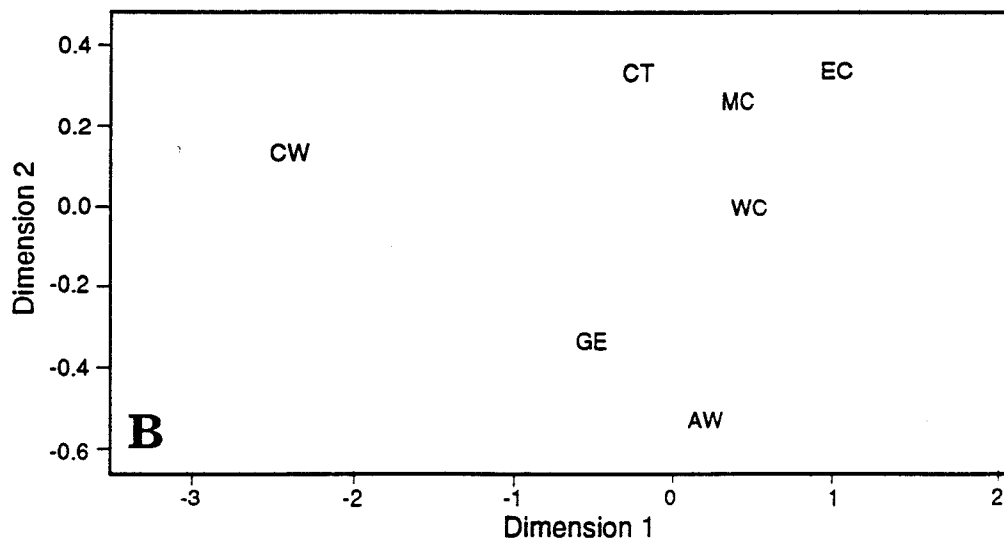


Fig. 4. MDS plots of Cayman Brac Northside Deep sites. A. Plot based on all data. B. Plot based on live-animal cover only. Dive sites with their abreviations used in the plot and the values of their coordinates are listed in the table above each graph.

Fig. 5a. C. Brac Northside Shallow (west end)

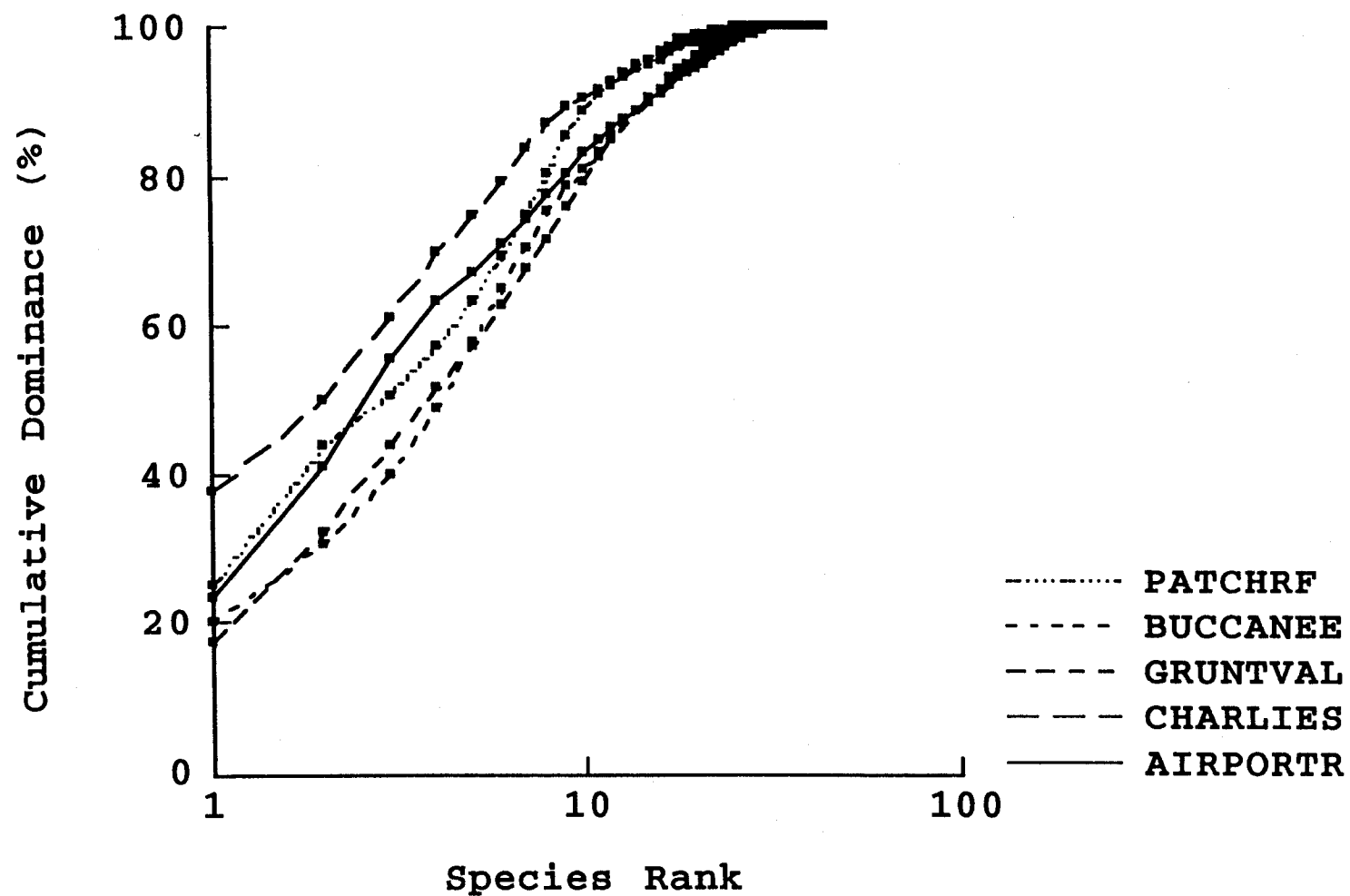
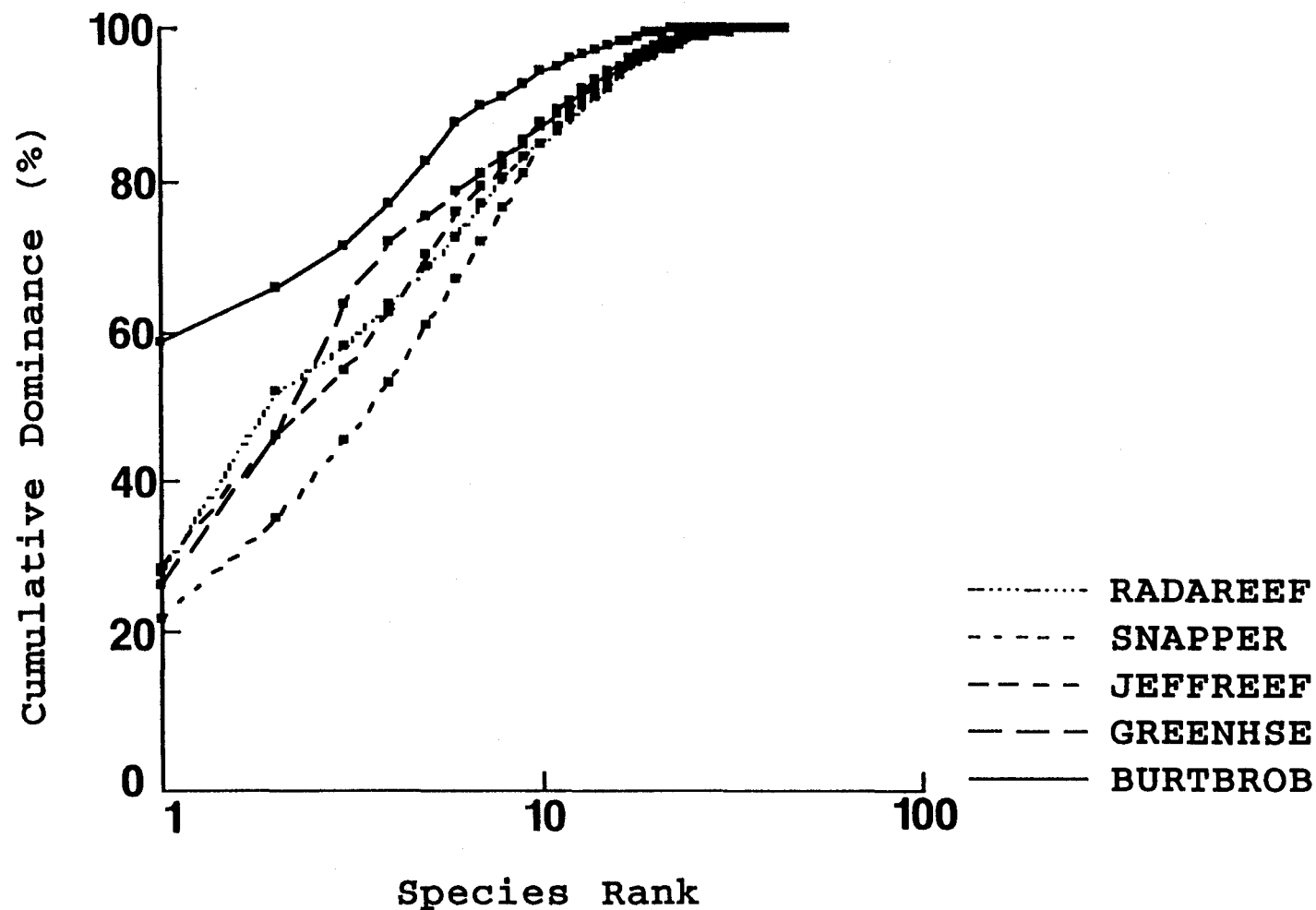


Fig. 5b. C. Brac Northside Shallow (stake bay)



Greenhouse Reef and Burt Brothers Boulders (see Fig. 2). Within this group, Snapper Reef showed a high level of species diversity, and Burt Brothers Boulders was less diverse, due to a dominance of *Montastrea annularis* (=31.5%). It also contained high amounts of *Acropora cervicornis* and *Colpophyllia natans*; total percent cover by live animals was high (=53.43%).

Sites showed consistent grouping by MDS (Fig. 6a), except for Airport Reef (pavement) and Burt Brothers Boulders. The separation of Airport Reef (pavement) is probably due to greater proportions of sand/rubble at that site. Similarly, the Burt Brothers site may reflect the lower diversity seen in Figure 6. Based on live-animal cover only (Fig. 6b), Airport Reef and Burt Brothers Boulders remained separated. The slight separation of Airport Reef (reef) reflects the relatively high abundances of *Montastrea* and *Diploria clivosa*, and relatively low *Agaricia* cover.

Southside Deep Sites - K-dominance curves (Fig. 7) are similar for all sites except Ken's Mount which showed the highest percent live-animal cover (=45.75%) and the lowest diversity. MDS analysis based on all categories showed a wide spread (Fig. 8a). Two groups can be identified. Eden Wall and Anchor Wall fell into one group, Wilderness Wall and Tiara Tunnels into another. Ken's Mount and Rock Monster Chimney plotted separately due to the greater proportion of sand/rubble found there.

MDS based on live-animal cover only (Fig. 8b) cluster all sites except for Wilderness Wall and Rock Monster Chimney. Wilderness Wall was separated because of relatively high abundance of *A. agaricities*, *D. strigosa*, and *Siderastrea siderea*, and relatively low cover by *M. annularis*. Rock Monster Chimney had relatively high cover by *C. natans*, and sponge, and relatively low *A. agaricities* cover. Eden Wall, Anchor Wall and Ken's Mount were similar having approximately 15% (relatively high) cover for *M. annularis*.

Southside Shallow Sites - K-dominance curves are plotted on three graphs for legibility (Fig. 9a-c). Lobster Valley is plotted as a reference on each chart. Reefs are similar on all graphs except perhaps Hede's Reef (Fig. 9b), which plots separately if all three graphs are combined. Lobster Valley and Tarpon-Lighthouse Reef, the two "control" sites, were similar with slightly higher diversity than the other two sites.

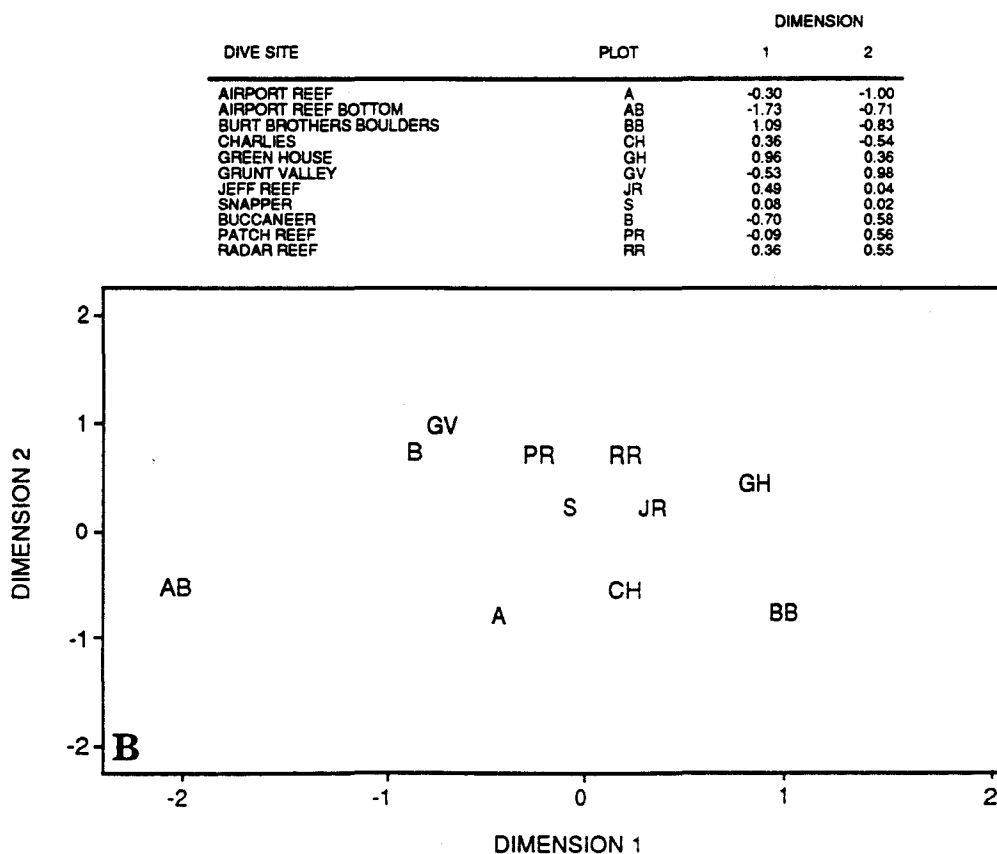
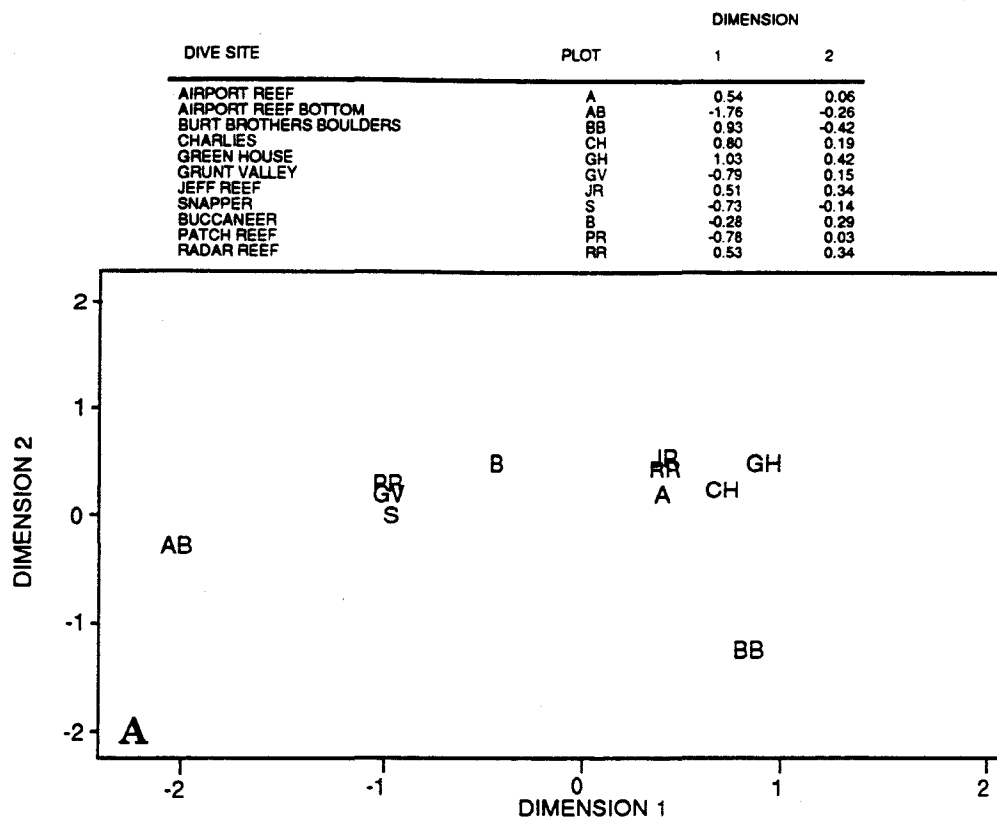
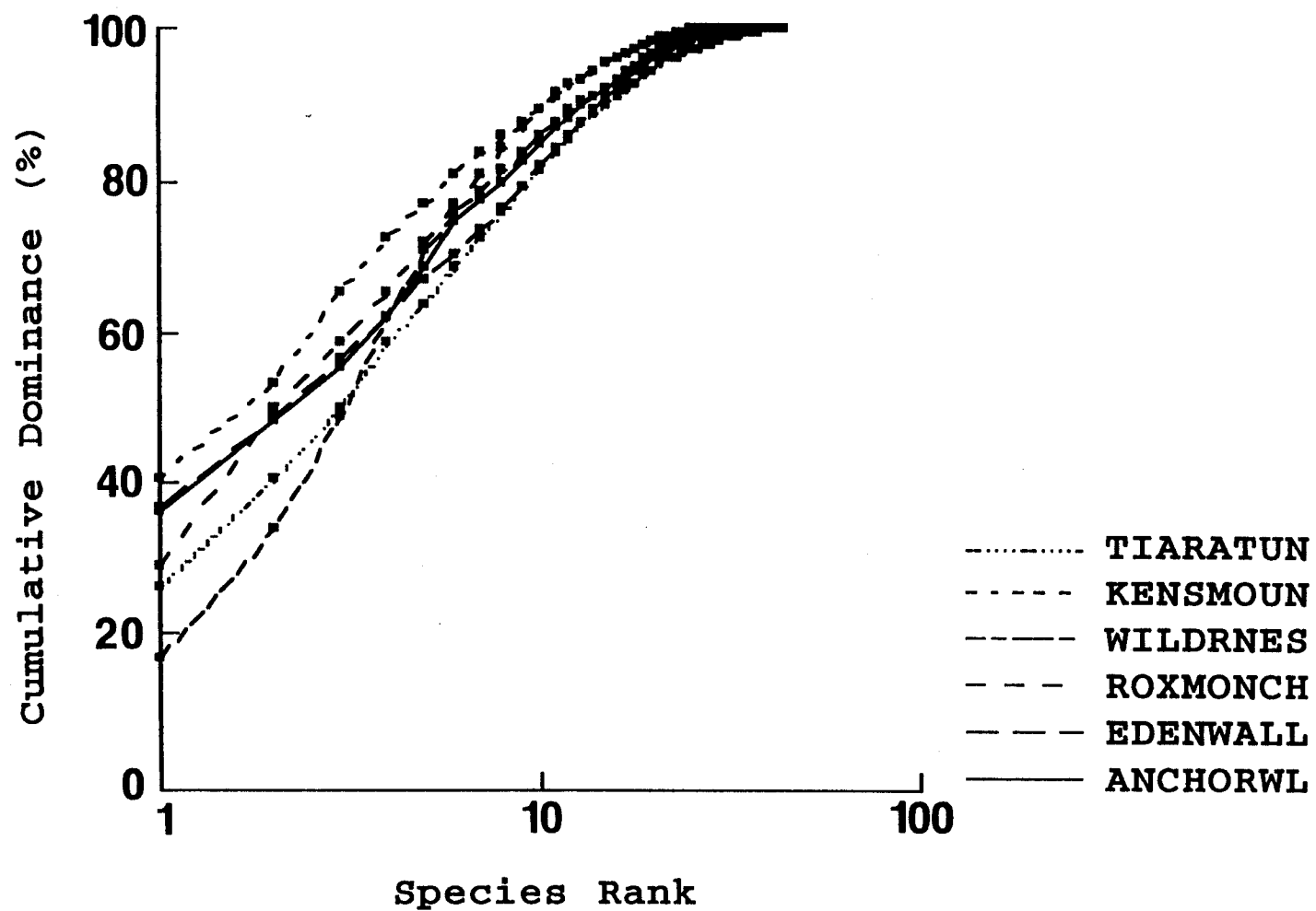


Fig. 6. MDS plots for data from Cayman Brac Northside Shallow dive sites. A. Plot based on all data. B. Plot based on live-animal cover alone.

Fig. 7. C. Brac Southside Deep



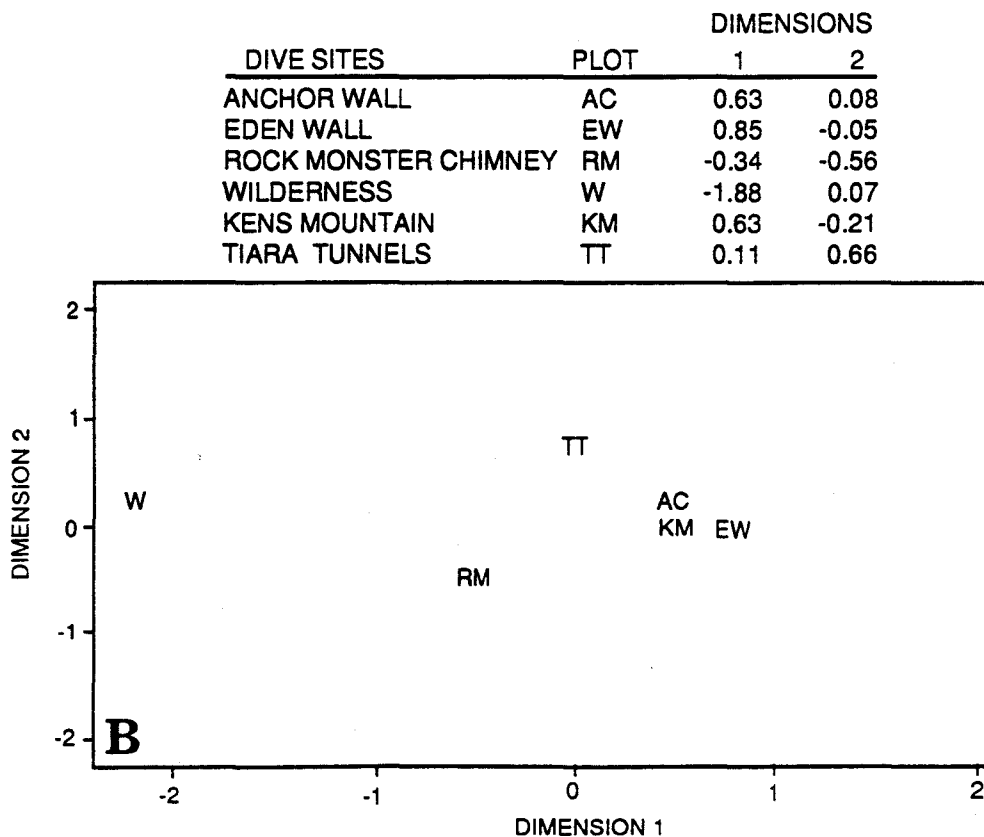
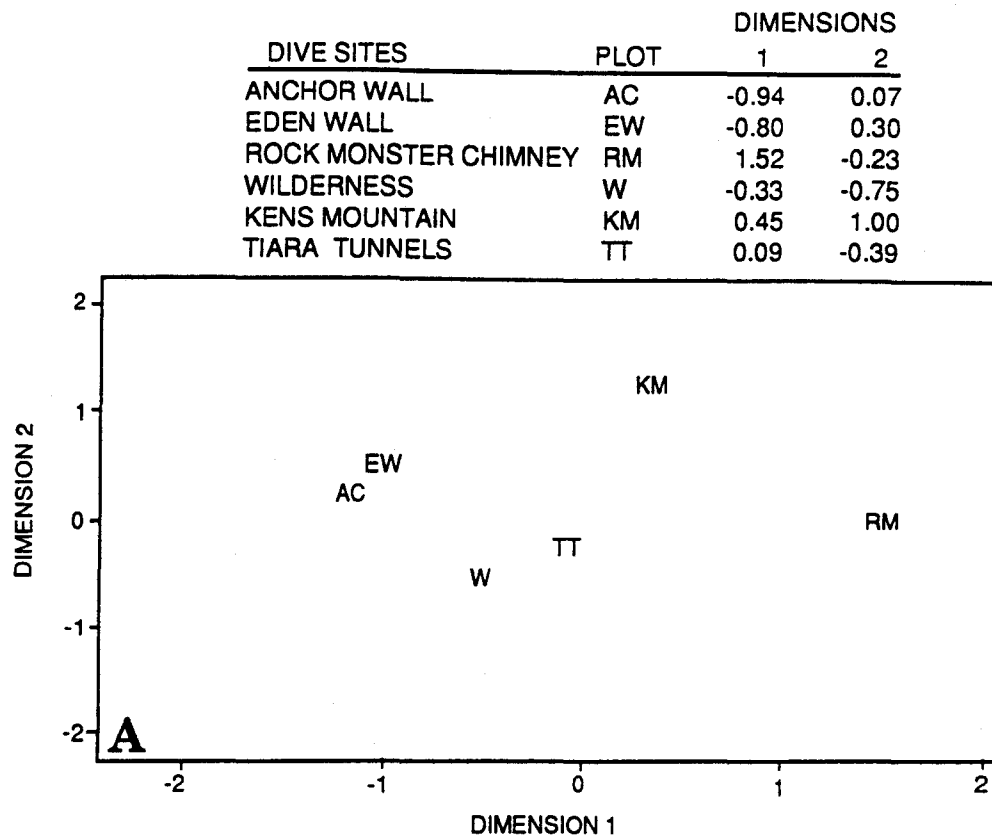


Fig. 8. MDS plots of Cayman Brac Southside Deep dive sites. A. Plots based on all data. B. Plots based on live-animal cover alone.

Fig. 9a. C. Brac Southside Shallow #1

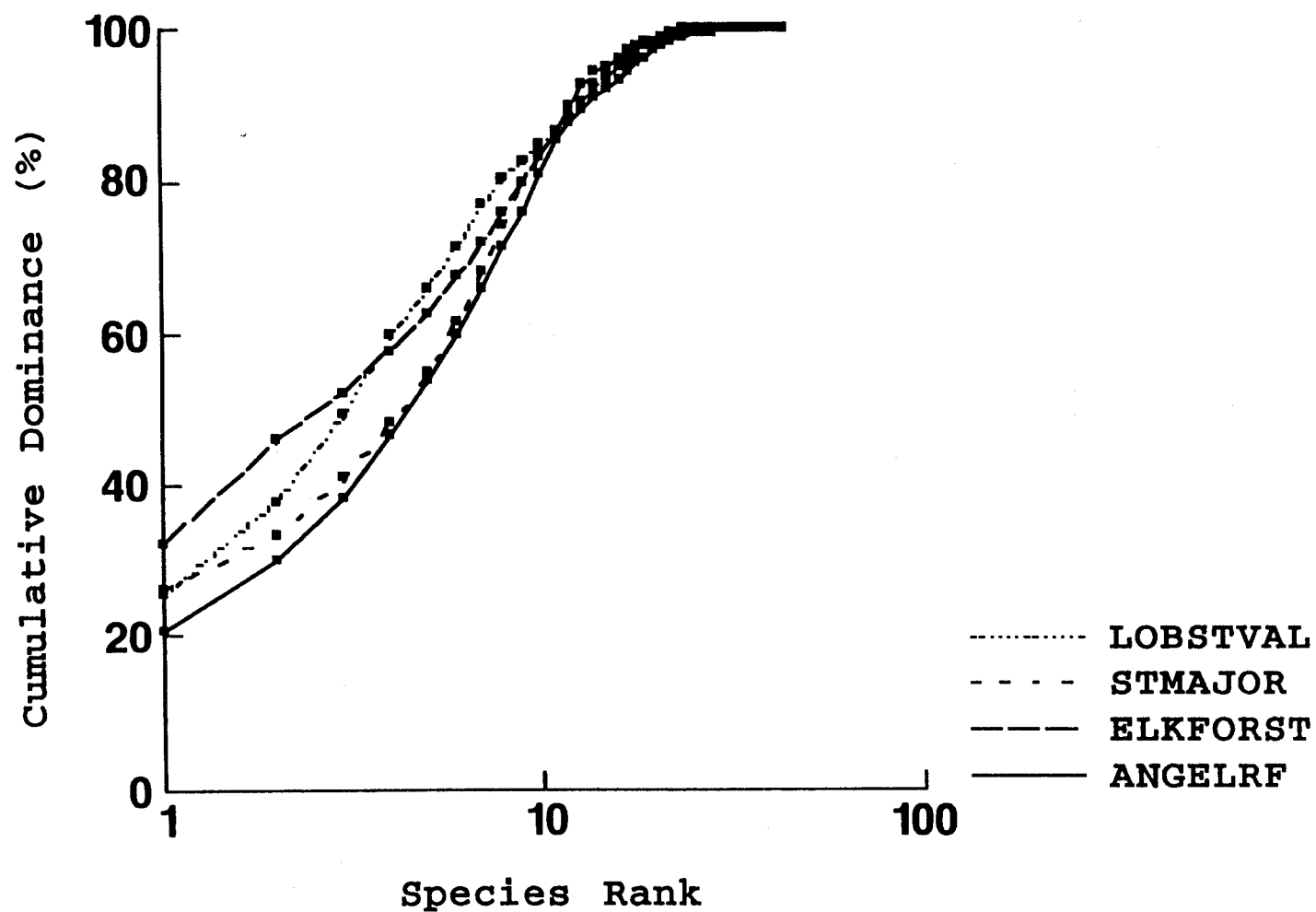


Fig. 9b. C. Brac Southside Shallow #2

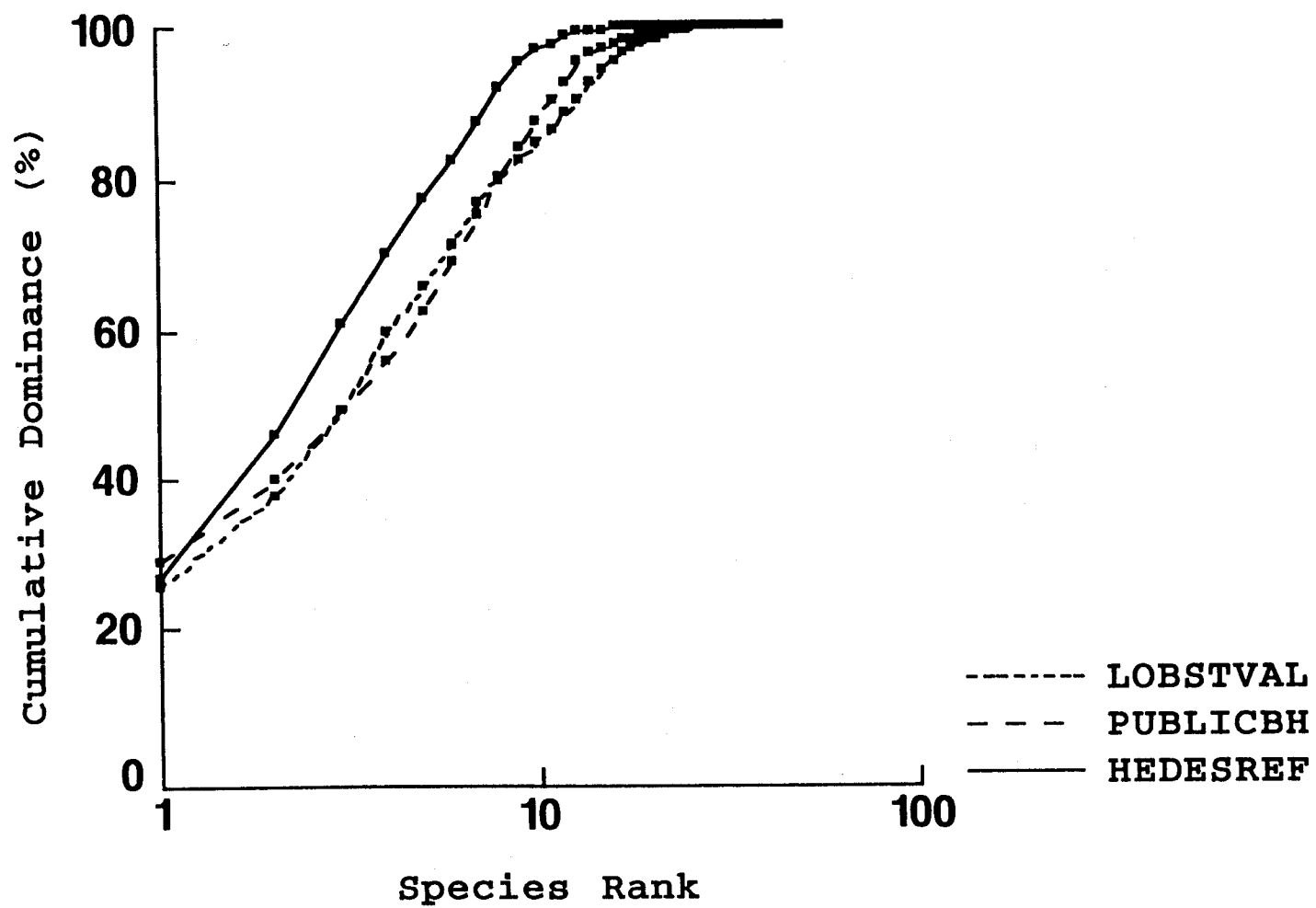
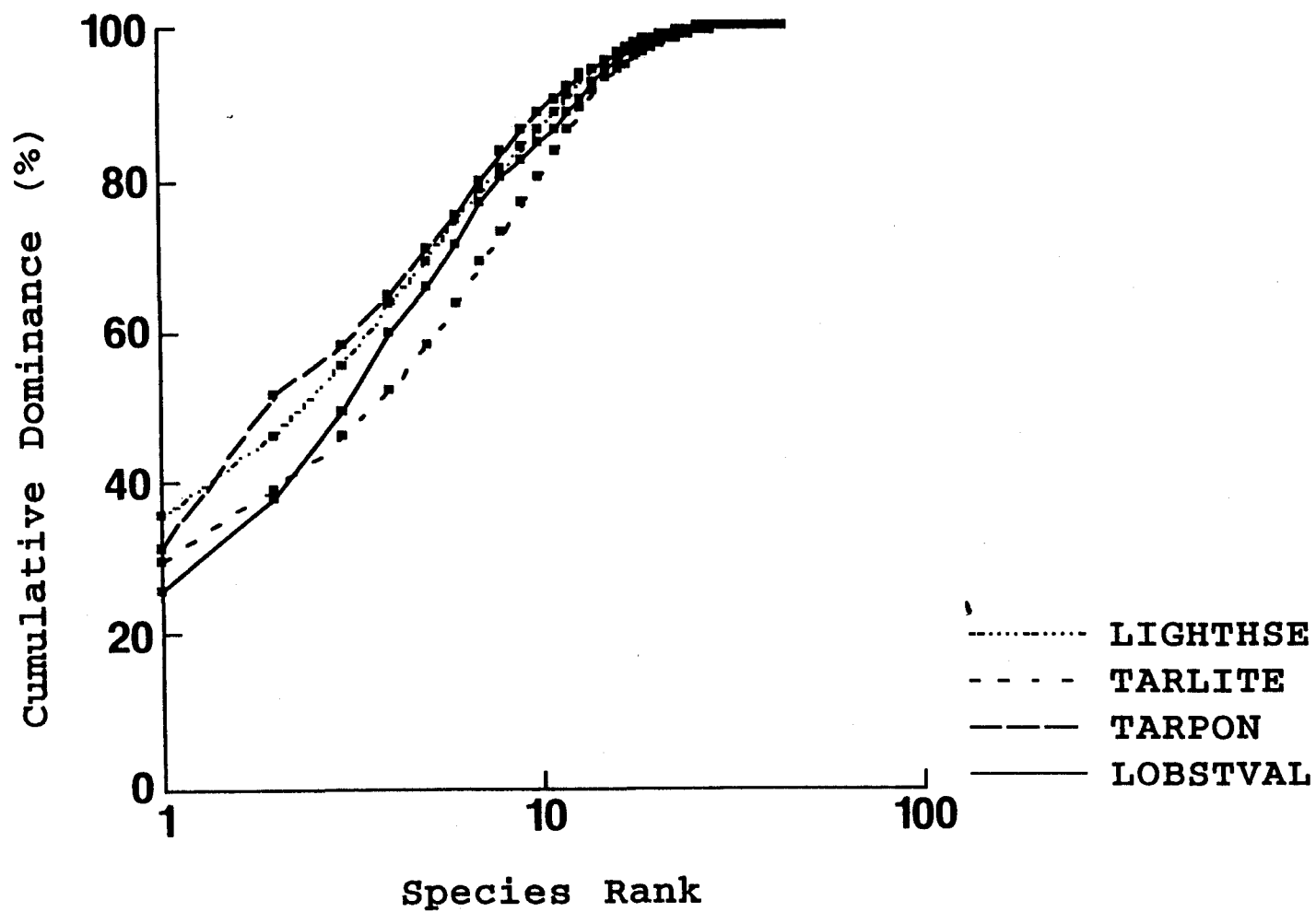


Fig. 9c. C. Brac Southside Shallow #3



MDS plots for all categories distinguish three groups (Fig 10a). Public Beach, Lobster Valley and Hede's Reef plot together reflecting similar algae cover (~65%). Tarpon Reef is separate, reflecting a relatively high percentage live-animal cover (=39.9%). The remaining sites are similar.

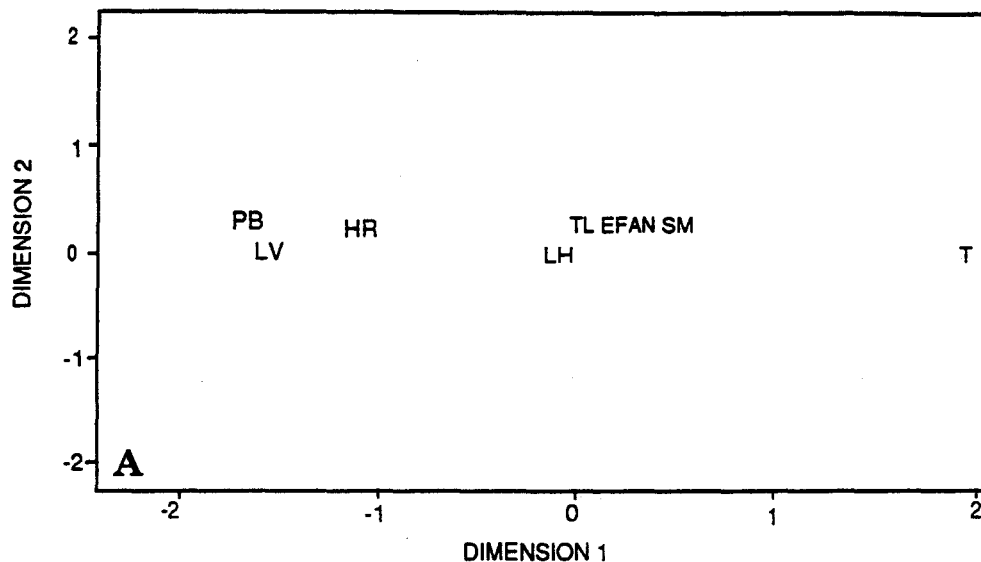
Based on live-animal cover only (Fig. 10b), Hede's Reef Tarpon Reef and Lobster Valley separated from the main group. Hede's Reef had high percentages of *Acropora palmata* and *C. natans* and thus plotted separately. Lobster Valley separated because of high abundance's of *A. agaricities*, *Diploria labyrinthiformis*, *Porities porities* and *S. siderea* and low values for *A. palmata* and *Diploria strigosa*. Tarpon Reef had a high percentage of gorgonians (primarily the encrusting *Briarium* or *Erythropodium* form). The greatest abundance of *A. palmata* was found at Public Beach.

Coral Cover At Little Cayman Sites

Jackson Wall - K-dominance curves showed no significant difference between sites (Fig. 11). Based on MDS analysis for all categories (Fig. 12a), Cumbers Caves and Jackson Reef and Wall plotted together within the larger group of Bus Stop, Sarah's Set, Eagle Ray Roundup and Jackson Wall Deep. The Outer Meadows site was significantly different due to high *Montastrea cavernosa* and gorgonian abundances, and low *A. agaricities* and *M. annularis* cover. The only South-facing reef site surveyed on Little Cayman plotted separately because of high values for *D. strigosa*, *Leptoseris cuculata* and gorgonians, and the highest percent live-animal cover (=47.71%) seen around Little Cayman Island. The MDS graph of live-animal cover (Fig. 12b) shows a similar pattern, with the exception of a slight separation of Sarah's Set and perhaps Outer Meadows (relatively high *A. agaricities* and relatively low *M. annularis*) from the main group.

Bloody Bay - K-dominance curves showed similarities between The Great Wall and Mixing Bowl (Fig. 13). The Chimney had higher diversity than the other sites. Mixing Bowl Deep was the least diverse (i.e., it had the highest species dominance), Sponge and *Agaricia* spp. were abundant, typical of deeper reef sites. An MDS plot for all categories (Fig. 14a) shows The Chimney as being unique. It had high values for *S. siderea*, *P. porities*, *M. annularis* and gorgonians, and it was the only site to include *Favia fragum*. In the MDS plot based on live-cover only (Fig. 14b), The Great Wall and Mixing Bowl Deep are similar. The Mixing Bowl terrace had relatively high

DIVE SITES	PLOT	DIMENSION	
		1	2
ANGEL REEF	AN	0.44	0.13
ELK FOREST	EF	0.33	0.01
HEDE'S REEF	HR	-0.85	0.18
PUBLIC BEACH	PB	-1.43	0.08
SERGEANT MAJOR	SM	0.59	0.05
TARPON/LIGHTHOUSE	TL	0.19	0.02
TARPON	T	1.94	-0.03
LOBSTER VALLEY	LV	-1.27	-0.20
LIGHT HOUSE	LH	0.06	-0.24



DIVE SITES	PLOT	DIMENSION	
		1	2
ANGEL REEF	AN	-0.33	0.08
ELK FOREST	EF	0.48	0.23
HEDE'S REEF	HR	-1.76	-0.56
PUBLIC BEACH	PB	-0.71	0.84
SERGEANT MAJOR	SM	-0.07	0.57
TARPON/LIGHTHOUSE	TL	0.08	0.00
TARPON	T	0.58	-1.15
LOBSTER VALLEY	LV	1.31	0.25
LIGHTHOUSE	LH	0.41	-0.25

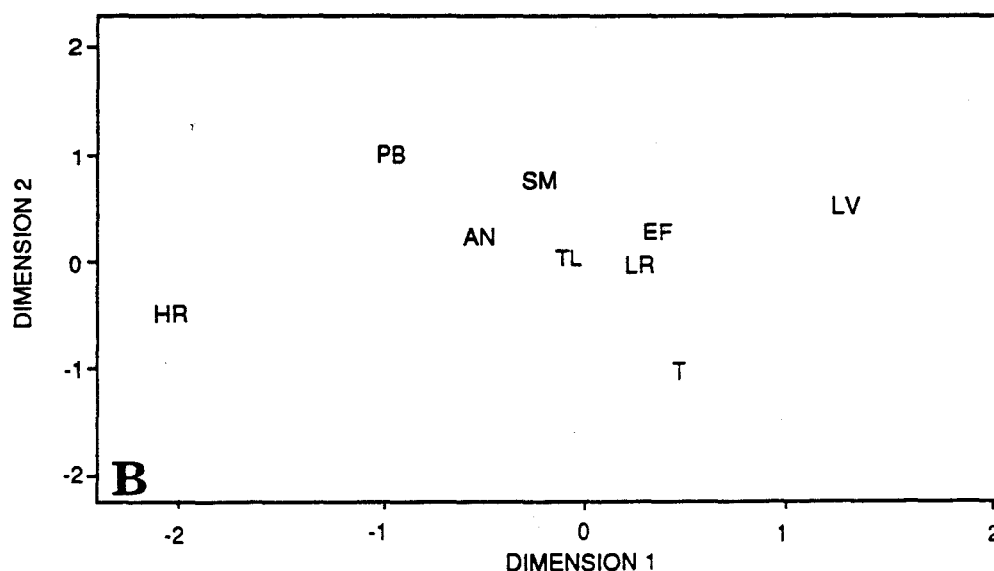
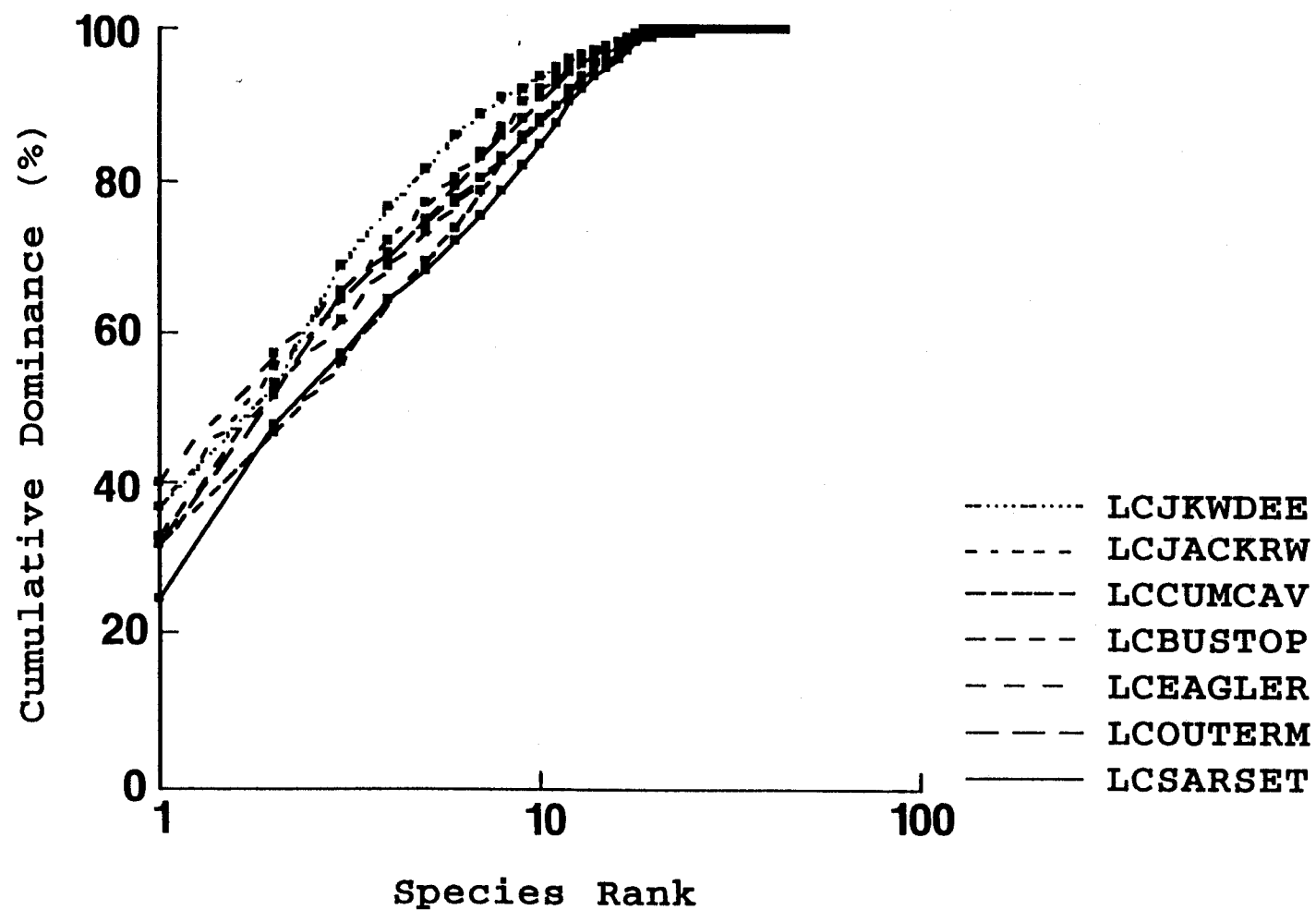
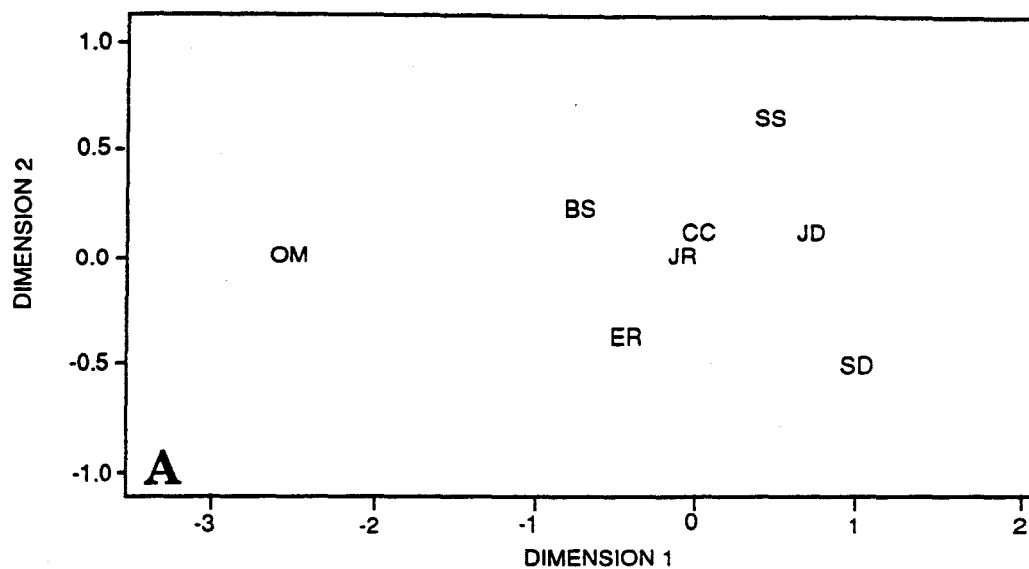


Fig. 10. MDS plots for data from Cayman Brac Southside Shallow dive sites. A. Plot based on all data. B. Plot based on live-animal cover alone.

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DIVE SITES	PLOT	DIMENSION	
		1	2
LC BUS STOP	BS	-0.47	0.18
LC CUMBERS CAVES	CC	0.18	0.10
LC JACKSON REEF/WALL	JR	0.18	0.10
LC JACKSON WALL DEEP	JD	0.82	0.03
LC SARAH SET	SS	0.61	0.58
LC SOUTHSIDE	SD	1.07	-0.52
LC OUTER MEADOWS	OM	-2.15	-0.06
LC EAGLE RAY ROUNDUP	ER	-0.23	-0.41



DIVE SITES	PLOT	DIMENSION	
		1	2
LC BUS STOP	BS	0.34	0.55
LC CUMBERS CAVES	CC	0.04	0.13
LC JACKSON REEF/WALL	JR	-0.10	0.55
LC JACKSON WALL DEEP	JD	0.26	-0.29
LC SARAH SET	SS	1.21	0.43
LC SOUTHSIDE	SD	-1.71	-0.06
LC OUTER MEADOWS	OM	0.42	-1.46
LC EAGLE RAY ROUNDUP	ER	-0.46	0.15

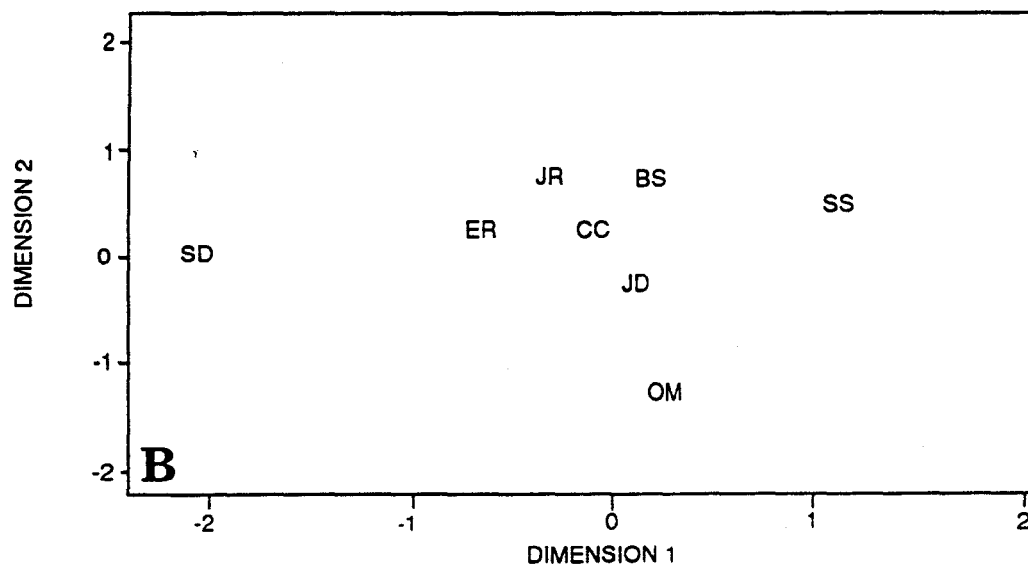
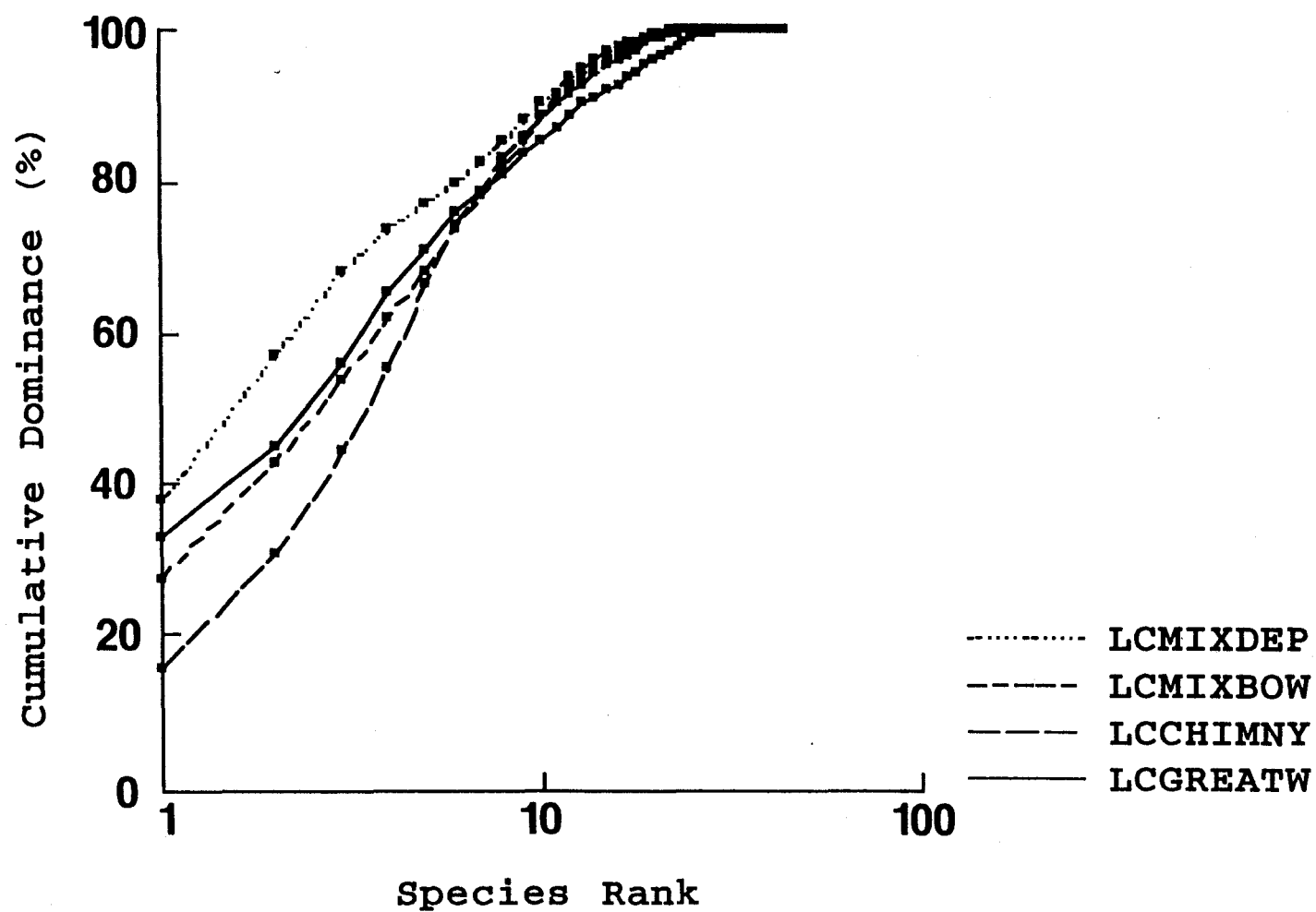
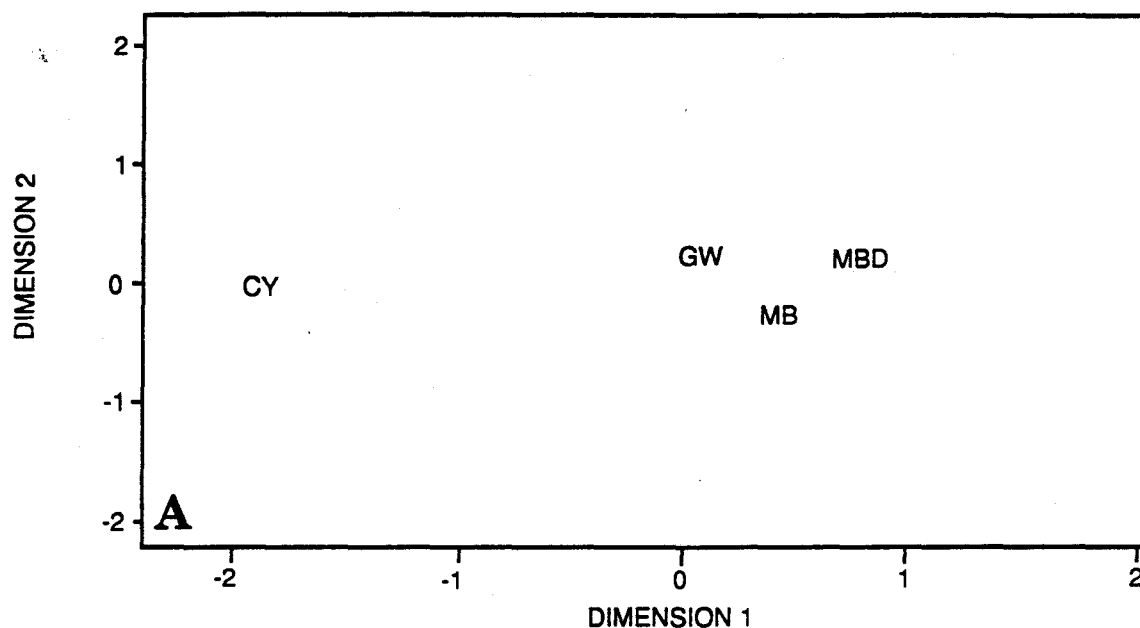


Fig. 12. MDS plots of Little Cayman Jackson Bight dive sites. A. Plot based on all data. B. Plot based on live-animal cover only.

Fig. 13. Little Cayman, Bloody Bay



DIVE SITES	PLOT	DIMENSION	
		1	2
LC CHIMNEY	CY	-1.61	0.00
LC THE GREAT WALL	GW	0.17	0.20
LC MIXING BOWL	MB	0.54	-0.42
LC MIXING BOWL DEEP	MBD	0.90	0.21



DIVE SITES	PLOT	DIMENSION	
		1	2
LC CHIMNEY	CY	0.87	0.75
LC THE GREAT WALL	GW	-0.80	0.32
LC MIXING BOWL	MB	0.74	-0.81
LC MIXING BOWL DEEP	MBD	-0.82	-0.25

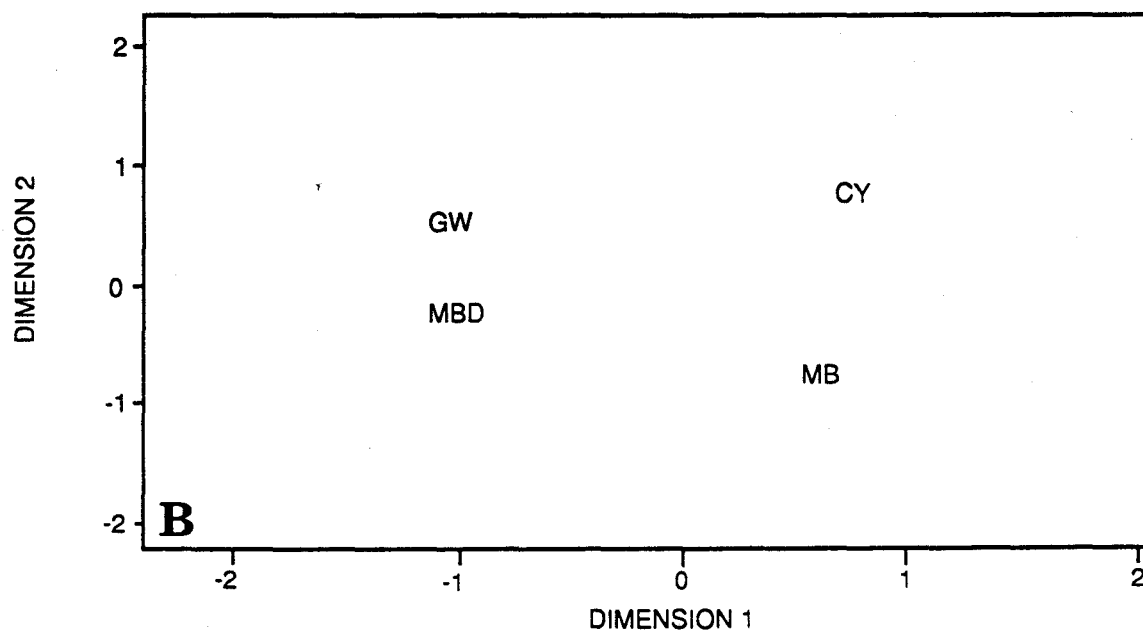


Fig. 14. MDS plots of Little Cayman Bloody Bay dive sites. A. Plot based on all data. B. Plot based on live-animal cover only.

values of *D. strigosa*, *Madracis decatis*, *Meandrina meandites* and *M. cavernosa*. The Chimney charted separately for reasons listed earlier.

Frequency Of Divers At Cayman Brac Dive Sites

Snapper Reef, a Northside shallow site, is the most frequently-dived of all the Brac dive sites (see Table 3) receiving 8.73% of the divers. The eleven most-frequented sites are all located on the Northside, and this represent 66.2% of the total. For Southside locations, Rock Monster Chimney is the most heavily dived (=3.77%).

The dive sites are chosen by the individual boat captains and are based on weather conditions, sea state, currents and degree of visibility. The north side of the island is the most often the lee-side (personal observation), therefore, it receives the majority of the divers (Fig. 15).

DISCUSSION

At the onset of this study, the intent was to look for groupings in the data that would reflect both natural and man-induced controls, and would allow us to compare the relative importance of both. For instance, it was expected that the North and South sides of Cayman Brac, Bloody Bay-Jackson Bight, and deep versus shallow sites might plot separately from each other. Natural process, such as wind and currents that often govern reef formation, can result in specific reef types unique to each control. Windward locations form highly developed "spur and groove" reefs while reefs from leeward areas are often "patches". Although these gross morphological (shape) characteristics are not revealed in the data (the focus was more on reef cover than on reef morphology), these patterns are clearly visible around Cayman Brac and Little Cayman (personal observation).

When evaluating the potential impact of divers, we looked for separation of control sites (non-dived locations) from all others, as well as a pattern that followed trends in diver frequency from site to site. Figure 16 is an MDS diagram for all sites, examined on Cayman Brac.

This plot shows Burt Brothers Boulders distinctly separated from other dive locations. It is unique in its geographic location (see Fig. 1), and its close proximity to the bluff affords some protection from the seas and swell, from the southeast. Being generally upcurrent of Spot Bay (water generally flows from east to west), it is removed from many of the potential effects of that community. Its consistent position in the MDS plot is, therefore considered to reflect natural governing forces. This is also consistent with the fact that it is infrequently dived.

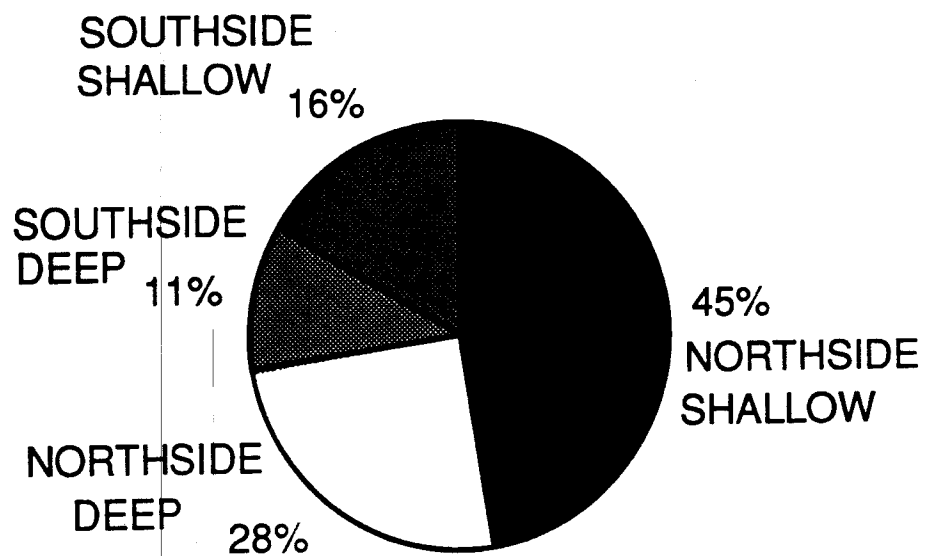


Figure 15. Percent diver frequency in Cayman Brac

DIVE SITES	DIMENSION	
	1	2
1. AIRPORT REEF	0.23	-0.11
2. ANCHOR WALL	0.97	-0.08
3. ANGEL REEF	-0.60	0.17
4. AIRPORT REEF BOTTOM	-2.54	0.26
5. BURT BROTHERS BOULDERS	0.14	-2.06
6. CEMETARY WALL	0.52	0.62
7. CEMETARY WALL TERRACE	0.61	0.26
8. CHARLIES	0.66	0.00
9. EAST CHUTE	0.04	-0.48
10. EDEN WALL	0.94	-0.18
11. ELKHORN FOREST	-0.51	0.08
12. GARDEN EEL	-0.19	0.26
13. GREEN HOUSE	1.01	0.17
14. GRUNT VALLEY	-1.35	0.46
15. HEDES REEF	0.60	-0.16
16. JEFF REEF	0.30	0.12
17. MIDDLE CHUTE	0.69	0.19
18. PUBLIC BEACH	1.04	0.30
19. ROCK MONSTER CHIMNEY	-0.43	-0.33
20. SNAPPER	-1.34	0.08
21. SERGEANT MAJOR	-0.70	0.04
22. TARPON/LIGHTHOUSE	-0.33	0.09
23. TARPON	-1.68	-0.66
24. WILDERNESS	0.64	0.35
25. AIRPORT WALL	0.80	0.25
26. BUCCANEER	-0.64	0.41
27. KENS MOUNT	0.30	-0.88
28. LOBSTER VALLEY	0.95	0.19
29. LIGHT HOUSE	-0.20	-0.13
30. PATCH REEF	-1.37	0.30
31. RADAR REEF	0.34	0.24
32. WEST CHUTE	0.75	0.16
33. TIARA TUNNELS	0.37	0.09

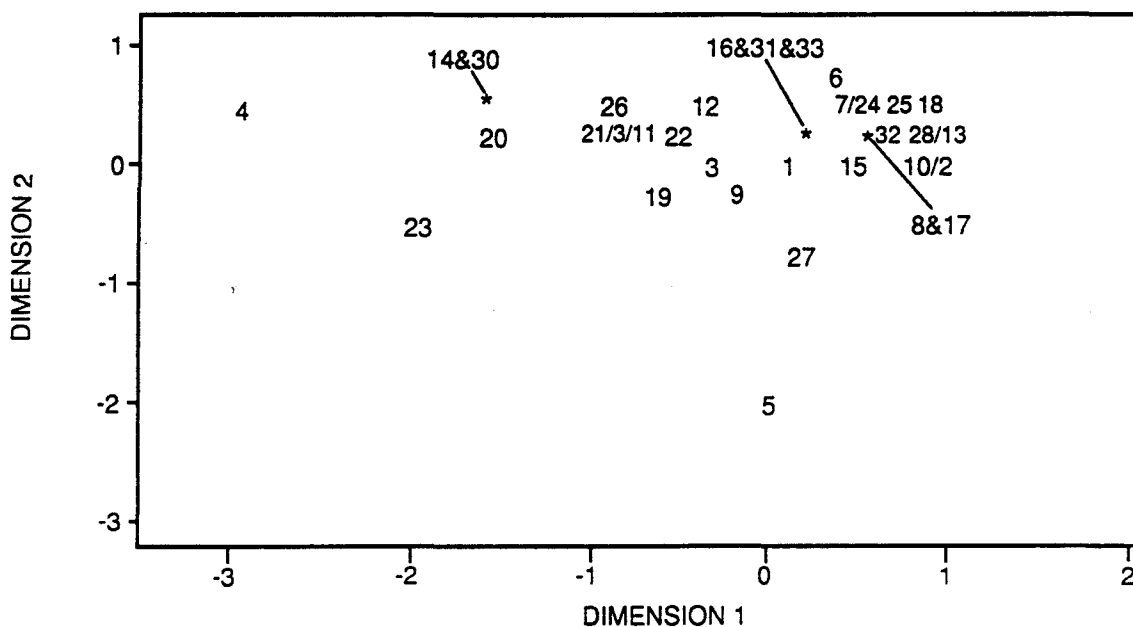


Fig. 16. MDS plot comparing all Cayman Brac dive sites. Asterisks on the plot refer to coordinates that plot more than one site in the same space.

The Airport Reef (pavement) site, at the very west end, also plots separately, but this is an artifact of the data-collection methods. The site was evaluated twice, once along the reef and once in the intervening pavement. The pavement plots separately, but the reef area falls into the main group. Snapper Reef, Grunt Valley, Tarpon Reef and Patch Reef also plotted outside the main cluster of reefs shown in Figure 16. All but one (Tarpon Reef) are among the most heavily-dived reefs (see Table 3). This constitutes the strongest evidence for diver pressure on Brac reefs. In contrast, however, 5 of the 7 remaining sites that were visited by more than 4% of the divers (see Table 3) fall into the portion of the main cluster farthest removed from the isolated sites. Therefore the evidence for diver impact is not compelling.

The remaining sites fall into one large cluster that does not reflect either location or dive frequency. The main cluster (Fig. 16) may actually be two small subgroups; but again, there is no apparent correlation between the locations of these sites, their structure or the frequency with which they are visited. Both "control" sites are located within the larger cluster. The dived sites cannot be distinguished from the undived ones, therefore, we can find no statistical evidence to support a strong impact by dive pressure at this point. Differences in the composition more likely reflect the natural variability of the system. This high diversity among the majority of sites attests to the "healthy" state of these reefs, the main draw for sport divers.

RECOMMENDATIONS

Considering the large number of dives (app. 2500 per month) conducted on a relatively small number of reefs, the potential for serious impact by SCUBA divers would seem high. The data from this study infer, however, that the impact caused by divers is not a significant controlling force and that the composition of the reefs are determined by other controls. This information is a validation for those involved in the usage of the reefs as a natural resource. The present activities, including mooring systems, and environmental awareness programs seem to be having the desired effect with respect to resource management, and these should be continued.

It needs to be understood, however, that the marine community is a complex system that does have limitations. Factors impacting this system may be absorbed for a long time with no apparent effect until some sort of threshold is crossed and a dramatic change suddenly occurs. Although the conclusions made here stress low diver impact, there is no way of knowing through this study alone, how close the

reef community might be to that threshold. Once a drastic change has occurred, it is often too late to consider "rapid response" remedial action since the time for "recovery" can be very long. Therefore, it is important to utilize available methods to monitor the "health" of the resource over time and to integrate the results of this monitoring program into a management plan that has the flexibility to respond to the ever-changing natural system as it responds to various external pressures.

The recommendations made below are a result of both personal observation and quantitative analysis. These remarks are valid for conditions existing at this point in time. The fact that no dive pressure was observed should not be used to justify major increases in island development and/or diver visitation. The potential impact from the infrastructure necessary to support a large increase of divers, combined with greater diver traffic itself, may be more than the marine system can tolerate without adverse change. These effects are, unfortunately, beyond the predictive scope of this study, and caution is recommended for those tempted to extrapolate beyond the simple interpretation that dive pressure does not seem to have an adverse impact up to this point.

To ensure the proper utilization of the natural resources surrounding these islands the following steps should be considered:

- 1) Continue with the efforts already at hand. If there is an expansion of dive operations, then there needs to be an expansion in the number of moored dive sites. Briefings that stress the fragile aspect of this system and encourage education as a form of conservation are beneficial. Sport divers can have a neutral and, perhaps, even positive impact on the marine community.

- 2) Collect diver-frequency and impact information. This project initiated the Diver Impact Data System which allows for the storage of diver-visitation data for all sites on both islands. This information is valuable and needs to be completed by each dive operation. It should be compiled annually, and data summaries should be provided for the participants. Where possible, data on the number and severity of direct diver contacts should be tabulated in these manuals. Although this information is difficult to collect, it will provide a quantitative measure of diver impact that can be invaluable in future planning efforts.

- 3) Establish a monitoring program. This study served to create a baseline for reef composition. It provides a starting point from which

subsequent studies can be compared. These monitoring programs can take place on a bi-annual or annual basis, and allow for a "time lapse" analysis of reef health. The techniques used need to be comparable in their methodology and number of measurements taken (These programs are most effective when the same methods are used by the same researcher in the same area). The costs can be directly offset through the promotion of eco-tourism programs and specialty courses with guided dives.

Tropical islands with tourism-dependent economies are beginning to realize the importance of proper resource management. Natural resources are limited in their ability to support development and direct interaction. This study is an informative first step in a program aimed at understanding the effects of sport divers on the coral reefs of Cayman Brac and Little Cayman. Through their sponsorship and support of this research, the Sister Island Tourism Association, the Government and the people of Cayman Brac and Little Cayman have shown their commitment towards protecting their investment in the Sea as a natural resource.

ACKNOWLEDGMENTS

This project was made possible through the support of the Sister Island Tourism Association- formerly, the Cayman Brac and Little Cayman Hotel and Tourism Association, with Chris Mc Laughlin and Alan Mallory as Presidents; and the Government Officers, Mr. Oswell Rankin and Mr. Audley Scott. I'd like to thank the dive staff of Dive Tiara, Brac Aquatics Ltd., and The Little Cayman Diver II for their assistance and support. Also, many thanks go to the staff and management of Divi's Tiara Beach Hotel, The Brac Reef Beach Resort, and Pirates Point Resort.

This study was made possible through the support and consideration of a large number of individuals. Specifically, I'd like to thank Dr. Karla Parsons-Hubbard (and her "little red pen") for her guidance and incredible patience. She, along with her husband, Dr. Dennis Hubbard, both of the nearly legendary "Cotton Valley Animal Shelter and Home for Frustrated Geoscientist", gave endlessly of their time, equipment, and knowledge, for which I am very grateful. Dr. Betsy Gladfelter also provided assistance during the project design and data analysis.

I was aided in the field by Keith Prescott and Harriett Fowles; in data management by Bruce Olson, Dee Mc Kenzie, Len Layman, Rozalia Muhlhan, and my mother and father, Gerry and Ken Miller; and in photography by Donna Mc Laughlin and Aileen Kane of Photo Tiara. My thanks to Colin Pearson for the lending of his wet suit and to Cornell Burke, for the use of his boat. Finally, I'd also like to thank Mr. Ed Beaty of Brac Photographics Ltd. for sharing his office, computer, video equipment, car, home, and rum; and his support and friendship.

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Appendix I: Tabulated data on bottom cover for all sites.

PERCENT COVER

APPENDIX Ia. CAYMAN BRAC NORTHSIDE DEEP

	Cemetery Wall	Cemetery Wall (terrace)	East Chute	Garden Eel Wall	Middle Chute	West Chute	Airport Wall
Mean Of Percent Live Cover (Animals):	29.76	29.80	42.05	30.96	31.66	34.13	31.28
Percent Hard Corals:	65.31	76.76	77.05	81.27	79.12	84.32	86.13
Percent Soft Corals:	3.07	6.84	10.23	0.16	8.72	6.59	3.96
Percent Sponges:	30.49	15.35	12.37	16.96	11.69	8.86	9.43
Percent Tunicates:	1.13	1.05	0.36	1.61	0.47	0.22	0.48
Percent Zoanthids:	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean Of Percent Plant /Non Living:	70.24	70.20	57.95	69.04	68.34	65.88	68.73
Percent Algae:	87.33	88.96	77.31	73.85	90.93	92.56	93.82
Percent Of sand/Rubble:	12.67	11.04	22.69	26.15	9.07	7.44	6.18
Description Of Each Category							
PERCENT HARD CORAL:	19.44	22.88	32.40	25.16	25.05	28.78	26.94
PERCENT SOFT CORAL:	0.91	2.04	4.30	0.05	2.76	2.25	1.24
PERCENT SPONGE:	9.08	4.58	5.20	5.25	3.70	3.03	2.95
PERCENT TUNICATE:	0.34	0.31	0.15	0.50	0.15	0.08	0.15
PERCENT ZOANTHID:	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERCENT ALGAE:	61.34	62.45	44.80	50.99	62.14	60.98	64.48
PERCENT SAND/RUBBLE:	8.90	7.75	13.15	18.05	6.20	4.90	4.25
Total percent:	100.00	100.00	100.00	100.00	100.00	100.00	100.00

CAYMAN BRAC NORTHSIDE SHALLOW

	Airport Reef	Airport Reef (pavement)	Burt Brothers Boulders	Charlies Reef	Buccaneer's Reef	Patch Reef	Radar Reef	Greenhouse Reef	Grunt Valley	Jeff's Reef	Snapper Reef
Mean of percent live cover (Animals):	38.13	23.71	53.43	32.59	26.38	24.71	33.88	31.44	17.74	31.24	33.15
Percent Hard Corals:	73.51	63.21	91.98	82.89	76.78	85.53	89.97	95.75	79.42	90.28	83.22
Percent Soft Corals:	17.70	24.46	1.60	11.20	8.53	6.27	4.23	3.30	3.95	5.84	3.54
Percent Sponges:	4.20	8.96	0.27	4.53	9.48	7.08	4.72	0.24	14.94	2.60	10.33
Percent Tunicates:	3.93	0.00	5.75	0.92	4.93	0.91	1.08	0.72	1.69	0.80	2.45
Percent Zoanthids:	0.66	3.37	0.40	0.46	0.28	0.20	0.00	0.00	0.00	0.48	0.45
Mean of percent plant/non living:	61.88	76.29	46.57	67.41	73.63	75.29	66.12	68.56	82.26	68.76	66.85
Percent algae:	81.09	42.78	76.69	89.99	67.47	57.03	83.26	97.30	57.51	82.11	57.29
Percent of sand/Rubble:	18.91	57.22	23.31	10.01	32.53	42.97	16.74	2.70	42.49	17.89	42.71
DESCRIPTION OF EACH CATEGORY											
PERCENT HARD CORAL:	28.03	14.99	49.14	27.01	20.25	21.14	30.48	30.10	14.09	28.20	27.59
PERCENT SOFT CORAL:	6.75	5.80	0.86	3.65	2.25	1.55	1.43	1.04	0.70	1.83	1.18
PERCENT SPONGE:	1.60	2.13	0.14	1.48	2.50	1.75	1.60	0.08	2.65	0.81	3.43
PERCENT TUNICATE:	1.50	0.00	3.07	0.30	1.30	0.23	0.37	0.23	0.30	0.25	0.81
PERCENT ZOANTHID:	0.25	0.80	0.21	0.15	0.08	0.05	0.00	0.00	0.00	0.15	0.15
PERCENT ALGAE:	50.18	32.64	35.71	60.66	49.68	42.94	55.05	66.71	47.31	56.46	38.30
PERCENT SAND/RUBBLE:	11.70	43.65	10.86	6.75	23.95	32.35	11.07	1.85	34.95	12.30	28.55
Total Percent:	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

PERCENT COVER

APPENDIX 1b. CAYMAN BRAC SOUTHSIDE DEEP

DESCRIPTION OF EACH CATEGORY

CAYMAN BRAC SOUTHSIDE SHALLOW

DESCRIPTION OF EACH CATEGORY

[illegible]

PERCENT COVER

APPENDIX 1c. LITTLE CAYMAN JACKSON BIGHT

	Outer Meadows	Eagle Ray Roundup	Bus Stop	Cumbers Caves	Jackson Reef and Wall	Jackson Wall (deep)	Sarah's Set	Southside site Unknown
Mean Of Percent Live Cover (Animals):	32.07	39.14	30.65	37.35	34.25	44.58	32.28	47.71
Percent Hard Corals:	89.81	92.81	86.54	88.22	88.47	78.63	87.92	91.32
Percent Soft Corals:	4.57	3.48	2.53	1.87	3.21	0.71	1.86	5.39
Percent Sponges:	5.20	2.49	8.81	8.37	8.03	15.94	6.82	2.40
Percent Tunicates:	0.42	1.21	2.12	1.54	0.29	4.49	3.41	0.90
Percent Zoanthids:	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.00
Mean Of Percent Plant/Non Living:	67.93	60.86	69.35	62.65	65.75	55.42	67.73	52.29
Percent Algae:	61.63	78.89	77.79	87.39	85.93	96.49	95.87	96.72
Percent Of sand/Rubble:	38.37	21.11	22.21	12.61	14.07	3.51	4.13	3.28

DESCRIPTION OF EACH CATEGORY

PERCENT HARD CORAL:	28.80	36.33	26.53	32.95	30.30	35.05	28.38	43.57
PERCENT SOFT CORAL:	1.47	1.36	0.78	0.70	1.10	0.32	0.60	2.57
PERCENT SPONGE:	1.67	0.98	2.70	3.13	2.75	7.11	2.20	1.14
PERCENT TUNICATE:	0.13	0.48	0.65	0.58	0.10	2.00	1.10	0.43
PERCENT ZOANTHID:	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00
PERCENT ALGAE:	41.87	48.01	53.95	54.75	56.50	53.47	64.93	50.57
PERCENT SAND/RUBBLE:	26.07	12.85	15.40	7.90	9.25	1.95	2.80	1.71
Total Percent:	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

LITTLE CAYMAN BLOODY BAY

	Chimney	The Great Wall	Mixing Bowl	Mix Bowl (deep)
Mean Of Percent Live Cover (Animals):	30.09	28.53	38.96	28.06
Percent Hard Corals:	72.33	61.17	79.57	57.91
Percent Soft Corals:	11.30	4.91	4.28	3.21
Percent Sponges:	15.12	33.13	15.83	37.77
Percent Tunicates:	1.25	0.79	0.32	1.11
Percent Zoanthids:	0.00	0.00	0.00	0.00
Mean Of Percent Plant/Non Living:	69.91	71.48	61.04	71.94
Percent Algae:	72.39	90.91	93.99	98.12
Percent Of Sand/Rubble:	27.61	9.09	6.01	1.88

DESCRIPTION OF EACH CATEGORY

PERCENT HARD CORAL:	21.76	17.45	31.00	16.25
PERCENT SOFT CORAL:	3.40	1.40	1.67	0.90
PERCENT SPONGE:	4.55	9.45	6.17	10.60
PERCENT TUNICATE:	0.38	0.23	0.13	0.31
PERCENT ZOANTHID:	0.00	0.00	0.00	0.00
PERCENT ALGAE:	50.61	64.98	57.38	70.59
PERCENT SAND/RUBBLE:	19.30	6.50	3.67	1.35
Total Percent:	100.00	100.00	100.00	100.00

Appendix II: Means and standard deviations for data presented in Appendix I.

Cayman Brac - Northside Deep

APPENDIX IIa. Table of Means and Standard Deviation

Taxa.	Cemetery Wall (deep)		Cemetery Wall (terrace)		East Chute		Garden Eel Wall		Middle Chute		Airport Wall		West Chute	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
A. cerv.			0.35	1.15	0.05	0.22			0.05	0.22	0.08	0.24	0.13	0.44
A. palm.														
A. pro.														
Ag. ag.	3.95	2.48	5.35	2.74	3.15	3.79	4.00	2.57	3.55	2.60	4.00	1.76	4.60	2.06
Ag. graham.	2.70	4.80	0.05	0.22	0.05	0.22	0.45	1.56	0.60	1.77	0.35	0.69	0.40	0.92
Col. nata	0.65	2.10	1.85	5.32	2.70	7.94	0.65	2.83	1.40	3.31	1.10	2.70	0.80	2.58
Dendro.														
Dicho.	0.03	0.11	0.05	0.22	0.45	1.12	0.35	0.91	0.25	0.89	0.94	1.20	0.43	0.79
Dip. cliv.			0.75	3.27	1.65	4.94					1.01	3.30	0.30	1.10
Dip. lab.			0.20	0.51	1.00	2.14	0.20	0.87	0.30	1.10	1.20	3.11	0.65	1.62
Dip. strig.									0.75	2.19	0.20	0.87	0.25	1.09
Eus. fast.	0.48	1.15	0.39	0.71	0.30	0.46	0.18	0.36	0.71	1.29	0.10	0.18	0.18	0.32
Favia							1.60	1.66						
Gorg.	0.91	2.22	2.04	3.22	4.30	4.14	0.05	0.22	2.76	3.95	1.24	0.89	2.25	0.89
Iso. rig.					0.05	0.22			0.23	0.68	0.18	0.36	0.03	0.11
Iso. sino.														
Lepto.	0.06	0.22	0.06	0.22	0.05	0.22			0.20	0.37	0.05	0.15	0.44	0.91
Mad. dec.	0.11	0.26	0.20	0.48	0.40	0.66	0.66	0.64	0.29	0.36	0.45	0.62	0.46	0.62
Mad. form.	0.40	1.53	0.05	0.22	0.05	0.22			0.25	0.54				
Mad. mir.	0.11	0.44	0.70	2.16			0.90	3.27	0.03	0.11			0.28	0.68
Manicinia							0.18	0.48						
Mean. mean.	0.25	1.09	0.10	0.44	0.15	0.36	0.05	0.22	0.15	0.65	0.20	0.68	0.38	0.72
Mil. alc.	0.18	0.33	0.28	0.39	0.75	0.70	0.55	0.50	0.70	0.50	0.71	0.65	0.64	0.51
Mil. comp.														
M. ann.	2.80	3.75	6.23	5.60	14.50	17.33	6.80	5.75	7.95	6.04	6.70	5.51	8.95	7.19
M. cav.	1.95	4.39	1.60	3.60	1.80	5.03	3.05	7.83	1.05	2.62	3.61	2.87	1.44	1.94
Mussa			0.05	0.22									0.05	0.22
Mycet. aliciae	0.48	0.97	0.05	0.22	0.30	0.95	0.30	0.95	0.40	0.86			0.10	0.30
Mycet. dan.	0.18	0.48	0.26	0.62	0.05	0.22	0.25	0.70	0.35	0.57	0.33	0.45	0.40	0.56
Mycet. ferox					0.50	1.77			0.10	0.44	0.30	1.31	0.55	1.20
Mycet. lam	0.10	0.44	0.18	0.36	0.25	0.43	0.30	0.46	0.30	0.62	0.06	0.16	0.41	0.64
Mycet. reesi	0.65	2.01												
P. ast.	0.56	0.73	0.66	0.56	0.55	0.86	0.90	0.77	1.25	1.36	1.36	1.70	1.46	1.67
P. div.	0.45	0.86	1.50	1.59			0.85	1.15	1.08	1.03	0.63	1.22	0.14	0.20
P. fur.														
P. por.	0.26	1.09	0.10	0.30	2.00	3.49	0.20	0.40	0.59	1.15	1.05	1.80	0.80	1.36
Scolyo.	0.15	0.30	0.06	0.22	0.10	0.30			0.14	0.31	0.04	0.09	0.03	0.08
Sid. rad.											0.04	0.12		
Sid. sid.	2.18	4.22	0.73	2.38	1.10	2.26	1.90	5.48	1.50	2.11	2.13	2.07	2.25	4.00
Sponge	9.08	6.99	4.58	3.07	5.20	9.94	5.25	8.80	3.70	3.45	2.95	2.71	3.03	3.66
Steph.	0.78	1.44	1.09	2.36	0.40	0.73	0.85	2.08	0.90	1.47	0.14	0.31	2.26	3.14
Tunicate	0.34	0.71	0.31	0.55	0.15	0.36	0.50	0.74	0.15	0.32	0.15	0.32	0.08	0.16
Zoo														
Algae	61.34	16.85	62.45	10.31	44.80	21.38	50.99	22.75	62.14	9.45	64.48	11.29	60.98	9.96
S/R	8.90	10.01	7.75	7.68	13.15	12.70	18.05	20.82	6.20	8.02	4.25	4.45	4.90	4.13

Cayman Brac - Northside Shallow, Part 1

APPENDIX IIb. Table of Mean and Standard Deviation

Taxa	Airport Reef		Airport Reef (pavement)		Burt Brothers Boulders		Charlies Reef		Greenhouse Reef	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Acropora cervicornis	0.20	0.60			3.00	6.91			0.30	0.90
Acropora palmata									0.05	0.22
Acropora prolifera										
Agaricia agaricites	2.95	2.01	1.68	1.57	2.86	1.60	4.10	2.90	6.30	2.92
Agaricia grahamae	0.40	1.32					0.10	0.30		
Colpophyllia natans	0.75	2.26	0.15	0.65	3.86	11.64	0.36	1.52	0.30	0.90
Dendrogyra cylindrus										
Dichocoenia stokesi	0.05	0.22	0.55	0.86			0.03	0.11		
Diploria clivosa	1.20	4.40	0.28	0.89			0.03	0.11	0.25	1.09
Diploria labyrinthiformis	0.48	1.24	2.80	4.38	0.50	1.35	0.36	0.65	0.70	1.68
Diploria strigosa	0.25	1.09	0.90	1.64	0.43	1.55	0.20	0.51	0.60	2.62
Eusmilia fastigiata	0.51	0.80	0.10	0.30	0.21	0.56	0.29	0.43	0.26	0.34
Favia fragum	0.06	0.22	0.34	0.44	0.07	0.26	0.24	0.60	0.15	0.25
Gorgonian	6.75	6.35	5.80	6.49	0.86	1.25	3.65	2.54	1.04	0.81
Isophyllastrea rigida	0.25	0.54	0.01	0.05			0.10	0.30		
Isophyllia sinuosa			0.10	0.30						
Leptoseris cucullata	0.25	0.70			0.07	0.26			0.09	0.18
Madracis decactis	0.45	0.74					0.09	0.24	0.04	0.12
Madracis formosa										
Madracis mirabilis	0.35	1.31					0.01	0.05	0.51	0.85
Manicinia areolata							0.30	0.62	0.20	0.37
Meandrina meandrites	0.05	0.22			0.07	0.26				
Millepora alcicornis	1.14	1.01	0.63	0.57	0.21	0.41	0.68	0.78	0.58	0.55
Millepora complanata	0.18	0.36			0.64	0.72	0.20	0.51		
Montastrea annularis	8.90	19.21	2.25	6.06	31.50	22.93	12.30	19.76	8.25	7.33
Montastrea cavernosa	5.50	8.70	1.48	5.44	1.14	3.18	2.80	6.82	0.55	1.28
Mussa angulosa										
Mycetophyllia aliciae										
Mycetophyllia danaana	0.30	0.78	0.05	0.22	0.21	0.41	0.15	0.48	0.20	0.40
Mycetophyllia ferox	0.55	1.24			0.29	0.80	0.05	0.22	0.20	0.87
Mycetophyllia lamarckiana	0.25	0.40	0.10	0.44	0.21	0.41	0.10	0.30	0.05	0.15
Mycetophyllia reesi										
Porites asteroides	0.33	0.55	0.88	0.95	0.86	0.91	1.00	1.05	2.55	2.51
Porites divaricata							0.28	0.70	0.35	0.65
Porites furcata	0.15	0.65							1.00	1.41
Porites porites	0.90	1.45	0.35	1.11	2.57	3.96	1.58	4.45	5.65	4.27
Scolymia cubensis	0.16	0.31								
Siderastrea radians			0.41	0.55			0.01	0.05		
Siderastrea siderea	1.28	2.54	1.85	5.49	0.43	1.29	1.55	3.54	0.83	2.11
Sponge	1.60	2.33	2.13	2.45	0.14	0.35	1.48	1.58	0.08	0.24
Stephanocoenia michelinii	0.20	0.51	0.10	0.30			0.13	0.44	0.15	0.36
Tunicate	1.50	2.87			3.07	8.92	0.30	0.56	0.23	0.60
Zoanthid	0.25	0.54	0.80	2.62	0.21	0.41	0.15	0.48		
Algae	50.18	20.90	32.64	32.99	35.71	19.44	60.66	21.98	66.71	8.43
Sand / Rubble	11.70	14.43	43.65	35.16	10.86	17.78	6.75	13.59	1.85	1.77

Cayman Brac - Northside Shallow, Part 2

APPENDIX IIb. Table of Mean and Standard Deviation

	Grunt Valley		Jeff's Reef		Snapper Reef		Buccaneer's Reef		Patch Reef		Radar Reef	
Taxa	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Acropora cervicornis					0.70	2.30					0.17	0.35
Acropora palmata												
Acropora prolifera												
Agaricia agaricites	3.10	2.07	5.45	3.15	4.40	2.80	5.33	3.54	6.20	3.20	9.40	3.09
Agaricia grahamae					0.05	0.22						
Colpophyllia natans	0.10	0.44	0.86	2.57	1.50	4.77			0.15	0.48	1.40	3.61
Dendrogyra cylindrus												
Dichocoenia stokesi	0.10	0.30	0.10	0.30	0.03	0.11	0.45	0.97	0.05	0.22		
Diploria clivosa	0.25	0.70			0.05	0.22	0.05	0.22				
Diploria labyrinthiformis	0.55	1.32	0.45	1.53	1.56	3.47	0.60	0.72	1.30	2.97	0.87	1.89
Diploria strigosa	1.05	3.19			0.60	2.62	0.60	1.71	0.75	2.26		
Eusmilia fastigiata	0.14	0.31	0.45	0.47	0.39	0.56	0.38	0.34	0.61	0.48	0.43	0.30
Favia fragum	0.16	0.27	0.28	0.43	0.33	0.38	0.11	0.17	0.33	0.41	0.13	0.18
Gorgonian	0.70	0.70	1.83	1.78	1.18	1.69	2.25	1.13	1.55	1.74	1.43	1.00
Isophyllastrea rigida	0.15	0.48	0.05	0.22	0.10	0.30	0.25	0.40	0.05	0.22		
Isophyllia sinuosa	0.08	0.24	0.05	0.22	0.05	0.22	0.05	0.22	0.05	0.22		
Leptoseris cucullata			0.18	0.36			0.35	1.10			0.52	0.39
Madracis decactis	0.15	0.48	0.16	0.36	0.16	0.48	0.24	0.50	0.03	0.11	0.13	0.34
Madracis formosa	0.05	0.22										
Madracis mirabilis			0.10	0.44			0.05	0.22			0.45	1.25
Manicinia areolata	0.20	0.40	0.14	0.31	0.15	0.48	0.03	0.11	0.20	0.40	0.13	0.29
Meandrina meandrites	0.45	1.12			0.20	0.87	0.50	1.20			0.20	0.75
Millepora alcicornis	0.90	1.54	0.49	0.57	0.20	0.40	0.58	0.71	0.30	0.46	0.60	0.55
Millepora complanata	0.06	0.22	0.35	0.73	0.18	0.36	0.03	0.11			0.03	0.12
Montastrea annularis	2.10	4.48	9.00	11.14	7.25	16.10	2.80	2.01	4.65	4.27	8.27	4.82
Montastrea cavernosa	0.94	2.27	0.95	1.94	1.68	4.65	2.35	3.07	1.40	4.47	0.53	1.20
Mussa angulosa									0.05	0.22	0.13	0.50
Mycetophyllia aliciae												
Mycetophyllia danaana	0.15	0.48	0.25	0.43	0.16	0.36	0.05	0.22	0.23	0.40	0.43	0.48
Mycetophyllia ferox					0.05	0.22	0.03	0.11				
Mycetophyllia lamarckiana			0.18	0.36	0.05	0.22	0.08	0.24	0.05	0.22	0.13	0.50
Mycetophyllia reesi												
Porites asteroides	0.65	0.73	2.45	3.07	2.46	3.87	1.46	1.15	1.56	1.49	1.27	1.22
Porites divaricata	0.08	0.24	1.00	1.00	0.26	0.70	0.30	0.53			0.52	0.59
Porites furcata											0.43	0.87
Porites porites	0.73	2.19	2.80	2.18	2.00	5.55	0.76	0.86	1.30	1.90	1.93	2.35
Scolymia cubensis	0.06	0.22					0.25	0.49	0.01	0.05	0.03	0.08
Siderastrea radians	0.33	0.38			0.05	0.22	0.34	0.50	0.13	0.30		
Siderastrea siderea	1.31	1.89	2.30	3.35	2.73	3.60	2.03	2.76	1.50	2.27	2.10	2.24
Sponge	2.65	2.74	0.81	2.38	3.43	4.84	2.50	2.11	1.75	1.76	1.60	1.67
Stephanocoenia michelinii	0.26	0.51	0.18	0.36	0.13	0.44	0.24	0.68	0.25	1.09	0.23	0.54
Tunicate	0.30	0.43	0.25	0.54	0.81	1.11	1.30	1.49	0.23	0.40	0.37	0.59
Zoanthid			0.15	0.48	0.15	0.65	0.08	0.24	0.05	0.22		
Algae	47.31	17.35	56.46	14.15	38.30	20.30	49.68	12.87	42.94	8.98	55.05	6.80
Sand / Rubble	34.95	20.93	12.30	10.45	28.55	20.14	23.95	11.33	32.35	10.28	11.07	8.89

Cayman Brac - Southside Deep

APPENDIX IIc. Table of Mean and Standard Deviation

Cayman Brac - Southside Deep

APPENDIX IIc. Table of Mean and Standard Deviation

	Anchor Wall		Eden Wall		Roch Monster Chimney		Tiara Tunnels		Wilderness Wall		Ken's Mount	
Taxa.	mean	std. dev.	mean	std. dev.	mean	std. dev.	mean	std. dev.	mean	std. dev.	mean	std. dev.
A. cerv.	0.45	1.12	0.40	0.97	0.30	0.64	0.35	0.63	0.31	0.56	0.33	0.62
A. palm.									0.25	0.97		
A. pro.												
Ag. ag.	4.45	4.09	3.15	1.77	3.00	2.37	3.95	2.64	5.06	4.25	3.17	2.23
Ag. graham.	0.15	0.65	0.05	0.22					0.13	0.48	0.17	0.55
Col. nata	2.70	4.48	2.16	5.64	7.70	14.95	3.90	6.34	5.81	20.47	5.58	7.02
Dendro.												
Dicho.	0.30	0.39	0.31	0.55			0.35	0.71	0.06	0.24		
Dip. cliv.	0.80	1.40	1.25	2.23	0.40	1.20	0.20	0.68	0.06	0.24	0.25	0.43
Dip. lab.	0.05	0.22	1.18	2.68			0.13	0.31	0.94	2.30	0.75	2.20
Dip. strig.			0.73	2.41	0.10	0.30	1.15	3.24	1.69	3.14		
Eus. fast.	0.26	0.51	0.18	0.32	0.20	0.40	0.28	0.40	0.14	0.28	0.25	0.43
Favia									0.02	0.06		
Gorg.	0.98	0.81	0.64	0.59	1.80	1.33	1.29	0.76	0.95	1.17	2.00	0.82
Iso. rig.					0.10	0.30			0.13	0.33	0.08	0.28
Iso. sino.												
Lepto.	0.55	0.84	0.08	0.24			0.24	0.40	0.14	0.28	0.17	0.37
Mad. dec.	0.36	0.46	0.50	0.65			0.83	0.63	0.17	0.49	0.33	0.62
Mad. form.					0.40	0.66			0.13	0.33		
Mad. mir.			0.18	0.36	0.20	0.40	0.16	0.36	0.02	0.06		
Manicinia	0.01	0.05							0.09	0.20		
Mean. mean.	0.25	0.70	0.80	1.53			0.65	1.31	0.50	1.17		
Mil. alc.	0.51	0.49	0.69	0.56	0.80	0.60	0.53	0.43	0.36	0.40	0.83	0.55
Mil. comp.									0.06	0.24		
M. ann.	13.50	8.80	14.50	9.72	10.60	17.44	9.30	13.66	5.78	5.22	18.67	20.65
M. cav.	2.43	3.48	4.60	4.57	2.40	3.01	2.45	3.40	3.02	4.64	5.92	7.15
Mussa			0.20	0.51			0.30	0.95				
Mycet. aliciae	0.10	0.44	0.20	0.87	0.10	0.30	0.40	1.16				
Mycet. dan.	0.25	0.54	0.33	0.43	0.10	0.30	0.48	0.49	0.34	0.42	0.67	0.47
Mycet. ferox	0.30	0.78	0.35	0.96	0.10	0.30	0.18	0.36	0.06	0.24	0.42	0.95
Mycet. lam	0.28	0.62	0.18	0.36	0.30	0.46	0.33	0.45	0.27	0.43	0.17	0.37
Mycet. reesi												
P. ast.	2.55	1.80	0.39	0.77	1.10	1.58	2.71	1.96	0.56	0.68	0.42	0.64
P. div.	0.38	0.72	1.21	1.35	0.20	0.40	0.84	1.19	0.81	1.24	0.08	0.28
P. fur.												
P. por.	0.98	1.38	1.05	1.60	1.40	2.42	1.15	1.96	0.25	0.56	1.00	1.41
Scolyo.	0.13	0.17	0.09	0.12	0.10	0.30	0.10	0.15	0.06	0.11	0.08	0.28
Sid. rad.												
Sid. sid.	0.76	1.08	1.09	2.06	1.20	2.18	1.28	2.48	4.52	7.09	1.92	3.75
Sponge	0.98	1.23	0.59	0.95	2.50	3.29	1.24	2.02	0.23	0.53	0.42	1.11
Steph.	2.25	3.34	2.05	3.14	0.70	1.00	1.44	3.17	0.78	1.94	1.08	2.75
Tunicate	0.48	0.97			0.40	0.92	0.25	0.68	0.38	0.60	0.83	1.14
Zoo			0.05	0.22	0.10	0.30	0.05	0.22			0.17	0.37
Algae	61.09	10.78	58.16	10.96	44.50	17.79	59.99	15.70	58.67	17.69	44.08	16.20
S/R	1.75	1.51	2.70	2.12	19.10	20.42	3.55	2.48	7.19	8.56	10.17	6.19

Cayman Brac - Southside Shallow

APPENDIX II. Table of Mean and Standard Deviation

Taxa.	Angel Reef		Elkhor Forest		Hede's Reef		Public Beach		Sgt. Major Reef		Tarpon lighthouse		Tarpon Reef		Lighthouse Reef		Lobster Valley	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
A. cerv.	0.30	1.31									0.20	0.60	0.05	0.22	0.10	0.44	0.13	0.44
A. palm.	2.50	6.70	0.85	1.71	6.67	3.51	2.88	3.58	2.35	5.38	1.60	3.79	0.30	1.10	0.65	1.62	0.60	1.02
A. pro.									0.13	0.44								
Ag. ag.	2.20	1.96	3.60	2.29	1.25	0.92	1.80	1.17	1.75	0.94	2.55	1.80	2.45	2.77	1.75	0.99	3.70	1.98
Ag. graham.											0.05	0.22	0.10	0.44				
Col. nata	0.35	1.06	1.00	3.51	5.00	2.19	1.80	3.61	0.40	1.36	1.40	3.68	2.80	8.27	3.00	7.81	1.73	3.22
Dendro.													0.40	1.74				
Dicho.	0.15	0.36					0.05	0.22	0.05	0.22	0.05	0.22						
Dip. cliv.	0.71	1.79	0.85	2.19	0.08	0.22	1.75	2.28	2.40	4.55	0.60	2.20	1.95	5.70	0.30	1.10	0.65	1.35
Dip. lab.	1.45	4.60	0.23	0.68			0.80	2.29	0.03	0.11	0.80	3.26	1.50	6.54	0.15	0.65	1.88	3.14
Dip. strig.	1.65	2.92	0.90	2.55			2.45	3.31	2.20	3.75	0.90	2.30			0.70	2.19		
Eus. fast.	0.28	0.43	0.10	0.25			0.08	0.24	0.08	0.24	0.15	0.36	0.20	0.68	0.18	0.36	0.21	0.48
Favia	0.09	0.23	0.06	0.22	0.08	0.59	0.04	0.12	0.33	0.38	0.03	0.11	0.10	0.30			0.13	0.24
Gorg.	2.80	3.03	1.25	2.66	3.25	1.47	0.29	0.51	2.18	2.03	1.63	1.63	8.15	8.48	1.85	2.24	1.13	1.06
Iso. rig.	0.03	0.11							0.08	0.24	0.18	0.66	0.05	0.22			0.01	0.05
Iso. sino.			0.10	0.44			0.08	0.24					0.40	1.74	0.05	0.22		
Lepto.	0.19	0.47	0.20	0.28							0.08	0.24					0.13	0.27
Mad. dec.			0.05	0.22					0.05	0.22			0.05	0.22				
Mad. form.																		
Mad. mir.									0.05	0.22	0.01	0.05			0.30	0.95		
Manicinia	0.05	0.22	0.13	0.27			0.01	0.05	0.11	0.30	0.10	0.25	0.15	0.48	0.05	0.22	0.14	0.22
Mean. mean.																		
Mil. alc.	0.34	0.76					0.06	0.16	0.45	0.86	0.23	0.68	0.15	0.48	0.05	0.22	0.10	0.20
Mil. comp.	0.45	0.97	1.08	1.81	1.42	0.55	1.28	1.50	0.55	0.79	0.71	0.95	1.75	2.30	1.18	1.26	0.68	0.83
M. ann.	6.30	5.64	8.65	8.04	9.17	4.61	7.65	5.23	8.45	9.45	8.25	8.76	12.45	19.15	11.45	12.09	8.35	5.48
M. cav.	0.20	0.68	0.05	0.22			1.15	2.74	0.63	2.20	0.10	0.44			0.95	3.26	0.64	1.79
Mussa																		
Mycet. aliciae																	0.03	0.11
Mycet. dan.	0.28	0.54	0.79	1.24	0.17	0.32	0.05	0.22	0.33	0.53	0.45	0.67	0.35	0.48	0.16	0.36	0.53	0.86
Mycet. ferox	0.05	0.22			0.08	0.22					0.05	0.22						
Mycet. lam	0.05	0.22	0.25	0.40					0.05	0.22	0.18	0.48	0.10	0.30	0.06	0.22	0.33	0.51
Mycet. reesi																		
P. ast.	1.30	1.49	1.20	1.29	0.42	0.26	0.65	0.91	2.33	2.74	1.10	0.87	0.60	1.39	0.88	2.17	2.01	1.93
P. div.	0.56	2.18	0.10	0.44			0.20	0.51	0.05	0.22	0.03	0.11	0.10	0.30			0.05	0.15
P. fur.																		
P. por.	1.80	2.40	1.30	1.95	1.75	1.28	0.13	0.44	1.91	2.67	1.00	1.00	2.50	6.68	0.75	1.04	4.08	4.72
Scolyo.									0.05	0.22	0.01	0.05			0.10	0.30	0.03	0.08
Sid. rad.	0.05	0.22					0.13	0.30	0.30	1.10					0.05	0.22	0.06	0.16
Sid. sid.	2.55	5.78	0.25	0.77	2.42	1.37	1.50	2.82	1.33	3.37	1.90	3.13	1.05	4.35	2.65	6.96	3.43	6.26
Sponge	1.98	3.86	1.54	2.48	1.75	1.03	0.70	1.19	2.10	4.78	1.08	2.68	0.90	3.27	0.70	1.65	0.70	1.23
Steph.	0.05	0.22					0.06	0.22			0.10	0.30			0.15	0.36	0.04	0.12
Tunicate	1.45	2.20	1.70	1.87	0.33	0.28	0.05	0.22	0.66	1.45	1.80	2.36	0.65	1.19	3.56	5.36	0.65	1.11
Zoo	0.23	0.51	0.40	0.56	0.25	0.20	0.65	1.38	0.75	0.86	0.30	0.56	0.65	1.53	0.50	0.87	0.50	0.87
Algae	47.29	24.38	50.64	28.09	57.67	28.80	73.09	6.73	45.09	24.00	52.01	19.92	31.80	24.36	49.99	21.26	65.26	9.86
S/R	22.35	25.97	22.75	28.72	8.25	7.90	0.65	0.91	22.83	21.37	20.40	25.58	28.30	27.07	17.75	17.72	2.15	2.82

Little Cayman - Jackson Bight

APPENDIX IIe. Table of Mean and Standard Deviation

	Outer Meadows		Eagle Ray Roundup		Bus Stop		Cumber's Caves		Jackson Reef and Wall		Sarah's Set		Jackson Wall (deep)		Southside Site	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Acropora cervicornis	0.53	1.09	0.34	0.95	0.30	0.56	0.80	1.44	0.40	0.92			0.35	0.90	0.14	0.35
Acropora palmata																
Acropora prolifera																
Agaricia agaricites	4.27	2.62	6.55	4.53	6.15	3.40	5.55	2.29	6.50	3.99	7.37	5.38	8.00	3.29	5.57	2.72
Agaricia grahamae / lamarchi																
Colpophyllia natans			3.45	5.77	0.55	1.36	3.50	5.96	3.00	6.05	2.26	4.25	1.30	2.19	2.86	4.79
Dendrogyra cylindrus	0.80	2.51														
Dichocoenia stokesi			0.05	0.15	0.10	0.30	0.05	0.22			0.05	0.22	0.15	0.32	0.14	0.35
Diploria clivosa																
Diploria labyrinthiformis	0.87	2.06	0.79	1.36					0.65	1.96	0.58	2.46				
Diploria strigosa	0.13	0.50	0.30	0.95					0.30	1.31	0.89	3.80			7.86	18.84
Eusmilia fastigiata	0.27	0.44	0.14	0.24	0.05	0.22	0.30	0.78	0.20	0.40	1.26	2.12	0.15	0.32	0.71	0.70
Favia fragum																
Gorgonian	1.47	1.20	1.36	0.99	0.78	0.75	0.70	0.78	1.10	1.97	0.32	0.65	0.60	0.62	2.57	1.05
Isophyllastrea rigida																
Isophyllia sinuosa																
Leptoseris cucullata											0.05	0.22	0.05	0.15	0.14	0.35
Madracis decactis	0.27	0.44	0.35	0.41	0.23	0.51	0.24	0.36	0.15	0.36	0.37	0.55	0.20	0.15	0.29	0.45
Madracis formosa																
Madracis mirabilis	1.47	2.33	1.78	2.32	1.20	2.22	1.56	3.02	0.50	0.67	0.05	0.22	0.40	0.88	0.14	0.35
Manicinia areolata																
Meandrina meandrites			0.03	0.11							0.11	0.45	0.40	1.20		
Millepora alcornis	0.80	0.65	0.68	0.69	0.65	0.71	0.68	0.84	0.35	0.48	0.16	0.49	0.25	0.34	0.43	0.49
Millepora complanata																
Montastrea annularis	10.27	9.36	15.80	9.01	10.05	7.48	11.95	12.39	12.55	9.67	16.37	13.16	7.50	5.68	14.71	11.70
Montastrea cavernosa	6.33	8.55	0.98	1.95	0.55	1.77	1.85	3.17			3.37	4.64	3.10	4.28	2.71	5.06
Mussa angulosa			0.20	0.87	0.05	0.22	0.25	1.09								
Mycetophyllia aliciae					0.05	0.22					0.11	0.45	0.85	1.52	0.14	0.35
Mycetophyllia danaana	0.07	0.25	0.15	0.28	0.13	0.31	0.35	0.91	0.20	0.51	0.05	0.22	0.45	0.91	1.00	0.93
Mycetophyllia ferox	0.40	0.88	0.46	0.97	0.45	1.96	0.20	0.68	0.35	1.31						
Mycetophyllia lamarckiana	0.07	0.25	0.08	0.18	0.03	0.11	0.15	0.36	0.05	0.22	0.05	0.22	0.05	0.15	0.29	0.70
Mycetophyllia reesi																
Porites asteroides	0.60	1.25	0.98	1.52	0.86	1.20	1.23	1.35	1.10	1.41	0.42	0.59	0.88	0.93	2.00	2.14
Porites divaricata			1.64	1.93	2.30	2.79	1.70	2.15	1.10	1.64	0.05	0.22	0.90	1.04	1.71	2.37
Porites furcata																
Porites porites	1.27	1.84	1.05	3.04	0.60	0.92	1.75	2.86	1.65	3.60	0.58	1.46	1.20	1.38	0.86	1.12
Scolymia cubensis			0.01	0.05							0.05	0.22			0.29	0.45
Siderastrea radians											0.11	0.45				
Siderastrea siderea	0.33	1.01	0.55	1.53	1.24	3.43	0.30	1.31	1.25	2.90	0.16	0.67	1.10	3.30	1.57	3.85
Sponge	1.67	2.12	0.98	1.31	2.70	3.47	3.13	5.32	2.75	7.82	7.11	9.32	2.20	2.17	1.14	2.03
Stephanocoenia michelinii	0.07	0.25			1.00	4.36	0.55	1.12			0.58	1.14	1.10	2.70		
Tunicate	0.13	0.34	0.48	0.66	0.65	0.79	0.58	0.79	0.10	0.30	2.00	2.49	1.10	1.37	0.43	0.49
Zoanthid											0.11	0.31				
Algae	41.87	14.39	48.01	15.54	53.95	15.23	54.75	15.11	56.50	16.31	53.47	17.28	64.93	8.67	50.57	18.67
Sand / Rubble	26.07	12.63	12.85	10.36	15.40	16.61	7.90	8.25	9.25	7.81	1.95	1.61	2.80	1.99	1.71	1.28

Little Cayman - Bloody Bay

APPENDIX IIF. Table of Mean and Standard Deviation

Taxa.	Chimney		Great Wall		Mixing Bowl		Mixing Bowl (Deep)	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Acropora cervicornis	0.05	0.22	0.10	0.44				
Acropora palmata								
Acropora prolifera								
Agaricia agaricites	2.35	1.88	2.65	1.82	2.25	2.27	3.05	3.31
Agaricia grahamae / lamarchi			1.65	3.93			0.30	1.10
Colpophyllia natans			0.45	1.96				
Dendrogyra cylindrus								
Dichocoenia stokesi	0.20	0.40	0.73	1.13	0.83	1.46	0.30	0.53
Diploria clivosa	0.40	1.02			0.17	0.37		
Diploria labyrinthiformis	0.86	1.68	0.25	0.89	1.33	2.98		
Diploria strigosa	0.35	1.06	0.70	3.05	3.33	7.45		
Eusmilia fastigiata	0.49	0.79	0.15	0.48	0.29	0.37	0.21	0.33
Favia fragum	0.03	0.08						
Gorgonian	3.40	2.01	1.40	1.20	1.67	0.94	0.90	0.82
Isophyllastrea rigida					0.17	0.37		
Isophyllia sinuosa	0.03	0.08			0.25	0.38		
Leptoseris cucullata			0.58	1.20			0.10	0.30
Madracis decactis	0.36	0.47	0.36	0.41	1.13	1.34	0.75	1.29
Madracis formosa			0.15	0.65			0.75	2.51
Madracis mirabilis								
Manicinia areolata								
Meandrina meandrites	0.15	0.36	0.50	1.24	2.33	3.50	0.35	1.06
Millepora alcicornis	0.74	0.38	0.25	0.37	0.50	0.29	0.13	0.27
Millepora complanata								
Montastrea annularis	4.70	5.74	3.08	4.03	4.17	3.53	1.55	2.33
Montastrea cavernosa	4.10	5.32	3.51	5.05	10.67	6.85	5.46	6.39
Mussa angulosa	0.20	0.87	0.03	0.11			0.03	0.11
Mycetophyllia aliciae			0.25	0.77			0.05	0.22
Mycetophyllia danaana	0.21	0.40	0.23	0.40	0.42	0.45	0.30	0.64
Mycetophyllia ferox			0.05	0.22				
Mycetophyllia lamarckiana	0.06	0.22	0.05	0.22	0.17	0.37	0.16	0.45
Mycetophyllia reesi			0.25	1.09				
Porites asteroides	1.33	2.20	0.23	0.37	1.42	1.02	0.83	1.83
Porites divaricata	0.64	0.24	0.05	0.15				
Porites furcata								
Porites porites	1.45	1.60	0.04	0.12	0.08	0.19	0.13	0.44
Scolymia cubensis			0.19	0.44	0.04	0.09	0.05	0.13
Siderastrea radians	0.19	0.36	0.09	0.23	0.04	0.09	0.20	0.87
Siderastrea siderea	3.28	4.36	0.74	1.12	1.33	2.13	0.64	1.04
Sponge	4.55	3.92	9.45	7.53	6.17	2.85	10.60	5.74
Stephanocoenia michelinii	0.18	0.48	0.18	0.32	0.08	0.19	0.83	2.03
Tunicate	0.38	0.91	0.23	0.68	0.13	0.19	0.31	0.50
Zoanthid								
Algae	50.61	12.61	64.98	11.66	57.38	5.23	70.59	7.70
Sand / Rubble	19.30	15.59	6.50	8.15	3.67	2.87	1.35	1.35

Appendix III: Frequency of occurrence of major bottom types in the quadrats.

FREQUENCIES OF OCCURANCE

CAYMAN BRC NORTHSIDE DEEP

	Cemetery Wall Deep		Cemetery Wall Terrace		East Chute		Garden Eel Wall		Middle Chute		Airport Wall		West Chute	
	#/20	%	#/20	%	#/20	%	#/20	%	#/20	%	#/20	%	#/20	%
Hard Corals:	20.00	100.00	20.00	100.00	20.00	100.00	20.00	100.00	20.00	100.00	20.00	100.00	20.00	100.00
Soft Corals:	9.00	45.00	16.00	80.00	20.00	100.00	1.00	5.00	16.00	80.00	17.00	85.00	20.00	100.00
Sponge:	20.00	100.00	19.00	95.00	14.00	70.00	16.00	80.00	16.00	80.00	17.00	85.00	17.00	85.00
Tunicate:	6.00	30.00	6.00	30.00	3.00	15.00	7.00	35.00	4.00	20.00	4.00	20.00	4.00	20.00
Zoanthid:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Algae:	20.00	100.00	20.00	100.00	20.00	100.00	20.00	100.00	20.00	100.00	20.00	100.00	20.00	100.00
Sand / Rubble:	18.00	90.00	18.00	90.00	14.00	70.00	18.00	90.00	16.00	80.00	19.00	95.00	20.00	100.00

CAYMAN BRAC NORTHSIDE SHALLOW

	Airport Reef		Airport Reef (Pavement)		Burt Brothers Boulders		Charlies Reef		Radar Reef	
	#/20	%	#/20	%	#/14	%	#/20	%	#/15	%
Hard Corals:	20.00	100.00	20.00	100.00	14.00	100.00	20.00	100.00	15.00	100.00
Soft Corals:	19.00	95.00	20.00	100.00	6.00	42.86	18.00	90.00	13.00	86.67
Sponge:	11.00	55.00	15.00	75.00	2.00	14.29	13.00	65.00	11.00	73.33
Tunicate:	7.00	35.00	0.00	0.00	5.00	35.71	5.00	25.00	5.00	33.33
Zoanthid:	4.00	20.00	4.00	20.00	3.00	21.43	2.00	10.00	0.00	0.00
Algae:	20.00	100.00	18.00	90.00	14.00	100.00	20.00	100.00	15.00	100.00
Sand / Rubble:	15.00	75.00	14.00	70.00	13.00	92.86	5.00	25.00	14.00	93.33

CAYMAN BRAC NORTHSIDE SHALLOW

	Greenhouse Reef		Grunt Valley		Jeff's Reef		Snapper Reef		Buccaneer Reef		Patch Reef	
	#/20	%	#/20	%	#/20	%	#/20	%	#/20	%	#/20	%
Hard Corals:	20.00	100.00	20.00	100.00	20.00	100.00	20.00	100.00	20.00	100.00	20.00	100.00
Soft Corals:	18.00	90.00	12.00	60.00	18.00	90.00	12.00	60.00	18.00	90.00	14.00	70.00
Sponge:	2.00	10.00	17.00	85.00	7.00	35.00	13.00	65.00	16.00	80.00	14.00	70.00
Tunicate:	3.00	15.00	7.00	35.00	4.00	20.00	10.00	50.00	11.00	55.00	5.00	25.00
Zoanthid:	0.00	0.00	0.00	0.00	2.00	10.00	1.00	5.00	2.00	10.00	1.00	5.00
Algae:	20.00	100.00	20.00	100.00	20.00	100.00	19.00	95.00	20.00	100.00	20.00	100.00
Sand / Rubble:	13.00	65.00	20.00	100.00	20.00	100.00	19.00	95.00	19.00	95.00	20.00	100.00

APPENDIX IIIb.

FREQUENCY OF OCCURANCE

CAYMAN BRAC SOUTHSIDE DEEP

	Anchor Wall		Eden Wall		Rock Monster Chimney		Tiara Tunnels		Wilderness Wall		Ken's Mount	
	#/20	%	#/20	%	#/10	%	#/20	%	#/16	%	#/12	%
Hard Corals:	20.00	100.00	20.00	100.00	10.00	100.00	20.00	100.00	16.00	100.00	12.00	100.00
Soft Corals:	16.00	80.00	16.00	80.00	8.00	80.00	18.00	90.00	11.00	68.75	12.00	100.00
Sponge:	11.00	55.00	9.00	45.00	6.00	60.00	13.00	65.00	4.00	25.00	2.00	16.67
Tunicate:	6.00	30.00	0.00	0.00	2.00	20.00	4.00	20.00	5.00	31.25	6.00	50.00
Zoanthid:	0.00	0.00	1.00	5.00	1.00	10.00	1.00	5.00	0.00	0.00	2.00	16.67
Algae:	20.00	100.00	20.00	100.00	10.00	100.00	20.00	100.00	16.00	100.00	12.00	100.00
Sand/Rubble:	15.00	75.00	18.00	90.00	8.00	80.00	19.00	95.00	15.00	93.75	12.00	100.00

CAYMAN BRAC SOUTHSIDE SHALLOW

	Angel Reef		Elkhorn Forest		Hede's Reef		Public Beach		Sgt. Major Reef		Tarpon-Lighthouse Reef		Tarpon Reef		Lighthouse Reef		Lobster Valley	
	#/20	%	#/20	%	#/12	%	#/20	%	#/20	%	#/20	%	#/20	%	#/20	%	#/20	%
HARD CORALS:	20.00	100.00	20.00	100.00	12.00	100.00	20.00	100.00	20.00	100.00	20.00	100.00	20.00	100.00	20.00	100.00	20.00	100.00
SOFT CORALS:	13.00	65.00	9.00	45.00	6.00	50.00	7.00	35.00	16.00	80.00	15.00	75.00	16.00	80.00	12.00	60.00	14.00	70.00
SPONGE:	10.00	50.00	10.00	50.00	3.00	25.00	7.00	35.00	9.00	45.00	6.00	30.00	3.00	15.00	5.00	25.00	7.00	35.00
TUNICATE:	11.00	55.00	12.00	60.00	2.00	16.67	1.00	5.00	6.00	30.00	9.00	45.00	7.00	35.00	12.00	60.00	7.00	35.00
ZOANTHID:	4.00	20.00	8.00	40.00	3.00	25.00	7.00	35.00	12.00	60.00	5.00	25.00	7.00	35.00	6.00	30.00	6.00	30.00
ALGAE:	20.00	100.00	20.00	100.00	12.00	100.00	20.00	100.00	19.00	95.00	20.00	100.00	20.00	100.00	20.00	100.00	20.00	100.00
SAND/RUBBLE:	17.00	85.00	13.00	65.00	2.00	16.67	7.00	35.00	18.00	90.00	17.00	85.00	19.00	95.00	16.00	80.00	12.00	60.00

APPENDIX IIIc.

FREQUENCY OF OCCURANCE

LITTLE CAYMAN JACKSON BIGHT SITES

	Outer Meadows		Eagle Ray Roundup		Bus Stop		Cumbers Caves		Jackson Reef and Wall		Jackson Wall Deep		Sarah's Set		Southside site Unknown	
	#/15	%	#/20	%	#/20	%	#/20	%	#/20	%	#/19	%	#/10	%	#/7	%
Hard Corals:	15.00	100.00	20.00	100.00	20.00	100.00	20.00	100.00	20.00	100.00	19.00	100.00	10.00	100.00	7.00	100.00
Soft Corals:	11.00	73.33	16.00	80.00	13.00	65.00	10.00	50.00	11.00	55.00	4.00	21.05	6.00	60.00	7.00	100.00
Sponge:	10.00	66.67	12.00	60.00	13.00	65.00	15.00	75.00	8.00	40.00	18.00	94.74	9.00	90.00	3.00	42.86
Tunicate:	2.00	13.33	9.00	45.00	10.00	50.00	9.00	45.00	2.00	10.00	12.00	63.16	5.00	50.00	3.00	42.86
Zoanthid:	0.00	0.00	0.00	0.00	0.00	0.00	1.00	5.00	0.00	0.00	2.00	10.53	0.00	0.00	0.00	0.00
Algae:	15.00	100.00	20.00	100.00	20.00	100.00	20.00	100.00	20.00	100.00	19.00	100.00	10.00	100.00	7.00	100.00
Sand / Rubble:	15.00	100.00	20.00	100.00	20.00	100.00	20.00	100.00	20.00	100.00	14.00	73.68	10.00	100.00	6.00	85.71

LITTLE CAYMAN BLOODY BAY SITES

	Chimney		The Great Wall		Mixing Bowl		Mixing Bowl (deep)	
	#/20	%	#/20	%	#/6	%	#/20	%
Hard Corals:	20.00	100.00	20.00	100.00	6.00	100.00	20.00	100.00
Soft Corals:	18.00	90.00	14.00	70.00	5.00	83.33	14.00	70.00
Sponge:	17.00	85.00	19.00	95.00	6.00	100.00	20.00	100.00
Tunicate:	4.00	20.00	3.00	15.00	2.00	33.33	9.00	45.00
Zoanthid:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Algae:	20.00	100.00	20.00	100.00	6.00	100.00	20.00	100.00
Sand / Rubble:	20.00	100.00	18.00	90.00	5.00	83.33	12.00	60.00