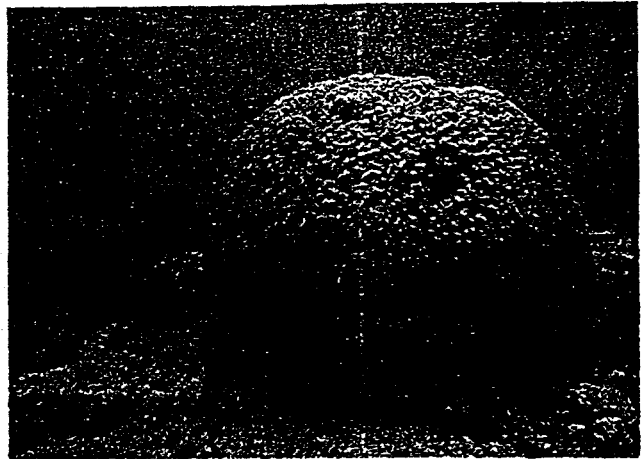


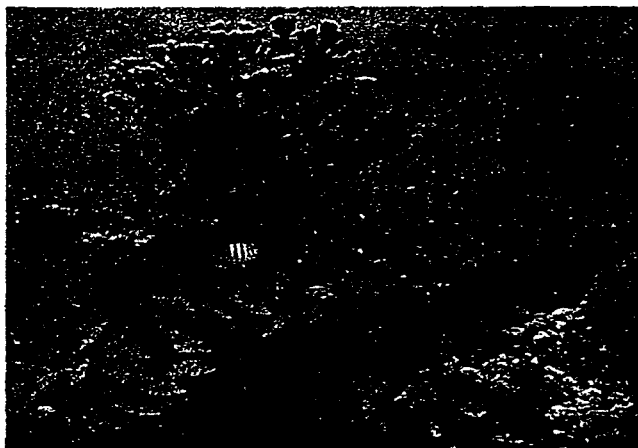
Coral Reef/Hardbottom Monitoring Project



Hardbottom



Patch Reef



Shallow Offshore Reef



Deep Offshore Reef

**Annual Report
1996**

**FLORIDA KEYS NATIONAL MARINE SANCTUARY
WATER QUALITY PROTECTION PLAN**

CORAL REEF AND HARDBOTTOM MONITORING PROJECT

**ANNUAL (10/1/95-9/30/96)
AND FOURTH QUARTERLY (7/1/96-9/30/96) REPORT**

submitted by

**PROJECT MANAGER
QUALITY CONTROL-QUALITY ASSURANCE OFFICER
CONTRACTS MANAGER**

**JENNIFER L. WHEATON
FLORIDA MARINE RESEARCH INSTITUTE**

in collaboration with

PRINCIPAL INVESTIGATORS

**WALTER C. JAAP
MARINE RESEARCH INSTITUTE
100 8TH AVE. S.E.
ST. PETERSBURG, FL 33701**

**DR. PHILLIP DUSTAN
DEPARTMENT OF BIOLOGY
UNIVERSITY OF CHARLESTON
CHARLESTON, SC 29424**

**DR. JAMES PORTER
INSTITUTE OF ECOLOGY
UNIVERSITY OF GEORGIA
ATHENS, GA 30602**

DECEMBER 1996

TABLE OF CONTENTS

INTRODUCTION	3
PROGRESS TOWARD WORK OBJECTIVES	3
FIELD WORK	4
SITE DISTRIBUTION	4
STATION MAP REFINEMENT	4
METHODS	5
VIDEO SAMPLING	5
STATION SPECIES INVENTORY	6
FIELD AND DIVING OPERATIONS	7
LABORATORY WORK	8
DATA CONVERSION, REDUCTION AND ANALYSES	8
SPECIES INVENTORY DATA PROCESSING	8
SPECIES INVENTORY ANALYSES	9
SPECIES INVENTORY PRELIMINARY RESULTS	9
INVENTORY AND ABNORMALITY SUMMARY	12
VIDEO DATA PROCESSING	13
VIDEO DATA REDUCTION	14
VIDEO DATA ANALYSES	16
DATA MANAGEMENT	16
QUALITY ASSURANCE/QUALITY CONTROL	17
PROJECT OUTREACH	17
ACKNOWLEDGMENTS	17
LITERATURE CITED	19
LIST OF FIGURES, TABLES, AND APPENDICES	21
1996-1997 PROJECT GOALS	26
1995-1996 ADMINISTRATIVE ACTIONS	27
FUNDING AND GRANT BUDGET	27
PERSONNEL	28
PROBLEMS AND RESOLUTIONS	28

INTRODUCTION

A comprehensive introductory rationale for the Coral Reef/Hardbottom Monitoring Project (CRMP) was presented in the First Annual Report (November, 1995). The Florida Keys National Marine Sanctuary and Protection Act (HR5909) designated over 2,800 square nautical miles of coastal waters as the Florida Keys National Marine Sanctuary (FKNMS). The Act required the US Environmental Protection Agency and the State of Florida to implement a Water Quality Protection Program in cooperation with NOAA. Programs in monitoring seagrass habitats, coral reefs and hardbottom communities, and water quality were instituted with the intent of integrating information with water quality as the central focus.

The primary goal of the monitoring project is to measure the status and trends of these communities to assist managers in understanding, protecting, and restoring the living marine resources of the Florida Keys National Marine Sanctuary. Data from the project will be used to determine an (1) overall net reef decline in percent cover, stony coral species richness, and other measurable community parameters, (2) overall net increase in measurable reef community parameters, (3) significant changes observed in individual reefs with no overall change on a landscape scale (decreases in one location balanced by increases elsewhere) or changes that are linked to specific regions of the landscape. Each of these potential mechanisms of change will result in different spatial patterns of change. A Sanctuary-wide, rather than a single-location survey, is necessary to detect ecosystem change.

This Sanctuary-wide project will document the status of reef habitats at 40 reef sites located within 5 of the 9 EPA Water Quality Segments in the Florida Keys National Marine Sanctuary (Figure 1). The randomly located reefs in this project may show no decline. Alternatively, all the reefs may show decline. Pollution from Florida Keys sources or damage from divers should give relatively precise signals. As the coral reef monitoring is integrated with the seagrass and water quality programs, the results can be used to focus research on determining causality and can be used to inform and evaluate management decisions. The Coral Reef/Hardbottom Monitoring Project provides the first real opportunity in the Florida Keys to address these questions at the spatial scales required to detect large-scale patterns and discriminate between hypotheses.

PROGRESS TOWARD WORK OBJECTIVES

During the first year (94/95), sampling sites were selected according to EPA's EMAP protocol throughout the research area, including the upper, middle and lower Florida Keys. All video stations were selected and installed. Underwater video transect and species identification and enumeration methodologies were developed and tested.

During the second year (95/96), the videographic survey technique was instituted. A supplemental method to verify the video technique and provide additional data on species identification and species richness was refined. All 40 sites were sampled during 1996.

Techniques for converting the video to CD Rom were refined and a software program was customized for image analysis of the underwater video data.

FIELD WORK

SITE DISTRIBUTION

The Implementation Plan for Coral Reef and Hardbottom Monitoring specifically documents site selection. The geographic layout of the Sanctuary survey sites constitutes the minimum coverage necessary to detect ecosystem change. Of the original 42 sites delimited, (23 among offshore reefs, 10 at patch reefs and 9 at hardbottom habitats) 41 were installed during 1995. However, one site was earmarked as a control for a Park (John Pennekamp Coral Reef State Park) Service study and was deleted from sampling in 1996. The project now encompasses a total of 40 sites (23 among offshore reefs, 9 at patch reefs and 8 at hardbottom habitats) (Figure 1, Table 1).

STATION MAP REFINEMENT

A complete description of station installation was provided in the CRMP First Annual Report (November 1995). All stations, permanently installed in 1995, consist of pairs of stainless steel stakes approximately 22 m apart. Each replicate station comprises a "video unit". The video camera collects video imagery along transects bounding and bisecting the video unit. A total of 160 individual video units (i.e. stations) were installed within 5 of the 9 previously established EPA Water Quality Segments in the Florida Keys.

Exact station locations were obtained by Differential Global Positioning System fixes. At each sampling site, maps drafted in 1995 (constructed with Harvard Graphics software) were transferred to underwater paper and used to re-locate stations. These draft station maps, relating stations to each other and to other structures underwater were edited and accuracy was refined. Compass headings, distances, and depth measurements were repeated and confirmed during 1996 sampling. Sites which were incompletely mapped in 1995 were mapped in detail in 1996. These data comprise the data base for final maps of all sampling sites/stations presented in Appendix 1.

A Geographic Information System database was created to assist in spatial analysis of site specific information as the data is collected and processed from the field. During the 1995/96 sampling season, Differential Global Positioning System (DGPS) fixes were taken at all forty sampling sites with a Trimble NT200D DGPS chart plotter to ensure accurate geographic coordinates were obtained for each site. The coordinates were transferred to revised site maps and an updated site/station list. An average of depths measured at the bottom of both stakes for each station (recorded by observers on station species inventory data sheets) was used to obtain exact station depths.

Table 1. Site Data, Coral Reef and Hardbottom Monitoring

Site no.	Site Type	Site Name	Segment no.	Latitude (N)	Longitude (W)	Station no.	Depth (ft)	Date Installed	Reference
9P1	P	Turtle	9	25°17.683'	80°13.145'	1&2	11-18	5/24/95	Buoy T-6
				25°17.718'	80°13.043'	3&4	13-23	5/24/95	
9D1	OD	Carysfort	9	25°13.239'	80°12.600'	1&2	41-53	5/23/95	Mooring eye
				25°13.335'	80°12.535'	3&4	40-47	5/23/95	Buoy CF-3
9S1	OS	Carysfort	9	25°13.205'	80°12.628'	1	8-9	5/23/95	
				25°13.245'	80°12.643'	2	5-8	5/23/95	
				25°13.346'	80°12.614'	3&4	8-14	5/23/95	
9H1	HB	Rattle Snake	9	25°10.415'	80°20.850'	1-4	5-6	5/17/95	
9S2	OS	Grecian Rocks	9	25°06.450'	80°18.410'	1&2	8-11	5/25/95	Buoy G1
				25°06.554'	80°18.354'	3&4	14-24	5/25/95	Buoy G11
9P3	P	Porter Patch	9	25°06.183'	80°19.471'	1-4	13-17	5/25/95	
9H2	HB	El Radabob	9	25°07.195'	80°22.703'	1-4	9	5/15/95	
9D3	OD	Molasses	9	25°00.441'	80°22.533'	1&2	40-44	5/16/95	Buoy M26
				25°00.459'	80°22.438'	3&4	45-49	5/15/95	Buoy M27
9S3	OS	Molasses	9	25°00.525'	80°22.589'	1	13-19	5/16/95	Buoy M4
				25°00.548'	80°22.502'	2	15-22	5/16/95	Buoy M6
				25°00.525'	80°22.461'	3	20-23	5/16/95	Buoy M9
				25°00.580'	80°22.467'	4	17-28	5/16/95	Buoy M10
9P4	P	Admiral	9	25°02.684'	80°23.685'	1-4	3-6	5/17/95	
9H3	HB	Dove Key	9	25°02.695'	80°28.105'	1-4	9-10	5/17/95	
9D4	OD	Conch	9	24°57.137'	80°27.091'	1-4	46-54	6/12/95	
9S4	OS	Conch	9	24°57.315'	80°27.481'	1&2	16-19	6/12/95	Buoy CO2
				24°57.371'	80°27.424'	3&4	16-21	6/12/95	Buoy CO3
7D1	OD	Alligator	7	24°50.716'	80°37.249'	1-4	34-38	6/14/95	
7S1	OS	Alligator	7	24°50.743'	80°37.440'	1&2	13-16	6/14/95	Buoy A2
				24°50.809'	80°37.360'	3&4	10-12	6/14/95	Buoy A3
7D2	OD	Tennessee	7	24°45.158'	80°45.485'	1-4	44-45	6/16/95	
7S2	OS	Tennessee	7	24°44.698'	80°46.873'	1-4	17-21	6/16/95	
7H2	HB	Long Key	7	24°47.824'	80°47.013'	1-4	12-13	9/29/95	
7P1	P	West Turtle Shoal	7	24°41.956'	80°58.219'	1-4	16-24	3/25/95	ATON 47
7P2	P	Dustan Rocks	7	24°41.392'	81°01.833'	1-4	12-21	3/27/95	W. Buoy
5D1	OD	Sombrero	5	24°37.336'	81°06.717'	1&2	45-52	12/6/94	Buoy #20
				24°37.382'	81°06.607'	3&4	47-48	12/7/94	Buoy #21
5S1	OS	Sombrero	5	24°37.517'	81°06.695'	1	15-17	12/8/94	Buoy #19
				24°37.615'	81°06.549'	2	15-17	12/8/94	Buoy #5
				24°37.549'	81°06.552'	3	9-15	12/8/94	Buoy #22
				24°37.531'	81°06.624'	4	15-18	12/8/94	Buoy #12
5H1	HB	Moser Channel	5	24°41.347'	81°10.038'	1-4	12-13	3/30/95	Buoy #4
5H2	HB	Molasses Keys	5	24°40.530'	81°11.425'	1-4	12-14	3/30/95	
5D2	OD	Looe Key	5	24°32.533'	81°24.866'	1&2	41-44	6/20/95	Buoy L53
				24°32.560'	81°24.761'	3&4	38-42	6/20/95	Buoy L51
5S2	OS	Looe Key	5	24°32.663'	81°24.455'	1	12-24	6/20/95	Buoy L7
				24°32.714'	81°24.424'	2	21-24	6/20/95	Buoy L8
				24°32.720'	81°24.380'	3&4	15-25	6/24/95	Buoy L24
5P1	P	West Washer Woman	5	24°32.813'	81°35.171'	1-4	15-25	6/19/95	
5H3	HB	Jaap Reef	5	24°35.270'	81°34.972'	1-4	6-9	7/14/95	
5D3	OD	Eastern Sambo	5	24°29.313'	81°39.946'	1-4	43-48	7/13/95	
5S3	OS	Eastern Sambo	5	24°29.468'	81°39.838'	1-4	3-9	7/18/95	
5D4	OD	Western Sambo	5	24°28.794'	81°42.865'	1&2	38-40	7/18/95	
				24°28.776'	81°42.850'	3&4	25-29	7/18/95	Buoy #10
5S4	OS	Western Sambo	5	24°28.775'	81°43.054'	1&2	11-17	7/18/95	Buoy #13
				24°28.788'	81°42.945'	3&4	7-9	7/18/95	Buoy #11
5P2	P	Western Head	5	24°29.830'	81°48.298'	1-4	26-35	7/18/95	ATON 3A
5P3	P	Cliff Green	5	24°30.216'	81°46.059'	1-4	20-26	7/18/95	
5D5	OD	Rock Key	5	24°27.200'	81°51.383'	1-4	37-42	7/13/95	
5S5	OS	Rock Key	5	24°27.269'	81°51.532'	1	6-15	7/13/95	Buoy #9
				24°27.269'	81°51.532'	2	16-17	7/13/95	Buoy #8
				24°27.269'	81°51.532'	3	15-17	7/13/95	
				24°27.253'	81°51.458'	4	6-9	7/13/95	Buoy #3
3H1	HB	Content Keys	3	24°49.323'	81°29.335'	1-4	17-19	7/10/95	
2D1	OD	Sand Key	2	24°27.082'	81°52.739'	1-4	24-35	7/12/95	
2S1	OS	Sand Key	2	24°27.119'	81°52.650'	1-4	10-21	7/14/95	Buoy #12
2P1	P	Smith Shoal	2	24°43.184'	81°55.172'	1-4	19-26	7/10/95	

HB: Hard bottom OD: Offshore deep OS: Offshore shallow P: Patch reef Revised 10/96 MEP

An Arc/Info (Environmental Systems Research Institute) geographic database point coverage was generated with the most recent coordinates and depths and then matched with other databases (FKNMS water quality segments, bathymetry, Aids to Navigation, major roads, 1/2 degree grid, and the State of Florida coastline). Site maps were re-produced and checked for accuracy. An additional database connected to the GIS database included the date of site installation, the date of sampling, number of stony coral species observed in station species inventories, and water quality segment, as well as coordinates, site name, and depth. All of this information can be used to build complex queries to see how the information parses out with different spatial or political relationships.

The database was created using Arc/Info 7.04 (Environmental Systems Research Institute, ESRI) software and then exporting it for ArcView 3.0 (ESRI) format. ArcView 3.0 allows data to be manipulated on a PC instead of processing the data on a UNIX workstation which is a major capital investment. Information can be added and edited to the existing database, and maps can be printed locally to a color printer. ArcView shares Arc/Info's power of spatial query without the equipment cost and time investment in software training.

Future data will be added to the existing database to show which sites and/or areas are changing with time. The ability to examine the data on a map instead of a list of points allows for spatial analysis to be performed with ease.

METHODS

During 1995, a variety of sampling methods were tested underwater to assess the feasibility of their use in the program. These were presented in the CRMP First Annual Report (November, 1995). Dustan Lab prepared a presentation of justification for methods changes and a follow-up that addressed specific points raised by individuals from the 5-member CRMP Peer Review Panel. Approved methods are detailed in the Standard Operating Procedures (Appendix 2) (also Appendix 14 of the CRMP Quality Assurance Project Plan).

Video Sampling

Several tests were conducted relating to video sampling: video configurations (distance from reef surface; artificial light versus ambient light; automatic versus manual focus controls); and 8-mm video cameras versus others. These tests were summarized in the Porter Lab's final contract report and are presented in Appendix 3. The Sony CCD-VX3 camera (Figure 2) was selected for the project. This camera, with three color processing chips (red, green, blue) provided better resolution and color than the single-chip video cameras. In tests and evaluations (with and without lights, at different distances from the reef surface, and with manual and automatic focusing), the Sony camera functioned best with full automatic settings and two 50 watt lights (Figure 2). The closer the camera is to the substrate, the easier it is to identify coral colonies to species. Distances ranging from 40 cm to 60 cm

were tested. The optimum height of the camera above the substrate was determined to be 40 cm. At distances less than 40 cm, the area sampled was too small to be representative of the reef; distances greater than 60 cm were too great to allow for accurate coral identification. All sampling for 1996 was conducted with the Sony CCD-VX3 with artificial lights at 40 cm above the benthos.

The Porter Lab and the UGA Instrument Shop, in collaboration with the Dustan Lab, designed and manufactured accessory video field equipment: clapperboard for filming date and site information for video transects, a convergent laser light system for videocamera guidance, and a parallel laser light system for providing scale information within video images. Technical drawings provided by Porter Lab are presented in Appendix 4. Dustan Lab also modified the lighting system for the videocamera by integrating the two 50-Watt lamps and a wiring harness, and fabricated a frame for the lights to ensure uniform lighting of the surface area. A buoyant frame for the videocamera housing (which holds the battery and renders the housing neutrally buoyant in seawater) was designed and constructed by the Dustan Lab. This frame orients the camera, helping point the lens downward to maintain the camera in a vertical position for filming.

The protocol for video sampling is presented in detail in the Standard Operating Procedures (Appendix 2). In brief, the videographer focuses on a "clapper board" (Figure 3a). The clapper board is videoed on the film leader just prior to the beginning of each transect. The original film therefore contains the complete record of the date and location of each film segment. During sampling, the distance from the benthos is maintained constant by focusing the cross-beam of paired laser lights (Figure 2, 3b). Video sampling was designed to be conducted in a transect format. A single sample transect (Cliff Green Patch Reef) in montage form, created from images framegrabbed, processed, and written to CD-ROM in JPEG format is shown in Figure 4 (1, 2, 3). We sampled 40 reef sites, (4-video units each), for a total of 160 video units (3 transects/unit yielding a total of 480 individual transects).

Results from this first sampling year (1996) will be used to determine if an increase or a decrease in sampling intensity is warranted. The video will also allow "retro-sampling" to be accomplished due to the archival nature of stored video imagery.

Species Inventory

Methods to verify video image analysis and provide supplemental species identification and enumeration data were researched the first year. Detailed discussion/protocols were presented in the CRMP First Annual Report (November, 1995). Counts representing the presence of coral species in plots formed by the video units (stations) with enumeration of selected "disease" conditions were selected as the optimum method.

The video unit census method (station species inventory) is described in detail in the Standard Operating Procedures (Appendix 2). Principal investigators and qualified observers (Dustan, Jaap, and Porter; Meier, K. Patterson and Wheaton) collected stony coral species

Figure 2.

UNDERWATER IMAGE ACQUISITION SYSTEM

SONY VX-3 Underwater Video Camera



Figure 3. a. Video Clapper Board., b. Underwater Cross-beam Laser Lights.,
c. Species Inventories., d. PointCount Image Analysis Software.

a.

c.



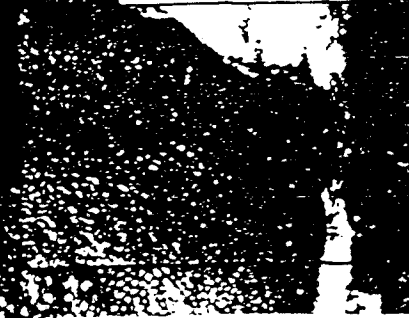
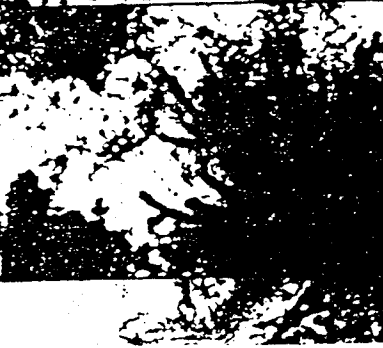
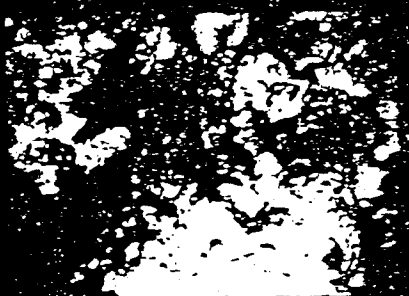
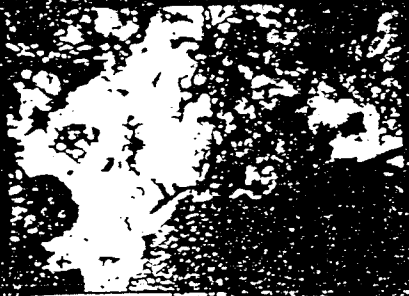
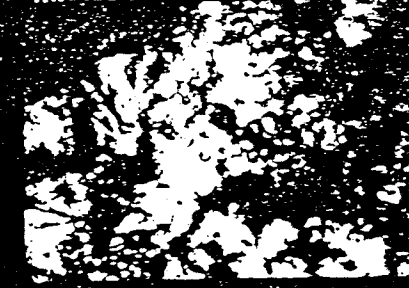
b.

d.

CRMP 1996







presence data within all stations, at all sites during 1996. To summarize, two observers conducted simultaneous 15-20 minute inventories within the roughly 22 x 2 m video stations (Figure 3 c) and entered the data on pre-printed underwater data sheets (Figure 5). Each observer recorded all scleractinian corals, fire corals (*Millepora* spp.), and long spined urchins (*Diadema anillarum*) within the station boundaries. After recording the data, observers compared counts and resolved any taxonomic differences. Data were again verified aboard the vessel.

In addition to "on site" training by principal investigators, a set of close-up photographic images of corals were taken by Dustan Lab, identifications were confirmed among investigators and a draft CRMP stony coral species identification guide (Appendix 5) was compiled. Photos from Reef Coral Identification (Humann, 1993) were also used for reference. Verified data was submitted to the senior scientist to forward to FMRI for data entry and processing. This method provided data to estimate stony coral species richness ("S") and facilitated data collection with broad spatial coverage at optimal expenditure of time and labor.

FIELD AND DIVING OPERATIONS

During 1996, FMRI supported the majority of field sampling aboard the R/V Tortugas. However, the expenditure of time and effort for primary project monitoring personnel was exponential in comparison to 1995. Table 2 summarizes actual field sampling days for the FY 95/96 and "man-days" contributed by the three primary project institutions with assistance of FKNMS staff. A total of 344 man days were expended in field sampling efforts through September 1996. Besides the effort expended by FMRI (67%), UGA (18%), UCSC (13%), and FKNMS staff (3%) also participated (Figure 6) in field sampling. Scheduled field work in May was severely impacted by weather; however, the three principal investigators, Meier and Wheaton devoted six full days to writing Standard Operating Procedures and drafting a final Quality Assurance Project Plan.

In addition to the total "man days" of actual field sampling, all labs devoted approximately 74 total "man-days" to travel in support of field operations. The inability to complete all field sampling scheduled for May forced project personnel to schedule field sampling into October (FY 96/97). EPA graciously supported the project sampling efforts with a cruise aboard the OSV Peter Anderson from 8-16 October. Three sites were sampled with the assistance of EPA divers. Unfortunately Hurricane Josephine delayed our departure at the beginning and Hurricane Lili required us to return to port early. The remaining two sites were sampled aboard the RV Tortugas. Table 3 summarizes the October field work. A total of 98 "man-days" were required to sample the remaining sites to complete 100% of the first annual sampling of the 40 reef sites. Of that latter effort, 33% was contributed by FMRI, 37% by EPA, 22% by UGA, and 8% by FKNMS (Figure 7).

Tables 4 through 7 provide summaries of diving operations for this first sampling year. Through September, a total of 672 dives were made for a cumulative bottom time of 630.83

Figure 5.

Station Species Inventory Data Form

Coral Reef Monitoring Project

Mark an X in the small box right of species code to indicate presence.
Use codes to characterize conditions and diseases in species subbox.

BL=Bleaching BB=Black band WB=White band WP=White plague
YB=Yellow band PB=Purple blotch OC=Specify Other Condition or Disease
(occurrence: WB in Acrop., WP in non-Acrop., YB in M.ann (& other?) not always yellow, PB in S.sid)

A.cer	A.pal	A.agar	A.frag	A.lam	C.nat
D.cyl	D.sto	D.cliv	D.lab	D.str	E.fas
F.frag	I.rig	I.sin	L.cuc	M.dec	M.mir
M.areo	M.mean	Mp.alc	Mp.com	M.ann	M.cav
My.ali	My.dan	My.fer	My.lam	M.ang	Mussid juv
O.dif	P.ast	P.bran	P.por	S.cub	S.lac
S.bour	S.hyad	S.rad	S.sid	S.mich	Diadema
					(#)

Site Code _____ Site Name _____ Station 1 2 3 4 Depth I O

Date _____ Collector _____ Start Time (hh:mm) _____ Stop _____

Cross-Ref (name) _____ Data Entry (init.) _____ Date _____

Return Form to Project Manager for data entry and archive

SPFORM1.DOC

Table 2. Field Sampling Days - FY 1995/1996 *

	March	April	May	June	July	August	Sept	Totals
B Barratachea	0	0	10	12	7	13	4	46
S Baumgartner	0	0	0	0	0	0	1	1
M Brill	0	0	0	9	9	0	0	18
C Daniels	0	0	0	0	0	0	1	1
P Dustan	0	0	8	5	0	0	0	13
J Dotten	0	7	11	11	12	13	6	60
D Eaken	0	0	0	0	0	0	1	1
K Fitzsimmons	0	0	0	0	3	0	0	3
J Halas	0	0	0	0	2	0	1	3
B Haskell	0	0	0	0	0	1	0	1
W Jaap	2	7	8	4	0	8	4	33
J Jones	0	0	6	0	0	0	0	6
L MacLaughlin	0	0	0	2	0	0	1	3
O Meier	0	0	8	0	4	0	0	12
P O'Donnell	0	0	0	0	0	0	1	1
M Patterson	2	7	10	13	14	13	4	63
K Patterson	0	0	0	4	12	9	0	25
J Porter	0	0	8	4	9	9	0	30
GP Schmahl	0	0	0	0	0	0	1	1
J Wheaton	0	2	8	9	0	0	4	23
Totals	4	23	77	73	72	66	29	344

* Travel days and QA development not included.

Figure 6. Agency Field Sampling Participation - FY 1995/1996

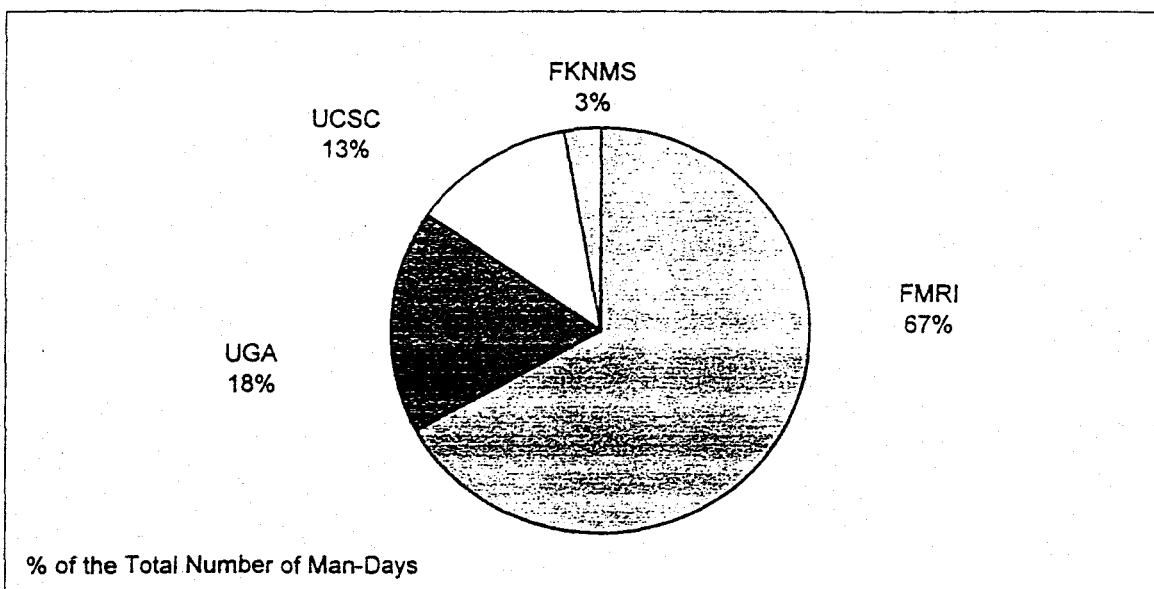


Table 3. Field Sampling Days - FY 1996/1997 *

	Oct	April	May	June	July	August	Sept	Totals
G Collins	9							9
J Dotten	14							14
J Halas	2							2
W Jaap	2							2
L MacLaughlin	2							2
P Moen	2							2
P Murphy	9							9
M Parsons	9							9
M Patterson	6							6
K Patterson	11							11
J Porter	11							11
K Potts	9							9
G Smith	1							1
J Wheaton	9							9
B Valley	2							2
Totals	98	0	0	0	0	0	0	98

* Travel days not included.

Figure 7. Agency Field Sampling Participation - FY 1996/1997

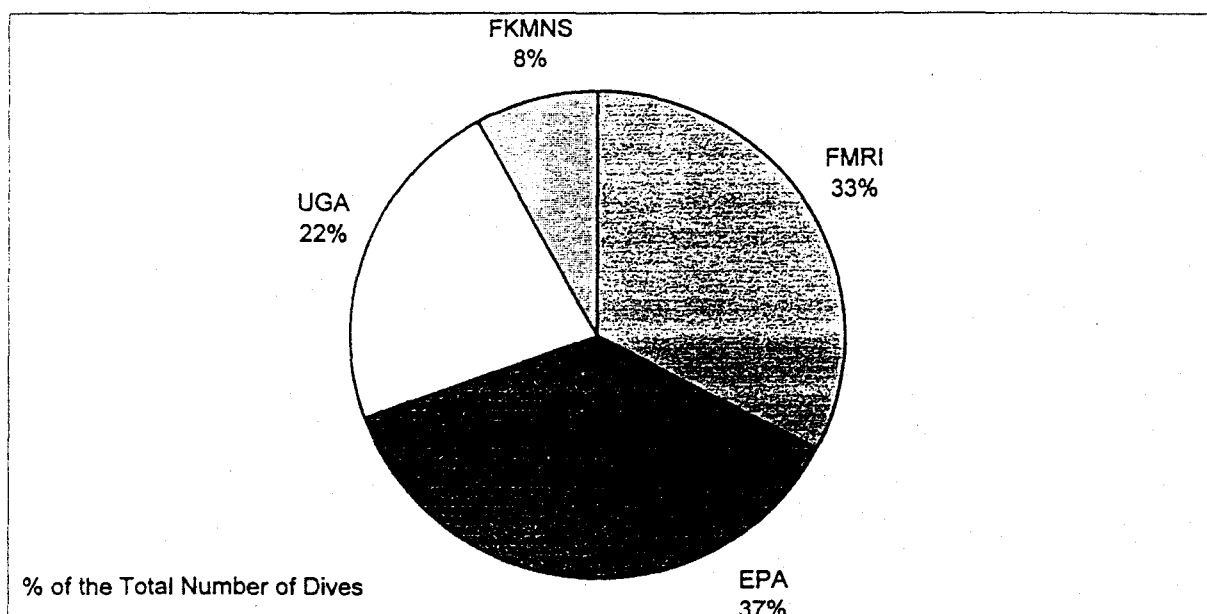


Table 4. Dive Summary - FY 1995/1996

DIVERS	APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER	
	# of Dives	B.T. in Minutes	# of Dives	B.T. in Minutes	# of Dives	B.T. in Minutes	# of Dives	B.T. in Minutes	# of Dives	B.T. in Minutes	# of Dives	B.T. in Minutes
B Barratachea	0	0	14	658	32	1528	20	819	29	1814	12	715
S Baumgartner *	0	0	0	0	0	0	0	0	0	0	2	105
M Brill	0	0	0	0	28	1583	19	1222	0	0	0	0
C Daniels *	0	0	0	0	0	0	0	0	0	0	0	0
P Dustan	0	0	4	150	13	767	0	0	0	0	4	115
J Dotten	4	72	19	785	37	1736	30	1586	20	2013	25	1162
D Eaken	0	0	0	0	0	0	0	0	0	0	2	104
K Fitzsimmons	0	0	0	0	0	0	7	549	0	0	0	0
J Halas *	0	0	0	0	0	0	0	0	0	0	2	60
B Haskell *	0	0	0	0	0	0	0	0	0	0	0	0
W Jaap	4	158	6	196	8	424	0	0	2	100	0	0
J Jones	0	0	6	369	0	0	0	0	19	1390	10	613
L MacLaughlin *	0	0	0	0	4	221	0	0	0	0	0	0
O Meier	0	0	2	136	0	0	10	603	0	0	2	228
P O'Donnell	0	0	0	0	0	0	0	0	0	0	0	0
M Patterson	4	197	16	771	39	1766	26	1365	30	1734	4	115
K Patterson	0	0	0	0	12	753	21	1379	20	1351	12	600
J Porter	0	0	3	130	13	808	21	1425	20	1552	0	0
GP Schmahl *	0	0	0	0	0	0	0	0	0	0	0	0
J Wheaton	0	0	0	0	17	1280	0	0	0	0	4	121
Monthly Total	12	427	70	3195	200	10866	154	8948	150	10014	86	4400

* FKNMS Staff
B.T. = Bottom Time

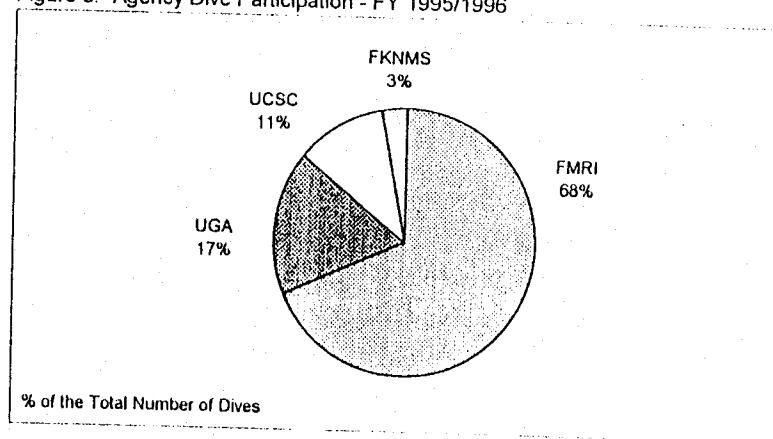
Annual Total # of Dives B.T. in Minutes B.T. in Hours
672 37850 630.83

Table 5. Agency Dive Participation - FY 1995/1996

Agency	# of Dives	% of Total
FMRI	460	68%
UGA	116	17%
UCSC	76	11%
FKNMS	20	3%
Total	672	100%

Agency	B.T. in Hours	% of Total
FMRI	411	65%
UGA	129	21%
UCSC	74	12%
FKNMS	16	3%
Total	630.83	100%

Figure 8. Agency Dive Participation - FY 1995/1996



hours. FMRI staff conducted 68% of the dives with assistance from UGA (17%), UCSC (11%), and FKNMS (3%) (Figure 8). For October, a total of 106 dives were made for a cumulative bottom time of 61.65 hours. Again, FMRI conducted the majority of the dives (39%), assisted by EPA (30%), UGA (24%) and FKNMS (7%) (Figure 9). The majority of diving was conducted in less than 30 ft depths (Table 8).

Table 8. Depth Distribution of Dives FY95/96 and FY96/97

Depth	FY95/96	FY96/97	Totals
0-30'	480	16	496
31-60'	192	85	277

Diving followed the American Academy of Underwater Sciences (AAUS), FMRI scientific diving regulations and regulations of the Environmental Protection Agency. The majority of compressed air diving was conducted following the time at depth protocols of the Defense and Civil Institute of Environmental Medicine Sport (DCIEM) also referred to as the Canadian Diving Tables. Dives with EPA staff were conducted using the NAVY tables. K. Patterson also attended a six day EPA diver training class in Gulf Breeze in satisfaction of EPA diving requirements.

Diving reciprocity with FMRI was initiated by UCSC who developed a Diving Program at the University of Charleston (UCSC) under the auspices of the SCDNR. Dr. Dustan became the Diving Board member from UCSC and supervises the diving program at the University of Charleston. The reciprocity will be finalized when UCSC addresses medical and qualifying protocols raised by FMRI's Diving Control Board. An additional team member (Mike Brill) from UCSC was prepared for diving, certified through both UCSC and FMRI. Dr. Porter also created a dive safety program at the University of Georgia and established a diving reciprocity agreement with FMRI. Their AAUS-style diving manual has been approved by UGA's president (Dr. Charles Knapp) and they intend to apply for AAUS membership in November, 1996.

LABORATORY WORK

DATA CONVERSION, DATA REDUCTION AND ANALYSES

Species Inventory Data Processing

At FMRI, stony coral species data were transcribed into Quattro Pro™ computer spreadsheets. Spreadsheets for raw data include site name and code, date of data collection, name of observers, presence of stony coral taxa recorded by each observer at each of four stations at each site. Spreadsheets also include the name of data entry technician and date entered. Observations on disease and bleaching (condition information) were entered on separate spreadsheets.

Table 6. Dive Summary - FY 1996/1997

DIVERS	OCTOBER		MAY		JUNE		JULY		AUGUST		SEPTEMBER	
	# of Dives	B.T. in Minutes	# of Dives	B.T. in Minutes	# of Dives	B.T. in Minutes	# of Dives	B.T. in Minutes	# of Dives	B.T. in Minutes	# of Dives	B.T. in Minutes
G Collins **	11	278										
J Dotten	18	564										
J Halas *	2	60										
W Jaap	4	195										
L MacLaughlin *	1	35										
P Moen *	2	60										
P Murphy **	6	132										
M Parsons **	12	399										
M Patterson	11	339										
K Patterson	12	484										
J Porter	13	563										
K Potts **	3	66										
G Smith	2	108										
J Whealon	7	356										
B Valley *	2	60										
Monthly Totals	106	3699	0	0	0	0	0	0	0	0	0	0
* FKNMS Staff	** EPA Staff											
B.T. = Bottom Time												
	# of Dives	B.T. in Minutes	B.T. in Hours									
Annual Total	106	3699	61.65									

Table 7. Agency Dive Participation - FY 1996/1997

Agency	# of Dives	% of Total
FMRI	42	40%
UGA	25	24%
FKNMS	7	7%
EPA	32	30%
Total	106	100%

Agency	B.T. in Hours	% of Total
FMRI	26.03	42%
UGA	17.45	28%
FKNMS	3.58	6%
EPA	14.58	24%
Total	61.65	100%

Figure 9. Agency Dive Participation - FY 1996/1997

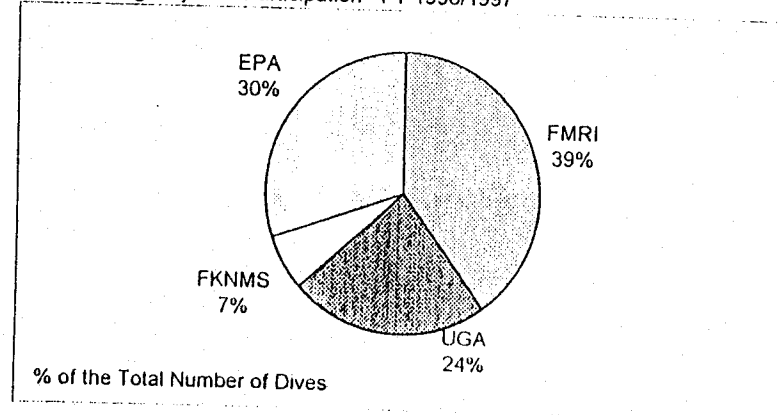


Table 9. Taxonomic List* of Hydrozoan and Scleractinian Corals from Species Inventories.

PHYLUM CNIDARIA

CLASS HYDROZOA

ORDER ATHECATE

Family Milleporidae

Millepora alcicornis Linne, 1758

Millepora complanata Lamarck, 1816

CLASS ANTHOZOA

SUBCLASS ZOANTHARIA

ORDER SCLERACTINIA

SUBORDER ASTROCOENIINA

Family Astrocoeniidae

Stephanocoenia michelinii Milne Edwards and Haime, 1848

Family Pocilloporidae

Madracis decactis (Lyman, 1859)

Madracis mirabilis sensu Wells, 1973

Family Acroporidae

Acropora cervicornis (Lamarck, 1816)

Acropora palmata (Lamarck, 1816)

SUBORDER FUNGIINA

Family Agaricidae

Agaricia agaricites ((Linne, 1758) [COMPLEX]**

Agaricia fragilis (Dana, 1846)

Agaricia lamarcki Milne Edwards and Haime, 1851

Leptoseris cucullata (Ellis and Solander, 1786)

Family Siderastreidae

Siderastrea radians (Pallas, 1766)

Siderastrea siderea (Ellis and Solander, 1786)

Family Poritidae

Porites astreoides Lamarck, 1816

Porites branneri Rathbun, 1888

Porites porites (Pallas, 1766) [COMPLEX]**

SUBORDER FAVIINA

Family Faviidae

Cladocora arbuscula (Lesueur, 1821)

Colpophyllia natans (Houttuyn, 1772)

Diploria clivosa (Ellis and Solander, 1786)

Diploria labyrinthiformis (Linne, 1758)

Diploria strigosa (Dana, 1846)

Favia fragum (Esper, 1795)

Manicina areolata (Linne, 1758)

Montastraea cavernosa (Linne, 1767)

Montastraea annularis (Ellis and Solander, 1786) [COMPLEX]**

Solenastrea bournoni Milne Edwards and Haime, 1850

Solenastrea hyades (Dana, 1846)

Family Rhizangiidae

Astrangia poculata (Ellis and Solander, 1786)

Phyllangia americana Milne Edwards and Haime, 1849

Family Oculinidae

Oculina diffusa Lamarck, 1816

Family Meandrinidae

Dendrogyra cylindrus Ehrenberg, 1834

Dichocoenia stokesi Milne Edwards and Haime, 1848

Meandrina meandrites (Linne, 1758)

Family Mussidae

Isophyllastraea rigida (Dana, 1846)

Isophyllia sinuosa (Ellis and Solander, 1786)

Mussa angulosa (Pallas, 1766)

Mycetophyllia lamarckiana Milne Edwards and Haime, 1848

Mycetophyllia danaana Milne Edwards and Haime, 1849

Mycetophyllia aliciae Wells, 1973

Mycetophyllia ferox Wells, 1973

Scolymia cubensis Milne Edwards and Haime, 1849

Scolymia lacera (Pallas, 1766)

SUBORDER CARYOPHYLLIINA

Family Caryophylliidae

Eusimilia fastigiata (Pallas, 1766)

*Systematics follows Wells and Lang, 1973 and Cairns *et. al.* 1991.

***Agaricia agaricites* COMPLEX may include:

agaricites (Linne, 1758)

carinata Wells, 1973

danai Milne Edwards and Haime, 1860

purpurea (Lesueur, 1821)

***Porites porites* COMPLEX may include:

porites (Pallas, 1766)

clavaria Lamarck, 1816

furcata Lamarck, 1816

divaricata Lesueur, 1821

***Montastraea annularis* COMPLEX may include:

annularis (Ellis and Solander, 1786)

faveolata (Ellis and Solander, 1786)

franksi (Gregory, 1895)

Table 10a. Presence/Absence of Stony Coral Taxa - All Sites FY 1995/1996

SITE CODES:	SP1	SP3	SP4	PH1	PH2	PH3	BS1	BS2	BS3	BS4	SD1	SD3	SD4	7P1	7P2	7H2	7H3	7H4	7H5	7H6	7H7	7H8	7H9	7H10	7H11	7H12	7H13	7H14	7H15	7H16	7H17	7H18	7H19	7H20	7H21	7H22	7H23	7H24	7H25	7H26	7H27	7H28	7H29	7H30	7H31	7H32	7H33	7H34	7H35	7H36	7H37	7H38	7H39	7H40	7H41	7H42	7H43	7H44	7H45	7H46	7H47	7H48	7H49	7H50	7H51	7H52	7H53	7H54	7H55	7H56	7H57	7H58	7H59	7H60	7H61	7H62	7H63	7H64	7H65	7H66	7H67	7H68	7H69	7H70	7H71	7H72	7H73	7H74	7H75	7H76	7H77	7H78	7H79	7H80	7H81	7H82	7H83	7H84	7H85	7H86	7H87	7H88	7H89	7H90	7H91	7H92	7H93	7H94	7H95	7H96	7H97	7H98	7H99	7H100	7H101	7H102	7H103	7H104	7H105	7H106	7H107	7H108	7H109	7H110	7H111	7H112	7H113	7H114	7H115	7H116	7H117	7H118	7H119	7H120	7H121	7H122	7H123	7H124	7H125	7H126	7H127	7H128	7H129	7H130	7H131	7H132	7H133	7H134	7H135	7H136	7H137	7H138	7H139	7H140	7H141	7H142	7H143	7H144	7H145	7H146	7H147	7H148	7H149	7H150	7H151	7H152	7H153	7H154	7H155	7H156	7H157	7H158	7H159	7H160	7H161	7H162	7H163	7H164	7H165	7H166	7H167	7H168	7H169	7H170	7H171	7H172	7H173	7H174	7H175	7H176	7H177	7H178	7H179	7H180	7H181	7H182	7H183	7H184	7H185	7H186	7H187	7H188	7H189	7H190	7H191	7H192	7H193	7H194	7H195	7H196	7H197	7H198	7H199	7H200	7H201	7H202	7H203	7H204	7H205	7H206	7H207	7H208	7H209	7H210	7H211	7H212	7H213	7H214	7H215	7H216	7H217	7H218	7H219	7H220	7H221	7H222	7H223	7H224	7H225	7H226	7H227	7H228	7H229	7H230	7H231	7H232	7H233	7H234	7H235	7H236	7H237	7H238	7H239	7H240	7H241	7H242	7H243	7H244	7H245	7H246	7H247	7H248	7H249	7H250	7H251	7H252	7H253	7H254	7H255	7H256	7H257	7H258	7H259	7H260	7H261	7H262	7H263	7H264	7H265	7H266	7H267	7H268	7H269	7H270	7H271	7H272	7H273	7H274	7H275	7H276	7H277	7H278	7H279	7H280	7H281	7H282	7H283	7H284	7H285	7H286	7H287	7H288	7H289	7H290	7H291	7H292	7H293	7H294	7H295	7H296	7H297	7H298	7H299	7H300	7H301	7H302	7H303	7H304	7H305	7H306	7H307	7H308	7H309	7H310	7H311	7H312	7H313	7H314	7H315	7H316	7H317	7H318	7H319	7H320	7H321	7H322	7H323	7H324	7H325	7H326	7H327	7H328	7H329	7H330	7H331	7H332	7H333	7H334	7H335	7H336	7H337	7H338	7H339	7H340	7H341	7H342	7H343	7H344	7H345	7H346	7H347	7H348	7H349	7H350	7H351	7H352	7H353	7H354	7H355	7H356	7H357	7H358	7H359	7H360	7H361	7H362	7H363	7H364	7H365	7H366	7H367	7H368	7H369	7H370	7H371	7H372	7H373	7H374	7H375	7H376	7H377	7H378	7H379	7H380	7H381	7H382	7H383	7H384	7H385	7H386	7H387	7H388	7H389	7H390	7H391	7H392	7H393	7H394	7H395	7H396	7H397	7H398	7H399	7H400	7H401	7H402	7H403	7H404	7H405	7H406	7H407	7H408	7H409	7H410	7H411	7H412	7H413	7H414	7H415	7H416	7H417	7H418	7H419	7H420	7H421	7H422	7H423	7H424	7H425	7H426	7H427	7H428	7H429	7H430	7H431	7H432	7H433	7H434	7H435	7H436	7H437	7H438	7H439	7H440	7H441	7H442	7H443	7H444	7H445	7H446	7H447	7H448	7H449	7H450	7H451	7H452	7H453	7H454	7H455	7H456	7H457	7H458	7H459	7H460	7H461	7H462	7H463	7H464	7H465	7H466	7H467	7H468	7H469	7H470	7H471	7H472	7H473	7H474	7H475	7H476	7H477	7H478	7H479	7H480	7H481	7H482	7H483	7H484	7H485	7H486	7H487	7H488	7H489	7H490	7H491	7H492	7H493	7H494	7H495	7H496	7H497	7H498	7H499	7H500	7H501	7H502	7H503	7H504	7H505	7H506	7H507	7H508	7H509	7H510	7H511	7H512	7H513	7H514	7H515	7H516	7H517	7H518	7H519	7H520	7H521	7H522	7H523	7H524	7H525	7H526	7H527	7H528	7H529	7H530	7H531	7H532	7H533	7H534	7H535	7H536	7H537	7H538	7H539	7H540	7H541	7H542	7H543	7H544	7H545	7H546	7H547	7H548	7H549	7H550	7H551	7H552	7H553	7H554	7H555	7H556	7H557	7H558	7H559	7H560	7H561	7H562	7H563	7H564	7H565	7H566	7H567	7H568	7H569	7H570	7H571	7H572	7H573	7H574	7H575	7H576	7H577	7H578	7H579	7H580	7H581	7H582	7H583	7H584	7H585	7H586	7H587	7H588	7H589	7H590	7H591	7H592	7H593	7H594	7H595	7H596	7H597	7H598	7H599	7H600	7H601	7H602	7H603	7H604	7H605	7H606	7H607	7H608	7H609	7H610	7H611	7H612	7H613	7H614	7H615	7H616	7H617	7H618	7H619	7H620	7H621	7H622	7H623	7H624	7H625	7H626	7H627	7H628	7H629	7H630	7H631	7H632	7H633	7H634	7H635	7H636	7H637	7H638	7H639	7H640	7H641	7H642	7H643	7H644	7H645	7H646	7H647	7H648	7H649	7H650	7H651	7H652	7H653	7H654	7H655	7H656	7H657	7H658	7H659	7H660	7H661	7H662	7H663	7H664	7H665	7H666	7H667	7H668	7H669	7H670	7H671	7H672	7H673	7H674	7H675	7H676	7H677	7H678	7H679	7H680	7H681	7H682	7H683	7H684	7H685	7H686	7H687	7H688	7H689	7H690	7H691	7H692	7H693	7H694	7H695	7H696	7H697	7H698	7H699	7H700	7H701	7H702	7H703	7H704	7H705	7H706	7H707	7H708	7H709	7H710	7H711	7H712	7H713	7H714	7H715	7H716	7H717	7H718	7H719	7H720	7H721	7H722	7H723	7H724	7H725	7H726	7H727	7H728	7H729	7H730	7H731	7H732	7H733	7H734	7H735	7H736	7H737	7H738	7H739	7H740	7H741	7H742	7H743	7H744	7H745	7H746	7H747	7H748	7H749	7H750	7H751	7H752	7H753	7H754	7H755	7H756	7H757	7H758	7H759	7H760	7H761	7H762	7H763	7H764	7H765	7H766	7H767	7H768	7H769	7H770	7H771	7H772	7H773	7H774	7H775	7H776	7H777	7H778	7H779	7H780	7H781	7H782	7H783	7H784	7H785	7H786	7H787	7H788	7H789	7H790	7H791	7H792	7H793	7H794	7H795	7H796	7H797	7H798	7H799	7H800	7H801	7H802	7H803	7H804	7H805	7H806	7H807	7H808	7H809	7H810	7H811	7H812	7H813	7H814	7H815	7H816	7H817	7H818	7H819	7H820	7H821	7H822	7H823	7H824	7H825	7H826	7H827	7H828	7H829	7H830	7H831	7H832	7H833	7H834	7H835	7H836	7H837	7H838	7H839	7H840	7H841	7H842	7H843	7H844	7H845	7H846	7H847	7H848	7H849	7H850	7H851	7H852	7H853	7H854	7H855	7H856	7H857	7H858	7H859	7H860	7H861	7H862	7H863	7H864	7H865	7H866	7H867	7H868	7H869	7H870	7H871	7H872	7H873	7H874	7H875	7H876	7H877	7H878	7H879	7H880	7H881	7H882	7H883	7H884	7H885	7H886	7H887	7H888	7H889	7H890	7H891	7H892	7H893	7H894	7H895	7H896	7H897	7H898	7H899	7H900	7H901	7H902	7H903	7H904	7H905	7H906	7H907	7H908	7H909	7H910	7H911	7H912	7H913	7H914	7H915	7H916	7H917	7H918	7H919	7H920	7H921	7H922	7H923	7H924	7H925	7H926	7H927	7H928	7H929	7H930	7H931	7H932	7H933	7H934	7H935	7H936	7H937	7H938	7H939	7H940	7H941	7H942	7H943	7H944	7H945	7H946	7H947	7H948	7H949	7H950	7H951	7H952	7H953	7H954	7H955	7H956	7H957	7H958	7H959	7H960	7H961	7H962	7H963	7H964	7H965	7H966	7H967	7H968	7H969	7H970	7H971	7H972	7H973	7H974	7H975	7H976	7H977	7H978	7H979	7H980	7H981	7H982	7H983	7H984	7H985	7H986	7H987	7H988	7H989	7H990	7H991	7H992	7H993	7H994	7H995	7H996	7H997	7H998	7H999	7H1000	7H1001	7H1002	7H1003	7H1004	7H1005	7H1006	7H1007	7H1008	7H1009	7H1010	7H1011	7H1012	7H1013	7H1014	7H1015	7H1016	7H1017	7H1018	7H1019	7H1020	7H1021	7H1022	7H1023	7H1024	7H1025	7H1026	7H1027	7H1028	7H1029	7H1030	7H1031	7H1032	7H1033	7H1034	7H1035	7H1036	7H1037	7H1038	7H1039	7H1040	7H1041	7H1042	7H1043	7H1044	7H1045	7H1046	7H1047	7H1048	7H1049	7H1050	7H1051	7H1052	7H1053	7H1054	7H1055	7H1056	7H1057	7H1058	7H1059	7H1060	7H1061	7H1062	7H1063	7H1064	7H1065	7H1066	7H1067	7H1068	7H1069	7H1070	7H1071	7H1072	7H1073	7H1074	7H1075	7H1076	7H1077	7H1078	7H1079	7H1080	7H1081	7H1082	7H1083	7H1084	7H1085	7H1086	7H1087	7H1088	7H1089	7H1090	7H1091	7H1092	7H1093	7H1094	7H1095	7H1096	7H1097	7H1098	7H1099	7H1100	7H1101	7H1102	7H1103	7H1104	7H1105	7H1106	7H1107	7H1108	7H1109	7H1110	7H1111	7H1112	7H1113	7H1114	7H1115	7H1116	7H1117	7H1118	7H1119	7H1120	7H1121	7H1122	7H1123	7H1124	7H1125	7H1126	7H1127	7H1128	7H1129	7H1130	7H1131	7H1132	7H1133	7H1134	7H1135	7H1136	7H1137	7H1138	7H1139	7H1140	7H1141	7H1142	7H1143	7H1144	7H1145	7H1146	7H1147	7H1148	7H1149	7H1150	7H1151	7H1152	7H1153	7H1154	7H1155	7H1156	7H1157	7H1158	7H1159	7H1160	7H1161	7H1162	7H1163	7H1164	7H1165	7H1166	7H1167	7H1168	7H1169	7H1170	7H1171	7H1172	7H1173	7H1174	7H1175	7H1176	7H1177	7H1178	7H1179	7H1180	7H1181	7H1182	7H1183	7H1184	7H1185	7H1186	7H1187	7H1188	7H1189	7H1190	7H1191	7H1192	7H1193	7H1194	7H1195	7H1196	7H1197	7H1198	7H1199	7H1200	7H1201	7H1202	7H1203	7H1204	7H1205	7H1206	7H1207	7H1208</
-------------	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	----------

Table 10b. Frequency of Stony Coral Taxa -All Sites FY 1990/1996

SITE CODES:	SP1	SP2	SP3	SP4	SP5	SP6	SP7	SP8	SP9	SP10	SP11	SP12	SP13	SP14	SP15	SP16	SP17	SP18	SP19	SP20	SP21	SP22	SP23	SP24	SP25	SP26	SP27	SP28	SP29	SP30	SP31	SP32	SP33	SP34	SP35	SP36	SP37	SP38	SP39	SP40	SP41	SP42	SP43	SP44	SP45	SP46	SP47	SP48	SP49	SP50	SP51	SP52	SP53	SP54	SP55	SP56	SP57	SP58	SP59	SP60	SP61	SP62	SP63	SP64	SP65	SP66	SP67	SP68	SP69	SP70	SP71	SP72	SP73	SP74	SP75	SP76	SP77	SP78	SP79	SP80	SP81	SP82	SP83	SP84	SP85	SP86	SP87	SP88	SP89	SP90	SP91	SP92	SP93	SP94	SP95	SP96	SP97	SP98	SP99	SP100	SP101	SP102	SP103	SP104	SP105	SP106	SP107	SP108	SP109	SP110	SP111	SP112	SP113	SP114	SP115	SP116	SP117	SP118	SP119	SP120	SP121	SP122	SP123	SP124	SP125	SP126	SP127	SP128	SP129	SP130	SP131	SP132	SP133	SP134	SP135	SP136	SP137	SP138	SP139	SP140	SP141	SP142	SP143	SP144	SP145	SP146	SP147	SP148	SP149	SP150	SP151	SP152	SP153	SP154	SP155	SP156	SP157	SP158	SP159	SP160	SP161	SP162	SP163	SP164	SP165	SP166	SP167	SP168	SP169	SP170	SP171	SP172	SP173	SP174	SP175	SP176	SP177	SP178	SP179	SP180	SP181	SP182	SP183	SP184	SP185	SP186	SP187	SP188	SP189	SP190	SP191	SP192	SP193	SP194	SP195	SP196	SP197	SP198	SP199	SP200	SP201	SP202	SP203	SP204	SP205	SP206	SP207	SP208	SP209	SP210	SP211	SP212	SP213	SP214	SP215	SP216	SP217	SP218	SP219	SP220	SP221	SP222	SP223	SP224	SP225	SP226	SP227	SP228	SP229	SP230	SP231	SP232	SP233	SP234	SP235	SP236	SP237	SP238	SP239	SP240	SP241	SP242	SP243	SP244	SP245	SP246	SP247	SP248	SP249	SP250	SP251	SP252	SP253	SP254	SP255	SP256	SP257	SP258	SP259	SP260	SP261	SP262	SP263	SP264	SP265	SP266	SP267	SP268	SP269	SP270	SP271	SP272	SP273	SP274	SP275	SP276	SP277	SP278	SP279	SP280	SP281	SP282	SP283	SP284	SP285	SP286	SP287	SP288	SP289	SP290	SP291	SP292	SP293	SP294	SP295	SP296	SP297	SP298	SP299	SP300	SP301	SP302	SP303	SP304	SP305	SP306	SP307	SP308	SP309	SP310	SP311	SP312	SP313	SP314	SP315	SP316	SP317	SP318	SP319	SP320	SP321	SP322	SP323	SP324	SP325	SP326	SP327	SP328	SP329	SP330	SP331	SP332	SP333	SP334	SP335	SP336	SP337	SP338	SP339	SP340	SP341	SP342	SP343	SP344	SP345	SP346	SP347	SP348	SP349	SP350	SP351	SP352	SP353	SP354	SP355	SP356	SP357	SP358	SP359	SP360	SP361	SP362	SP363	SP364	SP365	SP366	SP367	SP368	SP369	SP370	SP371	SP372	SP373	SP374	SP375	SP376	SP377	SP378	SP379	SP380	SP381	SP382	SP383	SP384	SP385	SP386	SP387	SP388	SP389	SP390	SP391	SP392	SP393	SP394	SP395	SP396	SP397	SP398	SP399	SP400	SP401	SP402	SP403	SP404	SP405	SP406	SP407	SP408	SP409	SP410	SP411	SP412	SP413	SP414	SP415	SP416	SP417	SP418	SP419	SP420	SP421	SP422	SP423	SP424	SP425	SP426	SP427	SP428	SP429	SP430	SP431	SP432	SP433	SP434	SP435	SP436	SP437	SP438	SP439	SP440	SP441	SP442	SP443	SP444	SP445	SP446	SP447	SP448	SP449	SP450	SP451	SP452	SP453	SP454	SP455	SP456	SP457	SP458	SP459	SP460	SP461	SP462	SP463	SP464	SP465	SP466	SP467	SP468	SP469	SP470	SP471	SP472	SP473	SP474	SP475	SP476	SP477	SP478	SP479	SP480	SP481	SP482	SP483	SP484	SP485	SP486	SP487	SP488	SP489	SP490	SP491	SP492	SP493	SP494	SP495	SP496	SP497	SP498	SP499	SP500	SP501	SP502	SP503	SP504	SP505	SP506	SP507	SP508	SP509	SP510	SP511	SP512	SP513	SP514	SP515	SP516	SP517	SP518	SP519	SP520	SP521	SP522	SP523	SP524	SP525	SP526	SP527	SP528	SP529	SP530	SP531	SP532	SP533	SP534	SP535	SP536	SP537	SP538	SP539	SP540	SP541	SP542	SP543	SP544	SP545	SP546	SP547	SP548	SP549	SP550	SP551	SP552	SP553	SP554	SP555	SP556	SP557	SP558	SP559	SP560	SP561	SP562	SP563	SP564	SP565	SP566	SP567	SP568	SP569	SP570	SP571	SP572	SP573	SP574	SP575	SP576	SP577	SP578	SP579	SP580	SP581	SP582	SP583	SP584	SP585	SP586	SP587	SP588	SP589	SP590	SP591	SP592	SP593	SP594	SP595	SP596	SP597	SP598	SP599	SP600	SP601	SP602	SP603	SP604	SP605	SP606	SP607	SP608	SP609	SP610	SP611	SP612	SP613	SP614	SP615	SP616	SP617	SP618	SP619	SP620	SP621	SP622	SP623	SP624	SP625	SP626	SP627	SP628	SP629	SP630	SP631	SP632	SP633	SP634	SP635	SP636	SP637	SP638	SP639	SP640	SP641	SP642	SP643	SP644	SP645	SP646	SP647	SP648	SP649	SP650	SP651	SP652	SP653	SP654	SP655	SP656	SP657	SP658	SP659	SP660	SP661	SP662	SP663	SP664	SP665	SP666	SP667	SP668	SP669	SP670	SP671	SP672	SP673	SP674	SP675	SP676	SP677	SP678	SP679	SP680	SP681	SP682	SP683	SP684	SP685	SP686	SP687	SP688	SP689	SP690	SP691	SP692	SP693	SP694	SP695	SP696	SP697	SP698	SP699	SP700	SP701	SP702	SP703	SP704	SP705	SP706	SP707	SP708	SP709	SP710	SP711	SP712	SP713	SP714	SP715	SP716	SP717	SP718	SP719	SP720	SP721	SP722	SP723	SP724	SP725	SP726	SP727	SP728	SP729	SP730	SP731	SP732	SP733	SP734	SP735	SP736	SP737	SP738	SP739	SP740	SP741	SP742	SP743	SP744	SP745	SP746	SP747	SP748	SP749	SP750	SP751	SP752	SP753	SP754	SP755	SP756	SP757	SP758	SP759	SP760	SP761	SP762	SP763	SP764	SP765	SP766	SP767	SP768	SP769	SP770	SP771	SP772	SP773	SP774	SP775	SP776	SP777	SP778	SP779	SP780	SP781	SP782	SP783	SP784	SP785	SP786	SP787	SP788	SP789	SP790	SP791	SP792	SP793	SP794	SP795	SP796	SP797	SP798	SP799	SP800	SP801	SP802	SP803	SP804	SP805	SP806	SP807	SP808	SP809	SP810	SP811	SP812	SP813	SP814	SP815	SP816	SP817	SP818	SP819	SP820	SP821	SP822	SP823	SP824	SP825	SP826	SP827	SP828	SP829	SP830	SP831	SP832	SP833	SP834	SP835	SP836	SP837	SP838	SP839	SP840	SP841	SP842	SP843	SP844	SP845	SP846	SP847	SP848	SP849	SP850	SP851	SP852	SP853	SP854	SP855	SP856	SP857	SP858	SP859	SP860	SP861	SP862	SP863	SP864	SP865	SP866	SP867	SP868	SP869	SP870	SP871	SP872	SP873	SP874	SP875	SP876	SP877	SP878	SP879	SP880	SP881	SP882	SP883	SP884	SP885	SP886	SP887	SP888	SP889	SP890	SP891	SP892	SP893	SP894	SP895	SP896	SP897	SP898	SP899	SP900	SP901	SP902	SP903	SP904	SP905	SP906	SP907	SP908	SP909	SP910	SP911	SP912	SP913	SP914	SP915	SP916	SP917	SP918	SP919	SP920	SP921	SP922	SP923	SP924	SP925	SP926	SP927	SP928	SP929	SP930	SP931	SP932	SP933	SP934	SP935	SP936	SP937	SP938	SP939	SP940	SP941	SP942	SP943	SP944	SP945	SP946	SP947	SP948	SP949	SP950	SP951	SP952	SP953	SP954	SP955	SP956	SP957	SP958	SP959	SP960	SP961	SP962	SP963	SP964	SP965	SP966	SP967	SP968	SP969	SP970	SP971	SP972	SP973	SP974	SP975	SP976	SP977	SP978	SP979	SP980	SP981	SP982	SP983	SP984	SP985	SP986	SP987	SP988	SP989	SP990	SP991	SP992	SP993	SP994	SP995	SP996	SP997	SP998	SP999	SP1000	SP1001	SP1002	SP1003	SP1004	SP1005	SP1006	SP1007	SP1008	SP1009	SP1010	SP1011	SP1012	SP1013	SP1014	SP1015	SP1016	SP1017	SP1018	SP1019	SP1020	SP1021	SP1022	SP1023	SP1024	SP1025	SP1026	SP1027	SP1028	SP1029	SP1030	SP1031	SP1032	SP1033	SP1034	SP1035	SP1036	SP1037	SP1038	SP1039	SP1040	SP1041	SP1042	SP1043	SP1044	SP1045	SP1046	SP1047	SP1048	SP1049	SP1050	SP1051	SP1052	SP1053	SP1054	SP1055	SP1056	SP1057	SP1058	SP1059	SP1060	SP1061	SP1062	SP1063	SP1064	SP1065	SP1066	SP1067	SP1068	SP1069	SP1070	SP1071	SP1072	SP1073	SP1074	SP1075	SP1076	SP1077	SP1078	SP1079	SP1080	SP1081	SP1082	SP1083	SP1084	SP1085	SP1086	SP1087	SP1088	SP1089	SP1090	SP1091	SP1092	SP1093	SP1094	SP1095	SP1096	SP1097	SP1098	SP1099	SP1100	SP1101	SP1102	SP1103	SP1104	SP1105	SP1106	SP1107	SP1108	SP1109	SP1110	SP1111	SP1112	SP1113	SP1114	SP1115	SP1116	SP1117	SP1118	SP1119	SP1120	SP1121	SP1122	SP1123	SP1124	SP1125	SP1126	SP1127	SP1128	SP1129	SP1130	SP1131	SP1132	SP1133	SP1134	SP1135	SP1136	SP1137	SP1138	SP1139	SP1140	SP1141	SP1142	SP1143	SP1144	SP1145	SP1146	SP1147	SP1148	SP1149	SP1150	SP1151	SP1152	SP1153	SP1154	SP1155	SP1156	SP1157	SP1158	SP1159	SP1160	SP1161	SP1162	SP1163	SP1164	SP1165	SP1166	SP1167	SP1168	SP1169	SP1170	SP1171	SP1172	SP1173	SP1174	SP1175	SP1176	SP1177	SP1178	SP1179	SP1180	SP1181	SP1182	SP1183	SP1184	SP1185	SP1186	SP1187	SP1188	SP1189	SP1190	SP1191	SP1192	SP1193	SP1194	SP1195	SP1196	SP1197	SP1198	SP1199	SP1200	SP1201	SP1202	SP1203	SP1204	SP1205	SP1206	SP1207	SP1208	SP1209	SP1210	SP1211	SP1212	SP1213	SP1214	SP1215	SP1216	SP1217	SP1218	SP1219	SP1220	SP1221	SP1222	SP1223	SP1224	SP1225	SP1226	SP1227	SP1228	SP1229	SP1230	SP1231	SP1232	SP1233	SP1234	SP1235	SP1236	SP1237	SP1238	SP1239	SP1240	SP1241	SP1242	SP1243	SP1244	SP1245	SP1246	SP1247	SP1248	SP1249	SP1250	SP1251	SP1252	SP1253	SP1254	SP1255	SP1256	SP1257	SP1258	SP1259	SP1260	SP1261	SP1262	SP1263	SP1264	SP1265	SP1266	SP1267	SP1268	SP1269	SP1270	SP1271	SP1272	SP1273	SP1274	SP1275	SP1276	SP1277	SP1278	SP1279	SP1280	SP1281	SP1282	SP1283	SP1284	SP1285	SP1286	SP1287	SP1288	SP1289	SP1290	SP1291	SP1292	SP1293	SP1294	SP1295	SP1296	SP1297	SP1298	SP1299	SP1300	SP1301	SP1302	SP1303	SP1304	SP1305	SP1306	SP1307	SP1308	SP1309	SP1310	SP1311	SP1312	SP1313	SP1314	SP1315	SP1316	SP1317	SP1318	SP1319	SP1320	SP1321	SP1322	SP1323	SP1324	SP1325	SP1326	SP1327	SP1328	SP1329	SP1330	SP1331	SP1332	SP1333	SP1334	SP1335	SP1336	SP1337	SP1338	SP1339	SP1340
-------------	-----	-----	-----	-----	-----	-----	-----	-----	-----	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

taxa were observed at 30 (75%) of the 40 sites. Four of the most frequently occurring of these prior taxa included *Porites astreoides*, *Siderastrea siderea*, *Porites porites*, and *Agaricia agaricites* complex. At half the sites, seven additional taxa were recorded. Five taxa were observed at 10% or less of the sites. Of these five, *Solenastrea hyades* was restricted to hardbottom site types, *Dendrogyra cylindrus* occurred at only shallow offshore sites, and *Porites branneri* was primarily observed at patch reef sites and one deep offshore site. *Astrangia poculata* and *Dendrogyra cylindrus* were the least frequently occurring (0.63) of all 43 taxa recorded (Table 10b). A range of seven to 35 taxa were recorded per site with an overall mean of 21.9 taxa per site.

By Site Type

Of the 43 total taxa observed, 19 were recorded at all four site types (Table 11a). Only three species were restricted to a single site type (*Acropora palmata* and *Dendrogyra cylindrus*-offshore shallow reef, *Solenastrea hyades*-hardbottom). *Dendrogyra cylindrus* was also the least frequently observed (Table 11b). Patch reefs had the greatest total number of taxa (40), shallow and deep offshore reefs had an intermediate number of taxa (34 and 36) and hardbottom sites had the least taxa (25).

Variability was greatest at patch reef sites and least at offshore deep sites (Figure 10). Long Key (7H2) had the most taxa (19) of the hardbottom sites; Molasses Key (5H2) had the fewest taxa (7) (Tables 12a,b). Western Head (5P2) had the most taxa (35) and Admiral (9P4) had the fewest taxa (16) for the patch reef sites (Tables 13a,b). Sand Key (2S1) and Grecian Rocks (9S2) had the greatest number of taxa (28) and Eastern Sambo (5S3) had the fewest (12) of the offshore shallow reef sites (Tables 14a,b). For offshore deep reef sites (Tables 15 a,b), Eastern Sambo (5D3) and Tennessee (7D2) had the most taxa (32 and 31, respectively) and Alligator (7D1) had the fewest (21). Table 16 summarizes most and least taxa at individual sites by type. Mean taxonomic richness was greatest at offshore deep and patch reef site types and least at hardbottom sites (Table 17).

Table 16. Summary of Taxonomic Richness of Individual Sites by Site Type

Site type	Hard Bottom (N=8)	Patch Reef (N=9)	Offshore Shallow (N=12)	Offshore Deep (N=11)
Sites with most taxa	Long Key (19 taxa)	Western Head (35 taxa)	Sand Key (28 taxa) Grecian Rocks (28 taxa)	Eastern Sambo (32 taxa) Tennessee (31 taxa)
Site with least taxa	Molasses Key (7 taxa)	Admiral (16 taxa)	Eastern Sambo (12 taxa)	Alligator (21 taxa)

Table 11a. Presence/Absence of Stony Coral Taxa-Site Types FY 1995/ 1996

SITE TYPES:	HARDBOTTOM	PATCH	SHALLOW OFFSHORE	DEEP OFFSHORE
STONY CORAL TAXA				
<i>Acropora cervicornis</i>	0	1	1	1
<i>Acropora palmata</i>	0	0	1	0
<i>Agaricia agaricites</i> (complex)	1	1	1	1
<i>Agaricia fragilis</i>	0	1	1	1
<i>Agaricia lemarckii</i>	0	1	0	1
<i>Astrangia poculata</i>	1	1	0	0
<i>Cladocora arbuscula</i>	1	1	0	0
<i>Colpophyllia natans</i>	1	1	1	1
<i>Dendrogyra cylindrus</i>	0	0	1	0
<i>Dichocoenia stokesii</i>	1	1	1	1
<i>Diploria clivosa</i>	1	1	1	1
<i>Diploria labyrinthiformis</i>	1	1	1	1
<i>Diploria strigosa</i>	1	1	1	1
<i>Eusmilia fastigiata</i>	0	1	1	1
<i>Favia fragum</i>	1	1	1	1
<i>Isophyllastrea rigida</i>	1	1	1	0
<i>Isophylla sinuosa</i>	1	1	1	1
<i>Leptoseris cucullata</i>	0	1	1	1
<i>Madracis decactis</i>	0	1	1	1
<i>Madracis mirabilis</i>	0	1	1	1
<i>Manicina areolata</i>	1	1	1	1
<i>Meandrina meandrites</i>	0	1	1	1
<i>Millepora alcicornis</i>	1	1	1	1
<i>Millepora complanata</i>	0	1	1	1
<i>Montastrea annularis</i> (complex)	1	1	1	1
<i>Montastrea cavernosa</i>	1	1	1	1
<i>Mycetophyllia elliciae</i>	0	1	0	1
<i>Mycetophyllia danaana</i>	0	1	1	1
<i>Mycetophyllia ferox</i>	0	1	1	1
<i>Mycetophyllia lamarckiana</i>	0	1	1	1
<i>Mussa angulosa</i>	0	1	0	1
<i>Oculina diffusa</i>	1	1	1	1
<i>Phyllangia americana</i>	1	1	0	0
<i>Porites astreoides</i>	1	1	1	1
<i>Porites branneri</i>	0	1	0	1
<i>Porites porites</i> (complex)	1	1	1	1
<i>Scolymia cubensis</i>	0	1	1	1
<i>Scolymia lacera</i>	1	1	0	1
<i>Siderastrea radians</i>	1	1	1	1
<i>Siderastrea sidera</i>	1	1	1	1
<i>Solenastrea boumtoni</i>	1	1	1	1
<i>Solenastrea hyades</i>	1	0	0	0
<i>Stephanocoenia michelinii</i>	1	1	1	1
Total number of taxa	25	40	34	36
<i>Mussid</i> (juvenile)	0	0	0	1
<i>Diadema antillarum</i>	0	0	0	0

Table 11b. Frequency of Stony Coral Taxa- Site Types FY 1995/1996

SITE TYPES:	HARDBOTTOM	PATCH	SHALLOW OFFSHORE	DEEP OFFSHORE
STONY CORAL TAXA				
<i>Acropora cervicornis</i>	0.00	0.25	0.30	0.35
<i>Acropora palmata</i>	0.00	0.00	0.41	0.00
<i>Agaricia agaricites</i> (complex)	0.16	0.93	0.98	1.00
<i>Agaricia fragilis</i>	0.00	0.15	0.07	0.63
<i>Agaricia lamarckii</i>	0.00	0.03	0.00	0.31
<i>Astrangia poculata</i>	0.06	0.01	0.00	0.00
<i>Cladocora arbuscula</i>	0.20	0.26	0.00	0.00
<i>Colpophyllia natans</i>	0.19	0.72	0.30	0.75
<i>Dendrogyra cylindrus</i>	0.00	0.00	0.05	0.00
<i>Dichocoenia stokesii</i>	0.47	0.88	0.47	0.94
<i>Diploria ciliosa</i>	0.34	0.29	0.40	0.10
<i>Diploria labyrinthiformis</i>	0.09	0.68	0.42	0.73
<i>Diploria strigosa</i>	0.28	0.78	0.38	0.72
<i>Eusmilia fastigiata</i>	0.00	0.64	0.26	0.90
<i>Favia fragum</i>	0.77	0.29	0.86	0.27
<i>Isophyllastrea rigida</i>	0.09	0.17	0.01	0.00
<i>Isophyllia sinuosa</i>	0.05	0.10	0.06	0.08
<i>Leptoseris cucullata</i>	0.00	0.31	0.17	0.78
<i>Madracis decactis</i>	0.00	0.31	0.22	0.77
<i>Madracis mirabilis</i>	0.00	0.03	0.06	0.50
<i>Manicina areolata</i>	0.33	0.03	0.02	0.66
<i>Meandrina meandrites</i>	0.00	0.56	0.38	0.84
<i>Millepora alcicornis</i>	0.95	0.99	0.93	1.00
<i>Millepora complanata</i>	0.00	0.19	0.84	0.02
<i>Montastraea annularis</i> (complex)	0.19	0.97	0.71	0.94
<i>Montastraea cavernosa</i>	0.31	0.94	0.75	0.95
<i>Mycetophyllia allicia</i>	0.00	0.33	0.00	0.39
<i>Mycetophyllia danaana</i>	0.00	0.36	0.18	0.31
<i>Mycetophyllia ferox</i>	0.00	0.21	0.15	0.49
<i>Mycetophyllia lamarckiana</i>	0.00	0.56	0.29	0.51
<i>Mussa angulosa</i>	0.00	0.44	0.00	0.15
<i>Oculina diffusa</i>	0.22	0.72	0.02	0.01
<i>Phyllangia americana</i>	0.11	0.10	0.00	0.00
<i>Porites astreoides</i>	0.72	0.99	0.92	1.00
<i>Porites branneri</i>	0.00	0.17	0.00	0.05
<i>Porites porites</i> (complex)	0.77	0.74	0.95	0.95
<i>Scolymia cubensis</i>	0.00	0.65	0.02	0.51
<i>Scolymia lacera</i>	0.03	0.31	0.00	0.01
<i>Siderastrea radians</i>	1.00	0.82	0.40	0.56
<i>Siderastrea sidera</i>	0.47	1.00	0.99	1.00
<i>Solenastrea bournoni</i>	0.33	0.54	0.05	0.33
<i>Solenastrea hyades</i>	0.22	0.00	0.00	0.00
<i>Stephanocoenia michelinii</i>	0.48	0.89	0.36	0.93
Mussel (juvenile)	0.03	0.24	0.01	0.41
URCHIN TAXA:				
<i>Diadema antillarum</i>	0.00	0.03	0.10	0.00

Figure 10. Taxonomic Richness by Site Type.

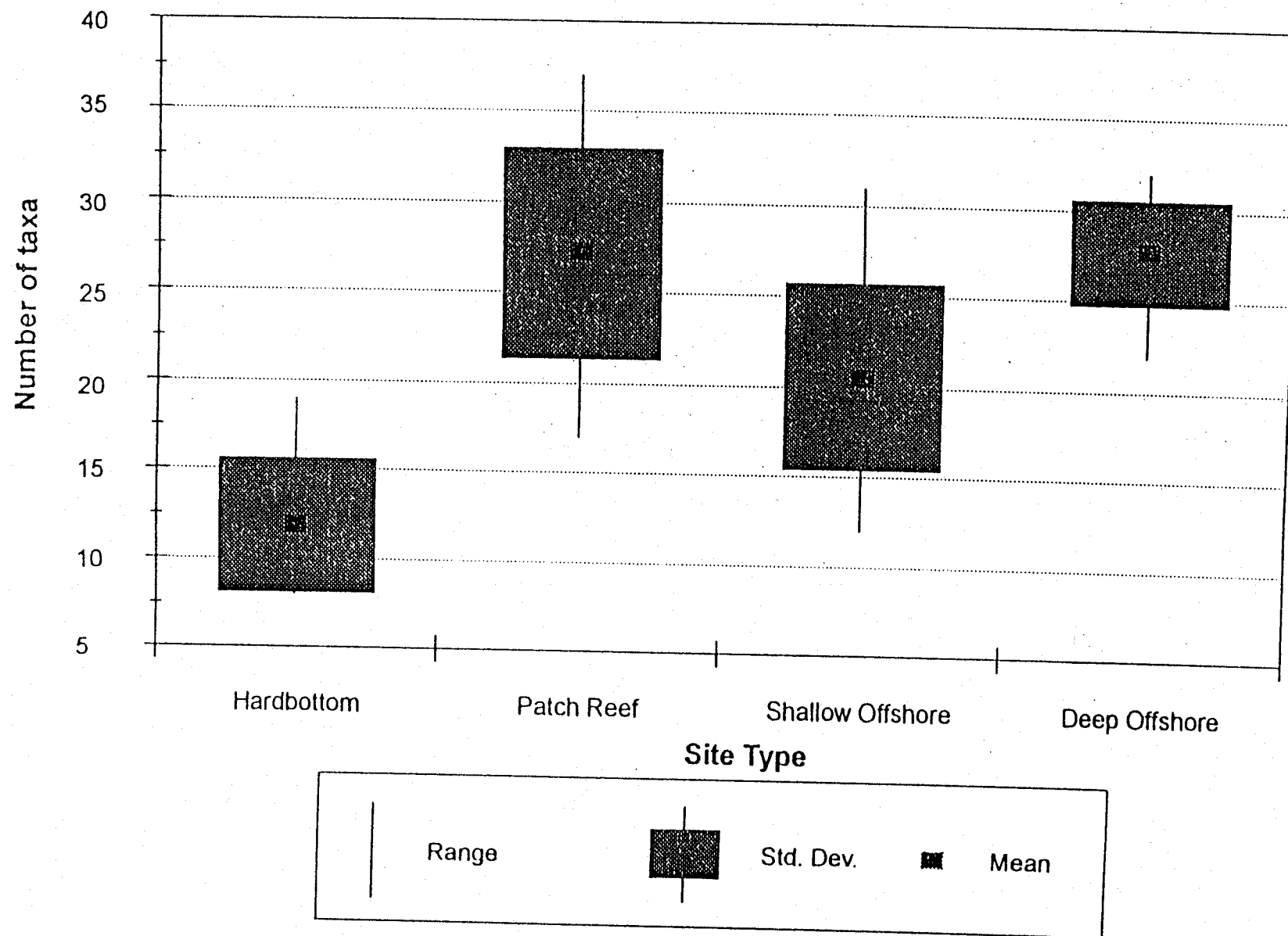


Table 12a. Presence/Absence of Stony Coral Taxa- Hardbottom FY 1996/1998

[illegible]

Table 12b. Frequency of Stony Coral Taxa- Hardbottom FY 1995/1996

[illegible]

Table 13a. Presence/Absence of Stony Coral Taxa- Patch Reefs FY 1995/1996

SITE CODES:	9P1	9P3	9P4	7P1	7P2	6P1	6P2	6P3	2P1	SUM
STONY CORAL TAXA										
<i>Acropora cervicornis</i>	1	1	0	1	0	0	1	1	0	5
<i>Acropora palmata</i>	0	0	0	0	0	0	0	0	0	0
<i>Agaricia agaricites</i> (complex)	1	1	1	1	1	1	1	1	1	9
<i>Agaricia fragilis</i>	1	1	0	0	0	0	0	1	1	4
<i>Agaricia lamarckii</i>	0	0	0	0	0	0	1	0	0	1
<i>Astrangia poculata</i>	0	0	0	0	0	0	1	0	0	1
<i>Cladocora arbuscula</i>	0	0	0	0	0	0	1	0	0	1
<i>Colpophyllia natans</i>	1	1	1	1	1	1	1	1	1	3
<i>Dendrogyra cylindrus</i>	0	0	0	0	0	0	0	0	0	0
<i>Dichocoenia stokesii</i>	1	1	1	1	1	1	1	1	1	9
<i>Diploria clivosa</i>	1	1	1	0	1	0	1	1	0	6
<i>Diploria labyrinthiformis</i>	1	1	1	1	1	1	1	1	0	8
<i>Diploria strigosa</i>	1	1	1	1	1	1	1	1	0	9
<i>Eusmilia fastigiata</i>	1	1	0	1	1	1	1	1	1	7
<i>Favia fragum</i>	1	1	0	1	1	0	1	0	0	5
<i>Isophyllastrea rigida</i>	0	0	0	1	1	0	1	0	0	3
<i>Isophylla sinuosa</i>	1	0	0	0	0	0	1	1	0	3
<i>Leptoseris cucullata</i>	1	0	0	0	0	1	1	1	0	4
<i>Madracis decactis</i>	1	0	0	1	1	0	1	1	1	6
<i>Madracis mirabilis</i>	0	1	0	0	0	0	1	0	0	2
<i>Manicina areolata</i>	0	1	0	0	0	0	0	0	0	1
<i>Meandrina meandrites</i>	1	1	1	1	1	0	1	1	1	8
<i>Millepora alcockii</i>	1	1	1	1	1	1	1	1	1	9
<i>Millepora complanata</i>	1	0	0	0	0	0	1	1	1	4
<i>Montastrea annularis</i> (complex)	1	1	1	1	1	1	1	1	1	9
<i>Montastrea cavernosa</i>	1	1	1	1	1	1	1	1	1	9
<i>Mycetophyllia alcyon</i>	1	0	0	1	0	1	1	1	0	5
<i>Mycetophyllia danaana</i>	1	0	0	0	1	1	1	1	0	5
<i>Mycetophyllia ferox</i>	1	0	0	0	1	1	0	1	0	4
<i>Mycetophyllia lamarckiana</i>	1	0	0	1	1	1	0	1	0	5
<i>Mussa angulosa</i>	1	1	0	1	1	1	1	1	1	8
<i>Oculina diffusa</i>	1	1	0	1	1	1	1	1	1	8
<i>Phyllangia americana</i>	0	0	0	0	0	0	0	0	1	1
<i>Porites astreoides</i>	1	1	1	1	1	1	1	1	1	9
<i>Porites branneri</i>	0	0	0	0	0	1	1	1	0	3
<i>Porites porites</i> (complex)	1	1	1	1	1	1	1	1	1	9
<i>Scolymia cubensis</i>	1	0	0	1	1	1	1	1	1	7
<i>Scolymia lecora</i>	0	0	0	1	0	0	1	1	1	4
<i>Siderastrea redlani</i>	1	1	1	1	1	1	1	1	1	9
<i>Siderastrea sideres</i>	1	1	1	1	1	1	1	1	1	9
<i>Solenastrea bourmonii</i>	1	1	1	1	1	1	1	1	0	8
<i>Solenastrea hyades</i>	0	0	0	0	0	0	0	0	0	0
<i>Stephanocoenia michelinii</i>	1	1	1	1	1	1	1	1	1	9
Total number of taxa	31	24	16	26	26	24	35	33	22	
Mean number of taxa=	26.33	Standard deviation=		5.89						
Mussid (juvenile)	0	0	0	1	1	1	0	0	0	3
URCHIN TAXA										
<i>Diodema antillarum</i>	0	0	0	1	0	0	0	0	0	1

Data entry by: KJF DATE: 12/2/96

Table 13b. Frequency of Stony Coral Taxa-Patch Reefs FY 1996/1998

SITE CODES:	SP1	SP3	SP4	7P1	7P2	SP1	SP2	SP3	2P1	Frequency of Occurrence
STONY CORAL TAXA										
<i>Acropora cervicornis</i>	1	0.25	0	0.5	0	0	0.25	0.25	0	0.25
<i>Acropora palmata</i>	0	0	0	0	0	0	0	0	0	0.00
<i>Agaveia egeria</i> (complex)	0	1	1	1	1	1	0.5	0.875	0	0.93
<i>Agaveia fragilis</i>	0.875	0.25	0	0	0	0	0	0.125	0.125	0.15
<i>Agaveia lemniscata</i>	0	0	0	0	0	0	0.25	0	0	0.03
<i>Astrangia pocellus</i>	0	0	0	0	0	0	0.125	0	0	0.01
<i>Cladocora arbuscula</i>	0	0	0	0	0	0	0.875	0.5	1	0.28
<i>Colpophyllia natans</i>	0.5	0.25	0.5	1	1	1	1	1	0.25	0.72
<i>Dendrogyra cylindrus</i>	0	0	0	0	0	0	0	0	0	0.00
<i>Dichocoenia stokesii</i>	1	1	1	1	1	0.75	0	1	0.125	0.88
<i>Diploria cfronsa</i>	0.5	0.5	0.25	0	0.25	0	0.5	0.625	0	0.29
<i>Diploria labyrinthiformis</i>	0.75	1	0.75	1	0.875	0.5	0.5	0.75	0	0.68
<i>Diploria sericea</i>	0.75	0.75	0.25	0.75	0.75	0.75	1	1	1	0.78
<i>Eusmilia fastigata</i>	1	0.625	0	1	1	0.25	1	0.875	0	0.64
<i>Favia fragum</i>	0.75	1	0	0.5	0.25	0	0.125	0	0	0.29
<i>Isophyllastrea rigida</i>	0	0	0	1	0.25	0	0.25	0	0	0.17
<i>Isophylla alveosa</i>	0.25	0	0	0	0	0	0.125	0.5	0	0.10
<i>Leptoseris cucullata</i>	1	0	0	0	0	0.625	0.75	0.375	0	0.31
<i>Madracis decactis</i>	0.75	0	0	0.625	0.25	0	0.125	0.625	0.375	0.31
<i>Madracis mirabilis</i>	0	0.125	0	0	0	0	0.125	0	0	0.03
<i>Merichia erodites</i>	0	0.25	0	0	0	0	0	0	0	0.03
<i>Neodittia mesenterica</i>	0.25	0.75	0.5	1	0.75	0	1	0.875	0.125	0.58
<i>Millepora alcicornis</i>	1	1	1	0.875	1	1	0.625	0.375	0.5	0.99
<i>Millepora complanata</i>	0.25	0	0	0	0	0	1	1	1	0.19
<i>Montastrea annularis</i> (complex)	1	0.75	1	1	1	1	1	1	1	0.97
<i>Montastrea cavernosa</i>	1	1	0.5	1	1	0.5	1	1	1	0.94
<i>Mycetophyllia allicia</i>	0.25	0	0	0.75	0	0.5	1	0.5	0	0.33
<i>Mycetophyllia densa</i>	1	0	0	0	0.25	0.875	0.125	1	0	0.36
<i>Mycetophyllia hexa</i>	0.5	0	0	0	0.375	0.875	0	0.125	0	0.21
<i>Mycetophyllia lemniscata</i>	1	0	0	1	1	1	0	1	0	0.58
<i>Mussa angulosa</i>	0.25	0.25	0	0.25	0.25	0.75	1	1	0.25	0.44
<i>Oculina diffusa</i>	0.625	0.75	0	1	0.625	0.5	1	1	1	0.72
<i>Phyllangia americana</i>	0	0	0	0	0	0	0	0	0.75	0.10
<i>Porites asereoides</i>	1	1	1	1	1	0.875	1	1	1	0.99
<i>Porites brassardii</i>	0	0	0	0	0	0.875	0.125	0.125	0	0.17
<i>Porites porites</i> (complex)	0.375	1	0.25	1	0.5	1	1	1	1	0.85
<i>Scolymia cubensis</i>	0	0	0	0.25	0.5	1	0.5	0.625	0.875	0.31
<i>Scolymia lacer</i>	0.75	1	1	1	1	0.25	0.5	0.875	1	0.82
<i>Siderastrea radialis</i>	1	1	1	1	1	0.5	1	1	1	1.00
<i>Siderastrea siderea</i>	1	1	1	1	1	0.25	0.75	1	0	0.54
<i>Solenastrea bournoni</i>	0	0.75	0.25	0.25	0.375	0.5	0	1	0	0.00
<i>Solenastrea hyades</i>	0	0	0	0	0	0	0	0	0	0.89
<i>Stephanocoenia michelinii</i>	1	0.75	0.25	1	1	1	1	1	1	0.89
<i>Mussa (juvenile)</i>	0	0	0	0.875	0.5	0.75	0	0	0	0.24
URCHIN TAXA										
<i>Diadema enditatum</i>	0	0	0	0.25	0	0	0	0	0	0.03

Table 14a. Presence/Absence of Stony Coral Taxa- Shallow Offshore Reefs FY 1995/1996

SITE CODES:	951	952	953	954	751	752	651	652	653	654	655	251	SUM
STONY CORAL TAXA													
<i>Acropora cervicornis</i>	0	1	0	0	0	1	1	1	0	1	1	1	7.00
<i>Acropora palmata</i>	1	1	1	0	0	0	1	0	0	1	1	1	7.00
<i>Agaricia agaricites</i> (complex)	1	1	1	1	1	1	1	1	1	1	1	1	12.00
<i>Agaricia fragilis</i>	0	1	1	0	1	0	0	0	0	1	0	1	5.00
<i>Agaricia lamarckii</i>	0	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Astrangia poculata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Cladocora arbuscula</i>	0	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Colpophyllia natans</i>	0	1	0	0	1	1	1	1	0	1	0	1	7.00
<i>Dendrogyra cylindrus</i>	0	0	0	1	0	0	1	0	0	0	0	1	3.00
<i>Dichocoenia stokesii</i>	0	1	1	1	1	1	1	1	0	0	0	1	8.00
<i>Diploria clivosa</i>	1	1	0	0	1	1	0	1	0	1	1	1	8.00
<i>Diploria labyrinthiformis</i>	0	1	1	1	1	1	1	1	0	1	0	1	9.00
<i>Diploria strigosa</i>	1	1	1	0	0	1	1	1	0	1	0	1	9.00
<i>Eusmilia fastigiata</i>	1	1	1	1	0	1	0	1	0	1	1	1	8.00
<i>Favia fragum</i>	1	1	1	1	1	1	1	1	1	1	1	1	12.00
<i>Isophyllastrea rigida</i>	0	1	0	0	0	0	0	0	0	0	0	0	1.00
<i>Isophylla sinuosa</i>	0	1	0	0	0	0	0	0	0	0	1	1	3.00
<i>Leptoseris cucullata</i>	0	1	1	1	0	0	0	0	0	0	1	1	5.00
<i>Madracis decactis</i>	0	0	1	1	1	1	0	0	1	1	1	1	8.00
<i>Madracis mirabilis</i>	0	0	0	0	0	0	0	0	1	1	0	0	2.00
<i>Manicina areolata</i>	0	0	0	0	0	0	0	0	1	1	0	0	2.00
<i>Meandrina meandrites</i>	0	1	1	1	1	1	1	1	0	1	0	1	9.00
<i>Millepora alcockii</i>	1	1	1	1	1	1	1	1	1	1	1	1	12.00
<i>Millepora complanata</i>	1	1	1	1	1	1	1	1	1	1	1	1	12.00
<i>Montastraea annularis</i> (complex)	1	1	1	1	1	1	1	1	1	1	1	1	12.00
<i>Montastraea cavernosa</i>	1	1	1	0	1	1	1	1	1	1	1	1	11.00
<i>Mycetophyllia allicia</i>	0	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Mycetophyllia danaana</i>	0	1	1	0	0	0	1	1	0	0	0	1	5.00
<i>Mycetophyllia ferox</i>	1	0	1	0	0	0	1	1	0	1	0	0	5.00
<i>Mycetophyllia lamarckiana</i>	1	1	1	0	0	0	1	1	0	1	0	1	7.00
<i>Mussa angulosa</i>	0	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Oculina diffusa</i>	0	0	0	0	0	1	0	0	0	0	0	0	1.00
<i>Phyllangia americana</i>	0	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Porites astreoides</i>	1	1	1	0	1	1	1	1	1	1	1	1	11.00
<i>Porites branneri</i>	0	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Porites porites</i> (complex)	1	1	1	1	1	1	1	1	1	1	1	1	12.00
<i>Scolymia cubensis</i>	0	1	0	0	0	0	0	1	1	1	1	1	1.00
<i>Scolymia lacera</i>	0	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Siderastrea radiana</i>	1	1	1	0	1	1	0	0	1	1	1	1	9.00
<i>Siderastrea sideres</i>	1	1	1	1	1	1	1	1	1	1	1	1	12.00
<i>Solenastrea boumouti</i>	0	1	0	0	0	1	0	0	0	0	0	0	2.00
<i>Solenastrea hyades</i>	0	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Stephanocoenia michelinii</i>	0	1	0	1	1	1	1	1	0	0	1	1	8.00
Total number of taxa	16.00	28.00	22.00	16.00	18.00	22.00	21.00	21.00	12.00	23.00	18.00	28.00	
Mean number of taxa=	20.33	Standard deviation=		4.85									
Mussak (juvenile)	0	0	0	0	0	0	0	0	0	0	0	1	

URCHIN TAXA

Diadema antillarum

1	1	0	0	0	0	0	0	0	1	1	1	0
---	---	---	---	---	---	---	---	---	---	---	---	---

DATA ENTRY BY: KJF DATE:12/2/96

Table 14b. Frequency of Stony Coral Taxa- Shallow Offshore Reefs FY 1995/1996

SITE CODES:	951	952	953	954	751	752	851	852	853	854	856	251	Frequency of Occurrence
STONY CORAL TAXA													
<i>Acropora cervicornis</i>	0	0.5	0	0	0	1	0.25	0.825	0	0.5	0.5	0.25	0.30
<i>Acropora palmata</i>	0.5	0.25	1	0	0	0	0.25	0	0	1	1	0.875	0.41
<i>Agaricia agaricites</i> (complex)	1	0.75	1	1	1	1	1	1	1	1	1	1	0.98
<i>Agaricia fragilis</i>	0	0.125	0.25	0	0.25	0	0	0	0	0.125	0	0.125	0.07
<i>Agaricia lemarckii</i>	0	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Astrangia poculata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Cladocora arbuscula</i>	0	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Colpophyllia natans</i>	0	0.5	0	0	0.25	0.5	0.375	0.875	0	0.875	0	0.25	0.30
<i>Dendrogyra cylindrus</i>	0	0	0	0.25	0	0	0.25	0	0	0	0	0.125	0.05
<i>Dichocoenia stokesii</i>	0	1	0.5	0.625	0.75	1	0.5	0.625	0	0	0	0.625	0.47
<i>Diploria clivosa</i>	1	0.5	0	0	0.25	0.5	0	0.25	0	0.5	0.875	0.875	0.40
<i>Diploria labyrinthiformis</i>	0	0.5	0.75	0.25	0.25	1	0.75	1	0	0.25	0	0.25	0.42
<i>Diploria strigosa</i>	0.25	0.25	0.75	0	0	1	0.25	0.75	0	0.25	0.5	0.5	0.38
<i>Eusmilia fastiglata</i>	0.25	0.5	0.5	0.825	0	0.25	0	0.5	0	0.125	0	0.375	0.26
<i>Favia fragum</i>	1	0.625	1	1	0.75	0.25	1	0.75	1	1	1	1	0.88
<i>Isophyllastrea rigida</i>	0	0.125	0	0	0	0	0	0	0	0	0	0	0.01
<i>Isophylla sinuosa</i>	0	0.125	0	0	0	0	0	0	0	0	0.25	0.375	0.06
<i>Leptoseris cucullata</i>	0	0.5	0.5	0.75	0	0	0	0	0	0	0.125	0.125	0.17
<i>Madracis decactis</i>	0	0	0.5	0.375	0.25	0.25	0	0	0.375	0.25	0.25	0.375	0.22
<i>Madracis mirabilis</i>	0	0	0	0	0	0	0	0	0.125	0.625	0	0	0.06
<i>Manicina areolata</i>	0	0	0	0	0	0	0	0	0	0	0	0.25	0.02
<i>Meandrina meandrites</i>	0	0.125	0.75	0.5	0.5	0.75	0.75	0.5	0	0.125	0	0.5	0.38
<i>Millepora alcicornis</i>	1	1	1	1	1	1	1	1	0.625	0.75	0.75	1	0.93
<i>Millepora complanata</i>	1	0.25	1	1	1	0.5	1	0.625	1	1	0.75	1	0.84
<i>Montastrea annularis</i> (complex)	0.25	0.75	1	0.25	0.25	0.75	0.75	1	1	1	0.5	1	0.71
<i>Montastrea cavernosa</i>	0.5	0.75	1	0	1	1	0.75	1	0.5	0.5	1	1	0.75
<i>Mycetophyllia alliciae</i>	0	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Mycetophyllia danaensis</i>	0	0.5	0.5	0	0	0	0.25	0.375	0	0	0	0.5	0.18
<i>Mycetophyllia ferox</i>	0.25	0	0.375	0	0	0	0.25	0.75	0	0.125	0	0	0.15
<i>Mycetophyllia lemarckiana</i>	0.25	1	0.5	0	0	0	0.25	0.375	0	0.25	0	0.875	0.29
<i>Mussa angulosa</i>	0	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Oculina diffusa</i>	0	0	0	0	0	0.25	0	0	0	0	0	0	0.02
<i>Phyllangia americana</i>	0	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Porites astreoides</i>	1	1	1	0	1	1	1	1	1	1	1	1	0.92
<i>Porites brunneri</i>	0	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Porites porites</i> (complex)	1	1	1	0.875	1	1	0.75	0.75	1	1	1	1	0.95
<i>Scolymia cubensis</i>	0	0.25	0	0	0	0	0	0	0	0	0	0	0.02
<i>Scolymia lacera</i>	0	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Siderastrea radlani</i>	0.75	1	0.125	0	0.5	1	0	0	0.25	0.25	0.375	0.5	0.40
<i>Siderastrea sideraea</i>	1	1	1	1	1	1	1	1	0.875	1	1	1	0.99
<i>Solenastrea bournoni</i>	0	0.375	0	0	0	0.25	0	0	0	0	0	0	0.05
<i>Solenastrea hyades</i>	0	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Stephanocoenia michelinii</i>	0	0.5	0	0.5	0.5	0.75	0.75	0.75	0	0	0.25	0.375	0.36

<i>Mussid (juvenile)</i>	0	0	0	0	0	0	0	0	0	0	0	0.125	0.01
--------------------------	---	---	---	---	---	---	---	---	---	---	---	-------	------

URCHIN TAXA

<i>Diadema antillarum</i>	0.25	0.25	0	0	0	0	0	0	0.5	0.125	0.125	0	0.10
---------------------------	------	------	---	---	---	---	---	---	-----	-------	-------	---	------

DATA ENTRY BY: KJF DATE: 12/6/96

Table 15a. Presence/Absence of Stony Coral Taxa- Deep Offshore Reefs FY 1996/1996

SITE CODES:	9D1	9D3	9D4	7D1	7D2	8D1	8D2	8D3	8D4	8D6	2D1	SUM
STONY CORAL TAXA												
<i>Acropora cervicornis</i>	1	0	0	0	1	0	1	1	1	1	1	7.00
<i>Acropora palmata</i>	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Agaricia agaricites</i> (complex)	1	1	1	1	1	1	1	1	1	1	1	11.00
<i>Agaricia fragilis</i>	1	1	1	0	1	1	1	1	1	1	1	10.00
<i>Agaricia lamarckii</i>	1	1	1	1	1	1	1	1	1	1	1	11.00
<i>Astrangia poculata</i>	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Cladocora arbuscula</i>	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Colpophyllia natans</i>	1	1	0	1	1	1	1	1	1	1	1	10.00
<i>Dendrogyra cylindrus</i>	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Dichocoenia stokesii</i>	1	1	1	1	1	1	1	1	1	1	1	11.00
<i>Diploria ciliosa</i>	0	0	0	0	1	1	1	1	1	1	1	11.00
<i>Diploria labyrinthiformis</i>	1	1	1	1	1	1	1	1	1	1	1	11.00
<i>Diploria strigosa</i>	0	1	1	1	1	1	1	1	1	1	1	11.00
<i>Eusmilia fastigiata</i>	1	1	1	1	1	1	1	1	1	1	1	11.00
<i>Favia fragum</i>	1	0	1	0	1	0	0	0	1	1	1	6.00
<i>Isophyllastrea rigida</i>	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Isophylla sinuosa</i>	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Leptoseris cucullata</i>	1	1	1	1	1	1	1	1	1	1	1	11.00
<i>Madracis decactis</i>	1	1	1	0	1	1	1	1	1	1	0	10.00
<i>Madracis mirabilis</i>	0	1	1	0	1	1	1	1	1	1	1	10.00
<i>Manicina areolata</i>	1	1	0	1	1	1	1	1	1	1	1	9.00
<i>Meandrina meandrites</i>	1	1	1	1	1	1	1	1	0	1	1	9.00
<i>Millepora albicornis</i>	1	1	1	1	1	1	1	1	1	1	1	11.00
<i>Millepora complanata</i>	0	0	0	0	0	0	0	0	1	1	1	11.00
<i>Montastrea annularis</i> (complex)	1	1	1	1	1	1	1	1	1	1	1	11.00
<i>Montastrea cavernosa</i>	1	1	1	1	1	1	1	1	1	1	1	11.00
<i>Mycetophyllia alliciae</i>	1	1	1	0	1	1	1	1	1	1	1	11.00
<i>Mycetophyllia danaana</i>	1	0	0	0	1	1	1	1	0	1	0	8.00
<i>Mycetophyllia ferox</i>	1	0	1	0	1	1	0	1	1	1	1	7.00
<i>Mycetophyllia lamarckiana</i>	1	1	1	1	1	1	1	1	1	1	1	9.00
<i>Mussa angulosa</i>	1	1	1	0	1	1	1	1	1	1	1	11.00
<i>Oculina diffusa</i>	0	0	0	1	0	0	1	1	0	0	0	6.00
<i>Phyllangia americana</i>	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Porites astreoides</i>	1	1	1	1	1	1	1	1	1	1	1	11.00
<i>Porites branneri</i>	0	1	0	0	0	0	0	0	0	0	0	0.00
<i>Porites porites</i> (complex)	1	1	1	1	1	1	1	1	1	1	1	11.00
<i>Scolymia cubensis</i>	1	0	1	0	1	1	1	1	1	1	1	11.00
<i>Scolymia lacera</i>	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Siderastrea radians</i>	0	1	1	1	1	1	1	1	0	0	0	7.00
<i>Siderastrea sidera</i>	1	1	1	1	1	1	1	1	1	1	1	10.00
<i>Solenastrea bournoni</i>	1	0	0	1	1	1	1	1	1	1	1	11.00
<i>Solenastrea hyades</i>	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Stephanocoenia michelinii</i>	1	1	1	1	1	1	1	1	1	1	1	11.00
Total number of taxa	27.00	26.00	26.00	21.00	31.00	27.00	27.00	32.00	27.00	28.00	28.00	
Mean number of taxa=	27.09	Standard deviation=		2.96								
Mussid (juvenile)	1	0	0	1	1	1	1	0	0	1	1	7.00
URCHIN TAXA												
<i>Diadema antillarum</i>	0	0	0	0	0	0	0	0	0	0	0	0.00

DATA ENTRY BY: KJF DATE: 12/2/96

Table 16b. Frequency of stony Coral Taxa- Deep Offshore Reefs FY 1996/1996

SITE CODES:	9D1	9D3	9D4	7D1	7D2	8D1	8D2	8D3	8D4	8D6	2D1	Frequency of Occurrence
STONY CORAL TAXA												
<i>Acropora cervicornis</i>	0.25	0	0	0	0.75	0	0.5	0.375	1	0.5	0.5	0.35
<i>Acropora palmata</i>	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Agaricia agaricites</i> (complex)	1	1	1	1	1	1	1	1	1	1	1	1.00
<i>Agaricia fragilis</i>	1	0.5	0.375	0	0.625	1	0.75	1	1	1	1	0.63
<i>Agaricia lamarckii</i>	0.25	0.75	0.75	0.25	0.25	0.25	0.25	0.625	0.75	0.5	0.375	0.31
<i>Astrangia poculata</i>	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Cladocora arbuscula</i>	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Colpophyllia natans</i>	1	0.25	0	0.5	0.75	0.75	1	1	1	1	1	0.75
<i>Dendrogya cylindrus</i>	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Dichocoenia stokesii</i>	1	1	1	1	1	1	1	1	1	1	1	0.00
<i>Diploria cilirosa</i>	0	0	0	0	0.375	0	0	0.125	0.25	0	0.375	0.10
<i>Diploria labyrinthiformis</i>	0.75	1	0.25	0.625	0.875	0.5	0.75	0.75	0.75	0.75	0.75	0.73
<i>Diploria strigosa</i>	0	0.75	0.25	0.5	1	1	1	1	0.875	0.75	0.75	0.72
<i>Eusmilia fastigiata</i>	1	1	0.75	0.25	1	1	1	1	0.875	0.75	1	0.90
<i>Favia fragum</i>	0.25	0	0.125	0	0.375	0	0	0	0.875	1	1	0.27
<i>Isophyllastrea rigida</i>	0	0	0	0	0	0	0	0	0.75	1	0.5	0.00
<i>Isophylla sinuosa</i>	0	0	0	0	0	0	0	0	0	0	0	0.08
<i>Leptoseris cucullata</i>	1	1	1	0.25	0.625	1	1	0.375	0.25	0	0.25	0.78
<i>Madracis decactis</i>	1	1	1	0	0.875	0.75	0.75	1	0.5	0.75	0.875	0.77
<i>Madracis mirabilis</i>	0	0.5	0.5	0	1	0.25	1	1	0.5	0.75	0.25	0.50
<i>Maritima areolata</i>	0.25	0.25	0	1	1	1	0.75	1	0.5	0.75	0.25	0.66
<i>Meadrina meandrites</i>	0.5	1	0.75	1	1	0.75	0.75	1	0	1	1	0.84
<i>Millepora albicornis</i>	1	1	1	1	1	1	1	1	0.5	1	1	1.00
<i>Millepora complanata</i>	0	0	0	0	0	0	0	0	1	1	1	0.02
<i>Montastrea annularis</i> (complex)	1	0.75	1	0.625	1	1	1	1	1	1	1	0.94
<i>Montastrea cavernosa</i>	1	1	1	1	1	1	1	1	1	1	1	0.95
<i>Mycetophyllia allicia</i>	1	0.25	0.25	0	0.25	0.75	0.5	1	0.5	1	1	0.39
<i>Mycetophyllia densaena</i>	0.75	0	0	0	0.625	0.25	0	0.375	0.125	0.75	0.5	0.31
<i>Mycetophyllia ferax</i>	1	0	0.25	0	0.625	0.75	0.25	1	0.25	1	0.25	0.49
<i>Mycetophyllia lamarckiana</i>	1	0.25	0.25	0.25	0.25	0.125	1	0.875	0.875	0.5	0.25	0.51
<i>Mussa angulosa</i>	0.5	0.25	0.25	0	0.25	0	0.125	0.25	0	0	0	0.15
<i>Oculina diffusa</i>	0	0	0	0.125	0	0	0	0	0	0	0	0.01
<i>Phyllangia americana</i>	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Porites astreoides</i>	1	1	1	1	1	1	1	1	1	1	1	1.00
<i>Porites bremeri</i>	0	0.5	0	0	0	0	0	0	0	0	0	0.05
<i>Porites porites</i> (complex)	1	1	1	1	1	0.75	0.75	1	1	1	1	0.95
<i>Scolymia cubensis</i>	0.625	0	1	0	0.75	1	0	1	1	1	1	0.51
<i>Scolymia lacera</i>	0	0	0	0	0	0	0	0.125	0	0	0.25	0.01
<i>Siderastrea radiana</i>	0	0.5	1	1	0.25	0.75	0.375	0.25	0.375	0.625	1	0.56
<i>Siderastrea sideres</i>	1	1	1	1	1	1	1	1	1	1	1	1.00
<i>Solenastrea bournoni</i>	0.25	0	0	0.75	0.25	1	0.125	0.5	0	0.25	0.5	0.33
<i>Solenastrea hyades</i>	0	0	0	0	0	0	0	0	0	0	0	0.00
<i>Stephanocoenia michelinii</i>	1	1	1	1	1	1	1	1	0.375	1	0.875	0.93
<i>Mussel (juvenile)</i>	0.75	0	0	0.25	1	0.625	1	0	0	0.375	0.5	0.41
URCHIN TAXA												
<i>Diodema antillarum</i>	0	0	0	0	0	0	0	0	0	0	0	0.00

DATA ENTRY BY: KJF DATE: 12/2/96

Bray Curtis Similarity classification pattern for hardbottom sites (Figure 11) documents that Rattle Snake Key (9 H1), El Radabob (9H2), Dove Key (9H3), and Molasses Keys (5H2) are similar. These sites are relatively close to shore. Long Key (7H2) and Moser Channel (5H1) are also closely linked; Jaap Reef was relatively similar; Content Keys were least similar (Figure 11). Rattlesnake Key and El Radabob Key sites (9H1 - 9H2) were most similar (82.76) and Molasses Key and Jaap Reef (5H2 - 5H3) were least similar (34.92) (Table 18). Hardbottom sites had the lowest mean site similarity and the greatest variability of all site groups (Figure 12). Variability was high because some sites had very few taxa, *e.g.*, Dove Key (9) whereas other sites were much richer taxonomically (Long Key, 19).

Table 17. Summary of Taxonomic Richness by Site Type

Site Type	Hardbottom (N=8)	Patch Reef (N=9)	Offshore Shallow (N=12)	Offshore Deep (N=11)
Mean taxonomic richness	11.88	26.33	20.33	27.09
Standard deviation	4.12	5.89	4.85	2.95
Range	7 to 19	16 to 35	12 to 28	21 to 32
Total taxa/type	25	40	34	36

West Turtle Shoal, Dustan Rocks, Turtle Reef, and Cliff Green exhibited high similarity among patch reef sites (Figure 13). Dustan Rocks and West Turtle Shoal were the most similar (84.69, Table 19). Admiral Reef and Western Head were least similar (54.61) to each other; however, Smith Shoal was least similar to all other patch reef sites.

Sombrero (5S1), Looe Key (5S2), Molasses (9S3) and Sand Key (2S1) were the most similar (Table 19, Figure 14) among shallow offshore sites. Carysfort (9S1), Western Sambo (5D4) and Rock Key (2S1) were also closely related. Conch (9S4) was least similar to most offshore shallow sites; however, Eastern Sambo (5S3) and Grecian Rocks ((9S2) had the lowest similarity value (54.46) (Table 20). The mean and standard deviation were similar to that of the previous patch reef sites (Figure 12).

Seven offshore deep reef sites (Carysfort, Sombrero, Looe Key, Eastern Sambo, Tennessee, Rock Key and Sand Key) clustered with greater than 80% similarity (Figure 15, Table 21). Molasses and Conch also had greater than 80% similarity (86.21); however, they were slightly less similar to the aforementioned sites. Alligator (7D1) and Western Sambo (5D4) were least similar (61.42) among offshore deep sites. Outer reefs exhibited highest intersite similarity among all site types; however, variability was quite similar to that for offshore shallow reef sites (Figure 12).

Figure 11. Classification, Hardbottom Sites
Rattle Snake

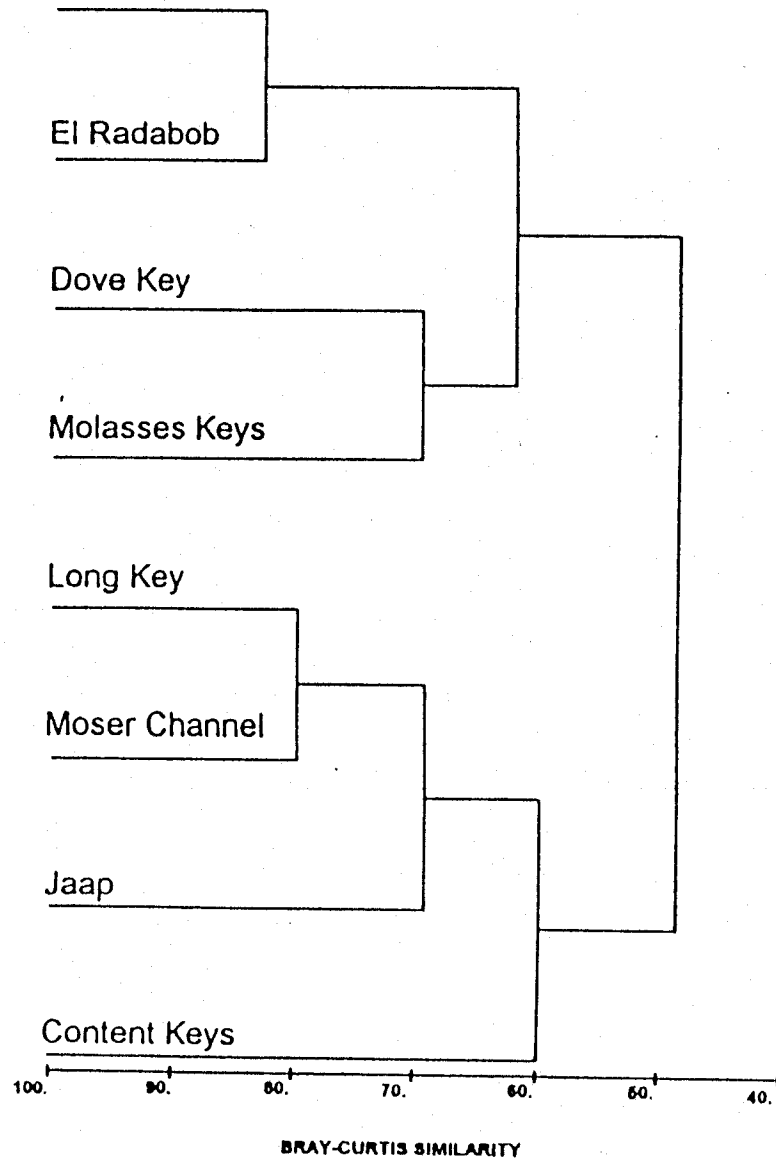


Figure 12. Similarity of Sites Within Site Types.

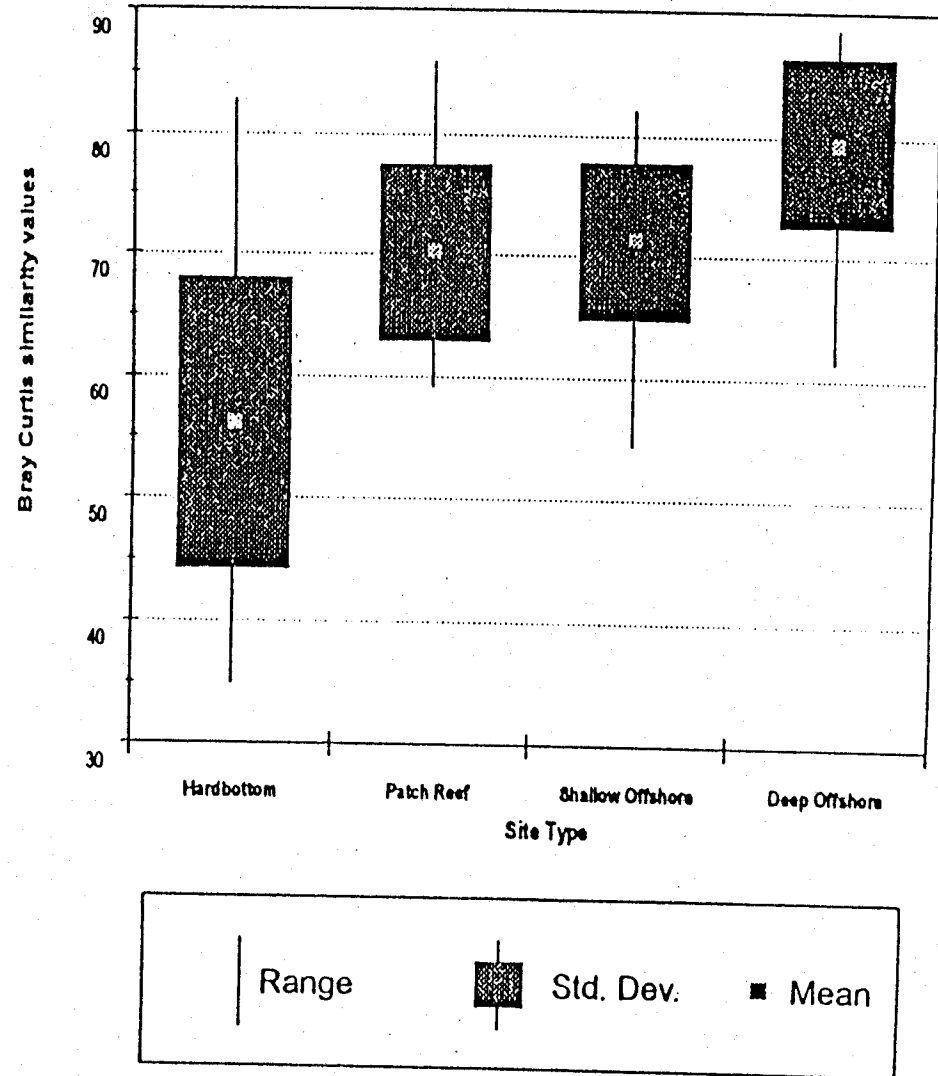


Table 18. Bray Curtis Similarity Index Values for Hardbottom Sites.

	Rattle							
	Snake							
El Radabob (EL)	82.759	EL						
Dove Key (DK)	68.966	62.963	DK					
Long Key (LK)	48.837	50.000	46.341	LK				
Moser Channel (MC)	53.333	56.338	47.887	79.798	MC			
Molasses Keys (MK)	55.670	60.674	69.663	41.379	52.033	MK		
Jaap Reef (JR)	52.288	55.172	35.862	72.637	65.922	34.921	JR	
Content Keys (CK)	60.938	53.333	46.667	60.227	59.740	43.564	59.873	

Table 19. Bray Curtis Similarity Index Values for Patch Reef Sites.

	Turtle							
Porter (P)	73.716	P						
Admiral (A)	57.348	74.576	A					
W. Turtle Shoal (WTS)	74.595	72.171	58.909	WTS				
Dustan (D)	78.338	76.190	69.421	84.685	D			
W. Washer Woman (WW)	73.256	65.116	59.438	72.941	76.221	WW		
Western Head (WH)	66.313	65.868	54.610	70.777	69.412	66.859	WH	
Cliff Green (CG)	81.443	70.145	56.655	79.167	77.493	75.978	80.818	CG
Smith Shoal (SS)	59.306	62.044	55.856	65.176	65.000	59.930	66.250	68.882

Figure 13. Classification, Patch Reef Sites.

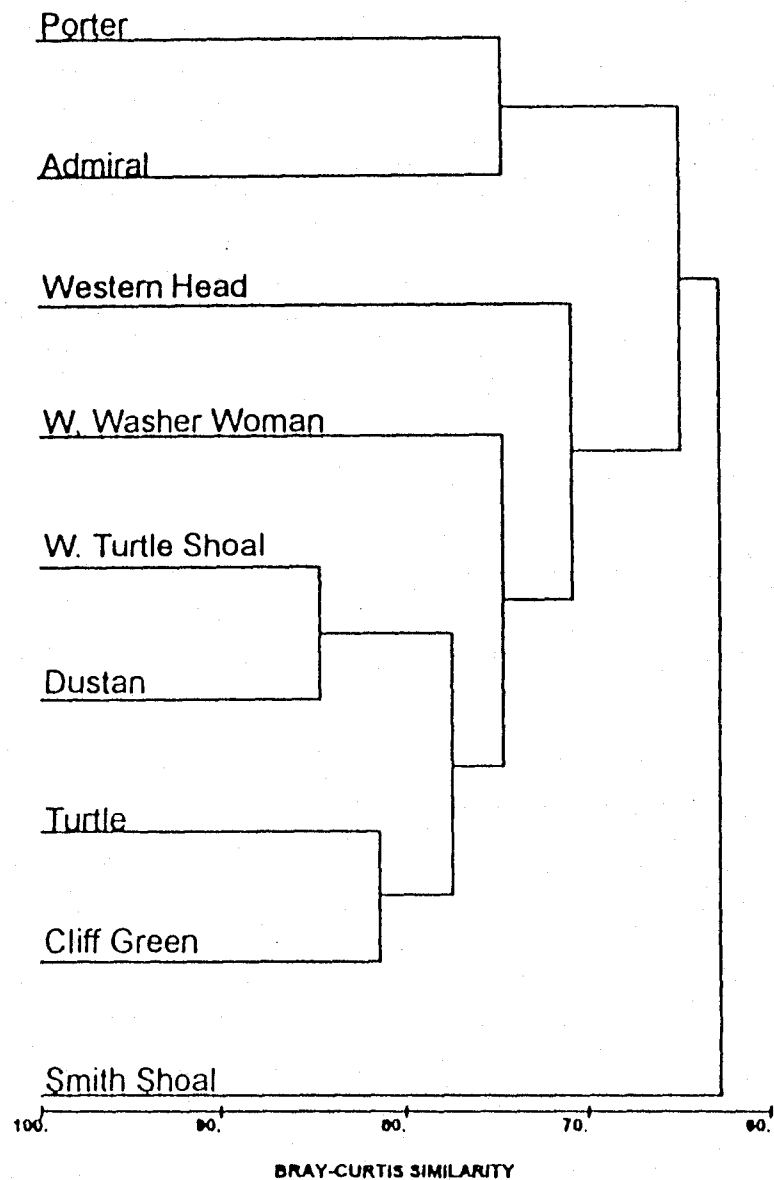
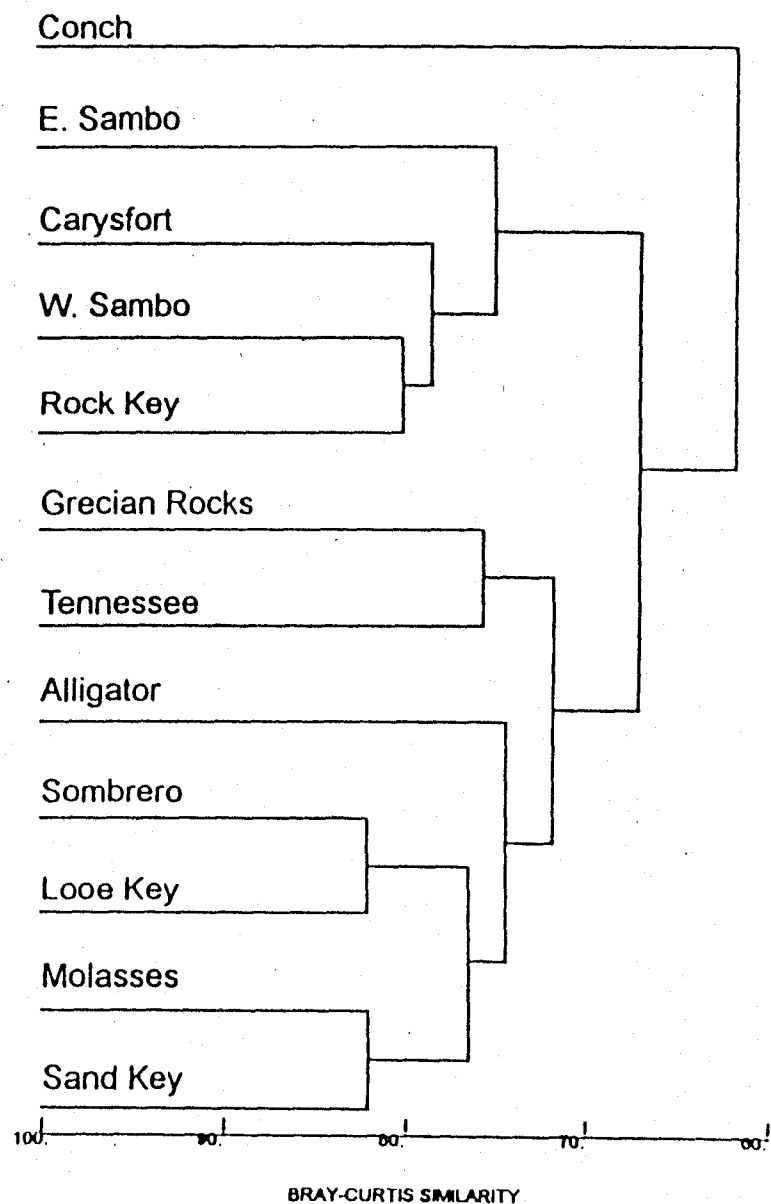


Figure 14. Classification, Shallow Offshore Sites



Classification of all sites (Figure 16) documents that seven of eight hardbottom sites clustered at slightly greater than 50% similarity. Jaap Reef (off Sugarloaf Key) is included as a hardbottom type; however it is more similar to a patch reef community. Although it is very close to shore, it has high relief massive *Montastraea annularis* colonies typical of patch reefs. Only Rattle Snake and El Radabob hardbottoms had greater than 80% similarity. Five of the patch reef sites clustered at greater than 70% similarity. Again, Smith Shoal, Porter, and Admiral were least similar among patch reefs. Nine of twelve shallow offshore sites were linked at 70% similarity. Grecian Rocks and Tennessee shallow sites were linked outside the main group of shallow sites. Ten of eleven offshore deep reef sites were clustered at 75% similarity.

Multi-Dimensional Scaling ordination analysis for the hardbottom sites loosely clustered Long Key, Moser Channel, and Jaap Reef together (Figure 17). Rattle Snake, El Radabob and Dove were also loosely clustered. Content Keys and Molasses Keys sites were the least equivalent among hardbottom sites.

Turtle Reef, West Turtle Shoal, Dustan Rocks, and Cliff Green were most closely related in a larger cluster of patch reefs (Figure 18) which also included West Washer Woman, Western Head, and Porter Patch. Admiral and Smith Shoal were outside the primary cluster.

Among offshore shallow sites, Western Sambo, Rock Key, and Carysfort were closely clustered (Figure 19). Five other sites clustered loosely whereas Grecian Rocks, Eastern Sambo and Conch were outside these two clusters.

Tennessee, Rock Key, Sombrero, Looe Key, and Eastern Sambo offshore deep sites were grouped closely (Figure 20). Sand Key and Carysfort deep sites were proximal to the primary cluster of offshore deep sites. Conch and Molasses offshore deep stations were clustered together but separate from the primary cluster. Alligator and Western Sambo sites displayed the weakest linkage to the other offshore deep sites.

Figure 21 exhibits the pooled MDS ordination of hardbottom, patch reef, offshore shallow, and offshore deep sites. The patch reef and offshore deep sites were enmeshed in an overlapping cluster. The offshore shallow sites also clustered relatively closely. Proximity of the Looe Key Shallow site and Western Sambo deep site nearly linked the two clusters. The two Gulf sites (one patch and one hardbottom) were linked and were depicted as related to the loosely clustered remaining hardbottom sites.

Species Inventory Summary

Overall, a few species were restricted to particular site types, but the majority of species occurred throughout the Sanctuary. Both the Bray Curtis and Multi-Dimensional Scaling analyses provided similar results in relating sites within each site type and comparing among the four site types.

Figure 17. MDS Ordination of Hardbottom Sites.

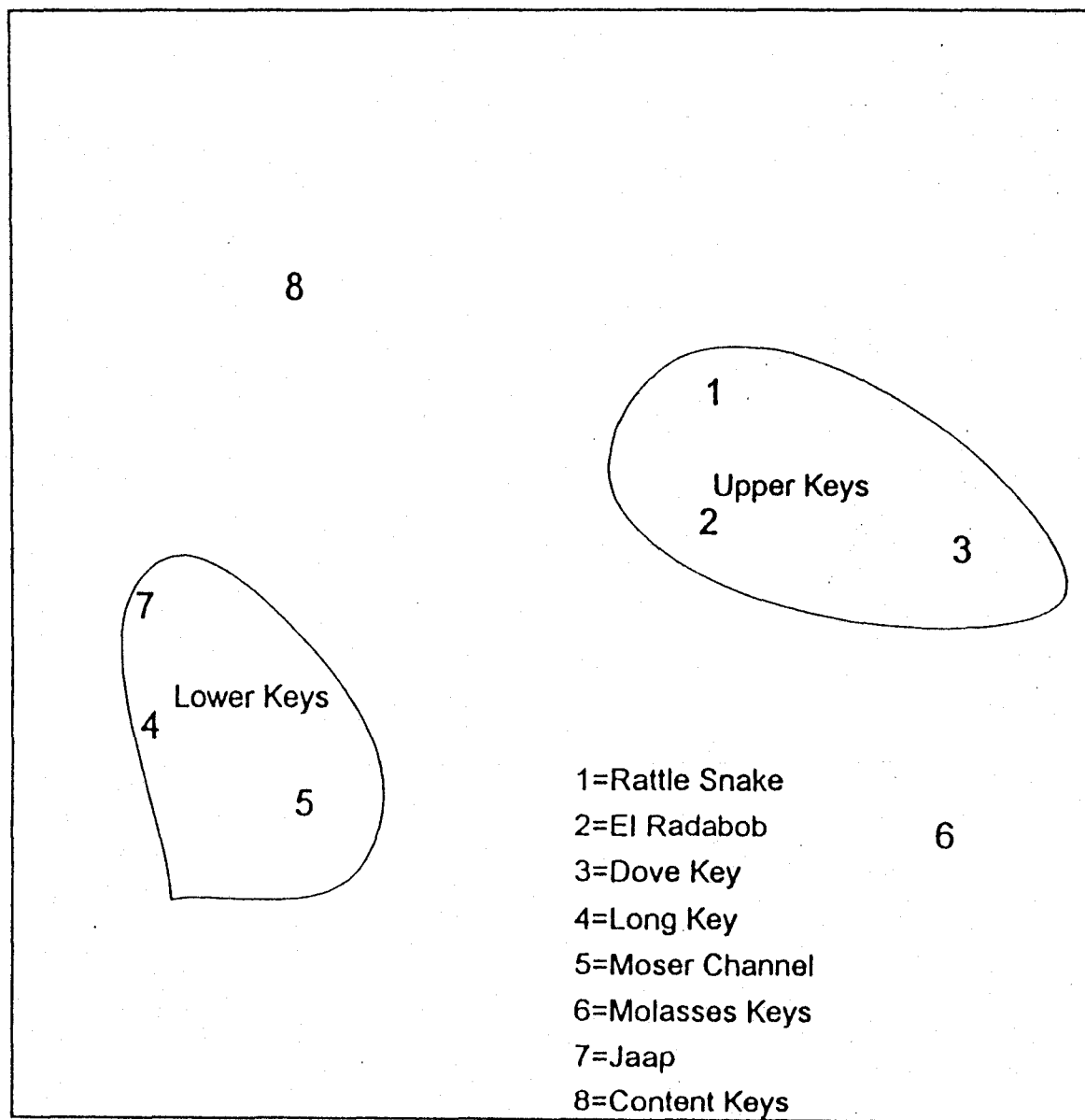


Figure 18. MDS Ordination of Patch Reef Sites.

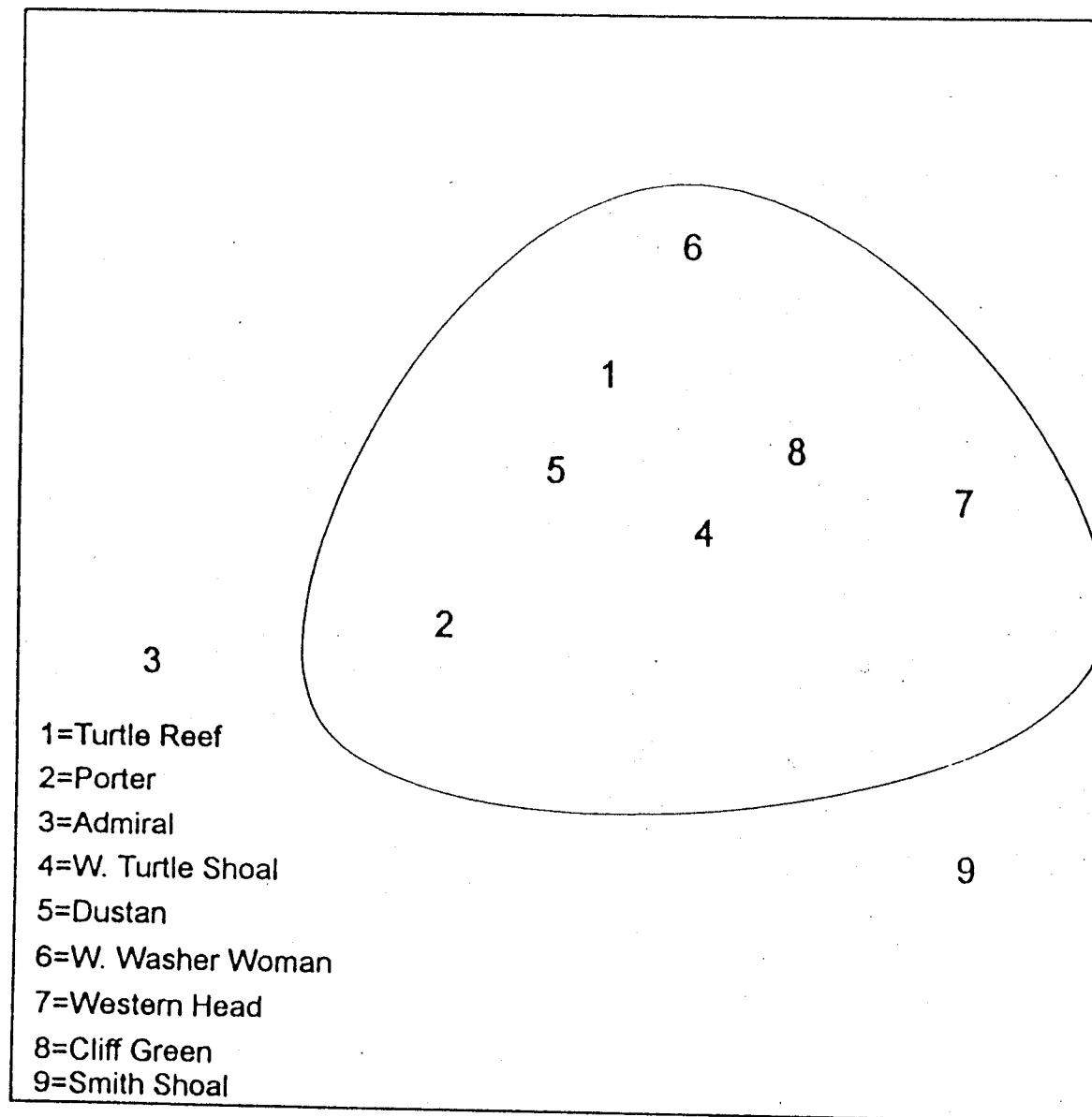


Figure 19. MDS Ordination of Offshore Shallow Sites.

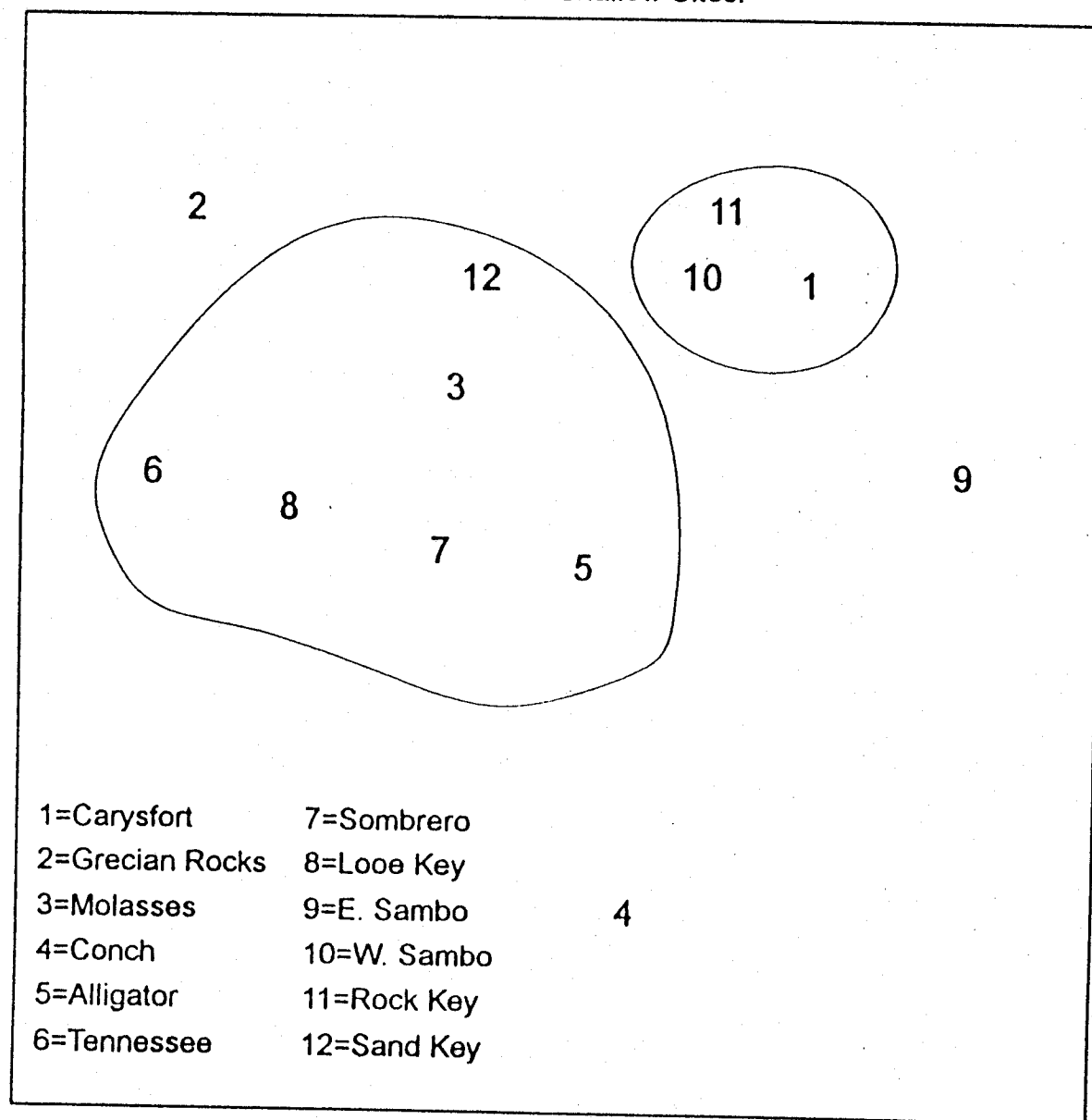


Figure 20. MDS Ordination of Offshore Deep Sites.

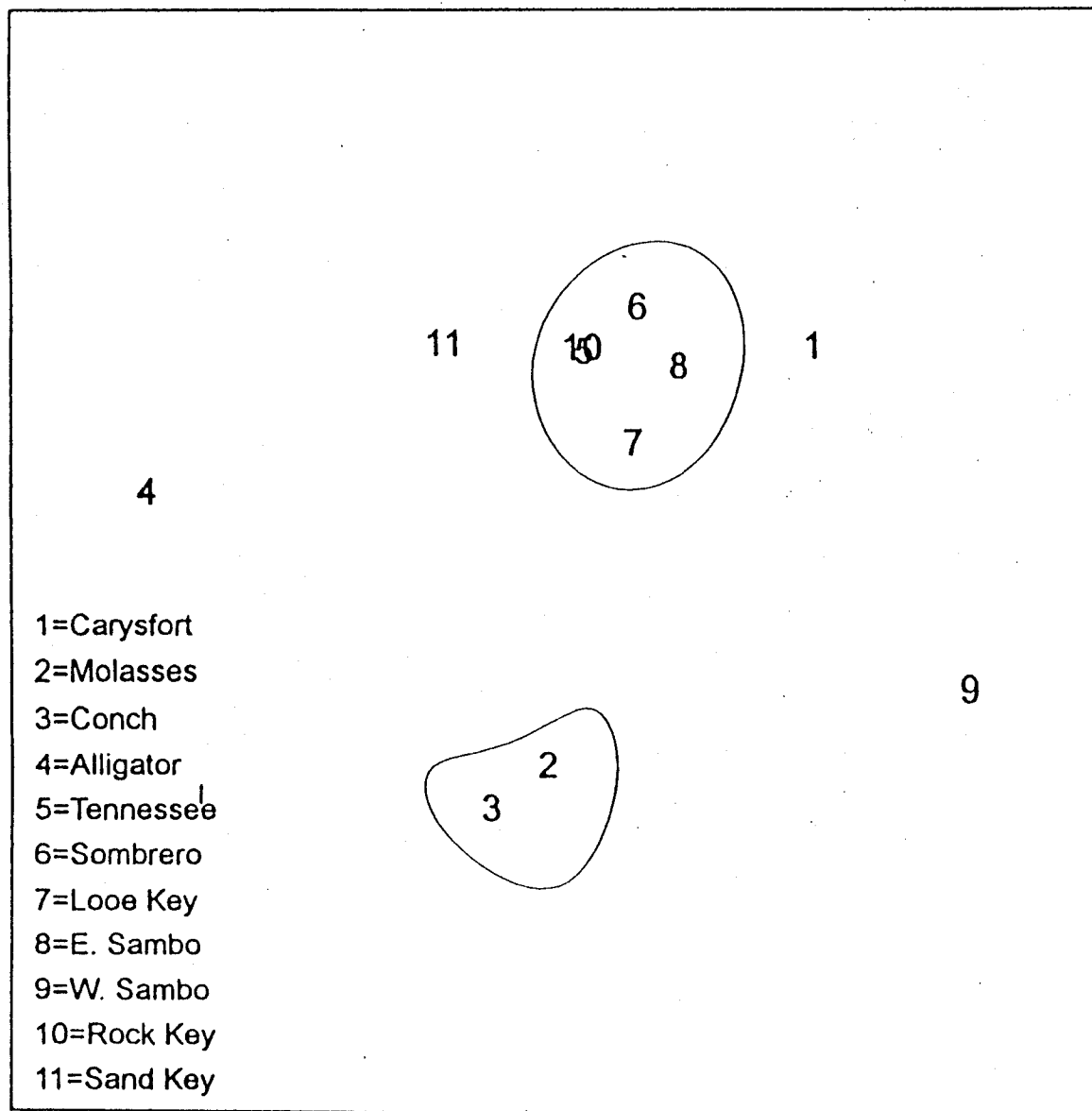
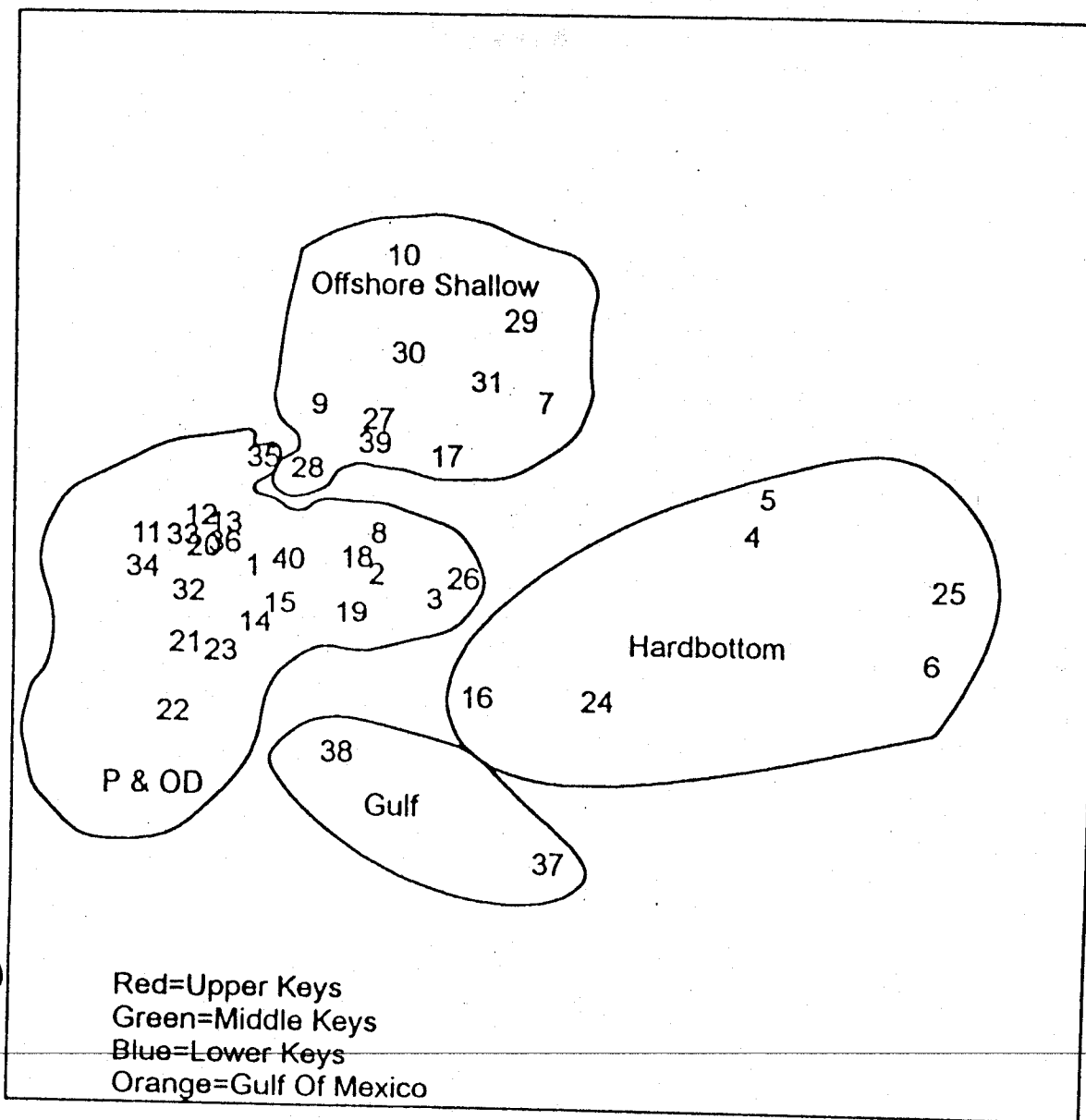


Figure 21. MDS Ordination of All Sites.

- 1=Turtle (P)
- 2=Porter (P)
- 3=Admiral (P)
- 4=Rattle Snake (H)
- 5=El Radabob (H)
- 6=Dove Key (H)
- 7=Carysfort (S)
- 8=Grecian Rocks (S)
- 9=Molasses (S)
- 10=Conch(S)
- 11=Carysfort (D)
- 12=Molasses (D)
- 13=Conch (D)
- 14=W. Turtle Shoal (P)
- 15=Dustan (P)
- 16=Long Key (H)
- 17=Alligator (S)
- 18=Tennessee (S)
- 19=Alligator (D)
- 20=Tennessee (D)
- 21=W. Washer Woman (P)
- 22=Western Head (P)
- 23=Cliff Green (P)



- 24=Moser Channel (H)
- 25=Molasses Keys (H)
- 26=Jaap (H)
- 27=Sombrero (S)
- 28=Looe Key (S)
- 29=E. Sambo (S)
- 30=W. Sambo (S)
- 31=Rock Key (S)
- 32=Sombrero (D)
- 33=Looe Key (D)
- 34=E. Sambo (D)
- 35=W. Sambo (D)
- 36=Rock Key (D)
- 37=Content Keys (H)
- 38=Smith Shoal (P)
- 39=Sand Key (S)
- 40=Sand Key (D)

On a broad scale, the analyses indicated that although there were discernible differences among the stony coral taxa present at hardbottom and offshore shallow site types, there were few differences in stony coral taxa present at offshore deep and patch reef sites. There were also no major differences in stony coral taxa present among the same types in different water quality segments (on a Sanctuary-wide basis).

Disease and bleaching (condition) information were recorded during regular sampling on a time available basis at hardbottom, patch reef, and shallow offshore sites. None was collected at deep offshore sites by CRMP monitoring personnel due to time constraints. However, Dr. Debbie Santavy (EPA Gulf Breeze Lab) conducted disease/condition surveys at Conch, Sand Key and Rock Key deep reef sites during the October EPA sponsored cruise aboard the OSV Anderson. The following summary was compiled from CRMP data only.

A total of 87 abnormalities were recorded during species inventories. Bleaching represented 70% of the abnormalities recorded. For hardbottom and patch reef sites, a maximum of seven abnormalities were recorded at one site (3H1, Content Keys; 5P1, West Washerwoman) (Tables 22a,b). A maximum of 8 abnormalities for shallow offshore sites was recorded at Looe Key (5S2) (Table 22c).

Bleaching was the most often recorded abnormality (Figure 22). No more than one incidence of any abnormality was recorded for any species at a hardbottom site. At patch reefs, eight abnormalities was the maximum with seven of the eight bleached cases for *Siderastrea siderea*. At offshore shallow reefs, seven abnormalities were the maximum. Bleaching was again the abnormality recorded in six of seven cases for *Favia fragum*. The maximum number of abnormalities recorded for any one species overall was 11 (*Siderastrea siderea* and *Montastrea annularis* complex).

Video Data Processing

With multiple investigators and labs in three different states, it was necessary to automate as many sequences as possible to ease the work load for all labs and to insure consistency among labs. Most project development efforts in the Dustan lab were focused on three problems: (1) image conversion from analog Hi8 tape to digital format, (2) image processing and software development needed to extract high-quality, compact images from videotape, and (3) software development for extracting information from images.

(1) Image Conversion (framegrabbing)

From each of the composite transects sampled, 120 images are being harvested and written to CD-ROM resulting in a data set of at least 20,000 images each year to process and analyze. Extensive time and effort was devoted to selecting an appropriate framegrabber board to subsample Hi8 videotape transects onto compact disk. Given the large number of frames which needed to be represented, it was essential to capture these images on the fly. A system that was capable of grabbing a field at a time (rather than a whole frame) and could

Figure 15. Classification, Deep Offshore Sites

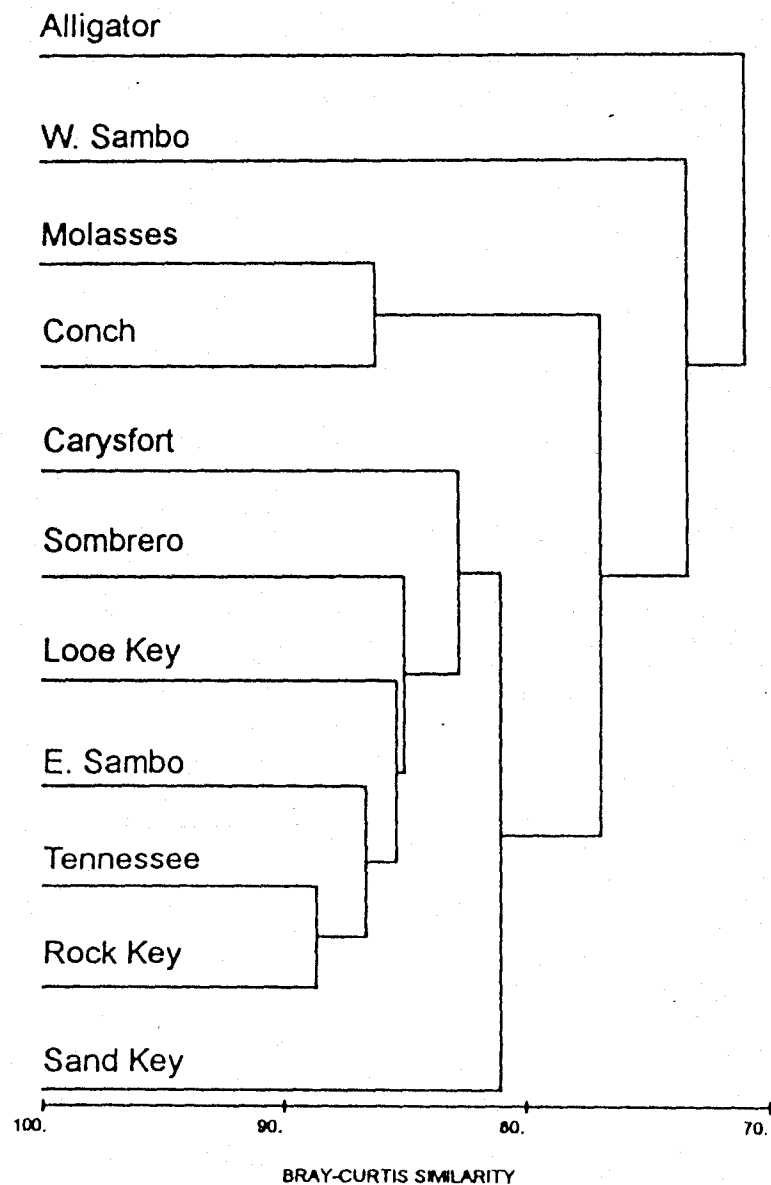


Figure 16. Classification, All Sites

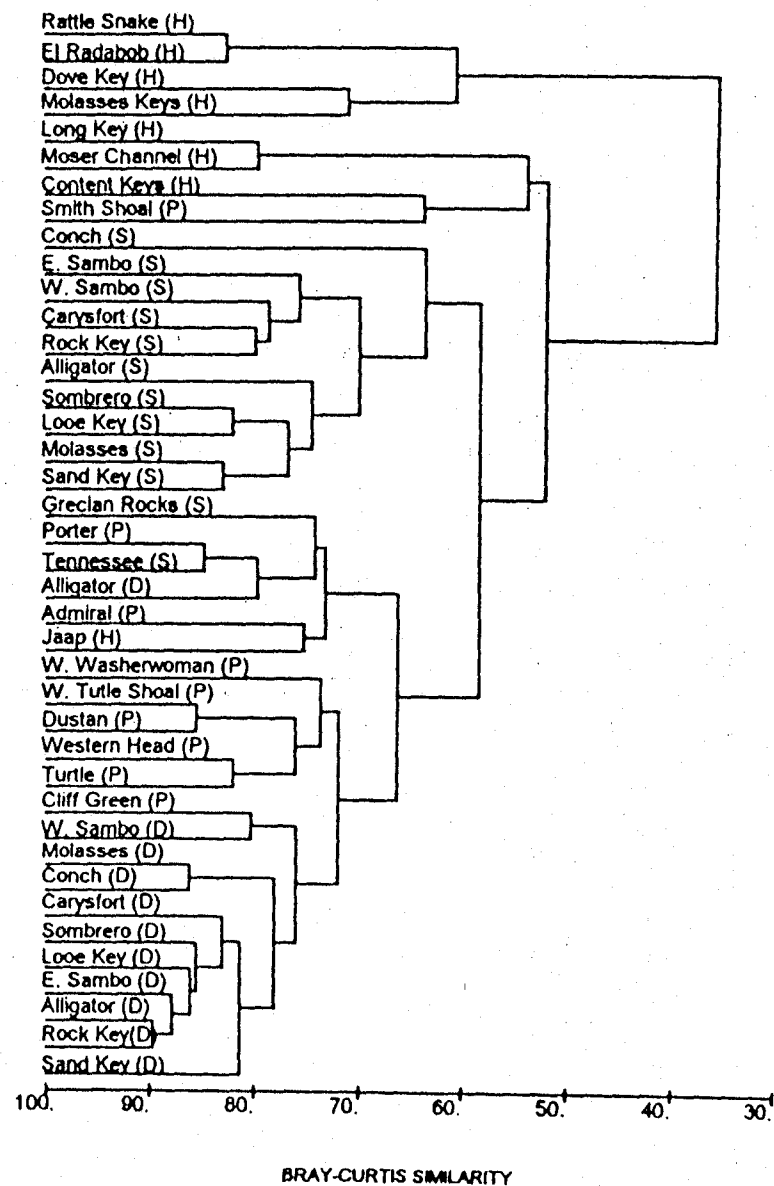


Table 20. Bray Curtis Similarity Index Values for Offshore Shallow Sites.

	Carysfort
Grecian (G)	65.138 G
Molasses (M)	68.807 68.750 M
Conch (C)	60.000 55.769 67.308 C
Alligator (A)	72.527 68.182 71.818 74.419 A
Tennessee (T)	60.550 75.781 67.969 55.769 74.545 T
Sombrero (S)	69.744 69.528 78.970 69.189 77.157 72.961 S
Looe Key (L)	60.748 72.222 77.778 60.784 72.222 79.365 82.096 L
Eastern Sambo (E)	75.610 54.455 67.327 62.338 72.289 55.446 67.039 57.576 E
Western Sambo (W)	77.387 66.667 73.418 56.085 69.652 64.135 71.963 69.528 76.503 W
Rock Key (R)	79.787 64.602 70.796 56.180 72.632 66.372 66.995 63.964 73.256 80.193 R
Sand Key (S)	72.174 75.373 82.090 64.545 76.724 70.149 75.102 74.242 64.486 75.502 78.992

Table 21. Bray Curtis Similarity Index Values for Offshore Deep Sites.

	Carysfort
Molasses (M)	73.846 M
Conch (C)	74.608 86.207 C
Alligator (A)	64.000 75.277 71.698 A
Tennessee (T)	81.744 78.698 75.904 71.565 T
Sombrero (S)	81.690 76.687 78.750 75.748 84.239 S
Looe Key (L)	82.286 80.997 75.556 71.622 87.052 84.330 L
Eastern Sambo (E)	85.789 79.202 77.681 68.712 86.005 86.614 85.106 E
Western Sambo (W)	71.028 71.918 68.531 61.423 74.850 68.323 78.864 74.352 W
Rock Key (R)	82.514 77.745 77.341 71.795 88.654 85.014 83.978 87.245 76.877 R
Sand Key (SK)	74.783 76.582 73.548 79.038 86.034 80.347 79.765 79.784 76.282 85.714

Table 22a. Abnormal Conditions of Stony Corals Recorded at Hardbottom Sites FY 1995/1996

HARDBOTTOM SITE CODES:	8H1	8H2	8H3	7H2	6H1	6H2	6H3	3H1
STONY CORAL TAXA								
<i>Cladocora arbuscula</i>								7
<i>Colpophyllia natans</i>				1				
<i>Diploria strigosa</i>								7
<i>Manicina areolata</i>	1							
<i>Montastraea annularis (complex)</i>							1	
<i>Montastraea cavernosa</i>							1	
<i>Mycetophyllia aliciae</i>								
<i>Phyllangia americana</i>								7
<i>Porites astreoides</i>								7
<i>Siderastrea radians</i>								1
<i>Siderastrea sidera</i>								1
<i>Stephanocoenia michelinii</i>								1

Table 22b. Abnormal Conditions of Stony Corals Recorded at Patch Reefs FY 1995/1996

PATCH REEF SITE CODES:	8P1	8P3	8P4	7P1	7P2	6P1	6P2	6P3	2P1
STONY CORAL TAXA									
<i>Colpophyllia natans</i>				1		1	1	1	
<i>Eusmilia fastigiata</i>		1							
<i>Meadrina meandrites</i>					1			7	
<i>Millepora albicornis</i>							1		
<i>Montastraea annularis (complex)</i>			2,1		5	1			2
<i>Montastraea cavernosa</i>	1				1	1	1	1	
<i>Mycetophyllia ferox</i>						7			
<i>Mycetophyllia lamarckiana</i>				7					
<i>Oculina diffusa</i>							1		1
<i>Porites astreoides</i>				1	1	1		1	
<i>Porites porites (complex)</i>		1							1
<i>Siderastrea radians</i>		1							1
<i>Siderastrea sidera</i>	1	1			6,1	1	1	1	1
<i>Stephanocoenia michelinii</i>				1,7		1			

Table 22c. Abnormal Conditions of Stony Corals Recorded at Shallow Offshore Reefs FY 1995/1996

SHALLOW OFFSHORE SITE CODES:	9S1	9S2	9S3	9S4	7S1	7S2	6S1	5S2	5S3	5S4	5S5	2S1
STONY CORAL TAXA												
<i>Acropora palmata</i>		7	7				3					7
<i>Agaricia agaricites (complex)</i>		1	1				1					1
<i>Dichocoenia stokesii</i>								7		1		
<i>Diploria labyrinthiformis</i>								7				
<i>Diploria strigosa</i>			1					2				
<i>Favia fragum</i>		1	1	1			1		1			1
<i>Montastraea annularis (complex)</i>		2		1				1,2,5				
<i>Montastraea cavernosa</i>					7	1		1,7				
<i>Mycetophyllia lamarckiana</i>		1										
<i>Porites astreoides</i>			1		7		1					1
<i>Siderastrea radians</i>				1								
<i>Siderastrea sidera</i>			1	1								

CONDITION CODES:

- 1= BLEACHING
 2= BLACK BAND
 3= WHITE BAND
 4= WHITE PLAGUE
 5= YELLOW BAND
 6= PURPLE BLOTCH
 7= OTHER CONDITION

TOTALS: HARDBOTTOM PATCH REEFS SHALLOW OFFSHORE REEFS

7	32	22
0	2	3
0	0	1
0	0	0
0	1	1
0	1	0
4	4	9

perform line interpolation (rather than line duplication) between lines of a single field was needed.

Several boards that were supposed to be able to accomplish the tasks were installed, evaluated, and rejected. After many trials, a board that was capable of grabbing a field (whose driving software was readily accessible to programming and modification) was obtained and extensively tested. Currently an efficient, reliable, and flexible system is being used to harvest TIFF images from Hi8 videotape.

(2) Image Processing

The Dustan lab solved the image de-interlacing problem (interlacing generates resolution problems when a still image is produced from videotape) by two independent methods. To remove motion from a frame (e.g., when the camera has moved more rapidly than normal, as under conditions of high surge), de-interlacing can be done at the time of image conversion by capturing a field rather than a frame or images can be de-interlaced in a post-production process by deleting one field. In both cases, the full de-interlaced image is reconstructed by line interpolation, not line duplication, yielding an optimized 24-bit RGB image.

It is important for all labs to consistently use the highest quality images available for consistent identification of species and substrates by investigators. For viewing uniformly high-quality images and increased end-user processing speed during analysis, all image files are de-interlaced by line interpolation and submitted to a sharpening algorithm. The best images obtainable (Figure 23) (not raw images) from videotape are being written to CD. This additional processing will save time and labor for the end user and will insure that all labs are viewing uniformly high-quality imagery for all identifications.

Framegrabbed video transect images will be distributed and archived in JPEG format rather than TIFF format. Converting the images from TIFF format to JPEG format for distribution will reduce the number of CD-ROM's required to represent one entire set of images from over 100 CD's per year to less than 10. Since five complete sets per year are required for archiving and distribution, this reduction represents a substantial savings in time and money. All image capture, deinterlacing, and processing is being performed on TIFF format images. Conversion to JPEG format is the last step before CD-ROM writing. Table 23 was developed for tracking of image harvesting, conversion and distribution.

Video Data Reduction

3) Software Development

Dustan Lab worked to determine the software required to analyze frames grabbed from videotape and to procure a multisite license that could be shared among the three Principal Investigators laboratories. Image-Pro Plus, produced by Media Cybernetics, is able to do the

Figure 22. Example of a Bleached Stony Coral, *Montastraea annularis*.

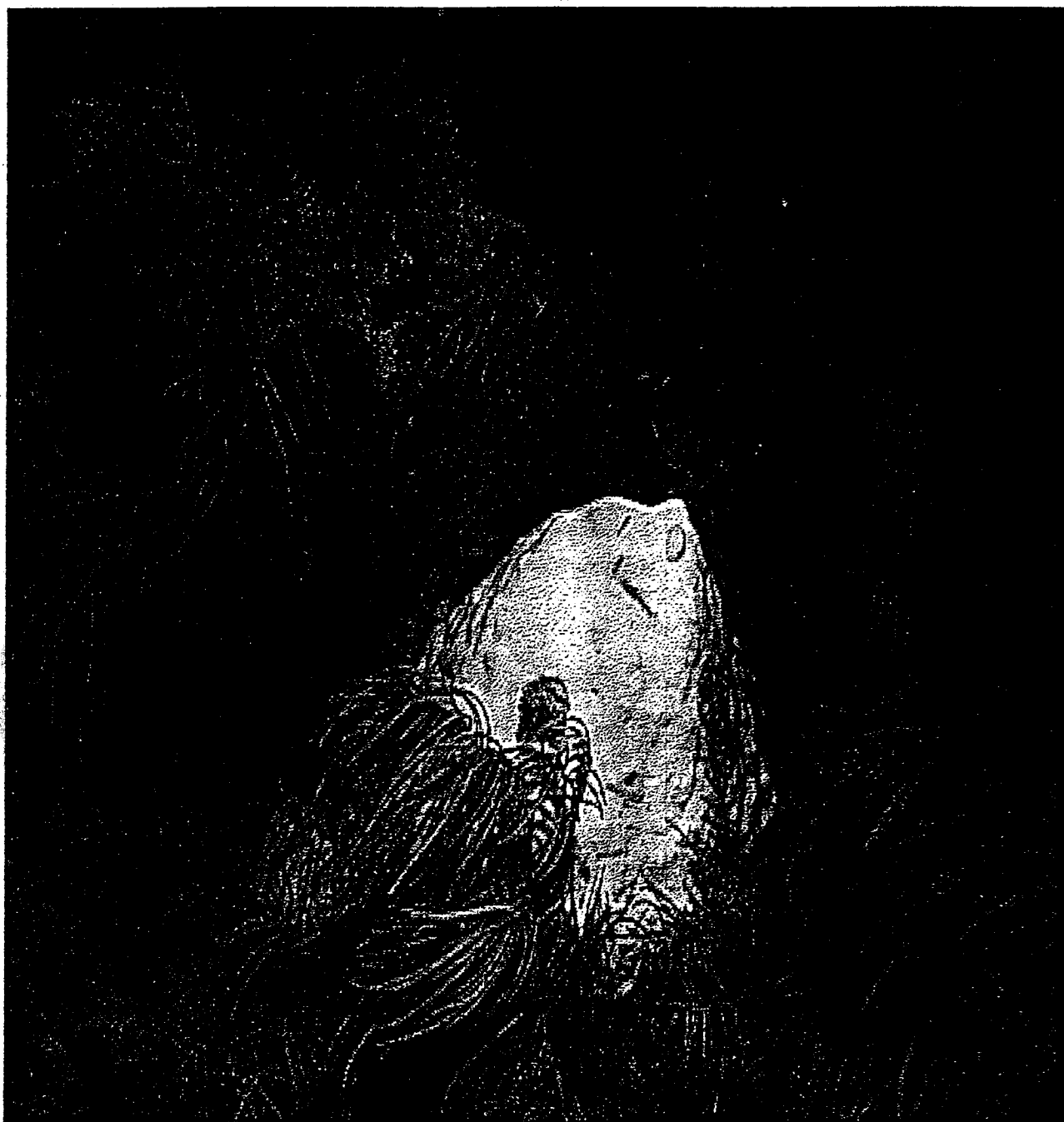
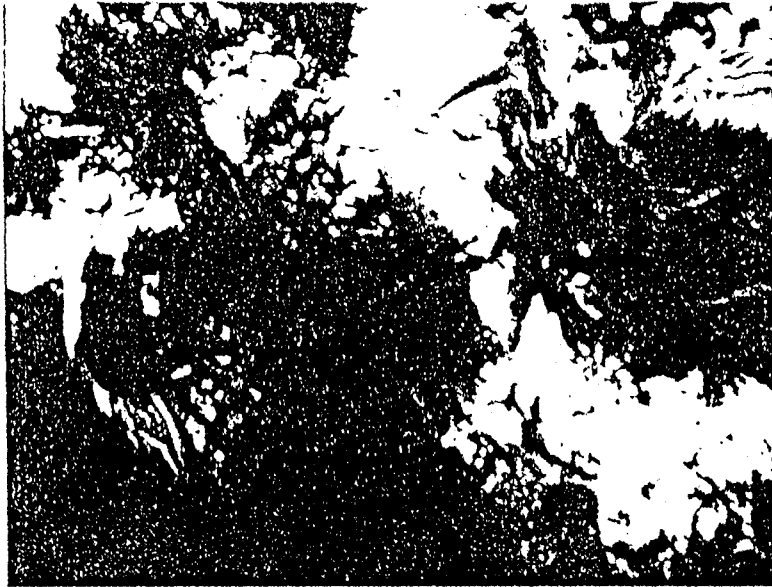


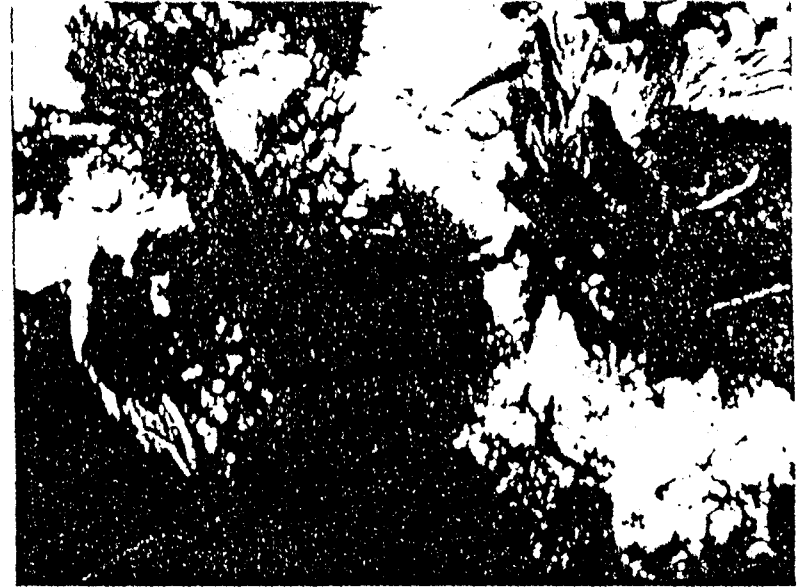
Figure 23.

Image Processing Techniques

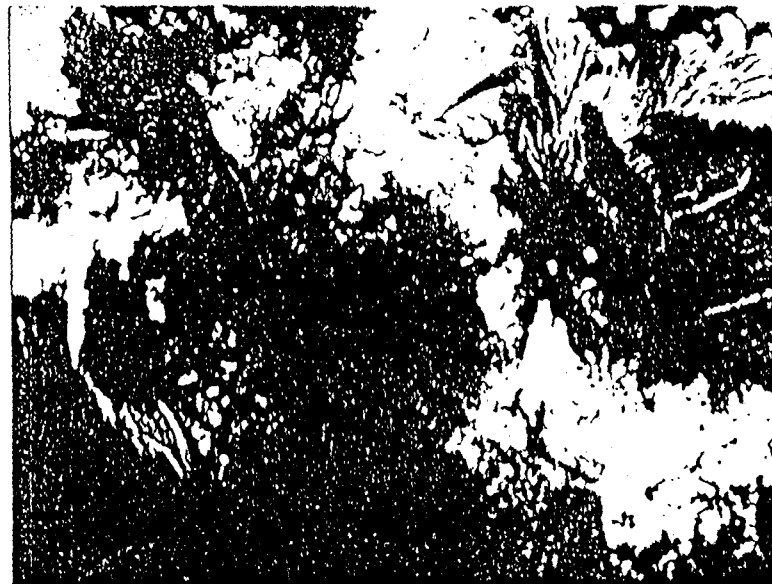
EPA Coral Reef Monitoring Project: Grecian Rocks site



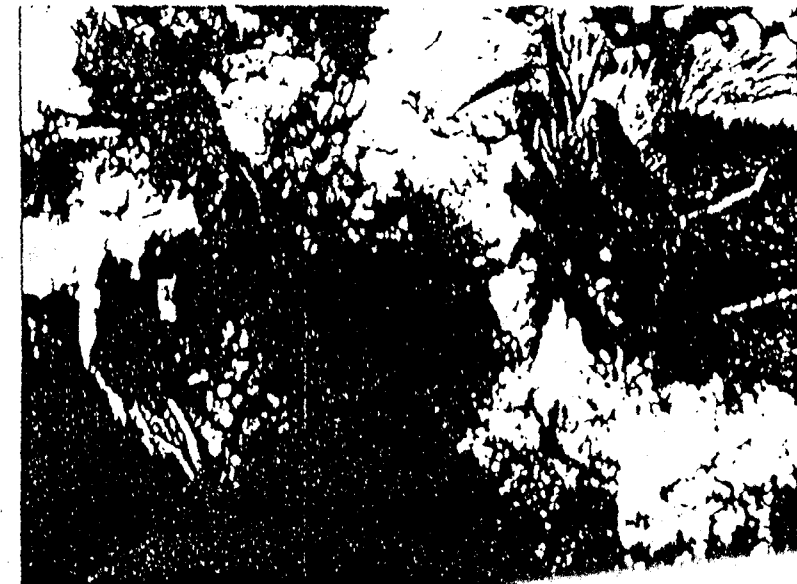
1. A full-frame interlaced image is captured from moving Hi8 videotape.



2. Image is de-interlaced through the technique of line interpolation.



3. Image clarity is improved by filtering with a weighted convolution kernel



4. Images are compared

EPA CRMP IMAGE HARVESTING, CONVERSION, AND DISTRIBUTION TRACKING SHEET

Site Name:	Site Code:	Site ID:	Code Date:
------------	------------	----------	------------

Filming Date:	Receipt Date:	Tape Tracking Label(s):
---------------	---------------	-------------------------

FRAMEGRABBING

Source if >1 tape:									
Station		1		2		3		4	
Directory									
		tape time	done	tape time	done	tape time	done	tape time	done
Frames:	pan001-010								
	100 w/label								
	101-220								
	300 w/label								
	301-420								
	500 w/label								
	501-620								
	pan051-060								
	cd.dat files:	created	stored	created	stored	created	stored	created	stored

IMAGE PROCESSING

Procedure	Date	Initials	Other Notes
De-interlacing w/line interpolation			
Sharpening (5x5, 1@70%)			
Conversion to JPEG format			
Other			

CD-ROM WRITING (include updated readme.txt, cd.dat, & sites.txt files)

Activity	Date	CD Volume	No. copies	Initials
First Write to CD-ROM:			1	
Date(s) of Cloning:				
.				
.				
.				

DISTRIBUTION

Destination	Date CD Mailed	Initials	Date Tapes Mailed	Initials
Dustan Lab Archive:				
Dustan Lab 1st copy:				
Dustan Lab 2nd copy:				
FMRI				
UGA				
CAMRA				
Other				

image manipulation and post-framegrabbing processing needed. Image-Pro Plus is based in and completely compatible with Visual Basic. Dustan Lab purchased Visual Basic Professional and developed a Visual Basic application tailored to the project's needs in which Image-Pro Plus was embedded as the data management tool for analyzing images.

Dustan Lab completed beta version and testing and issued a version 1.01 of the Visual Basic program PointCount for Coral Reefs (Dr. Ouida Meier, Mr. James Leard, and Dr. Phillip Dustan). For this 4 Mb program, a setup executable was created, written to CD-ROM, and distributed to other CRMP labs. This program is completely capable of performing all routines required for image analysis of the transect frames. Flexible features included in the PointCount program greatly facilitate standardized identification of images captured from video transects and make the program useful for conducting power analyses and generating data sets for statistical comparisons.

The PointCount program calls up an image file into Image-Pro from CD-ROM. The image is displayed (Figure 24) and a unique random point array is overlaid by creating a .tag file on the fly. The coral species or biotic or abiotic category underneath each point is identified and entered. The next image file and random point overlay are called up, and the new data is automatically appended to the larger data file. Dustan Lab established the standards and the data structure for transect image analysis results, including: 1. Image filename, data filename, and directory structure; 2. Numeric site codes; and 3. Numeric species codes.

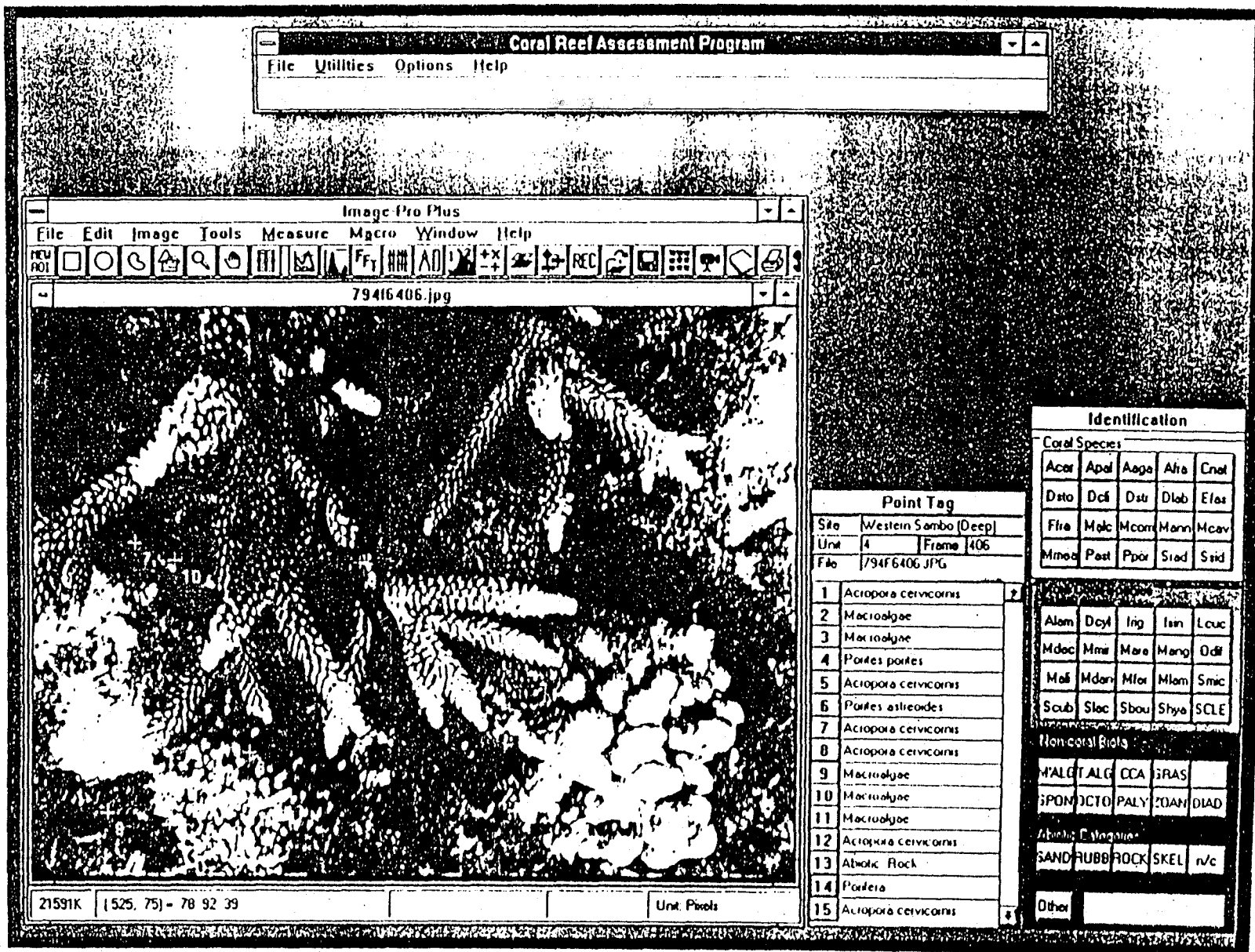
The process is extremely efficient: calling up an image requires only double-clicking on the filename; the unique set of random points for that image (stored on CD-ROM with the image) is overlaid automatically. Species and substrate identifications require only a single mouse click, corrections and multiple selections are made easily. All data and metadata associated with the image is automatically saved to a comma-separated value (text) file. The resulting data is complete, compact, accessible by any lab, can easily be sent over the internet among labs, and can be readily accessed by any spreadsheet or statistical analysis program.

These original video tape images stored on a CD ROM disk provide a complete composite of each video transect. Samples are selected for analyses from the composite transect CD. The number of samples per station is determined by statistical analyses based on sample size and effective video image dimensions. The Dustan Lab made accurate calculations of fields of view from framegrabbed transect images at test heights (live videotape shows a smaller area on most monitors than is actually framegrabbed and constitutes the analyzable image). This information was necessary for first estimates of total transect area required for analysis. Appendices 6 and 7 detail the preliminary power analyses and statistical background provided by the Porter Lab and Dr. Steven Rathbun (UGA spatial statistics expert).

Figure 24.

PointCount for Coral Reefs

Ouida Meier, James Leard, and Phillip Dustan
University of Charleston



Video Data Analyses

The Dustan Lab used eight Hi8 videotapes from 1995 test video transects to perform analog-to-digital image conversion for all unique transects and tests. Transect images were distributed on three CD's to each of the three Principal Investigators for test analyses and project development in their own labs.

Dustan Lab used Hi8 videotapes from 1995/1996 field sampling to capture video transect images, convert the analog signal to digital information, de-interlace and custom filter the resulting files to improve image quality, and convert the TIFF images to JPEG format to improve storage and retrieval efficiency. The Lab generated unique and permanent random point files for each image, wrote the images and accompanying information files to CD-ROM, and distributed the first of these to the other participating labs. Appendix 8 details the contents of the first CD-ROM (1996 EPA CRMP Volume 1 of 6).

Project personnel have begun point counting and preliminary analyses will be presented in the CRMP first quarterly report for 96/97. Porter Lab participated in a training session on the image analysis system at Charleston which allowed them to proceed with the preliminary statistical power analysis. Dustan Lab has also prepared for analysis of the CRMP massive data sets through consultation and discussion with competent statisticians, including Dr. Steven Rathbun of UGA, and Dr. Dennis Slice, (SUNY Stony Brook), a student and research colleague of Dr. James Rohlf and Dr. Robert Sokal.

DATA MANAGEMENT

The CRMP has created all of its own data entry tools, analysis software, and archiving procedures. During development of the technical aspects of the project Dustan Lab kept in mind potential requirements by current and future investigators. As a result, procedures designed for the project have built-in features in image capture and conversion protocols and in the PointCount software that preserve flexibility for a wide range of potential analytical procedures. These are apparent in choices made for framegrabbing methods, spreadsheet assignment categories and formats, and construction of hard-coded data sources.

The Dustan Lab instituted formal species and site identification codes (many analysis programs require numeric rather than string coding of certain types of data) and also instituted a protocol for consistent directory and filename structures for both image and data files. These tasks constitute a critical part of the overall scheme for the data retrieval, analysis and management.

Agreement has been reached with the archiving institution (FMRI CAMRA), who has accepted our transect image analysis data structure, data format, and filename conventions as they now exist for their receipt of information for archiving.

QUALITY ASSURANCE/QUALITY CONTROL

A Quality Assurance Project Plan for the Coral Reef/Hardbottom Monitoring Project was submitted to the Environmental Protection Agency July 17, 1996. Gary Bennett, USEPA Region 4 Quality Assurance Officer, reviewed and recommended approval. Formal approval was received 22 August 1996.

PROJECT OUTREACH

All three principal investigators and Meier attended the Eighth International Coral Reef Symposium in Panama in July 1996. Porter made the presentation titled "Coral Reef Monitoring in the Florida Keys" for the CRMP project. The abstract is presented in Appendix 9. Meier demonstrated PointCount for Coral Reefs to researchers and resource managers in a special session. Dustan Lab created a World Wide Web site(<http://www.cofc.edu/~coral/coral.htm>) that includes, among other projects, images and information about the CRMP in the Florida Keys National Marine Sanctuary.

Co-presentations were made at the Technical Advisory Committee meeting. Dr. Ouida Meier presented a demonstration of the PointCount for Coral Reefs software program at the TAC meeting. A site visit, primarily for EPA's Steering Committee, was co-hosted on 14 May 1996 to explain the project's field sampling program.

Dustan Lab provided FKNMS (Mr. Billy Causey and Mr. G.P. Schmahl) with slides and printed images describing the CRMP for public communication. They also provided the Sanctuary with display-ready images, text, CD-ROM's, and slides for use during Looe Key NMS's 15th anniversary celebration, Night at Looe Key, on August 20th which FMRI CRMP staff attended.

ACKNOWLEDGMENTS

Our staff of research and field assistants are acknowledged for their dedication. We are fortunate to have a staff of extremely capable and enthusiastic individuals. They include: John Dotten, Matthew E. Patterson, Katie Fitzsimmons and Bobby Barratachea (FMRI); Dr. Ouida Meier, Mike Brill and James Leard (University of Charleston); Katie Patterson and Sara Lewis (University of Georgia).

Sampling 100% of our stations was logistically complicated. It would have been impossible to sample the 40 geographically separated sites without the assistance of numerous individuals. Most of those are represented in the field sampling and dive tables as FKNMS and EPA staff. Although some only assisted one or two days, their assistance was often critical to meeting field schedule objectives at that particular time. We especially want to thank Laurie MacLaughlin (always willing to lend assistance onshore as well as being a great dive buddy).

The grand finale of sampling in October could not have been completed without the expert assistance of the EPA divers (Philip Murphy, Gary Collins, Mel Parsons, and Ken Potts) and the support of the captain (Capt. Mark Strout) and crew of the OSV Peter Anderson. Again, we want to thank John Halas; no one can re-locate obscure markers on the ocean bottom better! We can always count on John and the Sanctuary for dive and vessel support (when ours is high and dry). We appreciate the cooperation of Billy Causey (FKNMS, Superintendent) for his support of all phases of the Coral Reef/Hardbottom Monitoring Project. This year, the Grand Mariner Award goes jointly to Matt Patterson and John Dotten each with 74 total days "ship-time" during calendar year 1996 field sampling. Bobby Barratachea (FMRI's dive locker technician) is thanked for providing diver assistance throughout summer sampling.

Dr. Ouida Meier is commended for her perseverance in developing video analysis software. Matthew Patterson is recognized for his computer skills with graphics. Last but not least, Katie Fitzsimmons is applauded for keeping the project administration at FMRI running during chaotic field sampling months.

LITERATURE CITED

- Bloom, S.A. 1981. Similarity indices in community studies: potential pitfalls. *Mar. Prog. Ser.* 5: 125-128.
- Boesch, D.F. 1977. Application of numerical classification in ecological investigations of water pollution. U.S. EPA report 600/3-77-033, Corvallis, Oregon. 113 pp.
- Bray, J.R. and J. R.T. Curtis 1957. An ordination of the upland forest communities of southern Wisconsin. *Ecol. Mongr.* 27(4): 325-349.
- Carins, S.D., D.R. Calder, A. Brinckmann-Voss, C.B. Castro, P.R. Pugh, C.E. Cutress, W.C. Jaap, D.G. Fautin, J.R. Larson, G.H. Harbison, M.N. Arai,, and D.M. Opresko. 1991. Common and scientific names of aquatic invertebrates from the United States and Canada: Cnidaria and Ctenophora. *Amer. Fish. Soc. Spec. Publ.* 22. 75 Pp.
- Clarke, K.R. 1993. Non-parametric multivariate analyses of change in community structure. *Aust. J. of Ecol.* 18: 117-143.
- Clifford, D.H.T. and W. Stephenson 1975. An introduction to numerical classification Academic Press, New York.
- Field, J., K. Clarke, and R. Warwick 1982. A practical strategy for analyzing multi-species distribution patterns. *Mar. Ecol. Prog. Ser.* 8: 37-52.
- Humann, P. 1993. Reef coral identification: Florida-Caribbean-Bahamas. New World Publ. Jacksonville, FL., 252 pp.
- Lambshead, P.J.D., H.M. Platt, and K.M. Shaw 1983. The detection of differences among assemblages of marine benthic species based on an assessment of dominance and diversity. *J. Nat. Hist.* 17: 859-874
- Lance G.N. and W.T. Williams 1967. A general theory of classificatory sorting strategies. I. Hierarchical systems. *Cumput. J.* 1: 15-20.
- Plymouth Marine Laboratory, 1995. User guide to PRIMER V3.b (Plymouth Routines in multivariate ecological research). Plymouth, United Kingdom 53 pp.
- Squires, D.F. 1958. Stony corals from the vicinity of Bimini, Bahamas, British West Indies. *Bull. Amer. Mus. Nat. Hist.* 115(4): 219-262.
- UNESCO 1992. IOC-SOC training workshop manual on environmental effects on benthic communities. Intergovernmental Oceanographic Training Course Report. 19. 119 pp.

- Van Veghel, M.L.J., D.F.R. Cleary, and R.P.M. Bak. 1996. Interspecific interactions and competitive ability of the polymorphic reef-building coral *Montastraea annularis*. Bull Mar. Sci. 58(3): 792-803.
- Vaughan, T.W. 1901. The stony corals of Porto Rican waters. Bull. U.S. Fish. Comm. For 1900. 2: 289-320.
- Warwick, R.M. and K.R. Clarke. 1991. A comparison of some methods for analysing changes in benthic community structure. J. Mar. Biol. Ass. U.K. 71: 225-244.
- Wells, J.W. 1973. New and old scleractinian corals from Jamaica. Bull Mar. Sci. 23(1): 16-58.
- Wells, J.W. and J. Lang. 1973. Systematic list of Jamaican shallow-water Scleractinia. Bull Mar. Sci. 23(1): 55-58.
- Weil, E. and N. Knowlton 1994. A multi-character analysis of the Caribbean coral *Montastraea annularis* (Ellis and Solander, 1786) and its two sibling species, *M. faveolata* (Ellis and Solander, 1786) and *M. franksi* (Gregory, 1895). Bull. Mar. Sci. 55(1): 151-175.

LIST OF FIGURES

1. Site distribution by water quality segment.
2. SONY VX-3 underwater camera/image acquisition system.
3. a. Video clapper board, b. Underwater cross-beam laser lights, c. Species inventories, d. PointCount video image analysis software.
4. Video composite of Cliff Green patch reef.
5. Station species inventory data form.
6. Agency field sampling participation FY 1995/1996.
7. Agency field sampling participation FY 1996/1997.
8. Agency dive participation FY 1995/1996.
9. Agency dive participation FY 1996/1997.
10. Taxonomic richness by site type.
11. Classification, hardbottom sites.
12. Similarity of sites within site types.
13. Classification, patch reef sites.
14. Classification, shallow offshore sites.
15. Classification, deep offshore sites.
16. Classification, all sites.
17. MDS ordination of hardbottom sites.
18. MDS ordination of patch reef sites.
19. MDS ordination of shallow offshore sites.
20. MDS ordination of deep offshore sites.
21. MDS ordination of all sites.

22. Example of a bleached stony coral, *Montastrea annularis*.
23. Image processing techniques.
24. PointCount for coral reefs.
25. CRMP Fund disbursements.
26. CRMP Fund disbursements, FMRI supplies/equipment breakdown.

LIST OF TABLES

1. Site data, Coral Reef and Hardbottom Monitoring.
2. Field sampling days-FY 1995/1996.
3. Field sampling days-FY 1996/1997.
4. Dive summary-FY 1995/1996.
5. Agency dive participation-FY 1995/1996.
6. Dive summary-FY 1996/1997.
7. Agency dive participation-FY 1996/1997.
8. Depth distribution of dives FY 95/96 and FY 96/97
9. Taxonomic list of hydrozoan and scleractinian corals from species inventories.
10. a. Presence/absence of stony coral taxa-all sites FY 1995/1996.
b. Frequency of stony coral taxa-all sites FY 1995/1996.
11. a. Presence/absence of stony coral taxa-site types FY 1995/1996.
b. Frequency of stony coral taxa-site types FY 1995-1996.
12. a. Presence/absence of stony coral taxa-hardbottom FY 1996/1996.
b. Frequency of stony coral taxa-hardbottom FY 1995/1996.
13. a. Presence/absence of stony coral taxa-patch reefs FY 1995/1996.
b. Frequency of stony coral taxa-patch reefs FY 1995/1996.
14. a. Presence/absence of stony coral taxa-shallow offshore reefs FY 1995/1996.
b. Frequency of stony coral taxa-shallow offshore reefs FY 1995/1996.
15. a. Presence/absence of stony coral taxa-deep offshore reefs FY 1995/1996.
b. Frequency of stony coral taxa-deep offshore reefs FY 1995/1996.
16. Summary of taxonomic richness of individual sites by site type.
17. Summary of taxonomic richness by site type.
18. Bray Curtis similarity index values for hardbottom sites.

19. Bray Curtis similarity index values for patch reef sites.
20. Bray Curtis similarity index values for offshore shallow sites.
21. Bray Curtis similarity index values for offshore deep sites.
22. Abnormal conditions of stony corals recorded at a. hardbottom sites,
b. patch reef, c. shallow offshore reefs FY 1995/1996.
23. EPA CRMP image harvesting, conversion and distribution tracking sheet.

LIST OF APPENDICES

1. Revised site maps-FY 1995/1996.
2. CRMP Standard Operating Procedures.
3. Video testing results.
4. Video technical drawings.
5. CRMP stony coral photo-identification guide.
6. Preliminary power analysis.
7. Statistical appendix.
8. Contents of CD-ROM, 1996 EPA CRMP, Volume 1 of 6.
9. CRMP abstract.

1996-1997 PROJECT GOALS

The following list of 4 goals were listed as our project goals for 1995-1996.

- (1) Complete Quality Assurance Project Plan.
- (2) Commence data collection at stations installed during 94/5 funding cycle.
- (3) Analyze collected data to:
 - (a) obtain estimates of percent cover (standing stock) of corals at sampled stations
 - (b) determine conditions of colonies at sampling stations to gain insight into the generalized concept of coral population health and to better understand sources of mortality.
 - (c) determine species present in supplemental samples to monitor for changes in coral biodiversity.
- (4) Develop data management protocols.

We completed and submitted our Quality Assurance Project Plan. We commenced data collection at installed stations and completed 100% of the sampling during calendar year 1996. We have conducted preliminary analyses of the species presence data which will be our baseline to monitor for change in coral biodiversity. Preliminary data was collected on stony coral condition in the stations sampled at hardbottom, patch reef and offshore shallow sites. Point counting of video data is being conducted to obtain estimates of percent cover (standing stock) of corals at sampled stations. Data management protocols development is continuing.

Our project goals for 1996-1997 are to:

- (1) Complete point counting of all video imagery collected during 1996.
- (2) Finalize statistical methodology.
- (3) Conduct analyses of video data to estimate coral percent cover.
- (4) Integrate analyses from species inventory data and video data.
- (5) Refine data management protocols.
- (6) Refine Quality Assurance Project Plan.
- (7) Sample the project's 40 reef sites within calendar year 1997.

Much of the partitioning of effort has taken place as a natural result of the skills, expertise, and interests exhibited by groups and individual members within the CRMP. For FY 1996/1997, we must optimize efforts among required tasks (point counts, data management, and statistical analysis) which require equal input from all three groups.

1995-1996 ADMINISTRATIVE ACTIONS

FUNDING AND GRANT BUDGET

A revised Workplan was submitted in July 1996 along with the assistance request for funding for FY96/97. The CRMP had presented justification for \$75,000 in increased funding at the Technical Advisory Committee meeting. These funds were requested to secure administrative support for the project management at FMRI, and to provide additional funding for projected shortfalls at UCSC and UGA. Figure 25 depicts the disbursements made from project funds during FY 95/96. The breakdown of FMRI's supplies and equipment shown on Figure 26 shows that nearly all the funds in those categories were expended for support of the project's field operations (vessel support, field navigation, field supplies, and travel for the primary field team). The Labs of the three principal investigators otherwise received nearly equal portions of the grant funds.

PERSONNEL

The three principal investigators (Dustan, UCSC; Jaap, FMRI; Porter, UGA) and a project manager (Wheaton, FMRI) have primary responsibility for the project. FMRI staff consists of two full-time researchers (Patterson and Fitzsimmons) at FMRI and one full-time researcher (Dotten) at FMRI's Marathon South Florida Regional Lab. UCSC staff includes Meier and Brill full-time; UGA staff includes Patterson and Lewis part-time.

PROBLEMS AND RESOLUTIONS

Sampling Problems

It was a priority to sample all sites this first year to establish a baseline for observing change. We had weather set-backs in May which required sampling to be extended into October. More severe weather (Hurricanes) hampered October efforts. Extending the field sampling and annual report requirements has delayed image analysis by all labs.

Equipment Problems

The R/V Tortugas provided support for the majority of sampling this fiscal year with a minimum of "down time". The portable SCUBA air compressor carried on the vessel for all sampling required some extensive repair. The salt water and rigorous use have made it mandatory to replace the unit prior to field sampling for FY 96/97. One video camera flooded due to an incomplete seal on the housing. The camera has not been replaced but both camera's purchased by UGA are dedicated to project sampling effort.

Funding Problems

The project budget directly impacts man-power needs both in the field and in computer software development. During the first field season, FKNMS provided extensive field assistance for station installation including boats, captains, and divers. For the 1996 season, the project was primarily self-sufficient; however, staff and equipment showed the effects of such a rigorous schedule. With the intensive effort this comprehensive monitoring program requires increased funding was mandatory to adequately meet all work plan objectives.

Figure 26. EPA Coral Monitoring Project Funds
FMRI Supplies/Equipment Breakdown

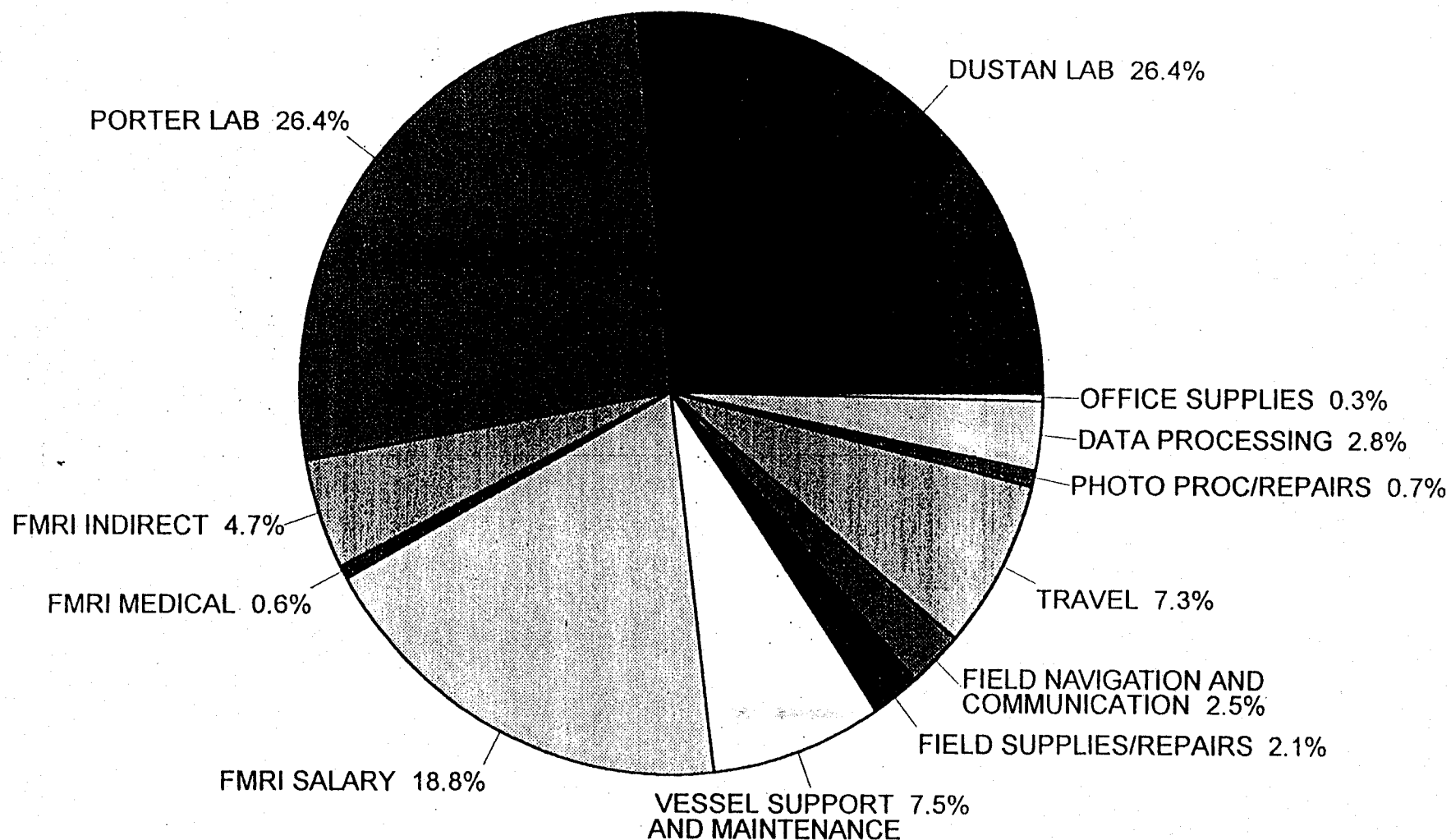


Figure 25. EPA Coral Monitoring Project Funds Disbursements
FY 1995/1996

