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Phase I - Preconstruction Progress Report for Biological Monitoring of the John U. Lloyd Beach Renourishment

Richard E. Dodge
Nova Southeastern University Oceanographic Center, dodge@nova.edu

Steven C. Hess
Environmental Resources Management - South, Inc.

Charles G. Messing
Nova Southeastern University Oceanographic Center, messingc@nova.edu

Glenda Kelley
Nova Southeastern University

PHASE I - PRECONSTRUCTION PROGRESS REPORT FOR BIOLOGICAL MONITORING OF THE JOHN U. LLOYD BEACH RENOURISHMENT

Prepared for:

Broward County Environmental Quality Control Board
Erosion Prevention District

Prepared by:

Dr. Richard E. Dodge[1], Dr. Steven Hess [2],

Dr. Charles Messing [1], and Ms. Glenda Kelley [1]

[1] Nova University Oceanographic Center
8000 N. Ocean Dr.
Dania, FL 33004

and

[2] Environmental Resources Management - South, Inc.
2858 N.W. 79th Ave.
Miami, FL 33122

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1.0 INTRODUCTION

1.1 Project Background

In 1987, Nova University (Contractor) with ERM South (Subcontractor) was awarded a contract to provide biological monitoring services for the John U. Lloyd State Recreation Area Beach Renourishment Project. A notice to proceed for the initial biological monitoring (Phase I - Preconstruction) was issued in February, 1989. Field monitoring took place in February and March, 1989. Laboratory work has continued from March, 1989 to present. The renourishment dredging took place from May 16, 1989 to July 14, 1989. Approximately 603,000 cu yds of sediment were removed and subsequently emplaced on 1.6 miles of shoreline. Within the next 6 months, Broward County anticipates letting a contract to till the compacted beach to a depth of 36" from the low water line to the upland vegetation line.

1.2 Project Overview

1.2.1 Contracted Scope of Services

Biological Analytical Services contracted for in the John U. Lloyd State Park Beach Renourishment Monitoring are required in three separate phases. These phases are: once before construction begins (Phase I - Preconstruction), once thirty days after project completion (Phase II - First Post-Construction), and once one year after project completion (Phase III - Second Post-Construction). The scope of analytical services consists of three tasks as described below.

Task 1. - Transects: Contractor shall at reef areas adjacent to each of the eleven coral community stations conduct line transects to allow an assessment of the density of scleractinian (stony) coral colonies in each area (corals/square meter).

Task 2 - Quadrats: Contractor shall conduct an in situ qualitative (species identification) and quantitative (species counts) inventory of all sessile flora and fauna found within eleven 2 x 2 m pre-established coral community monitoring stations.

Task 3 - Cores: Contractor shall sort and identify to the taxon as low as reasonably achievable all specimens larger than 0.5 mm stained with Rose Bengal contained in sand core samples obtained from offshore soft bottom sites, one sand site immediately seaward of the "toe of fill" at the discharge beach and one control sand site an equal distance offshore of Dania Beach, Florida. There will be two (2) offshore soft bottom sites (one inside the borrow area, and one north of the borrow area). Broward County will supply to the Contractor eighteen hand collected core samples from each of the four above described soft bottom areas for a total of 72 samples.

2.0 METHODS AND MATERIALS

2.1 FIELD EFFORTS

2.1.1 Selection of Sampling Locations

2.1.1.1 Transect and Quadrat Sites

Eleven Broward County reef sites were selected for detailed biological monitoring of the stony coral community. Figure 1 shows monitoring sites off the beach fill area and sites near the borrow area.

Four sites (#'s 1, 2, 3, and 4) were chosen in the vicinity of the borrow area (offshore of Hollywood). Sites 1 and 4 were at approximately 50' depth on the outer edge of the Second Reef. Sites 2 and 3 were in approximately 60' depth on the nearshore edge of the Third Reef.

Six sites (#'s 5, 6, 7, 8, 9, and 10) were chosen in the vicinity of the beach fill area with an additional site (# 11) to the north as a reference. Sites 5 and 6 were in approximately 10' water depth on the nearshore reef. Sites 7 and 10 were at approximately 30' depth on the Second Reef off the fill area. Site 11 was at similar depth to the north outside of the fill area off Ft. Lauderdale. Sites 8 and 9 were in 55' water depth on the Third Reef.

2.1.1.2 Cores Sites

Four stations were selected for monitoring the effects of dredging and beach renourishment on infaunal communities inhabiting unconsolidated substrates.

Two stations were chosen in the vicinity of the borrow area to monitor the direct effects of dredging on these communities. Station BA (BORROW AREA) is located within and just north of the center of the borrow area. Station DC (DEEP CONTROL) is located about 600 yards due north of the previous station on an unconsolidated substrate between the Second and Third Reef lines. Depth at both stations is approximately 60'.

Two stations were chosen in the vicinity of John U. Lloyd Beach to monitor the effects of erosion or sediment redistribution associated with renourishment. Station JUL (JOHN U. LLOYD) is located about 500' directly offshore of the "toe of fill" at the spoil discharge. Station DB (DANIA BEACH) is located a similar distance offshore of Dania Beach, about 200 yards south of Dania Beach Pier. Depth at both stations is approximately 10'.

2.1.2 Field Assessment Methods:

2.1.2.1 Transects

After an initial survey of each site, SCUBA divers laid a transect line of at least 20 m length (40 m in the cases of Sites 4, 10, and 11) along the reef surface. The line was usually in a straight north-south direction or arranged in an approximate rectangular pattern (Sites 10 and 4). When necessary, the transect line was fixed at approximate 20 m intervals by tying or encircling metal stakes (rebar), which had been driven into the bottom by divers.

2.1.2.1.1 Belt-Quadrat Transect

Each reef was assessed by laying a quadrat of known area (either 0.375 or 0.75 m^2) sequentially along first one side and then the other of the initial 20 m (40 m for Sites 4, 10, and 11) of

the transect line. The stony corals within each quadrat were identified to species and sized (either approximate diameter for hemispherical or length and width for subrectangular colonies). Corals with diameters less than 1 cm were omitted from analysis. The species Siderastrea siderea and Siderastrea radians were grouped as Siderastrea spp. because of difficulties with precise field identification. The hydrozoan Millepora alcicornis also was included in the assessment. Corals, if bleached, were so noted.

2.1.2.1.2 Loya Transect

The so-called Loya plotless line transect method was originally intended to be used in this study. However, from data collection and results comparisons during a separate study (the initial "Immediate" Bleaching Study), it was determined that the Loya transect method was less effective in meeting the study goals. Therefore, only the Belt-Quadrat transect method was utilized. This departure from the original plan was discussed with the Broward County Environmental Quality Control Board (BCEQCB) and the revised method approved by Louis Fisher in April, 1989.

2.1.2.2 Quadrats

At each of the eleven quadrat stations, four metal stakes, previously implanted by BCEQCB personnel, defined the corners of a 4 m^2 quadrat. Initial examination by SCUBA divers indicated if any stakes were dislocated or lost. Following this survey, and replacement of stakes, where necessary, SCUBA divers tied a length of plastic tape around the stakes to define the quadrat perimeter. Censusing of macroepibenthos within each quadrat was facilitated by using a 1.0 m^2 PVC subquadrat divided into 0.25 m^2 subdivisions. Macroepibenthic organisms were identified and counted in situ. When specific identifications could not be made, samples from outside the quadrat were collected, transferred to plastic zip-loc bags, preserved in 70% ethanol or fixed in 10% borate-buffered formalin, and identified in the laboratory. A series of color photographs were taken of each quadrat. Underwater photographs were taken using a Nikonus V camera with 28 mm lens affixed to an aluminum tripod. Mosaics were compiled from the photographs to facilitate future comparison of pre- and post-dredging conditions.

Certain taxa, notably algae, encrusting alcyonarians, and zoanthideans, were difficult to enumerate because, in many cases, it was not clear whether a single colony or cluster of separate colonies was present. Similarly, it sometimes was difficult to assess if loose associates of ascidians represented colonies or isolated zooids. Comparisons of pre- and post-dredging photographs will allow a further assessment of this situation by possibly demonstrating if single large colonies deteriorate into clusters of smaller (but numerically greater) colonies. Numerous taxa are denoted by asterisk (*). These are numerous, but uncounted, organisms in colonies or clusters.

The major taxonomic groups of organisms identified are as follows: Porifera, Cnidaria (Alcyonaria, Scleractinia, Zoanthidea) and algae (chiefly Phaeophyta). Minor components include Ascidiacae, Echinodermata, Hydrozoa, and Polychaeta.

2.1.3 Laboratory Assessment Methods

2.1.3.1 Cores

Unconsolidated sediment samples were diver collected with a hand-held coring apparatus. Each sediment sample was transferred underwater to a plastic bag and fixed on shipboard in 10% borate-buffered formalin solution containing Rose Bengal. Eighteen replicate cores were taken at each of the four stations.

At the laboratory, each replicate sample was separately washed with sea water through a 0.5 mm mesh Nalgene screen. Organisms and sediment retained on the screen were decanted into a 70% ethanol solution and stored in glass jars pending sorting.

Organisms were sorted initially to phylum or general morphological form (e.g., Mollusca, Crustacea, "worm", "other") and subsequently to lowest recognizably distinct taxa. Only organisms apparently alive at the time of collection were counted (i.e., dead molluscan shells were not considered). Virtually all material collected during this first phase has been distributed to specialists for specific identification and enumeration. Replicate samples were subsequently composited, a procedure approved by Mr. Lou Fisher of the BCEQCB.

3.0 PRELIMINARY RESULTS AND DISCUSSION

3.1 Transects

3.3.3 Belt-Quadrat Method

A relatively large bottom area was assessed at each reef site (30 m^2 at Sites 1, 2, 3, 5, 6, 7, 8, and 9; 60 m^2 at Sites 4, 10, and 11).

Figure 2 shows the species-area curves calculated from the belt-quadrat transect at each site. These curves plot the cumulative number of coral species encountered versus the cumulative number of square meters of reef sampled. When the curve shows pronounced leveling, a sufficiently large reef area has been assessed to obtain a representative and adequate sample. Most curves show pronounced leveling by approximately 20 m^2, which confirms that the 30 or 60 m^2 area is sufficient for assessment.

Table 1-1 of Appendix 1 provides a variety of statistics describing the coral community. Included are total number of corals sampled, percent coral coverage, coral density, and diversity indices. Diversity statistics included both number of species and the Shannon-Weaver diversity index (calculated both on coral abundance, H'N, and coral coverage, H'C). Eveness, using the two methods, also is provided. Table 1-2 of Appendix 1 provides additional detailed data for each station, including a breakdown of areal coverage of each species, number of specimens and percentage of coral.

Figure 3 depicts the data parameters versus depth of each individual station. In general, coral density increases with depth, although several of the deeper stations have very low density (Sites 8 and 3). Coral coverage is not as markedly correlated with station depth. It is noteworthy that the site with highest density (Site 9) has the lowest coral coverage. With regard to diversity statistics, there appears to be a general trend of increasing diversity with depth. There appears to be a less defined trend of increasing eveness with depth, although variability is high.

3.2 Quadrats

Table 2-1 of Appendix 2 indicates macroepibenthic organisms identified and enumerated at the eleven hardbottom quadrat stations. Several groups, such as sponges, alcyonarians, and algae, are in the process of being identified. Qualitative descriptions of the stations are as follows.

Station 1: Low relief, chiefly barren substrate with numerous large alcyonarians (e.g., Eunicea spp., Pseudopterogorgia) and scattered sponges (e.g., Ircinia campana, Callyspongia vaginalis). Corals few and mostly small.

Station 2: Low relief, chiefly barren substrate with numerous small clusters of brown algae (Dictyota sp), scattered chiefly small alcyonarians (e.g., Eunicea spp.) and sponges (e.g., Xestospongia muta, Rhaphidophlus juniperinus). Corals include four moderately sized colonies (10-40 cm across) of Montastrea cavernosa and Diploria sp. One colony of each species appears to be dying back significantly.

Station 3. Low relief with numerous small clusters of brown algae (Dictyota sp.) and the encrusting alcyonarian Erythropodium caribaeorum, scattered sponges (including a large Xestospongia muta). Corals are small and few in number.

Station 4. Low relief, chiefly barren substrate. Approximately 25% of the quadrat is unconsolidated sandy substrate. The metal stakes delimit an area considerably greater than 4 m^2. However, a 4 m^2 area was defined within the quadrat by marking off distances from one corner

with a 1 m^2 subquadrat. Specific individual sponges and alcyonarians were identified along the perimeter of the 4 m^2 area defined by using the 1 m^2 subquadrat so that the same area can be identified accurately during subsequent monitoring phases. Macroepifauna includes numerous sponges and alcyonarians. Corals are chiefly small and few in number.

Station 5: Low relief with a dense algal turf composed chiefly of numerous small clusters of brown (Dictyota sp.) and red algae. Macroepifauna is dominated by two large colonies of Diploria clivosa (40-50 cm across), 3 large Pseudopterogorgia spp. and 2 Ircinia campana.

Station 6: Low to moderate relief with a moderately dense algal turf and numerous alcyonarians. Corals are few and small.

Station 7: Moderate relief with a patchy low algal turf and several large colonies of the zoanthidean Palythoa mammillosa. Dominant macroepifauna includes a large Xestospongia muta and Callyspongia vaginalis, and Pseudopterogorgia sp..

Station 8: Low relief with a dense but patchy algal turf (including numerous Dictyota sp., numerous alcyonarians and sponges (including a large Xestospongia muta). The largest coral is a Dichocoenia stokesii, 10 cm across.

Station 9: Rugged relief, chiefly barren substrate with few alcyonarians (Gorgonia ventalina, Eunicea sp.) and scattered sponges (including several Iotrochota birotulata). Corals are few and small; the largest is a Diploria clivosa, 17 cm across.

Station 10: Rugged relief, chiefly barren substrate dominated by large colonies of the zoanthidean Palythoa mammillosa and the encrusting alcyonarian Erythropodium caribaeorum. The largest head of several Montastrea cavernosa colonies reaches 20 cm across.

Station 11: Rugged relief, chiefly barren substrate with scattered clusters of algae and Erythropodium caribaeorum, scattered alcyonarians, and sponges (including a large Xestospongia muta). The metal stakes define an uneven quadrilateral area rather than a square with 2 m sides.

3.3 Cores

Table 3-1 of Appendix 3 indicates the current listing of organisms sorted and enumerated from sediment samples. Within each taxonomic category listed, organisms have been sorted to lowest recognizably, distinct taxa and distributed to specialists for specific identification. Several lots of material already have been returned with identifications and enumerations. Notable among these is a species of minute, solitary, scleractinian coral that lives unattached on the sediment surface and represents an apparent undescribed species of Sphenotrochus (Cairns, pers. comm.).

A preliminary comparison of data between sites reveals that species abundance was highest at the Borrow Area (BA; 862 organisms). Lowest organismal abundance was enumerated at the nearshore Dania Beach site (DB; 209 organisms). The John U. Lloyd (JUL) and Deep Control (DC) sites demonstrated intermediate levels of abundance of 396 and 650 organisms, respectively. Comparison of species diversity are pending the results to be obtained from the taxonomic specialists.

4.0 PROJECT STATUS

4.1 Work Completed

All Phase I - Preconstruction fieldwork was completed, as scheduled. Phase I field and laboratory data generation is complete, with reference to the transect tasks. These data are final and merely await Phase II and Phase III to undertake an assessment of potential dredging impacts.

Quadrat and core data bases are still being compiled and await input from the various outside taxonomic specialists and the in-house identification of several obscure taxa.

4.2 Work in Progress

Fine sorting and identification of provisional species groups is underway at various institutions throughout the U.S. The various specialists and their affiliations that have received such material are presented in Appendix 4. Team members at Nova University are making periodic contacts with all consultants in an effort to expedite their efforts. As results are received, team members are updating the quadrat and core databases to reflect final species-level identities and species-level abundance. It is anticipated that all such information will be in-hand in approximately 30-60 calendar days. If this schedule can be adhered to, a final tabulation of macroepibenthos and macroinfauna for Phase I will appear in the Phase II - First Post-Construction Progress Report.

4.3 Problems Encountered

To date, the Nova/ERM project team has encountered no delays or technical difficulties that will significantly alter or modify the scheduling or scope of the original contract.

4.4 Projected Project Efforts

At present and weather permitting, Nova/ERM anticipate commencing the Phase II- First Post-Construction field effort on or about August 29, 1989. Laboratory and data management efforts concerning Phase I efforts will be proceeding, as noted above.

Appendix 1: Transect Data

Table 1-1

PHASE I - PRECONSTRUCTION TRANSECT DATA SUMMARY

STONY CORAL ASSESSMENT

SITE	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
DATE OF ASSESSMENT	Mar-89	Mar-89	Mar-89	Feb-89	Mar-89	Mar-89	Mar-89	Mar-89	Mar-89	Feb-89	Feb-89
DEPTH (ft)	55	55	60	47	10	9	30	50	55	27	30
TOTAL # CORALS SAMPLED	117	90	60	180	25	41	60	36	192	108	102
TOTAL REEF AREA SAMPLED (M2)	30	30	30	60	30	30	30	30	30	60	60
TOTAL CORAL COVERAGE (CM2)	4144	8986	7735	6004	4645	3994	2298	3069	1739	11091	12177
# CORALS/M2	3.9	3.0	2.0	3.0	0.8	1.4	2.0	1.2	6.4	1.8	1.7
% CORAL COVERAGE	0.69%	1.50%	1.29%	1.00%	0.77%	0.67%	0.38%	0.51%	0.29%	1.85%	2.03%
# BLEACHED CORALS	3	4	7	4	0	0	2	4	7	3	4
% # BLEACHED CORALS	2.6%	4.4%	11.7%	2.2%	0.0%	0.0%	3.3%	11.1%	3.6%	2.8%	3.9%
AREA BLEACHED CORALS (CM2)	159	124	78	25	0	0	36	73	133	13	27
% AREA BLEACHED CORALS	3.8%	1.4%	1.0%	0.4%	0.0%	0.0%	1.6%	2.4%	7.6%	0.1%	0.2%
DIVERSITY											
# SPECIES	14	11	12	15	6	5	10	8	13	12	15
H'C	2.10	1.71	1.46	2.20	0.99	0.96	1.83	1.64	2.51	1.42	2.28
H'N	2.18	2.22	2.09	2.30	1.68	0.99	1.68	2.02	2.08	1.83	2.20
HMAX	2.64	2.40	2.48	2.71	1.79	1.61	2.30	2.08	2.56	2.48	2.71
H'C/HMAX	0.80	0.71	0.59	0.81	0.55	0.60	0.79	0.79	0.98	0.57	0.84
H'N/HMAX	0.82	0.93	0.84	0.85	0.94	0.62	0.73	0.97	0.81	0.74	0.81

H'C = Shannon Weaver diversity index based on coverage data

H'N = Shannon Weaver diversity index based on numerical abundance data

H'MAX = Maximum diversity = ln (number of species)

H'C/HMAX (Eveness)

H'N/HMAX (Eveness)

Table 1-2: Preconstruction areal coverage, colony abundance, and corresponding percentages of stony corals by species and site.

SITE 1 (MAR 14, 1989) 55'

	SPECIES CODE	AREA COVERAGE CM2	NUM.of COLONIES	% AREA	% NUM
	AG	19.63	1	0.5%	0.9%
	CV	1455.46	11	35.1%	9.4%
	EU	50.27	1	1.2%	0.9%
	MA	10.00	1	0.2%	0.9%
	MD	28.27	1	0.7%	0.9%
	ME	431.77	17	10.4%	14.5%
	ML	162.18	11	3.9%	9.4%
	MU	3.14	1	0.1%	0.9%
	MY	58.12	2	1.4%	1.7%
	PA	522.87	11	12.6%	9.4%
	SD	168.80	11	4.1%	9.4%
	SK	511.29	20	12.3%	17.1%
	SL	351.55	3	8.5%	2.6%
	SP	799.97	27	19.3%	23.1%
TOTALS	14	4573.3	118		

SITE 2 (MAR 14, 1989) 55'

	SPECIES CODE	AREA COVERAGE CM2	NUM.of COLONIES	% AREA	% NUM
	CV	1207.88	12	13.4%	13.3%
	MA	3657.43	9	40.7%	10.0%
	MD	147.62	7	1.6%	7.8%
	ME	2039.33	11	22.7%	12.2%
	ML	316.05	18	3.5%	20.0%
	MY	38.48	1	0.4%	1.1%
	PA	121.74	4	1.4%	4.4%
	SD	254.50	13	2.8%	14.4%
	SK	117.81	6	1.3%	6.7%
	SL	848.63	3	9.4%	3.3%
	SP	224.62	6	2.5%	6.7%
TOTALS	11	8974.1	90		

TABLE 1-2 CONTINUED

SITE 3 (MAR 15, 1989) 60'

	SPECIES CODE	AREA COVERAGE CM2	NUM.of COLONIES	% AREA	% NUM
	CV	2990.76	20	38.7%	33.3%
	EU	38.48	1	0.5%	1.7%
	MA	3156.71	6	40.8%	10.0%
	MD	98.00	1	1.3%	1.7%
	ME	72.57	2	0.9%	3.3%
	ML	138.00	6	1.8%	10.0%
	MY	19.63	1	0.3%	1.7%
	PA	211.35	3	2.7%	5.0%
	SD	52.62	3	0.7%	5.0%
	SK	297.67	9	3.8%	15.0%
	SL	490.54	3	6.3%	5.0%
	SP	168.94	5	2.2%	8.3%
TOTALS	12	7735.3	60		

SITE 4 (FEB, 1989), 47'

	SPECIES CODE	AREA COVERAGE CM2	NUM.of COLONIES	% AREA	% NUM
	AG	55.34	3	0.9%	1.7%
	CV	1343.34	17	22.4%	9.4%
	DS	33.77	4	0.6%	2.2%
	EU	96.49	6	1.6%	3.3%
	MA	219.74	7	3.7%	3.9%
	MD	215.27	7	3.6%	3.9%
	ME	632.19	25	10.5%	13.9%
	ML	62.56	9	1.0%	5.0%
	MY	248.63	4	4.1%	2.2%
	PA	342.22	13	5.7%	7.2%
	PP	15.00	1	0.2%	0.6%
	SD	514.75	13	8.6%	7.2%
	SK	164.93	14	2.7%	7.8%
	SL	631.46	4	10.5%	2.2%
	SP	1507.14	54	25.1%	30.0%
TOTALS	15	8495.7	295		

TABLE 1-2 CONTINUED

SITE 5 (MAR 2, 1989) 10'

	SPECIES CODE	AREA COVERAGE CM2	NUM.of COLONIES	% AREA	% NUM
	AC	1012.00	6	21.8%	24.0%
	DC	3033.72	3	65.3%	12.0%
	PA	344.66	7	7.4%	28.0%
	SD	23.21	6	0.5%	24.0%
	SK	223.74	3	4.8%	12.0%
	SP	8.00	1	0.2%	4.0%
TOTALS	6	4645.3	26		

SITE 6 (MAR 2, 1989), 9'

	SPECIES CODE	AREA COVERAGE CM2	NUM.of COLONIES	% AREA	% NUM
	AC	1043.00	6	26.1%	14.6%
	DC	500.00	1	12.5%	2.4%
	PA	2414.71	29	60.5%	70.7%
	PP	10.21	2	0.3%	4.9%
	SD	25.92	4	0.6%	9.8%
TOTALS	5	3993.8	42		

SITE 7 (MAR 7, 1989) 30'

	SPECIES CODE	AREA COVERAGE CM2	NUM.of COLONIES	% AREA	% NUM
	AG	15.00	1	0.7%	1.7%
	CV	441.14	3	19.2%	5.0%
	DC	12.57	1	0.5%	1.7%
	ME	415.48	1	18.1%	1.7%
	ML	38.00	3	1.7%	5.0%
	PA	120.17	2	5.2%	3.3%
	SD	347.39	23	15.1%	38.3%
	SK	705.56	19	30.7%	31.7%
	SL	137.00	3	6.0%	5.0%
	SP	63.62	4	2.8%	6.7%
TOTALS	10	2295.9	60		

SITE 8 (MAR 7, 1989) 50'

	SPECIES CODE	AREA COVERAGE CM2	NUM.of COLONIES	% AREA	% NUM
	CV	571.74	6	18.6%	16.7%
	MA	498.00	2	16.2%	5.6%
	ML	126.33	4	4.1%	11.1%
	PA	104.96	4	3.4%	11.1%
	SD	74.90	6	2.4%	16.7%
	SK	283.97	8	9.3%	22.2%
	SL	1306.86	2	42.6%	5.6%
	SP	102.48	5	3.3%	13.9%
TOTALS	8	3069.2	37		

SITE 9 (MAR 13, 1989) 55'

	SPECIES CODE	AREA COVERAGE CM2	NUM.of COLONIES	% AREA	% NUM
	AG	3.14	1	0.2%	0.5%
	CV	480.50	20	27.6%	10.4%
	EU	47.91	4	2.8%	2.1%
	MA	77.55	5	4.5%	2.6%
	MD	94.56	10	5.4%	5.2%
	ME	7.07	1	0.4%	0.5%
	ML	81.84	9	4.7%	4.7%
	PA	819.40	29	47.1%	15.1%
	PP	12.57	1	0.7%	0.5%
	SD	514.53	45	29.6%	23.4%
	SK	337.94	24	19.4%	12.5%
	SL	93.46	4	5.4%	2.1%
	SP	505.53	40	29.1%	20.8%
TOTALS	13	3076.0	193		

TABLE 1-2 CONTINUED

SITE 10 (Feb, 1989), 27'

	SPECIES CODE	AREA COVERAGE CM2	NUM.of COLONIES	% AREA	% NUM
	AG	19.6	2	0.2%	1.9%
	CL	230.0	1	2.1%	0.9%
	CV	6557.0	21	59.1%	19.4%
	DS	136.6	2	1.2%	1.9%
	EU	78.5	1	0.7%	0.9%
	ME	1219.0	2	11.0%	1.9%
	ML	7.1	1	0.1%	0.9%
	PA	7.1	1	0.1%	0.9%
	SD	641.0	21	5.8%	19.4%
	SK	1241.1	32	11.2%	29.6%
	SL	320.2	4	2.9%	3.7%
	SP	634.1	21	5.7%	19.4%
TOTALS	12	11091.3	109		

SITE 11 (Feb, 1989) 30'

	SPECIES CODE	AREA COVERAGE CM2	NUM.of COLONIES	% AREA	% NUM
	CL	78.5	1	0.6%	1.0%
	CV	1290.5	25	10.6%	24.5%
	DL	1707.9	2	14.0%	2.0%
	DS	735.1	2	6.0%	2.0%
	EU	8.3	3	0.1%	2.9%
	MA	2100.0	2	17.2%	2.0%
	ME	1739.6	5	14.3%	4.9%
	ML	7.1	1	0.1%	1.0%
	MY	1335.2	2	11.0%	2.0%
	OC	10.0	4	0.1%	3.9%
	PA	96.6	3	0.8%	2.9%
	SD	1000.8	21	8.2%	20.6%
	SK	590.6	18	4.9%	17.6%
	SL	921.1	3	7.6%	2.9%
	SP	555.4	11	4.6%	10.8%
TOTALS	15	12176.8	103		

Code: Coral Species

AG	Agaracia agaricites
AC	Acropora cervicornis
CL	Colpophyllia natans
CV	Montastrea cavernosa
DC	Diploria clivosa
DL	Diploria labyrinthiformis
DS	Diploria strigosa
EU	Eusmilia fastigiata
MD	Madracis decatis
MA	Montastrea annularis
ME	Meandrina meandrites
ML	Millepora alcicornis
MU	Mussa angulosa
MY	Mycetophyllia danaana
OC	Oculina varicosa
PA	Porites astreoides
PP	Porites porites
SD	Siderastrea siderea, Sidereastrea radians
SK	Dichocoenia stoksii
SL	Solenastrea hyades, Solenastrea bournoni
SP	Stephanocoenia michelini

Appendix 2: Quadrat Data

Table 2-1: Macroepibenthos Abundance Matrix for Quadrat Sites 1-11

TAXON	QUADRAT NUMBER 1	2	3	4	5	6	7	8	9	10	11	TOTALS BY TAXON
Algae												
Algae sp. A		*			*	*						*
Algae sp. B		*										*
Algae sp. C			*									*
Algae sp. D							1	2				3
Algae sp. E										7		7
Algae sp. F											33	33
Algae sp. G							2					2
Dictyota sp. A					*	*	*		*	10	40	*
Halimeda sp. A			*					*				*
Laurencia sp. A					*	*	*					*
Udotea sp. A			4									4
Algal Totals by Quadrat		*	*		*	*	*	*	*	17	73	*
Phylum Porifera												
Agelas clathrodes		2	2					2	2			8
Agelas conifera										3		3
Amphimedon compressa	1	7	6	2			6	2	7	12	16	59
Amphimedon viridis					1	6						7
Aplysina cauliformis	1		5	7			4		6		1	24
Aplysina fistularis						8	1					9
Aplysina lacunosa								1	2			3
Aplysina sp. A									2			2
Callyspongia fallax							1					1
Callyspongia plicifera		3	2						3			8
Callyspongia vaginalis	4	2	4	1			3			1	1	16
Callyspongia sp. A										1		1
Chondrilla nucula					1					1		2
Clathriidae sp. A	9	52	15	7					23			106
Clionidae sp.								1				1
Ectyoplasia ferox				7								7
Haplosclerida sp. A											3	3
Homaxinella rudis	3		2					1	2	1		9
Hymedesmia sp. A									4			4
Iotrochota birotulata	1	2	2	1			1	1	47	5	2	62
Ircinia campana	2		1	2	4							9
Ircinia felix	2	1			1	2			2	3	1	12
Ircinia strobilina	1	3	2	1			3	2	6	2		20
Niphates amorpha	4	1			2		6			9	12	34
Niphates digitalis	6	1	2	3			3	3	9	1	1	29
Niphates erecta	6	12	11	12	4		5	30	9	14	11	114
Pseudaxinella lunaecharta	1	2	2				2	2		1		10
Pseudoceratina compressa									1			1

Table 2-1 Continued

Pseudoceratina crassa	1								1			2
Rhaphidophlus juniperinus	5	2	1	2			2		3		1	16
Spheciospongia vesparia						1						1
Spirastrella coccinea	6	9	5	7			9	3		16	1	56
Timea sp. A								1				1
Ulosa ruetzleri	5	18	30	3	2	5	1	32	19	27	10	152
Xestospongia muta		3	1	2			1	1		2	3	13
Porifera sp. A							3			1		4
Porifera sp. B	3			3								6
Porifera sp. C					15	23						38
Porifera sp. D								1	1			2
Porifera sp. E	6			7						1		14
Porifera sp. F										1		1
Porifera sp. G		2		1								3
Porifera sp. H								1		2		3
Porifera sp. I		1										1
Porifera sp. J									1			1
Porifera sp. K				5								5
Porifera sp. L										1		1
Phylum Cnidaria												
Class Hydrozoa												
Millepora alcicornis	5	2		3					8			18
Class Anthozoa												
Order Scleractinia												
Acropora cervicornis	1											1
Agaricia agaricites									2			2
Agaricia sp. A										2		2
Dichocoenia stokesi	4	1	3	3	1			5	2	4	2	25
Diploria clivosa					2							2
Diploria strigosa		2							1	1		4
Eusmilla fastigata									2			2
Madracis decactis		1		1		1			3			6
Meandrina meandrites	2			3					1			6
Montastrea cavernosa	2	3	1	2			1	1	17	10	1	38
Montastrea annularis			2					1	1			4
Porites astreoides			2		2	5			5			14
Solenastrea boumoni	3	1	1	1			3	1	4	3	1	18
Siderastrea siderea	1			2	1	1	4		5	7	1	22
Stephanocoenia michelini	3	3		3						2		11
Subclass Alcyonaria												
Erythropodium caribaeorum	16	20	45	14			11	30	35	18	29	218
Plexaura flexuosa		5	3	4			2	18			10	42
Pseudopterogorgia america	14	2	2		1	1	1	3			1	25
Pseudopterogorgia acerosa	1				3	1	1			1		7
Pterogorgia citrina			4		2	1						7
Eunicea fusca			6									6
Eunicea species complex	16	14	1	28	7	4	13	12	2	5	18	120
Unknown Gorgonians	7				9	6	2	2				26
Gorgonia ventalina		1							1			2
Plexaurella sp. A										1		1
Pseudoplexaura sp. A											1	1
Muricea sp. A			2		2					1		5
Briareum asbestinium	17	4	23	9	23		2			3	14	95
Order Zoanthidea												

Table 2-1 Continued

Palythoa mammillosa	7				1	1	14			22	3	48
Zoanthus sp. A					3							3
Parazoanthus swifti									*			*
Phylum Annelida												
Class Polychaeta												
Sabellastarte magnifica										2		2
Sabellidae sp. A										2		2
Sabellidae sp. B	1						2	2				5
Spirobranchus giganteus							2					2
Phylum Mollusca												
Class Bivalvia												
Spondylus americana	3											3
Bivalve sp. A										1		1
Phylum Chordata												
Subphylum Urochordata												
Ascidian sp. A		50	12	3				2				67
Phylum Echinodermata												
Class Echinoidea												
Eucidaris tribuloides					1			2				3
Quadrat Numbers	1	2	3	4	5	6	7	8	9	10	11	
Faunal Totals by Quadrat	159	243	200	149	88	66	109	163	239	190	144	1750

* = numerous, but not countable, individuals in a colony or clump

Appendix 3: Core Data

Table 3-1: Preliminary Taxonomic Identifications and Enumerations of Macroinfauna and Macroepifauna at core sites.

TAXON	SITE JUL	DB	BA	DC	TOTAL
Phylum Porifera			1	8	9
Phylum Cnidaria					
Class Hydrozoa	1		10	1	12
Class Scyphozoa				38	38
Class Anthozoa					
Sphenotrochus n. sp.				12	12
Phylum Nemertea	-/ 7	-/ 3	-/ 5	-/ 23	38
Phylum Nematoda	-/ 138		-/ 49	-/ 83	270
Phylum Annelida					
Class Polychaeta	30/ 93	15/ 114	61/ 561	53/ 342	1110
Class Oligochaeta			3		3
Phylum Sipuncula					
Apionsoma misakiana			3		3
Aspidosiphon sp. A	2				2
Aspidosiphon sp. B			1		1
Aspidosiphon sp. C				2	2
Phascolion sp. A			1		1
Phylum Mollusca					
Class Polyplacophora					
Lepidozona sp. A				3	3
Class Scaphopoda					
Dentalum sp. A				1	1
Scaphopoda sp. A			1		1
Tetrodon sp. A			1		1
Class Gastropoda					
Acteocina candei			4		4
Acteocina inconspicua	4				4
Arene tricarina				1	1
Atys riiseana			4		4
Caecum imbricatum			1		1
Caecum pulchellum	1				1
Calyptraea centralis				2	2
Finella dubia			1		1
Fissurella sp. A				1	1
Granulina ovuliformis			2		2
Kurtziella sp. A				1	1

Table 3-1 Continued

Marginella hartleyanum							1		1
Marginella egg capsules					5				5
Retusa silcata					2				2
Tricolia affinis		1							1
Turridae sp. A							1		1
Vitricythara metria					1				1
Class Bivalvia									
Bushia sp. A							1		1
Carditopsis smithi		1							1
Chama sp. A							2		2
Chione sp. A		1					1		2
Chione cancellata					1				1
Crassinella dupliniana		2							2
Crassinella sp. A					1				1
Ervillia concentrica		3			1				4
Gouldia cerina					1		1		2
Mytilidae sp. A		1					1		2
Pteromeris perplana							1		1
Pleuromeris tridentata		5		2	1		1		9
Semele bellastrita							1		1
Tellina sp. A					2				2
Tellina gouldi					3		3		6
Tellina iris				1			1		2
Tellina promera							1		1
Tellina versicolor					2		1		3
Tivela floridana		27		78					105
Transennella cubaiana		1							1
Phylum Bryozoa					-/	11	-/	10	21
Phylum Arthropoda									
Subphylum Chelicerata									
Class Pycnogonida						1			1
Class Arachnida									
Order Acarina	-/	3							3
Subphylum Crustacea									
Class Copepoda									
Order Calanoida						1			1
Order Cyclopoida						1			1
Order Harpacticoida	-/	22			-/	11	-/	9	42
Class Ostracoda	-/	1			-/	11	-/	22	34
Class Malacostraca									
Order Amphipoda									
Order Isopoda	3/	28			3/	10	-/	4	42
Order Cumacea	-/	1			4/	4	1/	2	7
Order Tanaidacea	-/	25			-/	88	-/	13	126
Order Decapoda			2/	2	1/	1	2/	2	5
Subphylum Hexaramia									
Class Insecta		1				1		1	3
Phylum Echinodermata									
Class Ophiuroidea					-/	1	-/	5	6

Table 3-1 Continued

Class Echinoidea			1	1	2
Class Holothuroidea				1	1
Phylum Chordata					
Subphylum Urochordata				1	1
Subphylum Cephalochordata					
Class Ascidiacea					
Stylelidae sp. A			1		1
Subphylum Vertebrata					
Class Osteichthyes					
Unidentified	-/ 27	-/ 9	-/ 51	-/ 44	131
TOTAL NUMBER OF ORGANISMS	396	209	862	650	2117

* Where currently available, specific-level taxa are listed. For groups where species identifications are not yet available, the number of provisional taxa / number of specimens is indicated. For those groups where fine sorting to species is being completed by specialists, the number of provisional taxa is represented by a dash (-) symbol.

Appendix 4: List of Taxonomic Specialists

Porifera:
Dr. Shirley Pomponi
Harbor ranch Oceanographic Inst.
5600 Old Dixie Highway
Ft. Pierce, FL 34946
(407) 465 2400

Cnidaria
Dr. Stephen D. Cairns
Division of Echinoderms
NHB-163
Smithsonian Inst.
Washington, DC 20560

Nemertea (& Unknown/unidentified/other)
Dr. Jon Norenburg
Smithsonian Inst.
Museum Support Center
4210 Silver Hill Road
Smitland, MD 20746
(301) 238 3508

Sipuncula
Dr. M. Rice
Smithsonian Marine Station
5612 Old Dixie Highway
Ft. Pierce, FL 34946
(407) 465 6630

Ostracoda
Dr. Louis Kornicker
Division of Crustacea
NHB-163
Smithsonian Inst.
Washington, DC 20560

Decapoda
Dr. Austin B. Williams
Natl. Marine Fish. Ser. Systematics Lab
Smithsonian Inst.
Washington, DC 20560

Nematoda
Dwane Hope
Div. of Worms (NHB)
Smithsonian Inst.
Washington, DC 20560
(202) 357 4750

Algae
Jeffrey Prince
Biol. Dept.
Univ. of Miami
Coral Gables, FL 33124

Dr. Bart Baca
Nova University Oceanographic Center
8000 North Ocean Dr.
Dania, FL 33004

Urochordata
Linda Cole
Div. Echinoderms
Smithsonian Inst.
Washington, DC 20560
(202) 357 2486

Isopoda
Brian Kensley
Div. of Crustacea
Natural History Museum
Smithsonian Inst.
Washington, DC 20560
(202) 357 4666

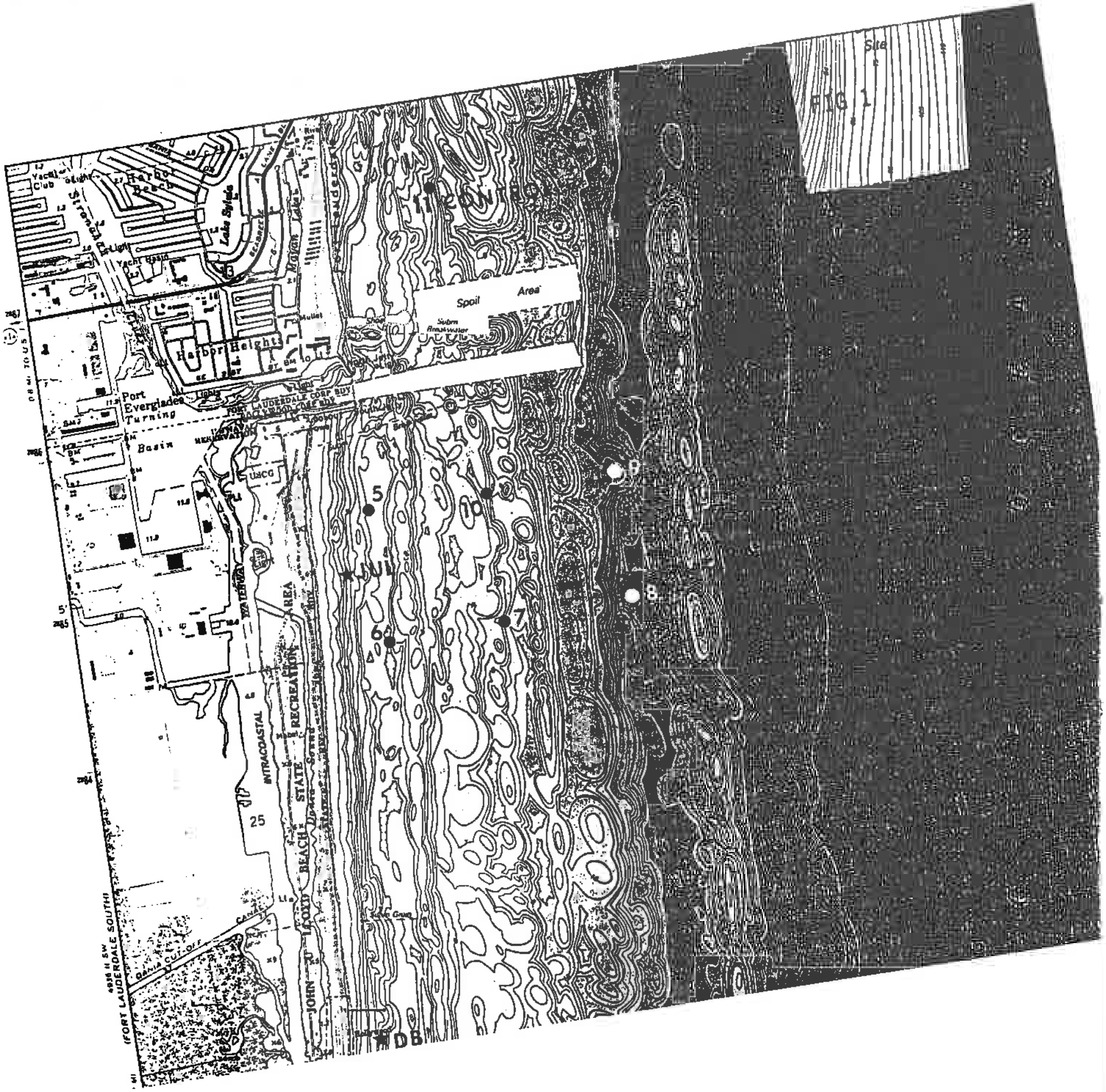
Amphipoda
James D. Thomas
PO Box 120
Big Pine Key, FL 33043

Cumacea
Les Watling
Darling Marine Center
Univ. of Maine
Walpole, ME 04573
(207) 563 3146

Annelida
Dr. Mike Milligan
Mote Marine Lab.
1600 City Island
Sarasota, FL 33577
(813) 388 4441

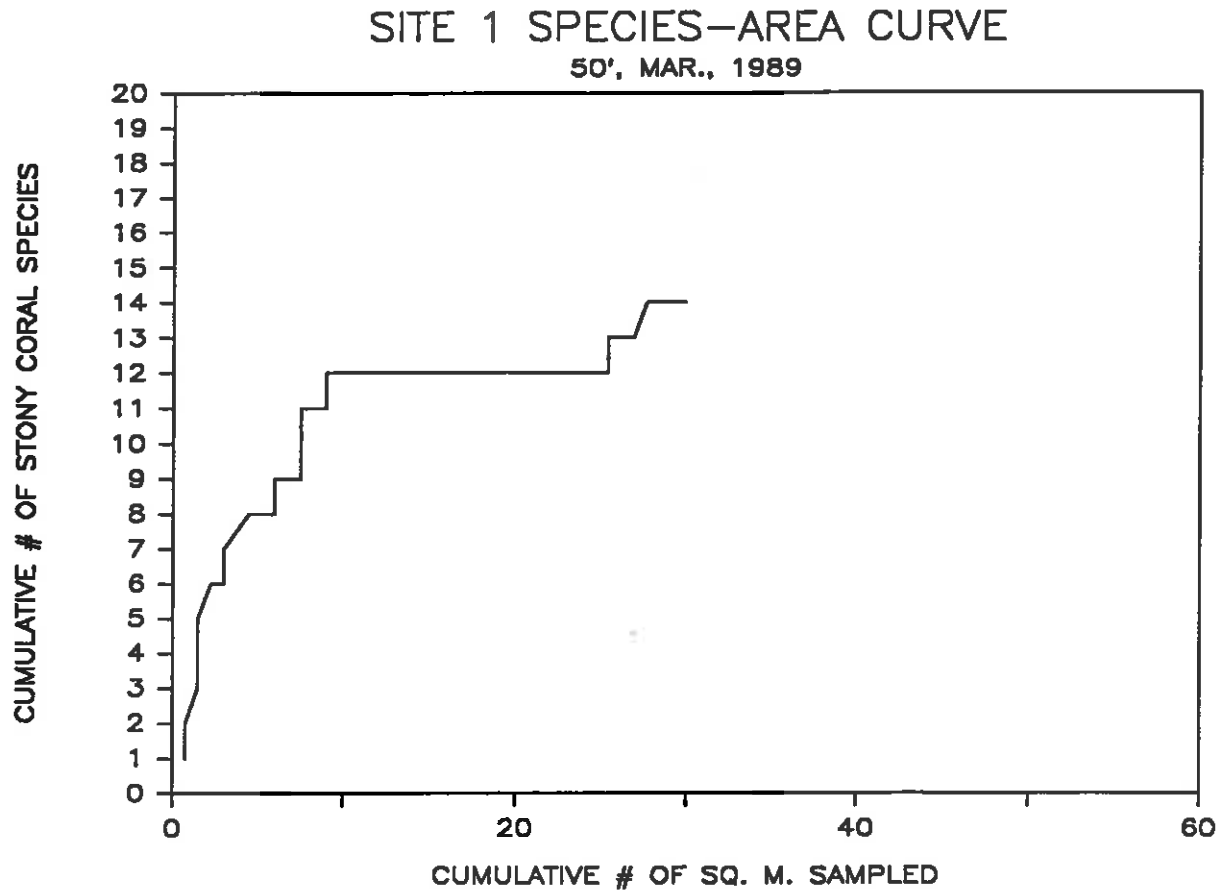
Mollusca
Dr. Donald R. Moore
Marine Geol. & Geophysics
Univ. of Miami/RSMAS
4600 Rickenbacker Cswy.
Miami, FL 33149

FIGURES



Site
FIG 1
Yacht Club
Harbor Beach
Lake Sylvia
Yacht Basin
Spoil Area
Harbor Heights
Port Everglades Turning Basin
USCG
INTRACOASTAL WATERWAY
JOHN U. LLOYD BEACH STATE RECREATION AREA
25
DANIA CUT-OFF CANAL
(FORT LAUDERDALE SOUTH)
5
6
7
8
10
DB

Fig. 2a


SITE 1 SPECIES–AREA CURVE
50', MAR., 1989
CUMULATIVE # OF STONY CORAL SPECIES
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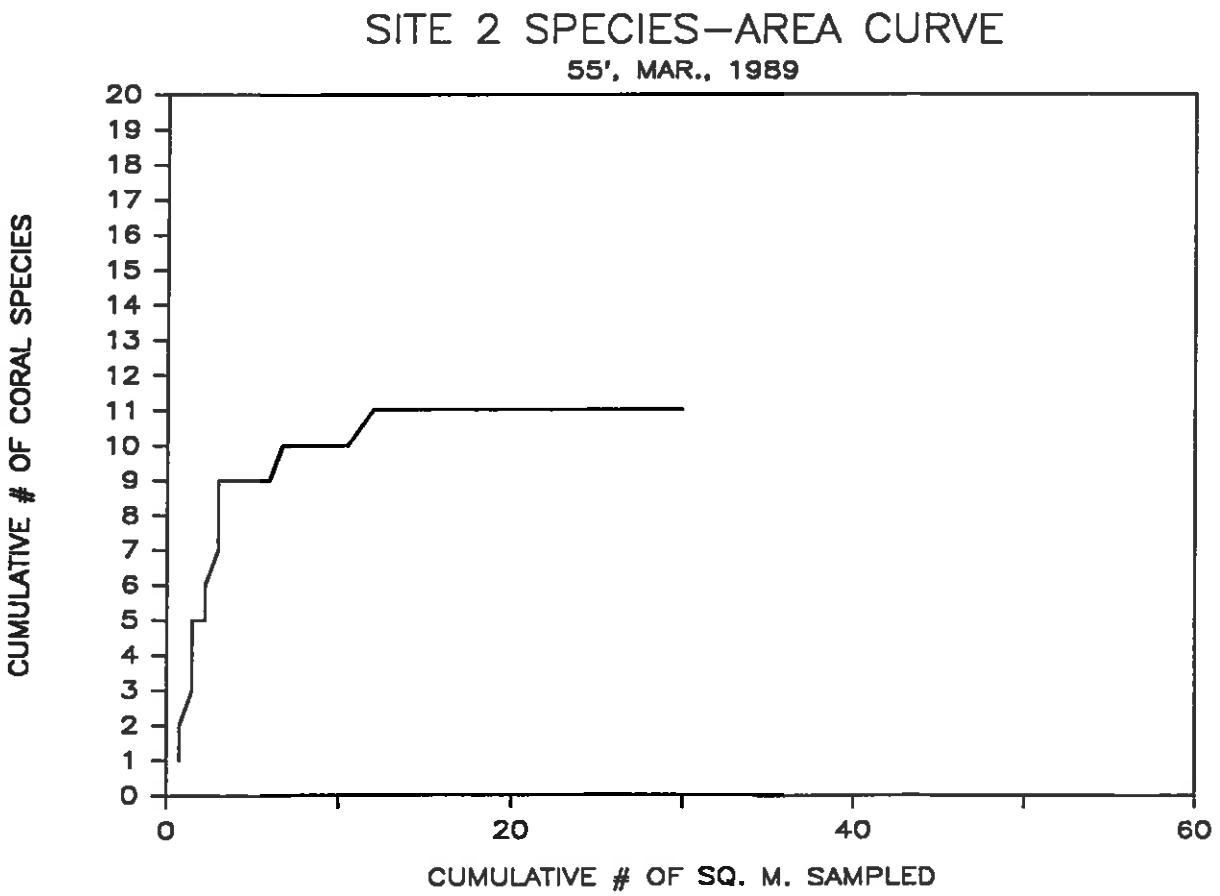
CUMULATIVE # OF SQ. M. SAMPLED

Fig. 2b


SITE 2 SPECIES–AREA CURVE
55', MAR., 1989
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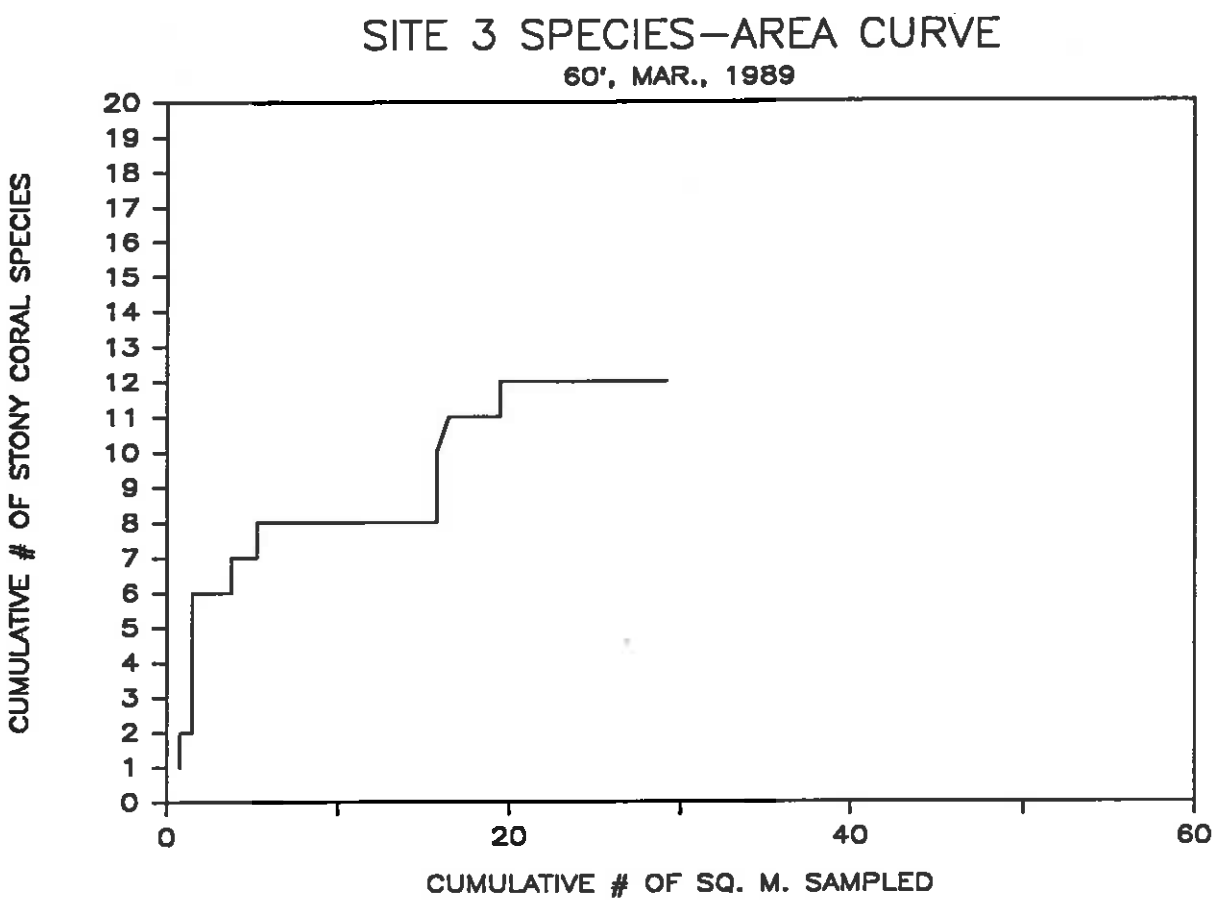
CUMULATIVE # OF SQ. M. SAMPLED

Fig. 2c


SITE 3 SPECIES–AREA CURVE
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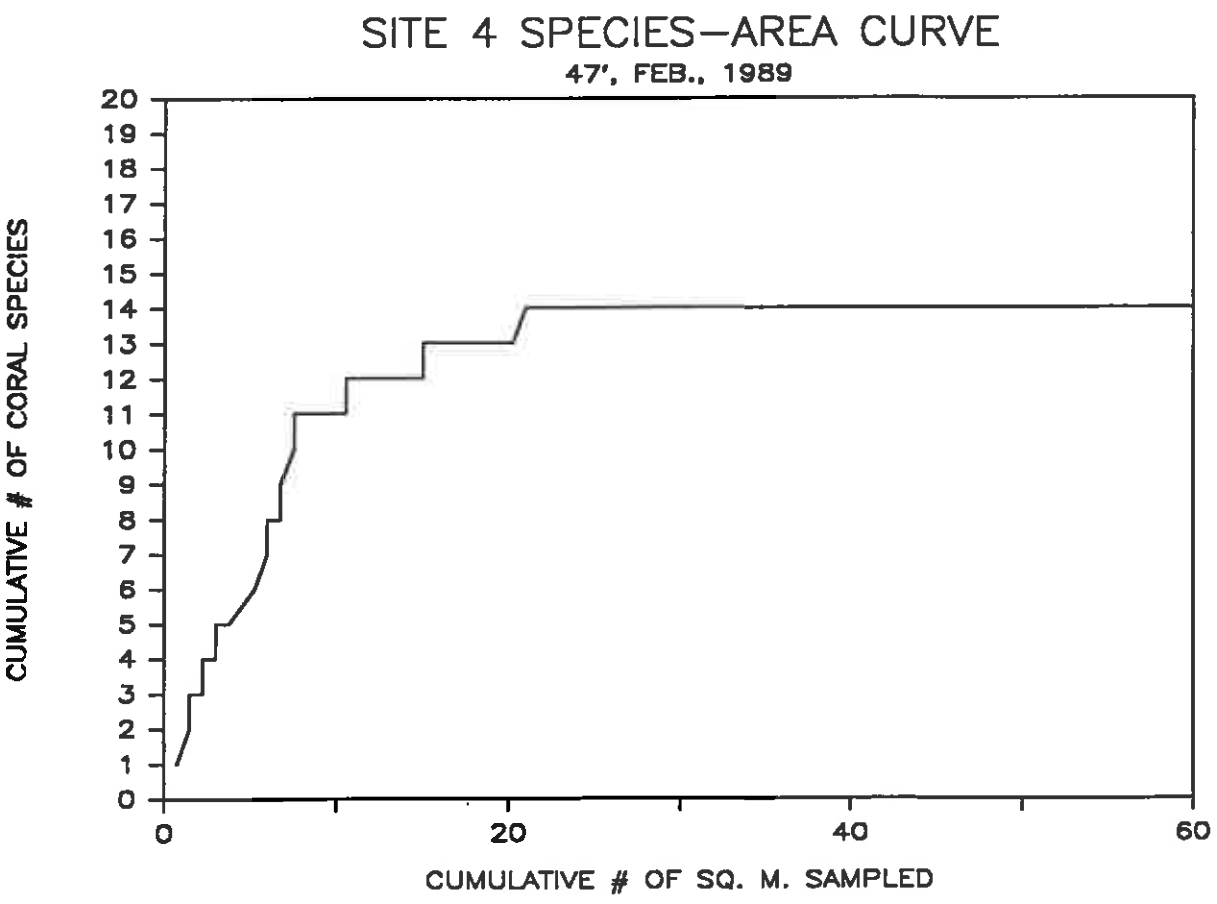
CUMULATIVE # OF SQ. M. SAMPLED

Fig. 2d


SITE 4 SPECIES–AREA CURVE
47', FEB., 1989
CUMULATIVE # OF CORAL SPECIES
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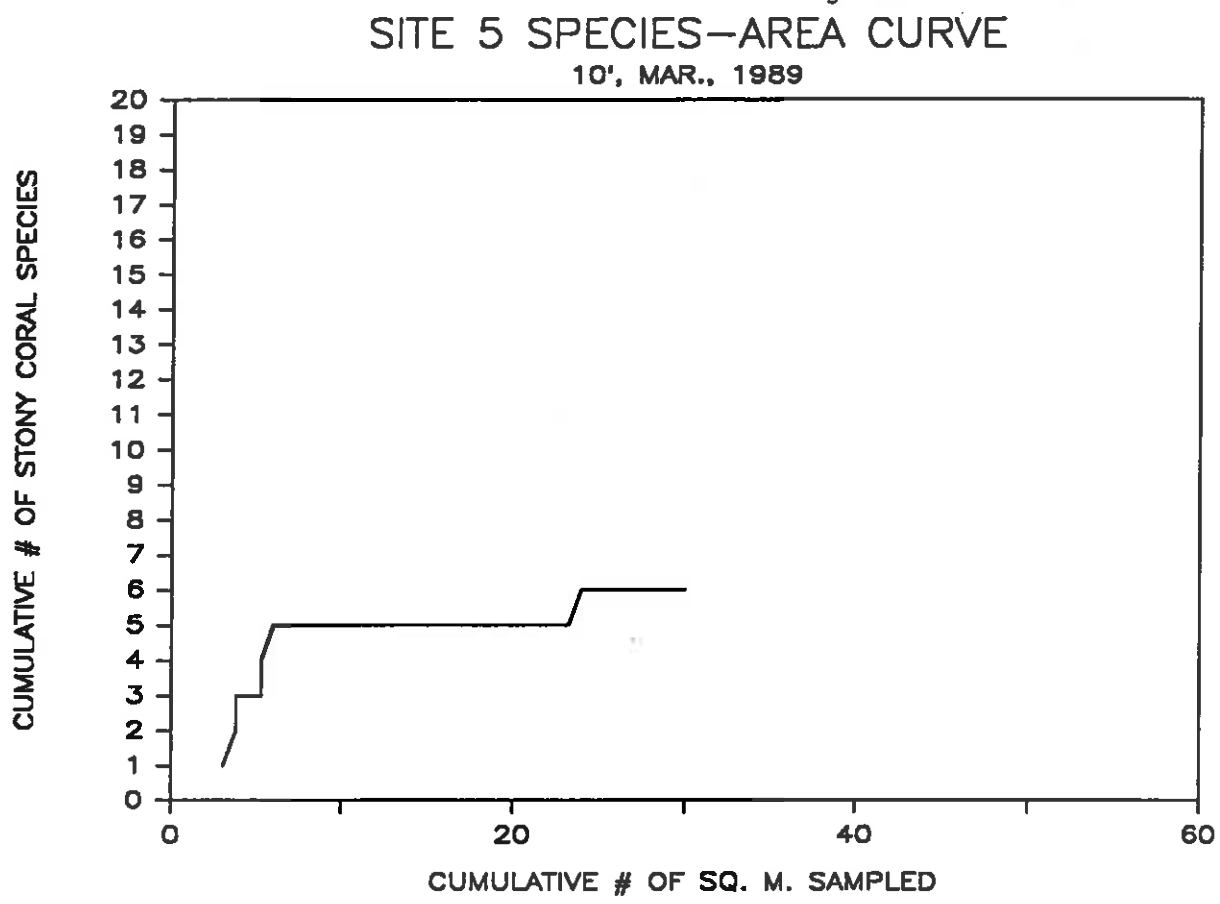
CUMULATIVE # OF SQ. M. SAMPLED

Fig. 2e


SITE 5 SPECIES–AREA CURVE
10', MAR., 1989
CUMULATIVE # OF STONY CORAL SPECIES
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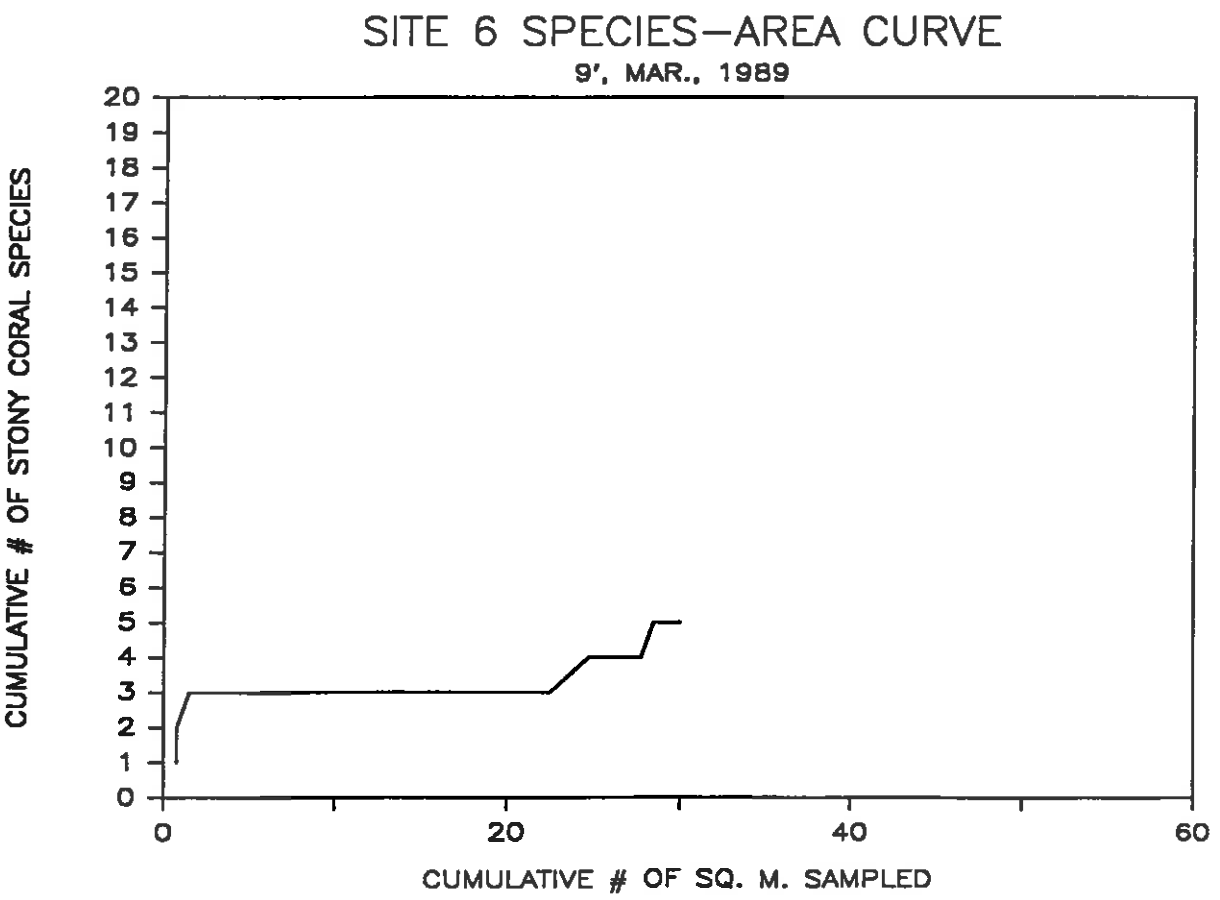
CUMULATIVE # OF SQ. M. SAMPLED

Fig. 2f


SITE 6 SPECIES–AREA CURVE
9', MAR., 1989
CUMULATIVE # OF STONY CORAL SPECIES
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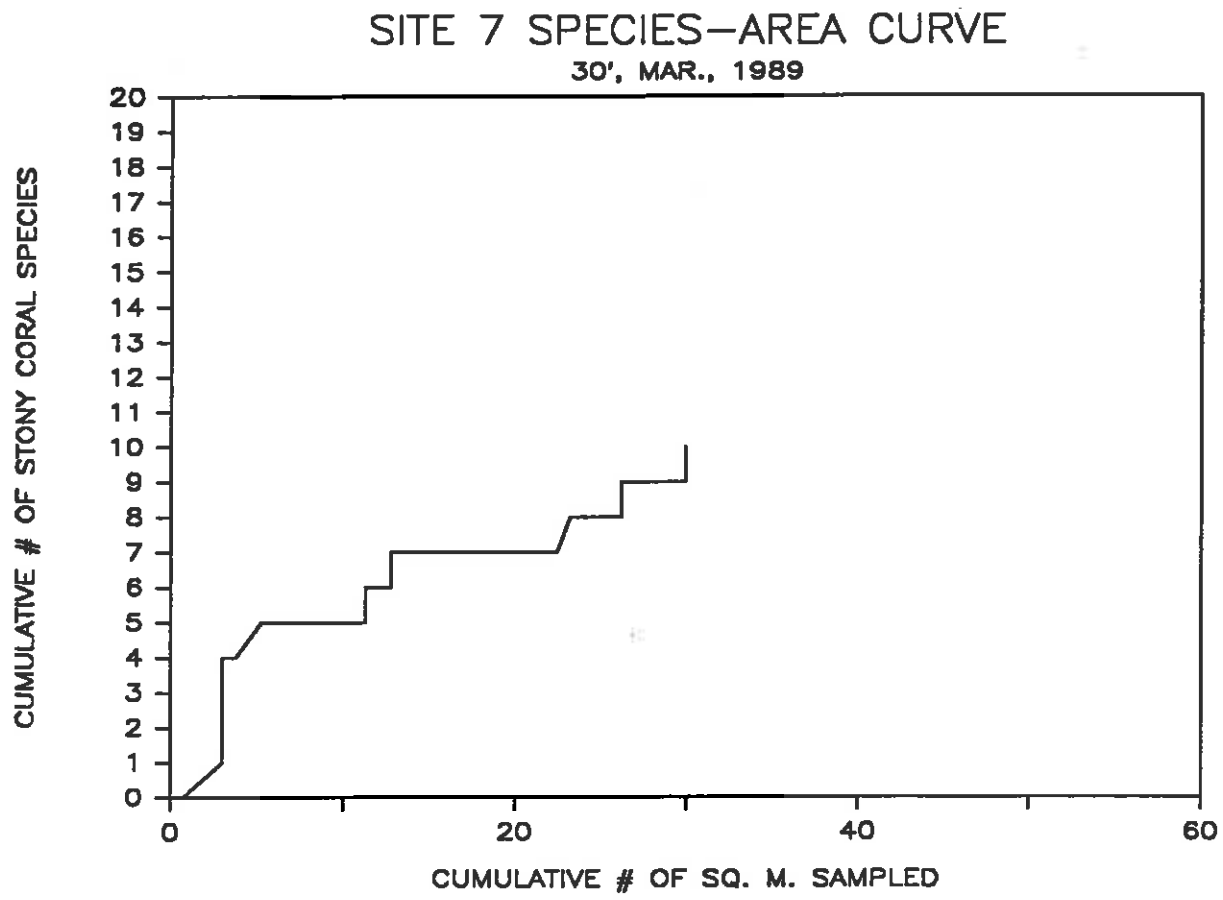
CUMULATIVE # OF SQ. M. SAMPLED

Fig. 2g


SITE 7 SPECIES–AREA CURVE
30', MAR., 1989
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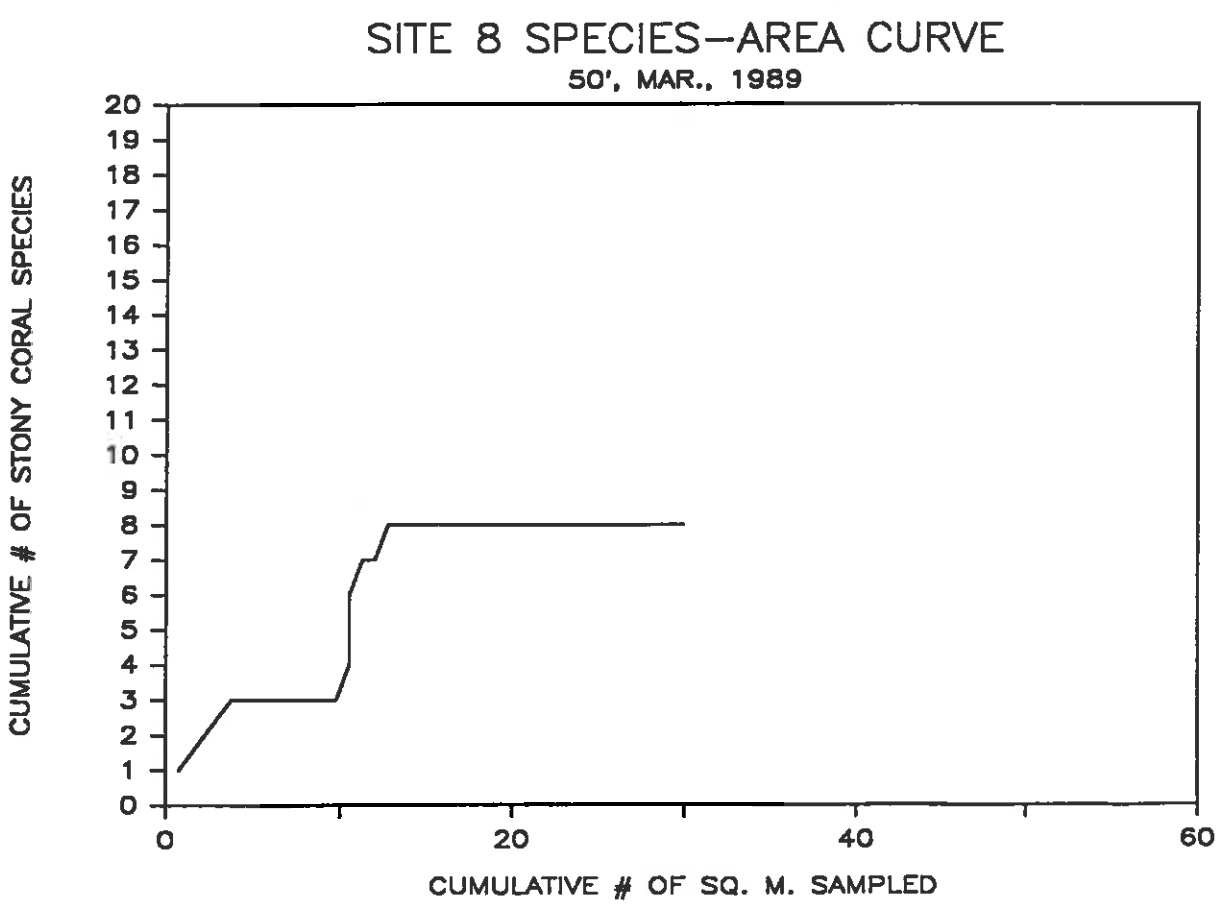
CUMULATIVE # OF SQ. M. SAMPLED

Fig. 2h


SITE 8 SPECIES–AREA CURVE
50', MAR., 1989
CUMULATIVE # OF STONY CORAL SPECIES
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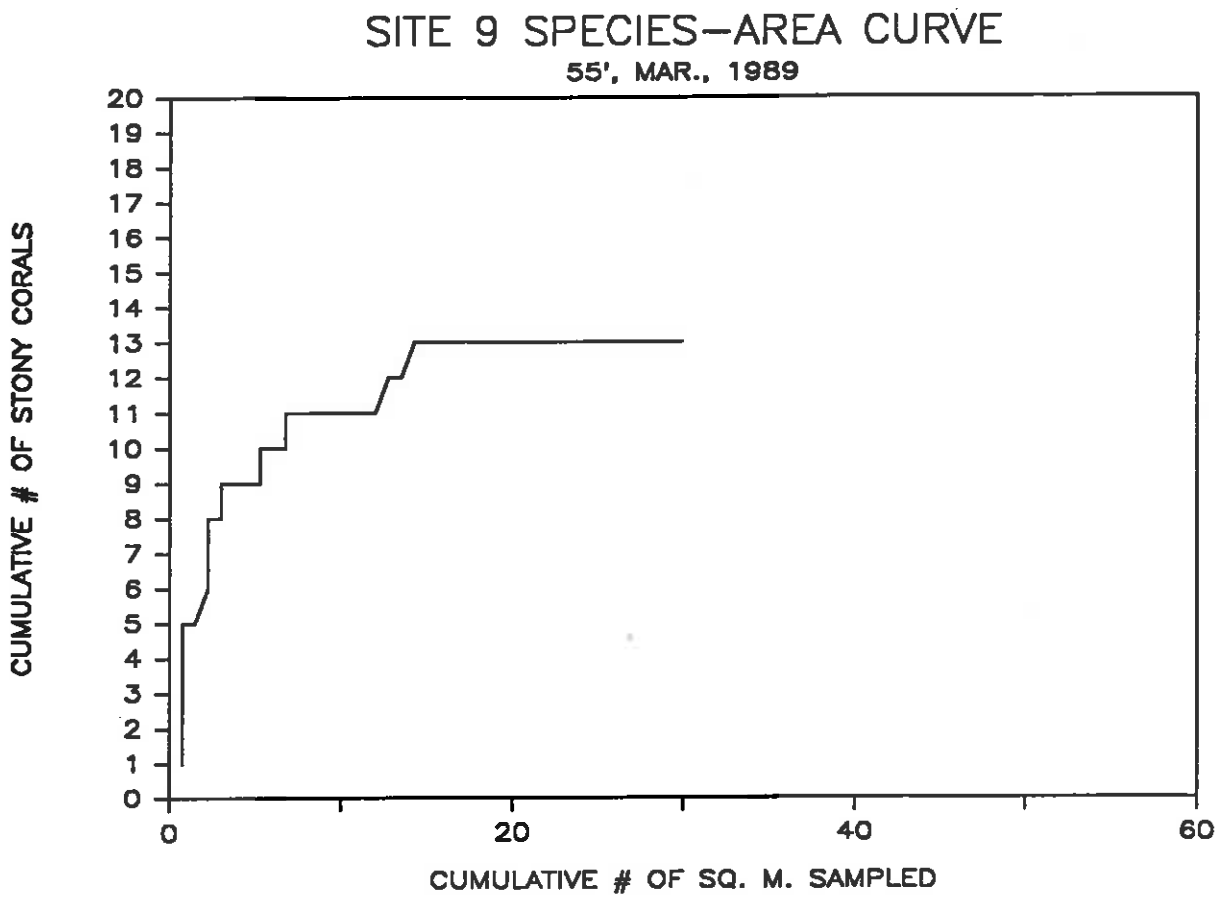
60
CUMULATIVE # OF SQ. M. SAMPLED

Fig. 2i


SITE 9 SPECIES–AREA CURVE
55', MAR., 1989
CUMULATIVE # OF STONY CORALS
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2
3
4
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17
18
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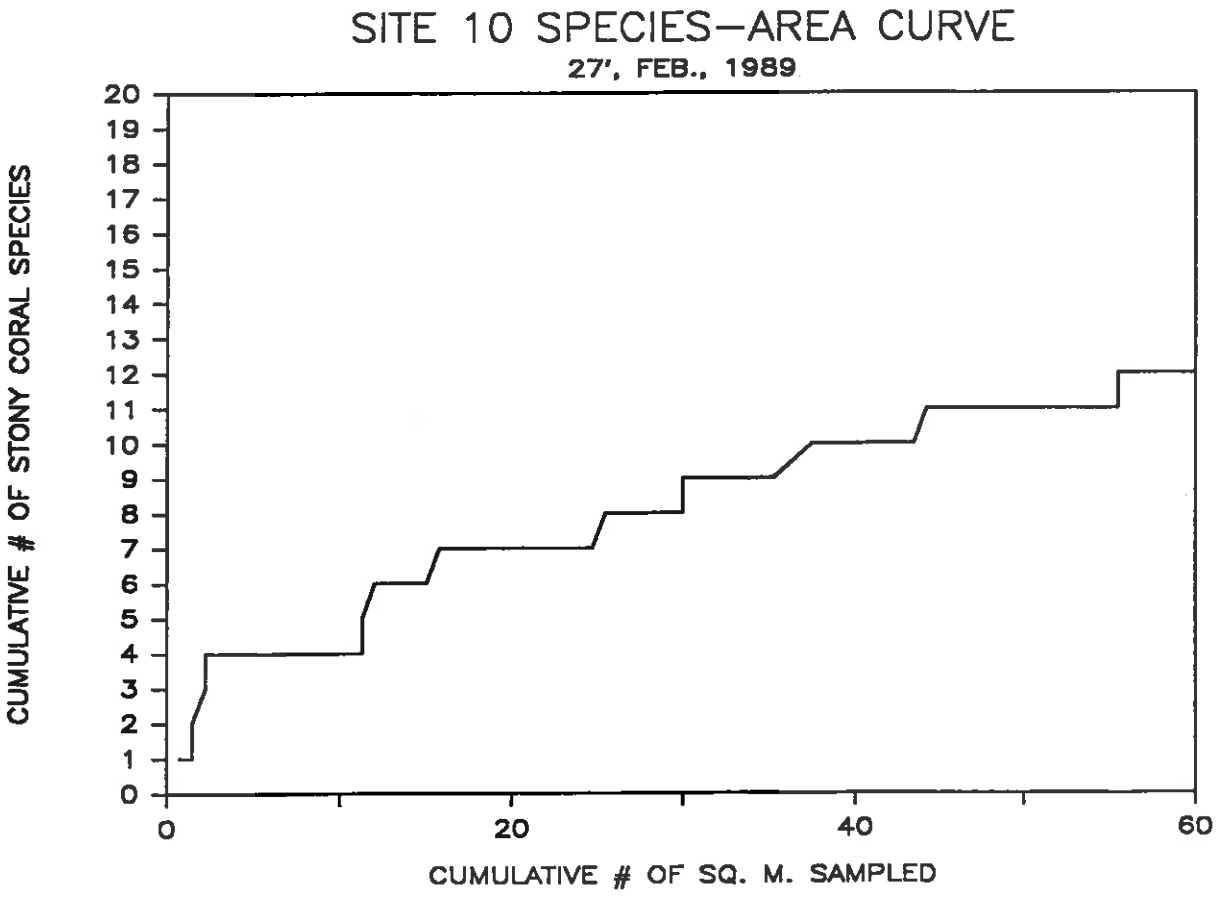
20
0
20
40
60
CUMULATIVE # OF SQ. M. SAMPLED

Fig. 2j


SITE 10 SPECIES–AREA CURVE
27', FEB., 1989
CUMULATIVE # OF STONY CORAL SPECIES
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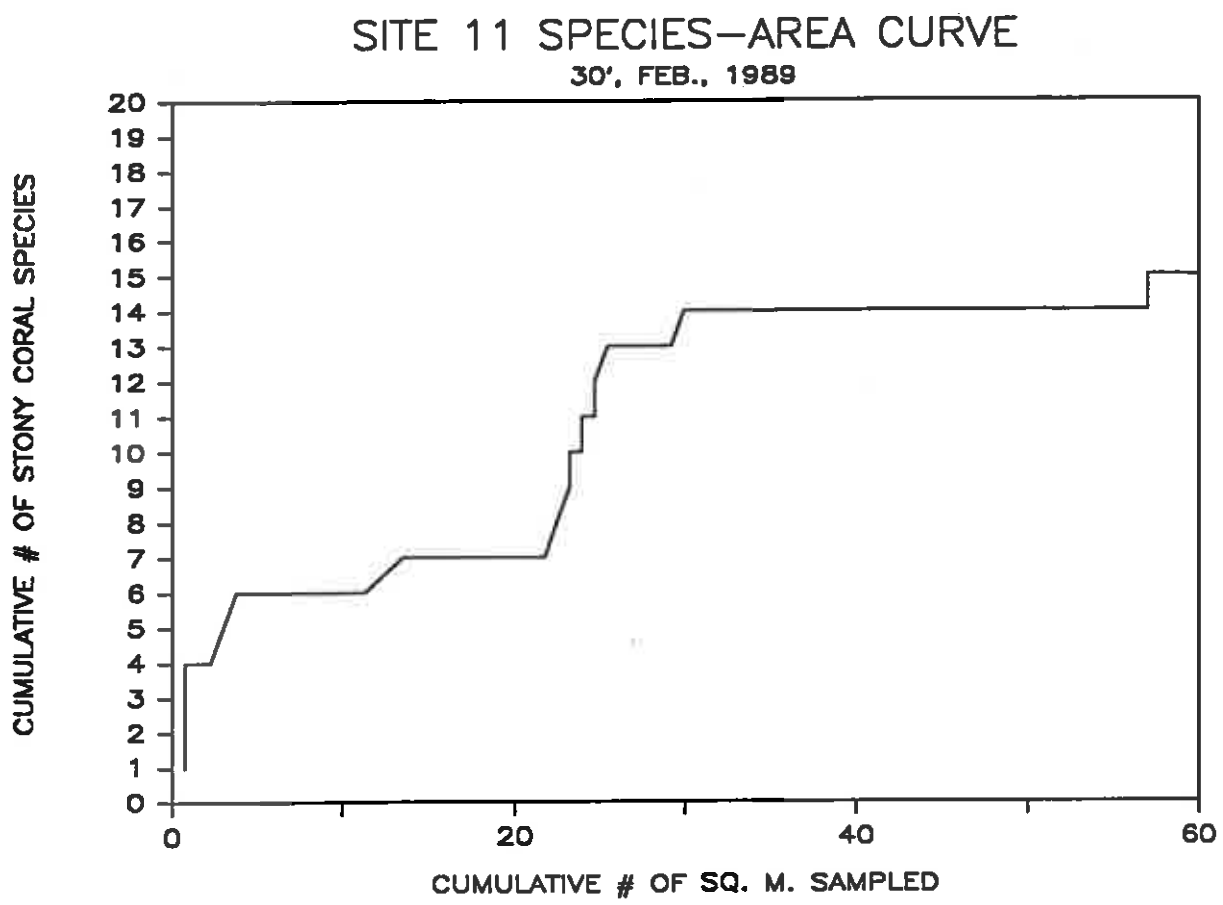
60
CUMULATIVE # OF SQ. M. SAMPLED

Fig. 2k


SITE 11 SPECIES–AREA CURVE
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10
11
12
13
14
15
16
17
18
19
20
0
20
40
60
CUMULATIVE # OF SQ. M. SAMPLED

Fig. 3a

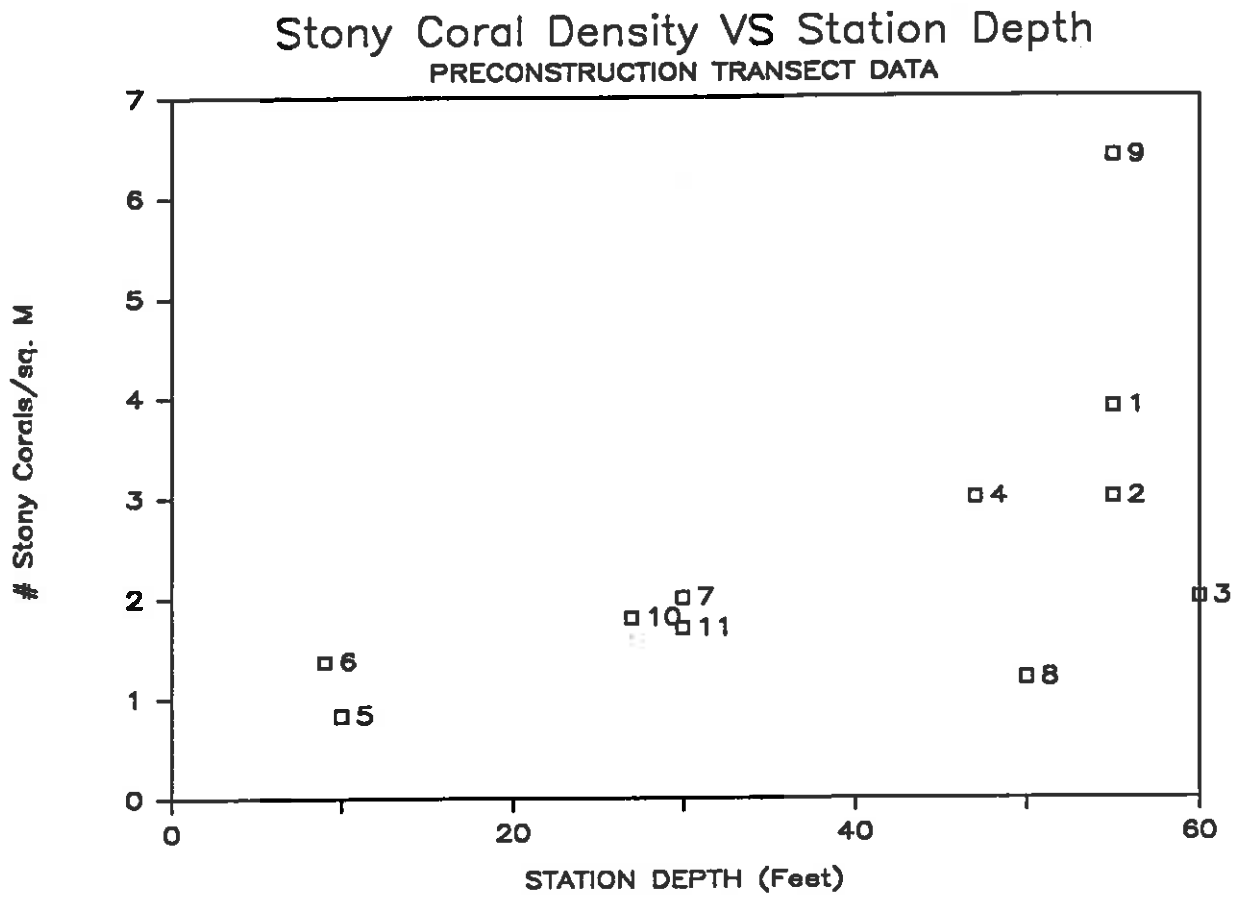

Stony Coral Density VS Station Depth
PRECONSTRUCTION TRANSECT DATA
Stony Corals/sq. M
STATION DEPTH (Feet)
0
1
2
3
4
5
6
7
0
20
40
60
9
1
4
2
3
7
10
11
6
8
5

Fig. 3b

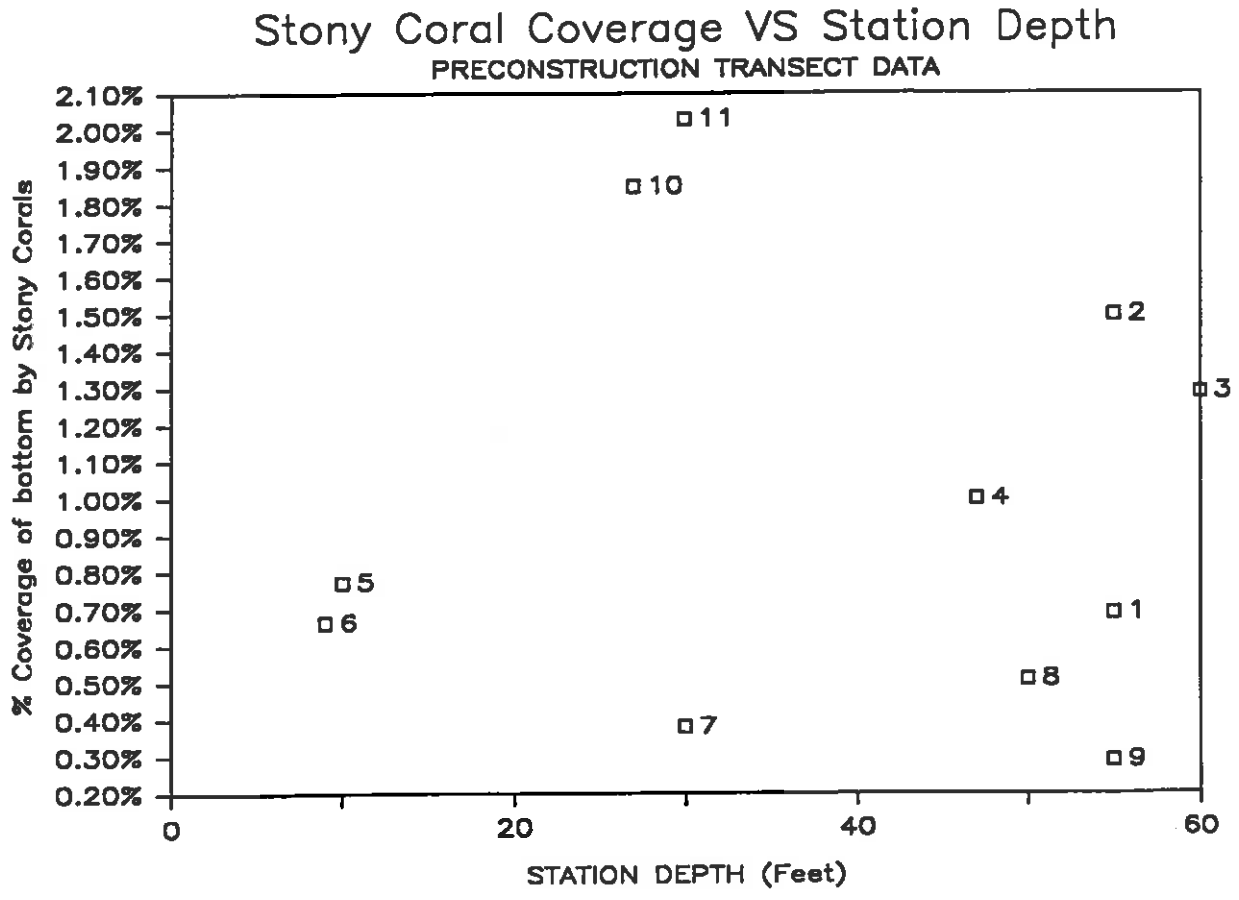

Stony Coral Coverage VS Station Depth
PRECONSTRUCTION TRANSECT DATA
% Coverage of bottom by Stony Corals
STATION DEPTH (Feet)
2.10%
2.00%
1.90%
1.80%
1.70%
1.60%
1.50%
1.40%
1.30%
1.20%
1.10%
1.00%
0.90%
0.80%
0.70%
0.60%
0.50%
0.40%
0.30%
0.20%
0
20
40
60
11
10
2
3
4
5
6
1
8
7
9

Fig. 3e

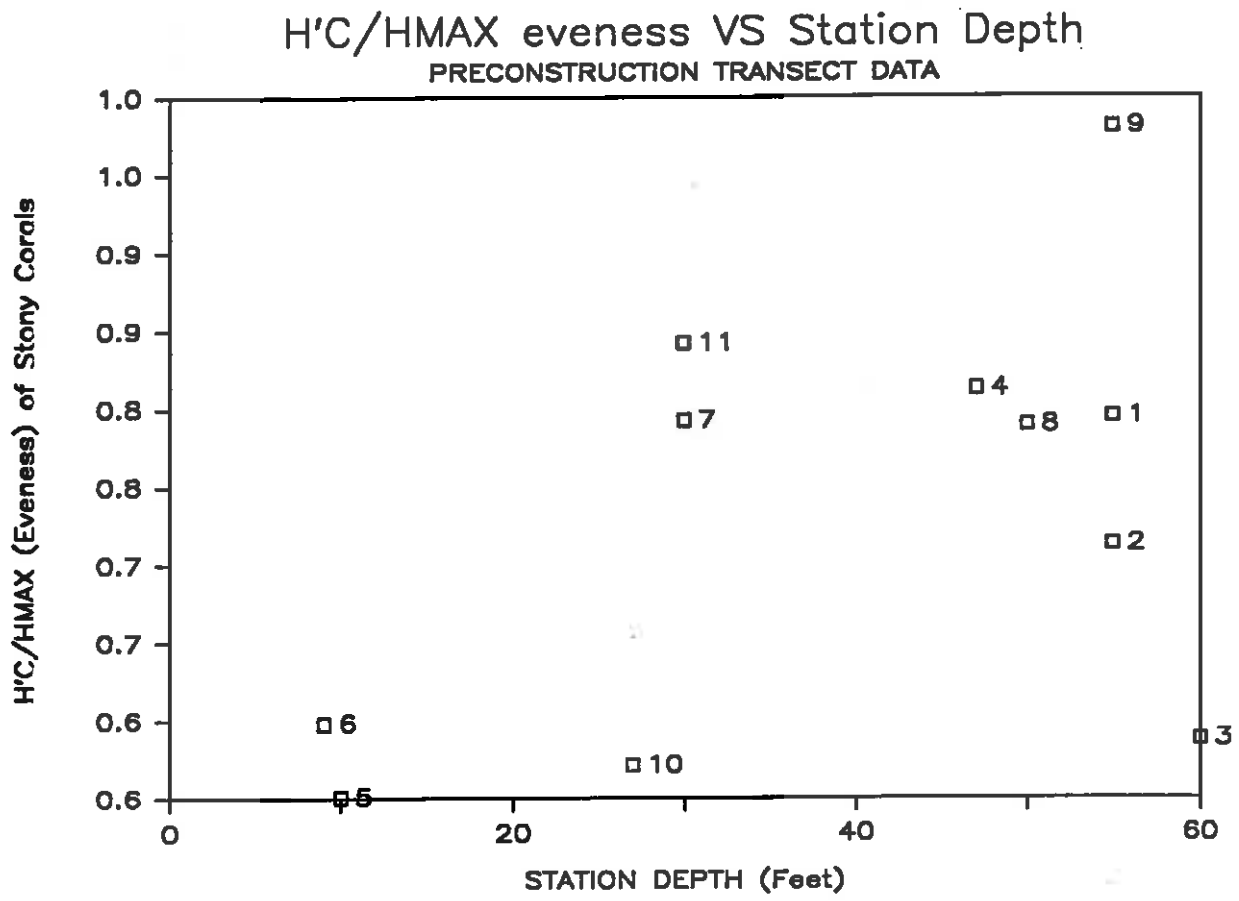

H'C/HMAX eveness VS Station Depth
PRECONSTRUCTION TRANSECT DATA
H'C/HMAX (Eveness) of Stony Corals
1.0
1.0
0.9
0.9
0.8
0.8
0.7
0.7
0.6
0.6
9
11
4
7
8
1
2
6
3
10
5
0
20
40
60
STATION DEPTH (Feet)

Fig. 3f

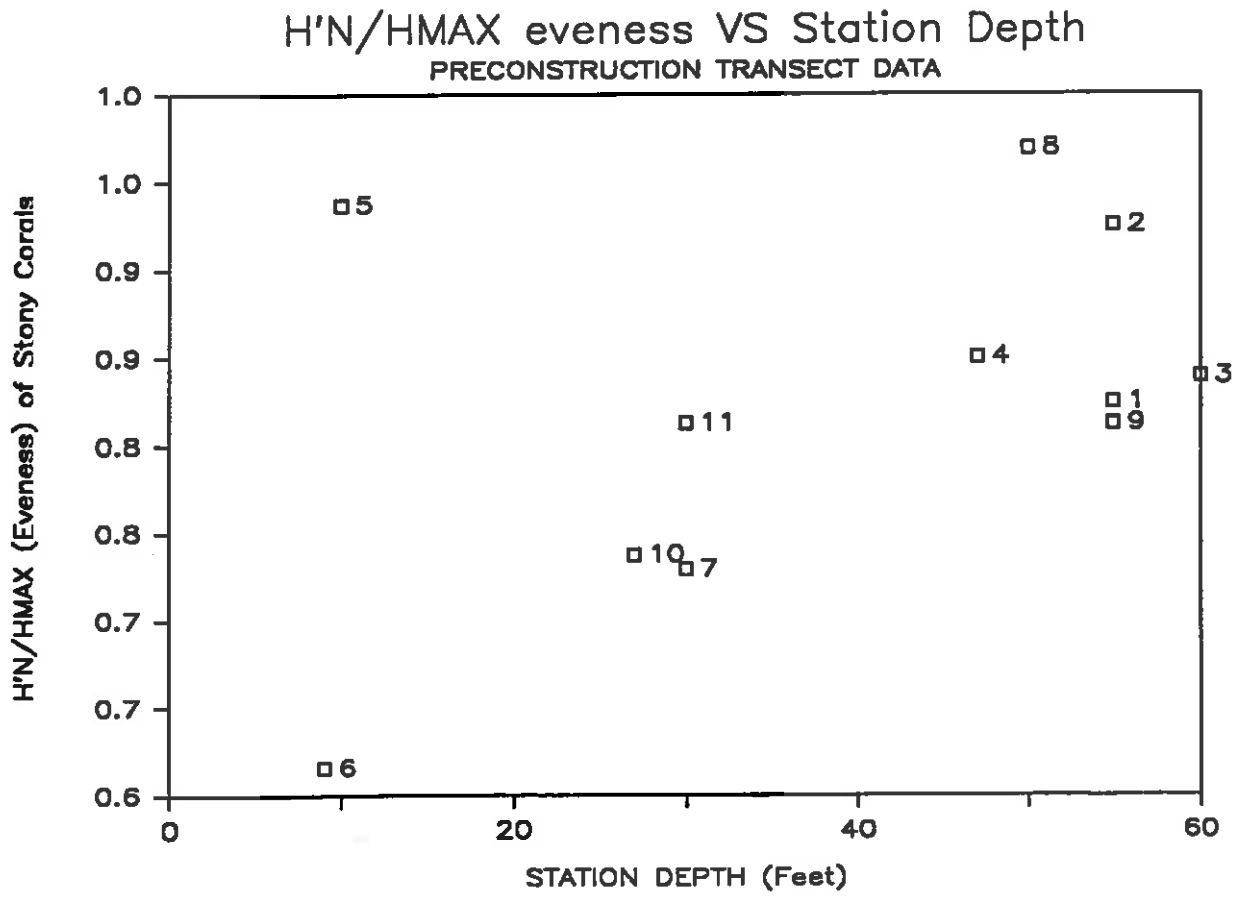

H'N/HMAX eveness VS Station Depth
PRECONSTRUCTION TRANSECT DATA
H'N/HMAX (Eveness) of Stony Corals
1.0
1.0
0.9
0.9
0.8
0.8
0.7
0.7
0.6
8
5
2
4
3
1
9
11
10
7
6
0
20
40
60
STATION DEPTH (Feet)

Fig. 3c

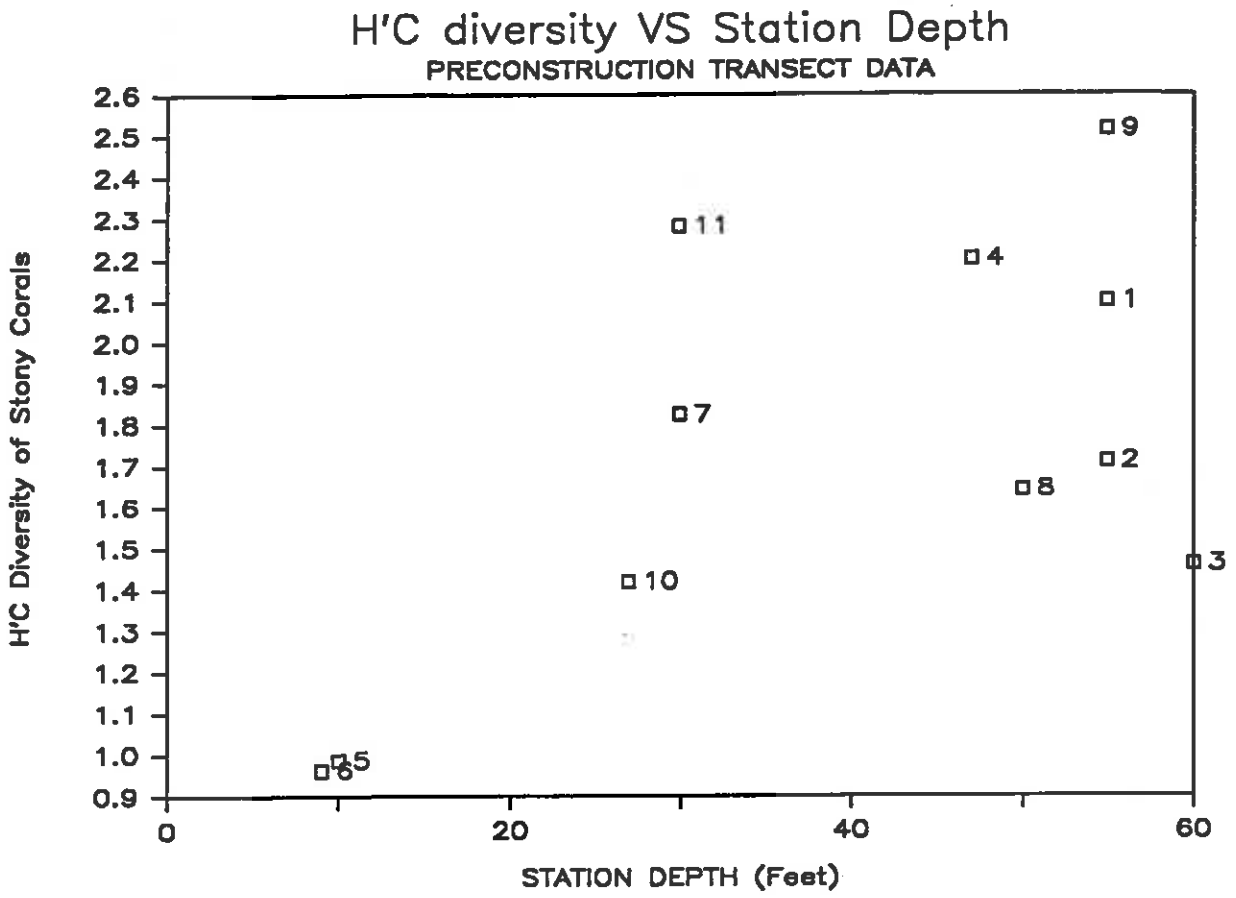
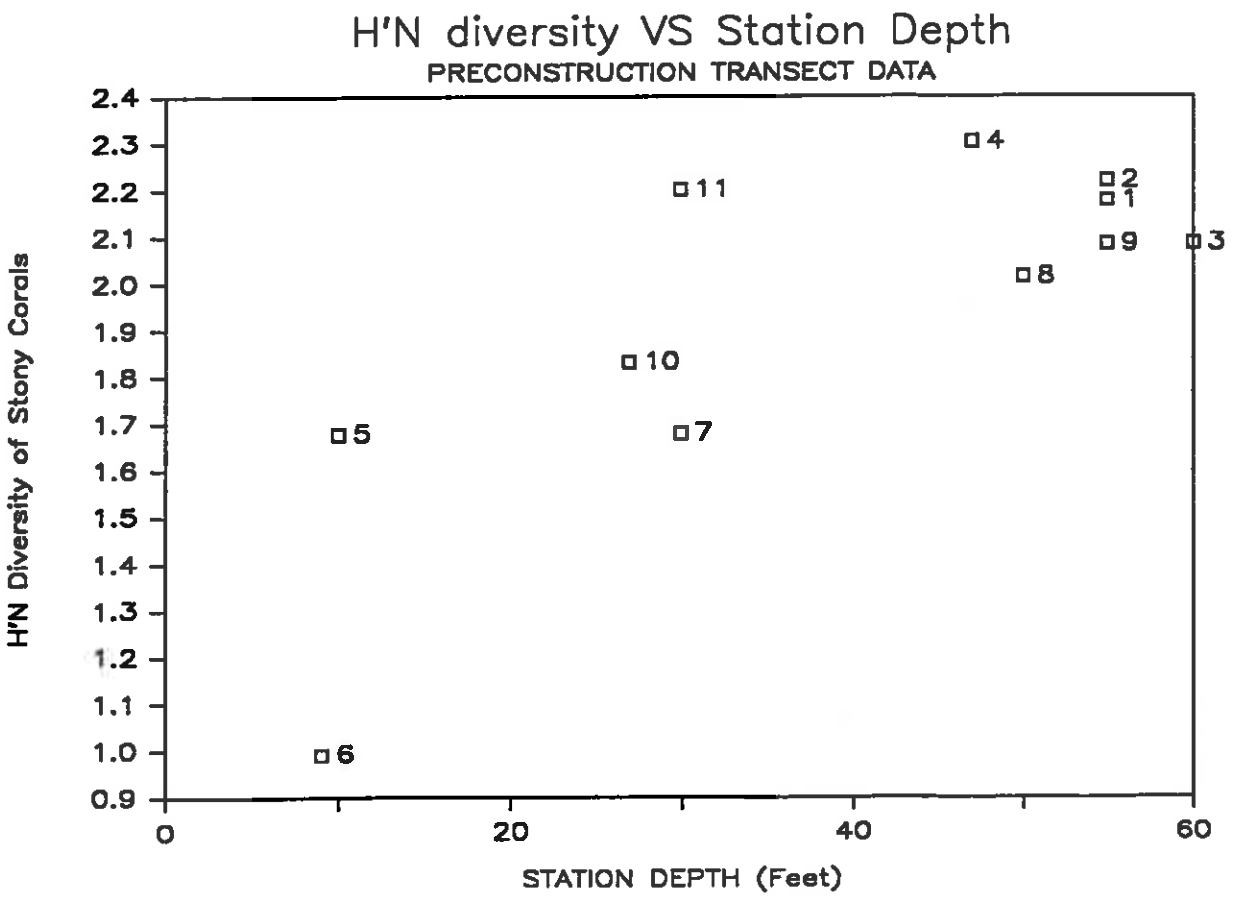

H'C diversity VS Station Depth
PRECONSTRUCTION TRANSECT DATA
H'C Diversity of Stony Corals
STATION DEPTH (Feet)
2.6
2.5
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0
20
40
60
9
11
4
1
7
2
8
3
10
5
6

Fig. 3d


H'N diversity VS Station Depth
PRECONSTRUCTION TRANSECT DATA
H'N Diversity of Stony Corals
STATION DEPTH (Feet)
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0
20
40
60
4
11
2
1
9
3
8
10
5
7
6