

SEMI-ANNUAL REPORT
SUSTAINED ECOLOGICAL RESEARCH ON CORAL REEF RESOURCES
FORT JEFFERSON NATIONAL MONUMENT
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BY THE FLORIDA MARINE RESEARCH INSTITUTE
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SUMMARY

Quadrat and transect data from Loggerhead Key, Pulaski Shoal, and White Shoal were tabulated and analyzed for octocoral and stony coral abundance, cover, and species density. Recruitment tiles from these stations were examined and all scleractinian polyps were enumerated.

A paper by Walter Jaap, Jennifer Wheaton, and Kelly Boomer Donnelly entitled, "Materials and methods to establish multipurpose, sustained ecological research stations on coral reefs at Dry Tortugas," was published in the proceedings of the American Academy of Underwater Sciences, 1990... Diving for Science Symposium. The paper describes site installation, photographic methods, and sampling techniques utilized at monitoring stations in Fort Jefferson National Monument (Attachment 1).

SAMPLING RESULTS

SYSTEMATIC TAXONOMIC ANALYSIS

Twenty-eight octocoral species and 29 stony coral species were observed within quadrat and transect stations in 1989 and 1990 (Table 1).

QUADRATS

Loggerhead Key

Plots were dominated by *Halimeda*-encrusted *Acropora cervicornis* rubble, often covered with a fine filamentous algae. This habitat was extensive, but was not quantified. In both 1989 and 1990, three octocoral species were found in Loggerhead Key quadrats (Table 2); however, two previously unreported species (*Erythropodium caribaeorum* and *Eunicea calyculata*) found in 1990, may have been interchanged with *Briareum asbestinum* and *E.*

mammosa, respectively, in 1989. Encrusting forms of *Erythropodium* and *Briareum* are difficult to distinguish and are particularly difficult to identify *in situ*. Octocoral colonies increased from 4 to 7 in 1990 due to a greater abundance of *Erythropodium caribaeorum* at stations 1 and 3 (Figure 1).

Species of Scleractinia and Milleporina increased by 4 in 1990; one species (*Colpophyllia natans*) present in 1989 was not found, while 5 new species were observed (*Agaricia agaricites*, *Favia fragum*, *Meandrina meandrites*, *Porites astreoides*, and *P. porites*). Numbers of colonies increased due largely to a proliferation of *Millepora alcicornis* (Table 2). Only station 4 exhibited no changes over the year (Figure 2).

Pulaski Shoal

Twenty-one species of octocoral were tabulated in quadrats in both 1989 and 1990, eighteen species were common to both years. The number of individual colonies increased by 106 (Table 3). A dramatic increase of *Pseudopterogorgia acerosa* occurred at stations 4 and 5, and *Eunicea tourneforti* recruited in all plots (Figure 3). Juveniles of *E. tourneforti* are often indistinguishable from juveniles of other *Eunicea* species. Some of the individuals identified in 1989 as *Eunicea* spp. were probably juvenile *E. tourneforti*. *Plexaura flexuosa*, *Pseudopterogorgia acerosa*, and *P. americana* were the most abundant species at Pulaski Shoal both years.

Ten scleractinian and milleporid species were detected in 1990, an increase of one from 1989 (Table 3). One previously unreported species (*Porites astreoides*) was located. It is also possible that *Colpophyllia natans* was identified as *Diploria* sp. in 1989. Number of colonies increased by eight; six additional *Millepora alcicornis* represented the most impressive change (Table 3, Figure 4). Abundance of the zoanthid *Palythoa caribbea* increased at all stations.

White Shoal

Octocoral colonies increased by five and the species number remained constant between 1989 and 1990 (Table 4). *Erythropodium caribaeorum* reported in 1989 and *Briareum asbestinum* reported in 1990 may have been interchanged. An increase in *B. asbestinum* at stations 3, 4, and 5 accounted for the majority of change in octocoral abundance (Figure 5).

The number of stony coral species remained the same from 1989 to 1990. Individual colonies decreased due to apparent decreases in *Acropora cervicornis* and *Millepora alcicornis* at four stations (Table 4, Figure 6). The branching growth habit of these species, particularly *A. cervicornis*, makes distinguishing separate colonies difficult. A small *A. cervicornis* thicket dominated the plot at station 5 and was counted as a single colony. *Meandrina meandrites* was the only new species in 1990, while *Colpophyllia natans* observed in 1989 was not found.

TRANSECTS

Loggerhead Key

Coral (stony coral, octocoral and hydrocoral) cover along a 23 m transect sampled three times ranged from 70.2 to 78.0 cm; total biotic cover was 206.7 to 256.1 cm (Tables 5, 6, and 7). One octocoral and five stony coral species were tallied. *Briareum asbestinum*, *Acropora cervicornis*, and *Diploria labyrinthiformes* were the most abundant coral species. *Dictyota* sp. and *Halimeda* sp. also provided substantial coverage. Only 8 of the 23 meters sampled had measurable coral cover (Figure 7). Biotic substrate coverage was greatest at meters 8 and 16, while meters 15 and 21 were completely void of biota (Figure 8). Carbonate substrate (i.e., coral rubble, rock, and sand) accounted for 2502.5 to 2722.2 cm.

In 1989, the same length transect yielded 28.6 cm coral cover and 2169.7 cm biotic cover (Table 8). All of the species encountered in 1989 were reported in the 1990 transects. The *Halimeda*-encrusted rubble was counted as living algae in 1989; therefore, biotic cover was much greater. In 1990, most of this habitat was classified as DCA (dead coral and algae). It was difficult to distinguish the extent of living or dead tissue within the algal mats.

Pulaski Shoal

The 22 m long transect, sampled three times in 1990, exhibited a wide range in both coral (46.8 - 115.7 cm) and total biotic cover (486.2 - 609.7 cm) (Tables 9, 10, and 11). *Montastraea annularis*, *Pseudopterogorgia americana*, and *Briareum asbestinum*; dominated coral coverage; however, *Palythoa caribbea* and *Dictyota* sp. were the most abundant organisms along the transect in all three samplings. Coral cover ranged from 0 to 39.0 cm and biotic cover varied from 0 to 93.6 cm within individual meters (Figures 9 and 10). Carbonate substrate at this site ranged from 2038.4 to 2312.7 cm.

A 20 m long transect sampled in 1989 contained 146.9 cm coral cover and 608.4 cm biotic cover (Table 12). Of the species identified in 1989, *Meandrina meandrites* and *Montastraea cavernosa* were not found in the transect examined in 1990. Blue-green algae was considered as a distinct category only in 1989.

White Shoal

The 22 m long transect had 523.9 - 689.0 cm coral and 681.2 - 748.8 cm biotic cover (Tables 13, 14, and 15). Combined *Millepora alcicornis*, *Briareum asbestinum*, and *Acropora cervicornis* yielded 310.7 to 526.5 cm of the living cover along the multi-sampled transect. Coral coverage within individual meters ranged from 0 to >135.0 cm (Figure 11). The most living cover occurred within meters 3 and 4, whereas, biota was absent from meter 10 (Figure 12). *Dictyota* sp. and various sponges

accounted for the non-coral biota. Carbonate substrate covered 1829.1 to 2179.9 cm.

In 1989, the transect at White Shoal yielded a total of 245.7 cm coral cover and 534.3 cm biotic cover (Table 16). *Diploria strigosa* was the only species found in 1989 but not in 1990. Fine filamentous algae was included as a separate category only in 1989.

RECRUITMENT

Two recruitment tiles from each reef, deployed in 1989, were collected, bleached, air-dried, and examined for scleractinian corals. Eleven recruits (11) were found at White Shoal, whereas, Pulaski Shoal and Texas Rock each yielded two polyps (see table below).

Reef	# Coral Recruits
*Bird Key Reef	6
Loggerhead Key	7
Pulaski Shoal	2
*Texas Rock	2
White Shoal	11

*Previously reported	

Twenty-two (79%) of the 28 new recruits counted were observed on the unglazed, ridged surface of the ceramic tiles. No determination of the angle of orientation of individual plates was made at the time of collection.

CLASSIFICATION ANALYSIS

A community analysis program (Bloom, 1990) was used to compute faunal similarity among quadrats at each reef between 1989 and 1990. Czekanowski's (Bray-Curtis) quantitative coefficient (Bloom, 1981) was utilized to generate similarity coefficients. Coefficients range from 0 (no similarity) to 1 (total similarity). Classification based on species abundance and group average sorting was utilized to develop linkage for dendrogram clustering (Figures 13 - 17).

The similarity coefficients of the five quadrat pairs at Bird Key Reef ranged from .73 to .85 (Table 17). This suggests the communities within individual quadrats changed 15 to 27 percent from 1989 to 1990. The greatest difference among quadrats was at Loggerhead Key (Table 18), reflected in a similarity coefficient range of 0 to 1. Cnidarians occurred in

Quadrat 1 in 1990, but not in 1989, resulting in a similarity coefficient of 0. Similarity coefficient values ranged from .58 to .66 (Table 19) at Pulaski Shoal; .57 to .79 (Table 20) at Texas Rock; and .63 to .90 (Table 21) at White Shoal.

FISH RESEARCH

Recent fish research in Fort Jefferson has been directed at 1) establishing an easy to follow field protocol that is applicable among Western North Atlantic coral reef systems, and 2) maintaining the quantitative integrity of estimates of species abundance and size.

The visual point counting technique described by Bohnsack and Bannerot (1983) was modified and used to quantitatively describe reef fish assemblages at five reefs (Bird Key Reef, Loggerhead Key, Pulaski Shoal, Texas Rock, and White Shoal). Modifications to the original method included reducing the area of the count from a 16 m diameter circle to one of 10 m, and establishing 15 minutes as the optimal time for listing species composition, counting and measuring fish. Instead of estimating the circle diameter, as in the original method, a surveyor tape or calibrated line for reference was laid down before beginning each count. A surveyor tape is recommended since it can also be used in fish size estimates. Divers were encouraged to slowly move within their census area, so as not to disturb the natural behavior of the fish assemblage, and obtain as complete a count as possible. The original method involved a stationary diver rotating around a vertical axis in the center of the counting area. Each area censused was briefly characterized with regard to the height of vertical relief and percent cover of the major biotic and abiotic components of the substrate before starting the counting clock. Area characterizations never exceeded one minute in duration. We felt these modifications would reduce variation between counts by allowing sufficient time for a more complete, accurate assessment. This sample protocol has been used successfully in Saba Marine Park and U.S. Virgin Islands.

A minimum of twelve 15-minute censuses were made at the five reef sites within Fort Jefferson National Monument. In 66 counts, an average of 102 individuals and 20 species per count were recorded. Comprehensive data analysis has been delayed until a suitable data entry format is selected. Preliminary analysis indicates the most numerically abundant species among all sites is the striped parrotfish, *Scarus croicensis*. This species is of special interest because its color pattern and average size are different in other regions of the Caribbean.

COMMENTS/DISCUSSION

The total number of species increased in quadrats at both Loggerhead Key and Pulaski Shoal due to additions of one or more stony coral species. Numbers of both octocoral and scleractinian colonies increased at these sites. White Shoal demonstrated a

different trend. There, octocoral and stony coral species numbers remained constant; numbers of stony coral colonies decreased by 16; and numbers of octocoral colonies increased by five. *Millepora alcicornis*, an easily fragmented branching or encrusting species, is responsible for the majority of this loss. Portions of our stations at White Shoal are characterized by unconsolidated substrate which can be redistributed by wave and storm surge. *Millepora alcicornis*-encrusted rubble was probably transported out of our sampled quadrats.

Only three octocoral species were encountered during three replicate chain transects at Pulaski Shoal, whereas, White Shoal transects yielded 6 octocoral species. White Shoal actually has a lower octocoral diversity than Pulaski Shoal that is not documented by chain transect data. Chain transect data indicates that Pulaski Shoal is dominated by *Scleractinia* (8 species found); in fact, this site is characterized by a highly diverse octocoral population mixed with a less diverse stony coral community. Both examples show that quadrat data in addition to chain transect data are needed to form an accurate account of the community.

Concerns exist regarding the continuity of the fish program at Fort Jefferson. Research is now sponsored by this NPS-FMRI cooperative agreement. Adequate funding is needed to establish a meaningful commitment to enhancing our knowledge of reef fish population structure, standing stock estimates, life history patterns, and population dynamics. Essential items needed to maintain the program include travel and per diem for two 14-day visits to Fort Jefferson each year for two qualified researchers, use of a vessel able to accommodate divers, dive gear, and field materials. Each researcher's parent organization will provide additional support including salaries, secretarial services, copying, and computer time.

WORK IN PROGRESS

All photographs of each station will be digitized to quantify coverage of coral species. This technique will be important to distinguish sizes of individual colonies and compare actual area of coverage at each sampling site. Species whose cover and/or abundance are difficult to quantify in the field (i.e., *Acropora cervicornis*, *Millepora alcicornis*, assorted octocorals, and *Halimeda*-encrusted rubble) will be accurately measured and enumerated. A clearer picture of true coral coverage and species abundance will be obtained.

Organisms other than coral which are settling onto the recruitment plates will be identified to lowest possible taxon and quantified using a random point method.

Literature Cited

Bohnsack, J.A. and S.P. Bannerot. 1986. A stationary visual census technique for quantitatively assessing community structure of coral reef fishes. NOAA Tech. Rept. NMFS 41:1-15.

Bloom, S.A. 1981. Similarity indices in community studies: potential pitfalls. Mar. Ecol. Prog. Ser. 5:125-128.

Bloom, S.A. 1990. Community Analysis System 4.0, Beta Version. Ecological Data Consultants, Inc.

Table 1

Octocoral and Stony Coral Species Observed in Quadrats and
Transects in 1989 and 1990

Octocorallia

Briareum asbestinum
Erythropodium caribaeorum
Eunicea calyculata
Eunicea fusca
Eunicea laciniata
Eunicea laxispica
Eunicea mammosa
Eunicea tourneforti
Eunicea sp.
Gorgonia ventalina
Iciligorgia schrammi
Muricea atlantica
Muricea elongata
Muricea laxa
Plexaura flexuosa
Plexaura homomalla
Plexaurella dichotoma
Plexaurella fusifera
Plexaurella grisea
Pseudoplexaura crucis
Pseudoplexaura flagellosa
Pseudoplexaura porosa
Pseudopterogorgia acerosa
Pseudopterogorgia americana
Pseudopterogorgia bipinnata
Pseudopterogorgia sp.
Pterogorgia anceps
Pterogorgia citrina

Scleractinia & Milleporina

Acropora cervicornis
Agaricia agaricites
Colpophyllia natans
Dichocoenia stokesii
Diploria labyrinthiformes
Diploria strigosa
Diploria sp.
Eusmilia fastigiata
Favia fragum
Madracis decactis
Madracis mirabilis
Madracis pharensis
Manicina areolata
Meandrina meandrites
Millepora alcicornis

Table 1, continued

Scleractinia & Milleporina

Montastraea annularis
Montastraea cavernosa
Mussa angulosa
Mycetophyllia ferox
Mycetophyllia lamarckiana
Mycetophyllia sp.
Oculina diffusa
Porites astreoides
Porites porites
Scolymia lacera
Scolymia sp.
Siderastrea radians
Siderastrea siderea
Stephanocoenia michelinii

Table 2

Loggerhead Key Reef - 1989 and 1990 Quadrat census data

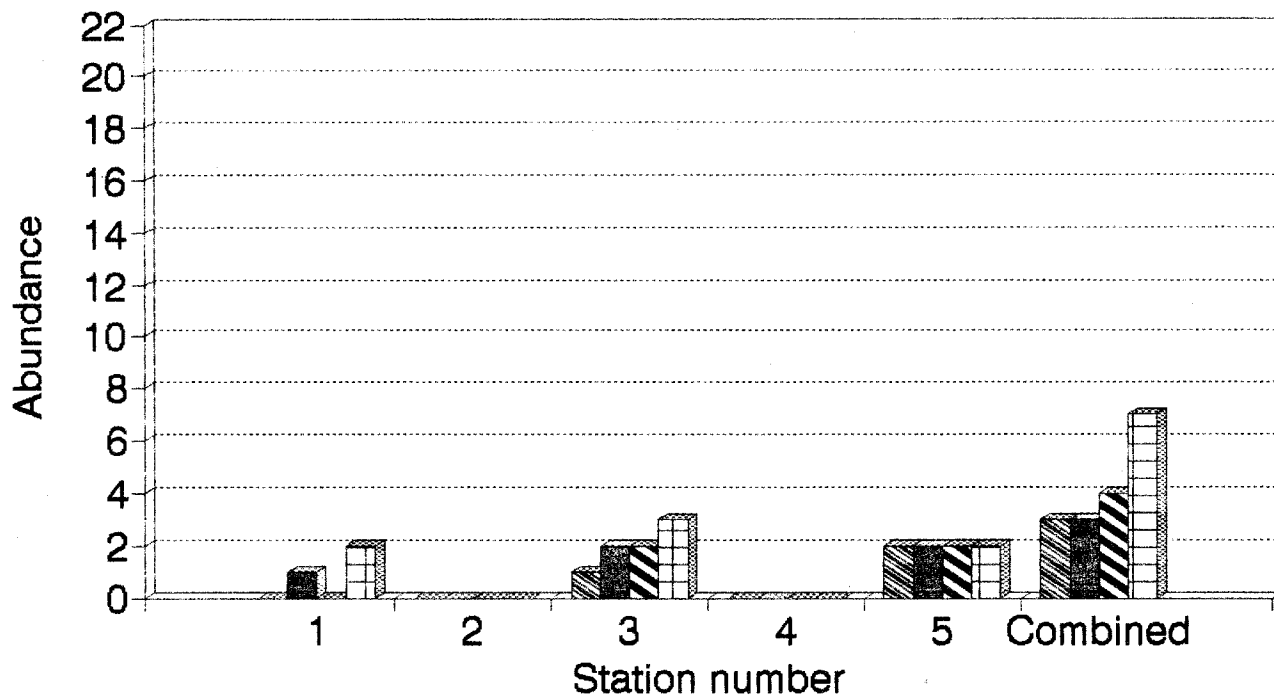
Abundance of hydrocorals, octocorals, and stony corals

	1989						1990					
	Quadrat Number					Total	Quadrat Number					Total
	1	2	3	4	5		1	2	3	4	5	
=====												
OCTOCORALLIA												
Briareum asbestinum					1	1						
Erythropodium caribaeorum							2		2		1	5
Eunicea calyculata											1	1
Eunicea fusca			2			2			1			1
Eunicea mammosa					1	1						
=====												
SCLERACTINIA & MILLEPORINA												
Agaricia agaricites									1		1	2
Colpophyllia natans					1	1						
Pavia fragum											1	1
Meandrina meandrites											1	1
Millepora alcicornis		2		1	2	5	2	2	2	1	5	12
Porites astreoides								1				1
Porites porites											1	1
Siderastrea siderea					1	1					1	1
=====												
No. of octocoral species	0	0	1	0	2	3	1	0	2	0	2	5
Octocoral abundance	0	0	2	0	2	4	2	0	3	0	2	7
Octocoral species density	0.00	0.00	0.33	0.00	0.78		0.33	0.00	0.78	0.00	0.78	
Octocoral colony density	0.00	0.00	0.78	0.00	0.78		0.78	0.00	1.17	0.00	0.78	
=====												
No. of stony coral species	0	1	0	1	2	3	1	2	2	1	6	7
Stony coral abundance	0	2	0	1	5	8	2	4	4	1	10	21
Stony coral species density	0.00	0.33	0.00	0.33	1.17		0.33	0.78	0.78	0.33	2.34	
Stony coral colony density	0.00	0.78	0.00	0.33	1.95		0.78	1.56	1.56	0.33	3.91	
=====												
Total number of species	0	1	1	1	5	8	2	2	4	1	8	10
Total abundance	0	2	2	1	7	12	4	4	7	1	12	28
Species density	0.00	0.33	0.33	0.33	1.35		0.78	0.78	1.56	0.33	2.13	
Colony density	0.00	0.78	0.78	0.33	2.72		1.56	1.56	2.72	0.33	4.33	

Figure 1

LOGGERHEAD KEY REEF QUADRATS

Octocoral species and colonies

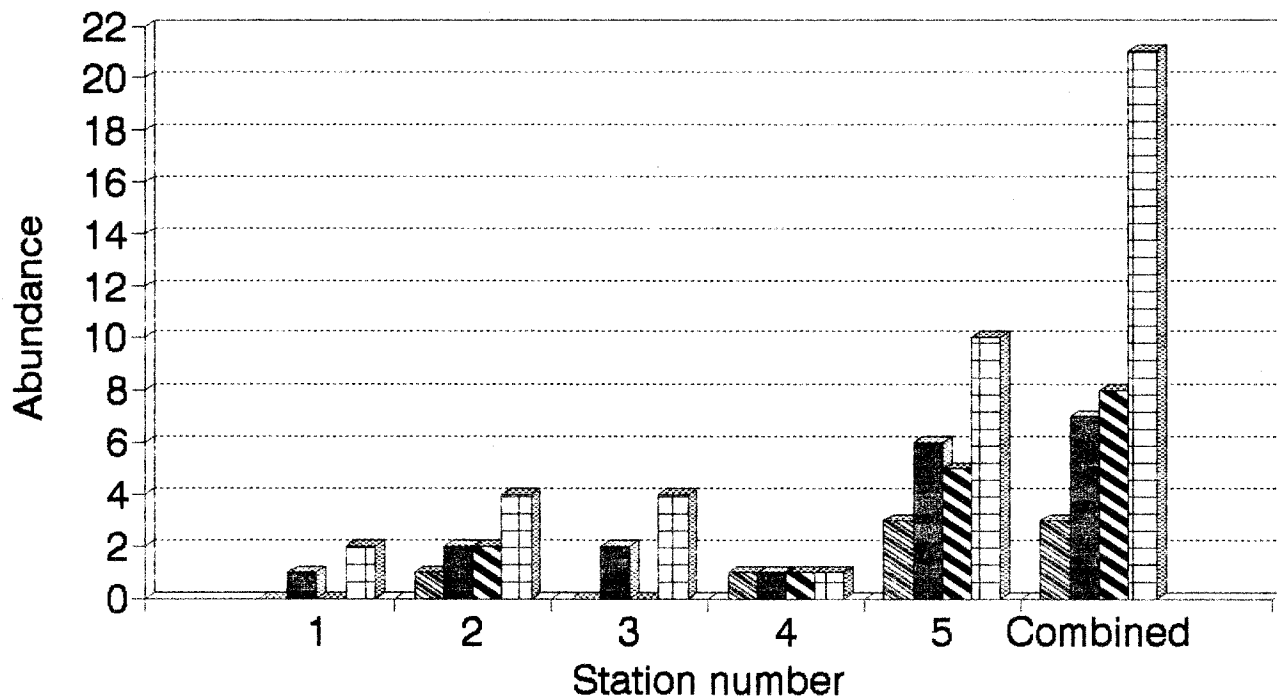


Species 89 # Species 90 Colonies 89 Colonies 90

Figure 2

LOGGERHEAD KEY REEF QUADRATS

Stony coral species & colonies



 # Species 89  # Species 90  Colonies 89  Colonies 90

Pulaski Shoal - 1989 and 1990 Quadrat census data

OCTOCORALLIA

	1989						1990					
	Quadrat Number						Quadrat Number					
	1	2	3	4	5	Total	1	2	3	4	5	Total
OCTOCORALLIA												
<i>Erythropodium caribaeorum</i>		1				1		3	1			4
<i>Eunicea calyculata</i>	3	1	5	1	6	16	1	3	1	1	7	13
<i>Eunicea fusca</i>	1		3	6	4	14	1	4	1	2	7	15
<i>Eunicea laciniata</i>	1	1	2	3	3	10	1		2	1	5	9
<i>Eunicea laxispica</i>								2				2
<i>Eunicea mammosa</i>	1					1				1		1
<i>Eunicea tourneforti</i>							3	2	11	2	9	27
<i>Eunicea</i> sp.							1					1
<i>Gorgonia ventalina</i>	1	2	1	1		5	1	2	2	3	1	9
<i>Muricea atlantica</i>			2	4	4	10	1		5	5	8	19
<i>Muricea elongata</i>				3	3	6				3	4	7
<i>Muricea laxa</i>			2			2						
<i>Plexaura flexuosa</i>	20	7	8	8	15	58	10	10	15	5	24	64
<i>Plexaura homomalla</i>					2	2	1	1	2	1	3	8
<i>Plexaurella dichotoma</i>					1	1						
<i>Plexaurella fusifera</i>				1		1				1	1	2
<i>Plexaurella grisea</i>			1		2	3					3	3
<i>Pseudoplexaura crucis</i>		1				1					1	1
<i>Pseudoplexaura flagellosa</i>				1		1			1	3	2	6
<i>Pseudoplexaura porosa</i>			2		1	3		6	5		4	15
<i>Pseudopterogorgia acerosa</i>	1		3	16	7	27	2	2	5	35	15	59
<i>Pseudopterogorgia americana</i>	11	6	10	16	9	52	18	7	8	8	4	45
<i>Pterogorgia anceps</i>				1		1						
<i>Pterogorgia citrina</i>				1	4	5			1	7	8	16
SCLERACTINIA & MILLEPORINA												
<i>Acropora cervicornis</i>				3		3				1		1
<i>Agaricia agaricites</i>	1	2				3		1				1
<i>Colpophyllia natans</i>									1			1
<i>Dichocoenia stokesii</i>		1	1		1	3	1	1	1	1	1	5
<i>Diploria</i> sp.			1			1						
<i>Millepora alcicornis</i>			4	4	6	14	2	1	6	3	8	20
<i>Montastraea annularis</i>		4		1		5		5	1			6
<i>Montastraea cavernosa</i>		2				2		2				2
<i>Porites astreoides</i>								1			1	2
<i>Porites porites</i>			2			2					1	1
<i>Siderastrea siderea</i>	4	3	3	2	1	13	7	4	3		1	15
ZOANTHIDEA												
<i>Palythoa caribbea</i>		2		1		3	7	8	2	2	3	22

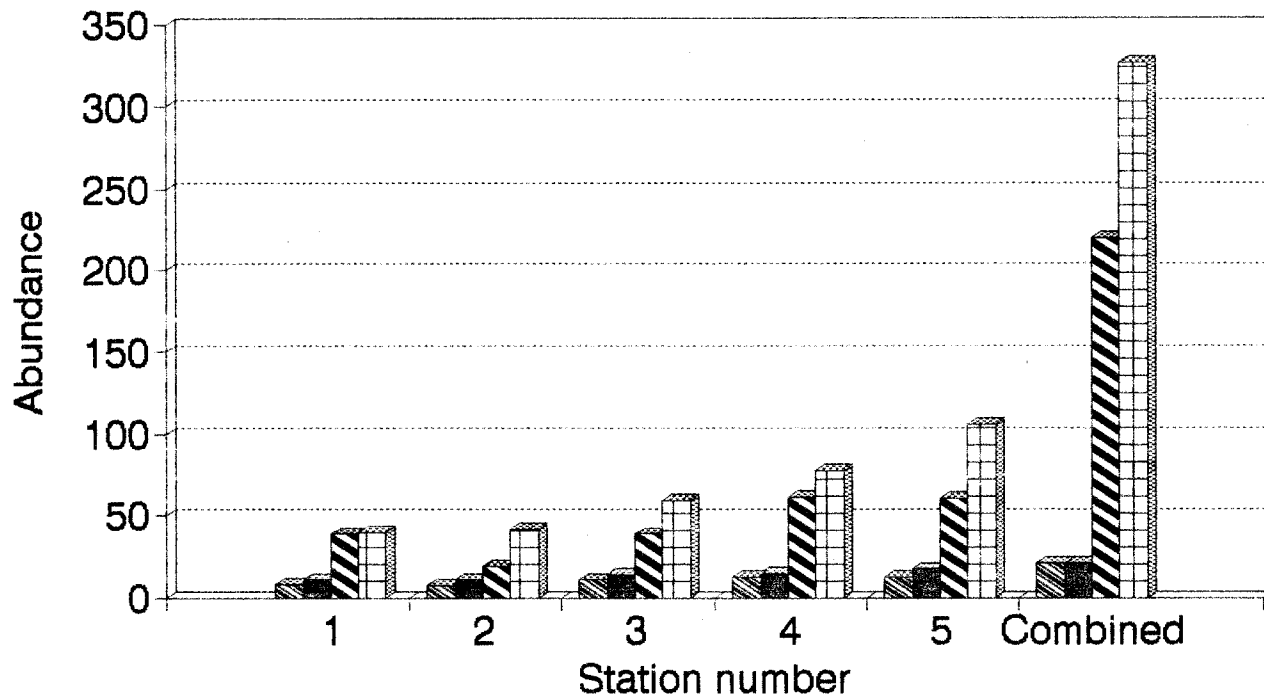
Table 3, continued

No. of octocoral species	8	7	11	13	13	21
Octocoral abundance	39	19	39	62	61	220
Octocoral species density	3.13	2.73	4.30	5.08	5.08	
Octocoral colony density	15.23	7.42	15.23	24.22	23.83	
No. of stony coral species	2	5	5	4	3	9
Stony coral abundance	5	12	11	10	8	46
Stony coral species density	0.78	1.95	1.95	1.56	1.17	
Stony coral colony density	1.95	4.69	4.30	3.91	3.13	
No. of zoanthid species	0	1	0	1	0	1
Zoanthid abundance	0	2	0	1	0	3
Zoanthid species density	0.00	0.39	0.00	0.39	0.00	
Zoanthid colony density	0.00	0.78	0.00	0.39	0.00	
Total number of species	10	13	16	18	16	31
Total abundance	44	33	50	73	69	269
Species density	3.91	5.08	6.25	7.03	6.25	
Colony density	17.19	12.89	19.53	28.52	26.95	

Figure 3

PULASKI SHOAL QUADRATS

Octocoral species and colonies

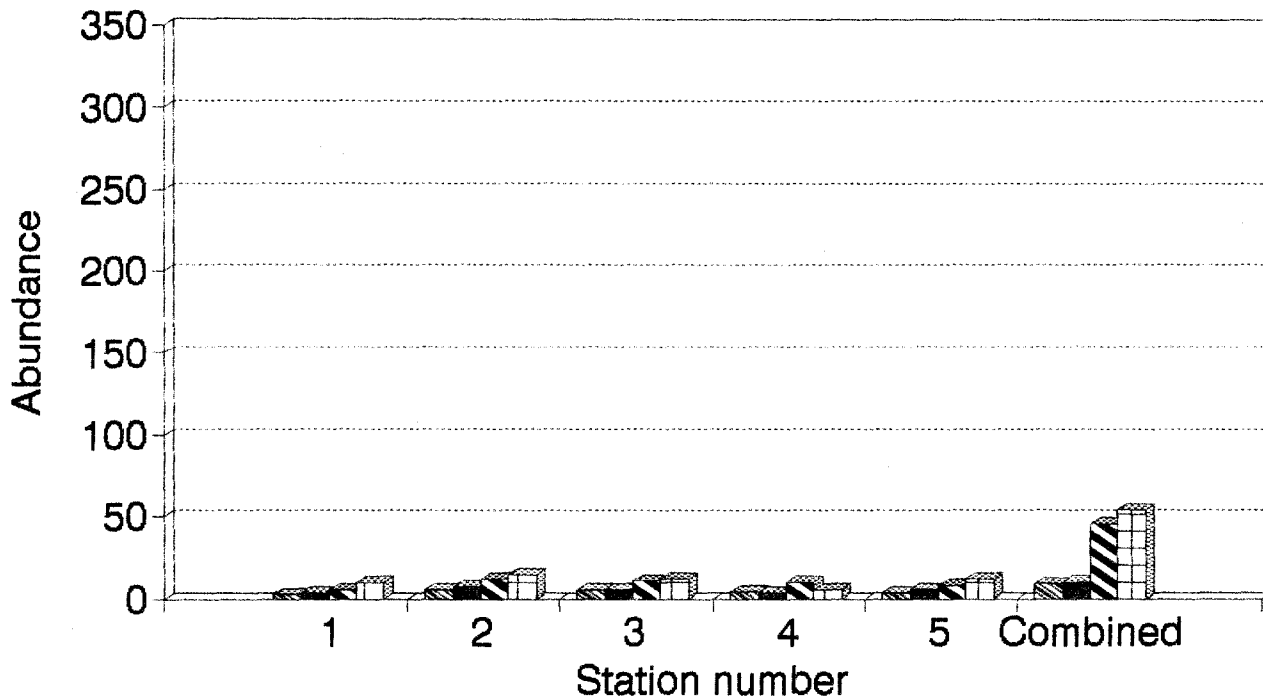


 # Species 89  # Species 90  Colonies 89  Colonies 90

Figure 4

PULASKI SHOAL QUADRATS

Stony coral species & colonies



Species 89 # Species 90 Colonies 89 Colonies 90

Table 4

White Shoal - 1989 and 1990 Quadrat census data

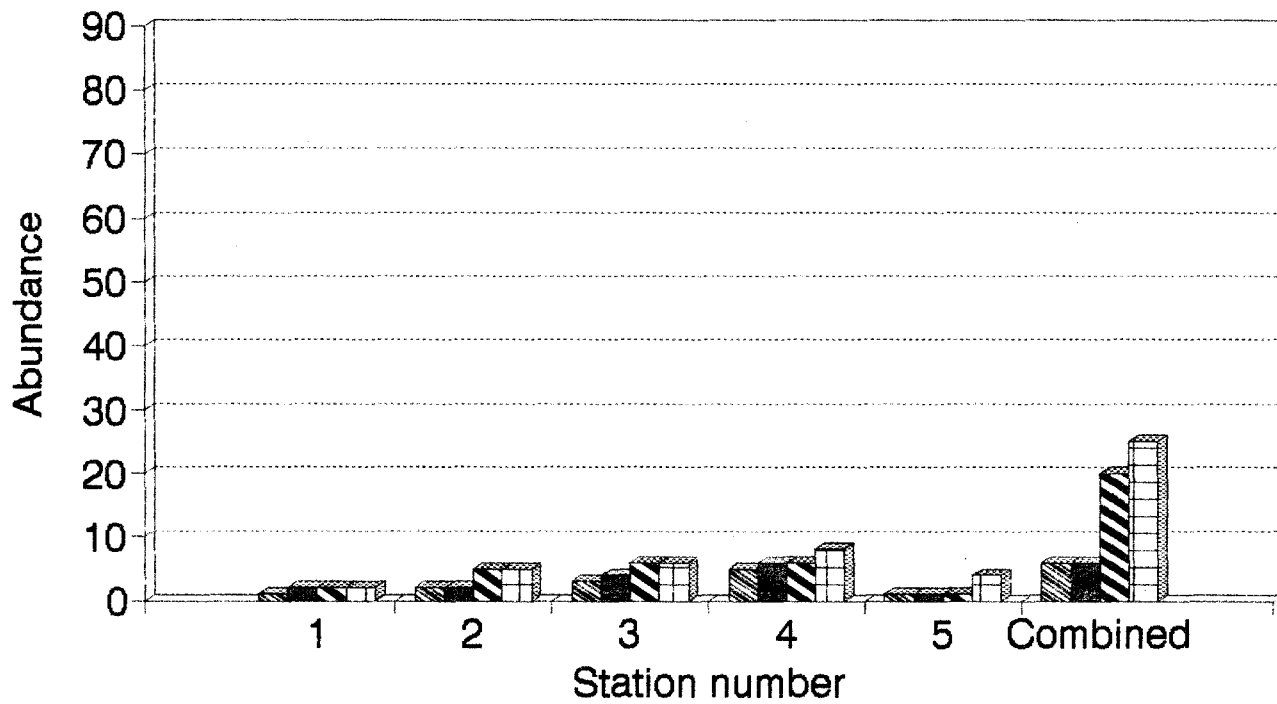
Abundance of hydrocorals, octocorals, and stony corals

	1989						1990					
	Quadrat Number						Quadrat Number					
	1	2	3	4	5	Total	1	2	3	4	5	Total
=====												
OCTOCORALLIA												
<i>Briareum asbestinum</i>									2	2	4	8
<i>Erythropodium caribaeorum</i>			1		1	2						
<i>Gorgonia ventalina</i>				1		1	1			1		2
<i>Plexaura flexuosa</i>		3	4	1		8		3	2	1		6
<i>Plexaura homomalla</i>	2	2		2		6	1	2	1	2		6
<i>Pseudoplexaura flagellosa</i>				1		1				1		1
<i>Pseudopterorgia americana</i>			1	1		2			1	1		2
=====												
SCLERACTINIA & MILLEPORINA												
<i>Acropora cervicornis</i>			3		1	4					1	1
<i>Agaricia agaricites</i>				1	1	2				1	1	2
<i>Colpophyllia natans</i>		1		1		2						
<i>Eusmilia fastigiata</i>				1		1				1		1
<i>Meandrina meandrites</i>								1				1
<i>Millepora alcicornis</i>	25	15	17	3	6	66	22	10	10	3	8	53
<i>Porites astreoides</i>			1			1		1				1
<i>Porites porites</i>		2	2	2	2	8		2	3	1	2	8
<i>Siderastrea siderea</i>			1	1		2			2	1		3
=====												
No. of octocoral species	1	2	3	5	1	6	2	2	4	6	1	6
Octocoral abundance	2	5	6	6	1	20	2	5	6	8	4	25
Octocoral species density	0.39	0.78	1.17	1.95	0.39		0.78	0.78	1.56	2.34	0.39	
Octocoral colony density	0.78	1.95	2.34	2.34	0.39		0.78	1.95	2.34	3.13	1.56	
=====												
No. of stony coral species	1	3	5	6	4	8	1	4	3	5	4	8
Stony coral abundance	25	18	24	9	10	86	22	14	15	7	12	70
Stony coral species density	0.39	1.17	1.95	2.34	1.56		0.39	1.56	1.17	1.95	1.56	
Stony coral colony density	9.77	7.03	9.38	3.52	3.91		8.59	5.47	5.86	2.73	4.69	
=====												
Total number of species	2	5	8	11	5	14	3	6	7	11	5	14
Total abundance	27	23	30	15	11	106	24	19	21	15	16	95
Species density	0.78	1.95	3.13	4.30	1.95		1.17	2.34	2.73	4.30	1.95	
Colony density	10.55	8.98	11.72	5.86	4.30		9.38	7.42	8.20	5.86	6.25	

Figure 5

WHITE SHOAL QUADRATS

Octocoral species and colonies

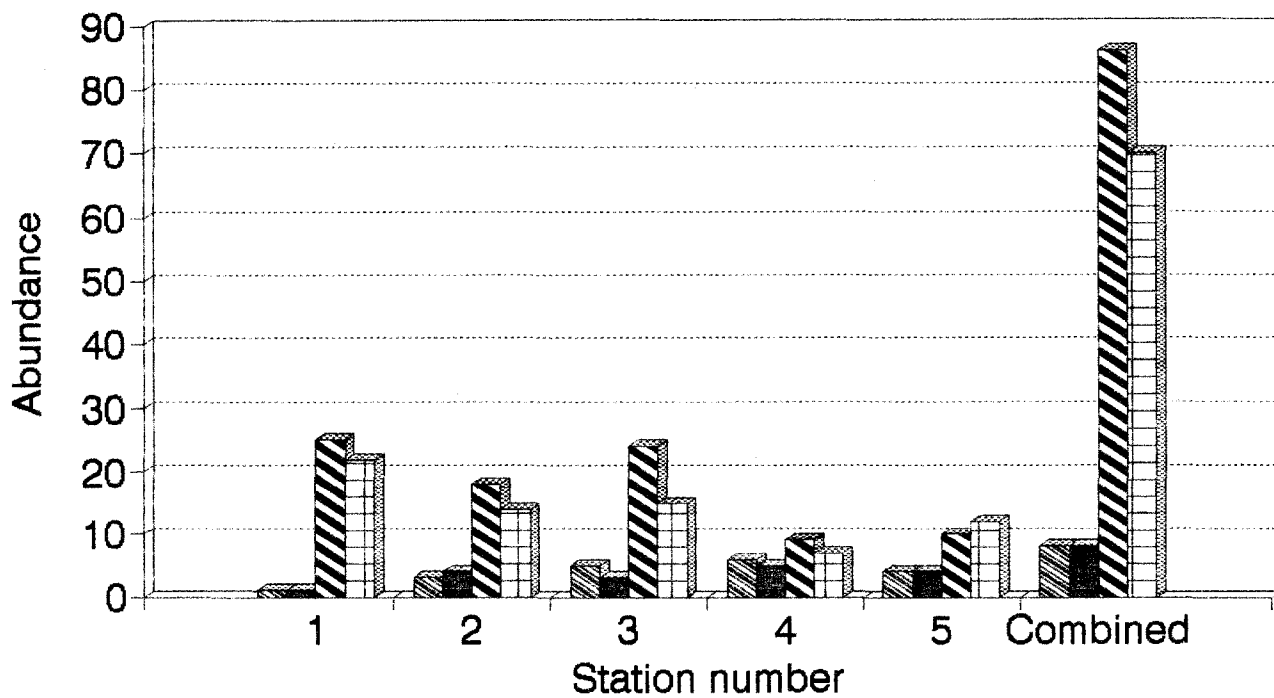


 # Species 89  # Species 90  Colonies 89  Colonies 90

Figure 6

WHITE SHOAL QUADRATS

Stony coral species & colonies



 # Species 89  # Species 90  Colonies 89  Colonies 90

Figure 7

Loggerhead Key Transect 1990

Coral cover per linear meter

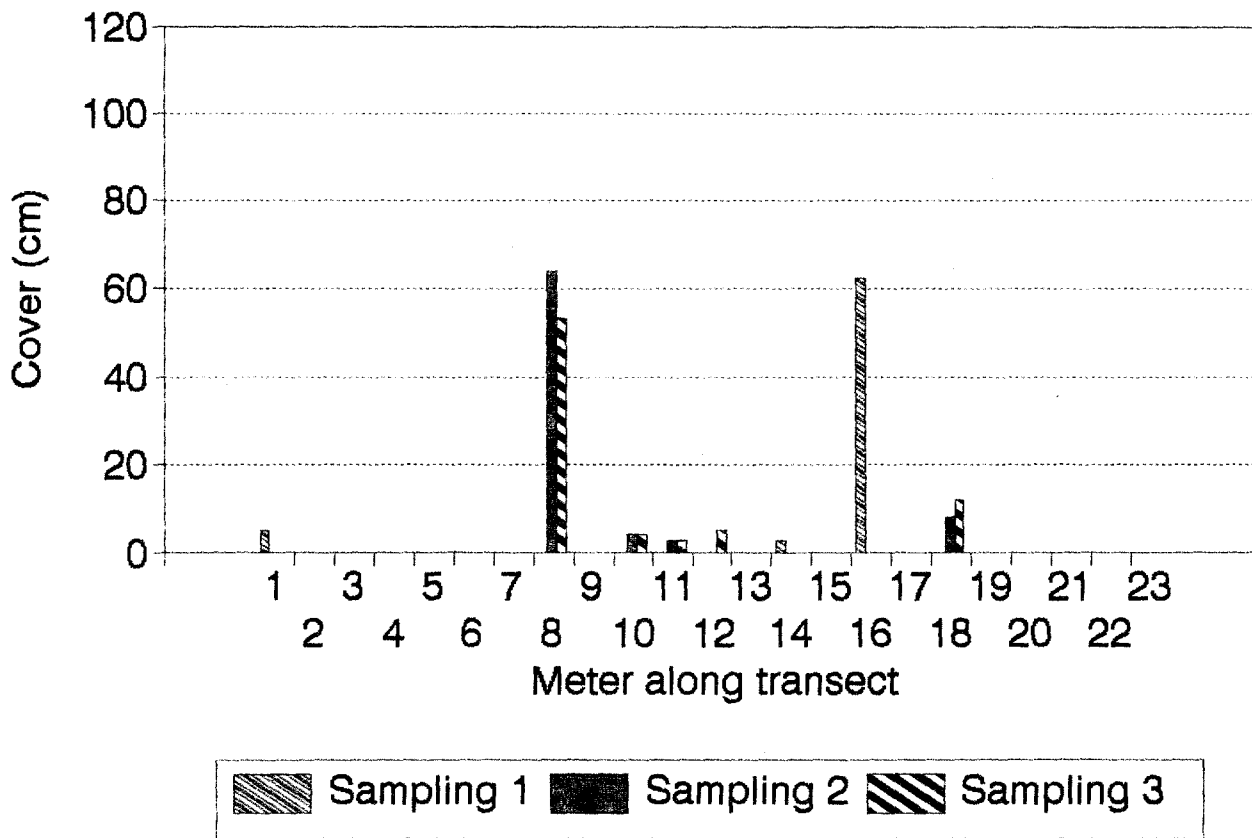


Figure 8

Loggerhead Key Transect 1990

Biotic cover per linear meter

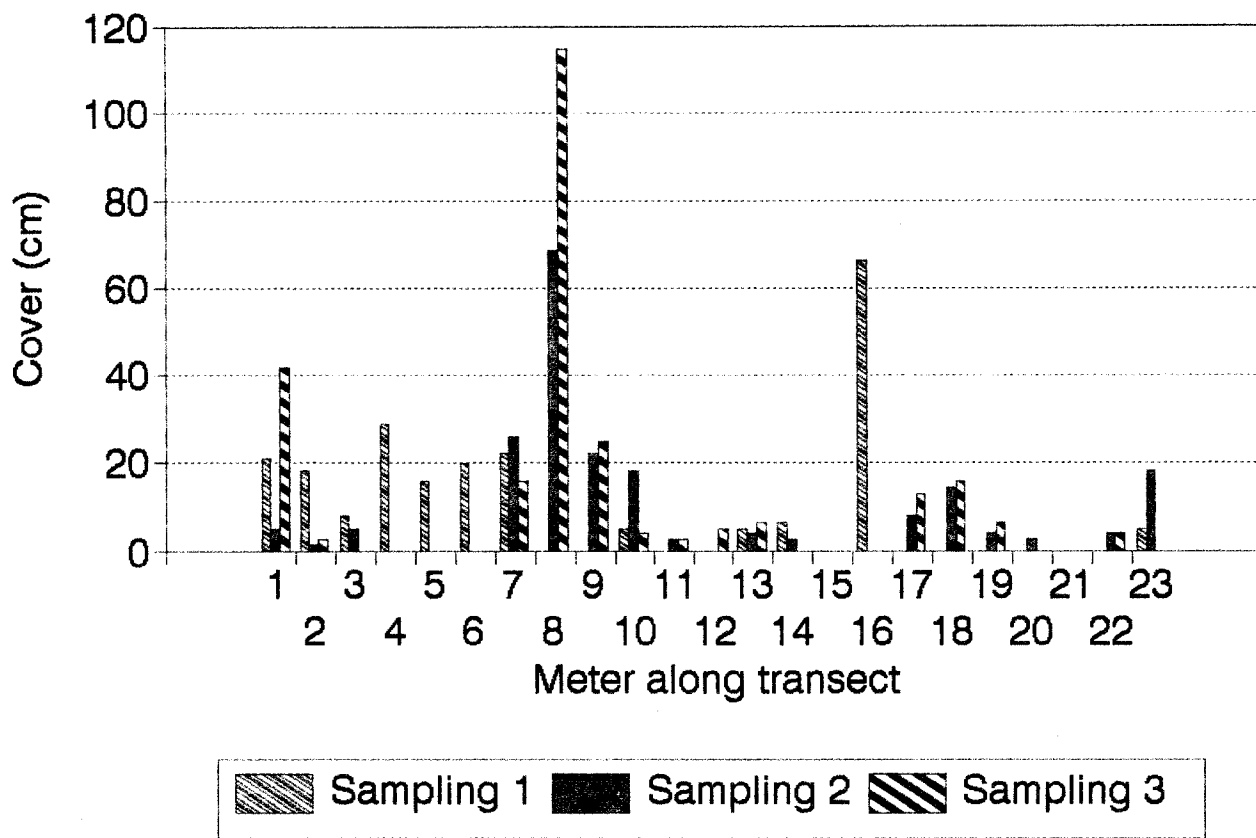


Figure 9

Pulaski Shoal Transect 1990

Coral cover per linear meter

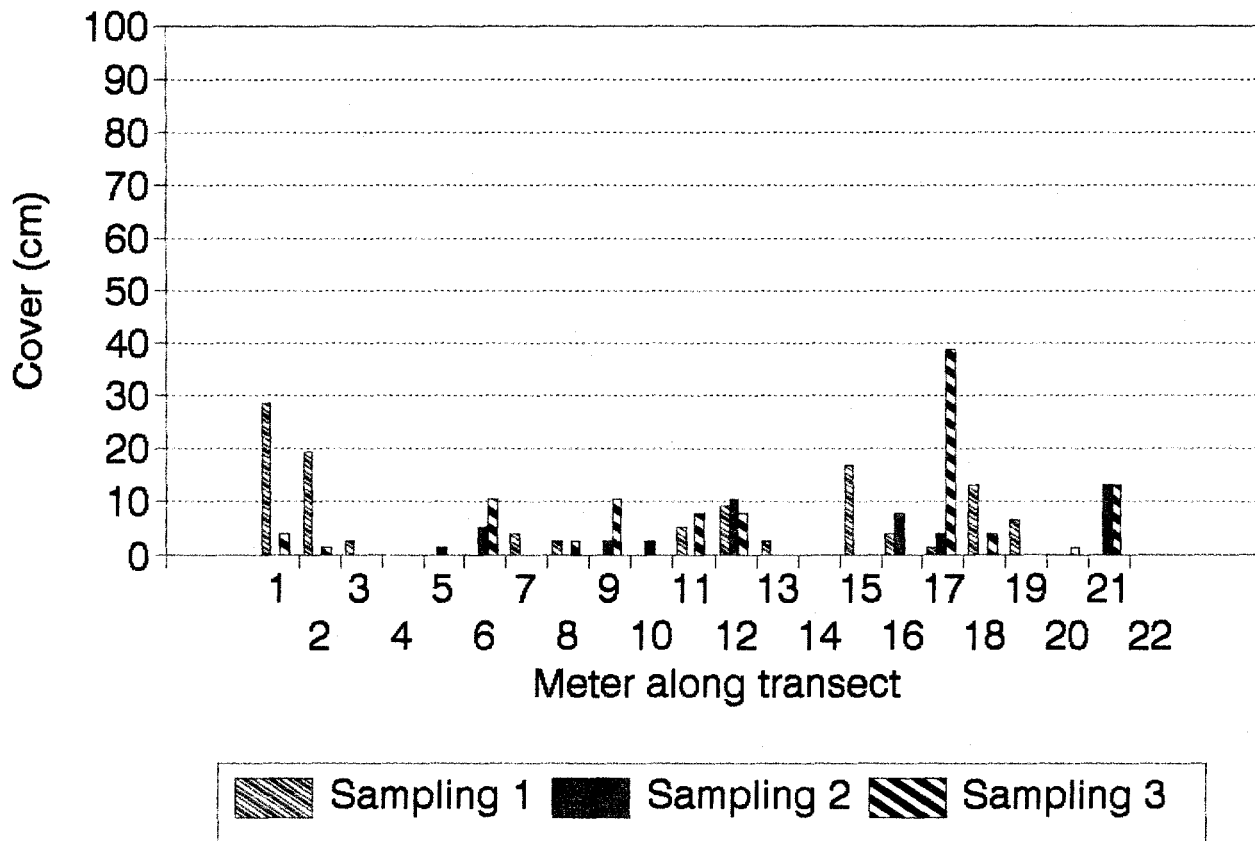


Figure 10

Pulaski Shoal Transect 1990

Biotic cover per linear meter

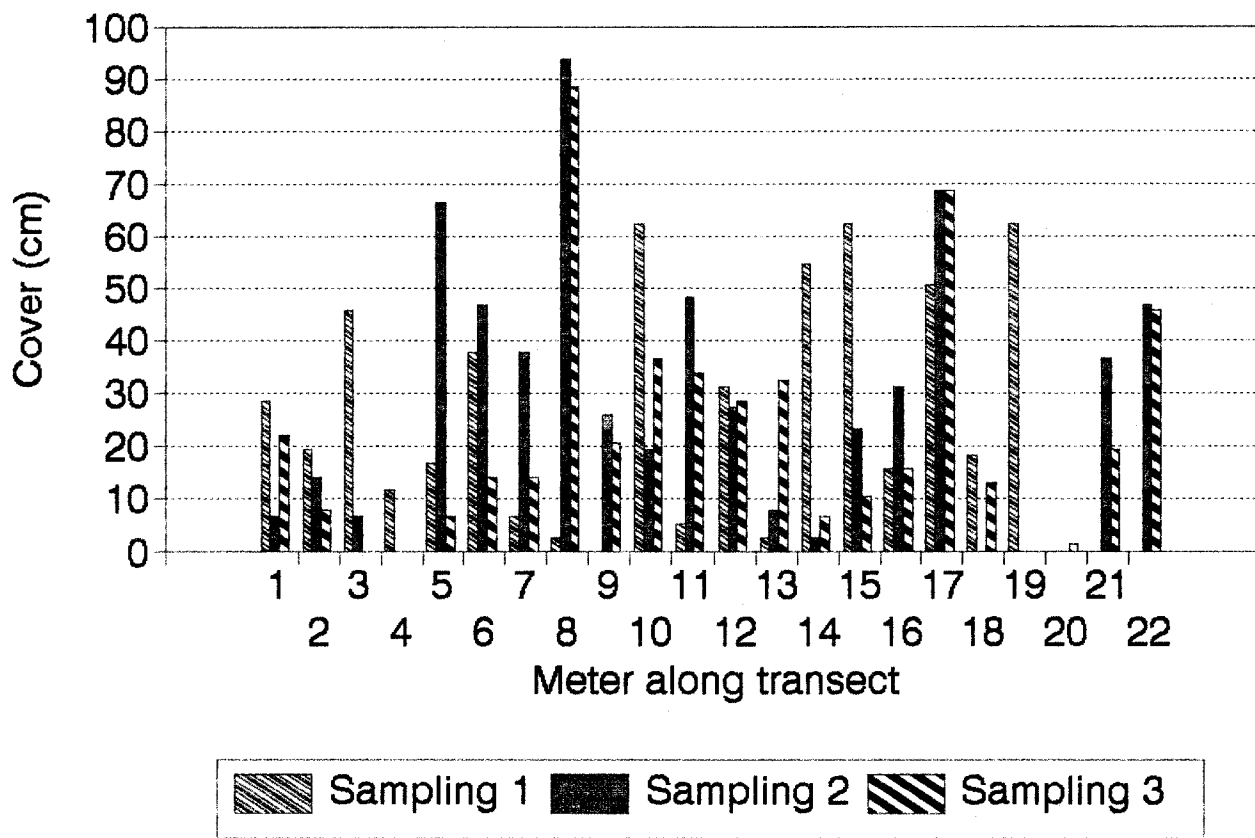


Figure 11

White Shoal Transect 1990

Coral cover per linear meter

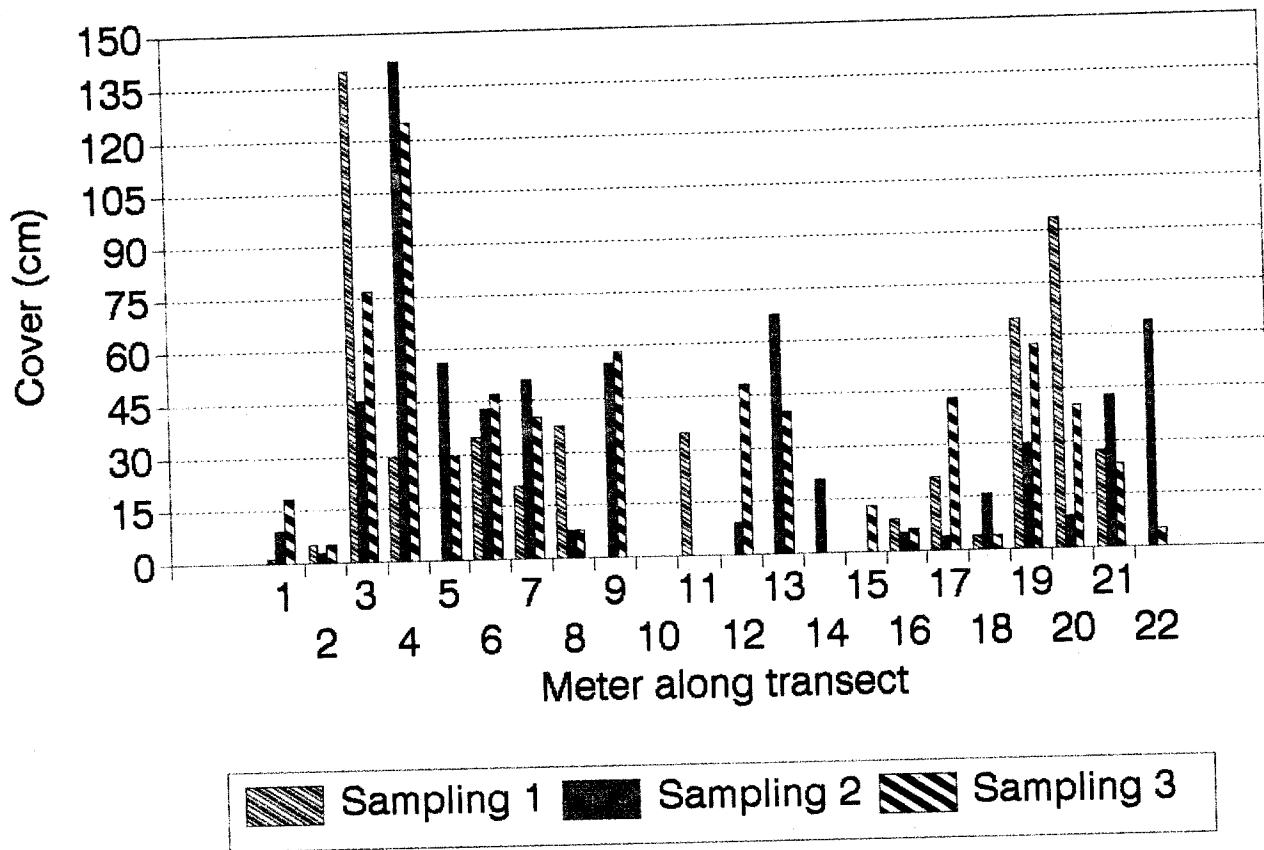


Figure 12

White Shoal Transect 1990

Biotic cover per linear meter

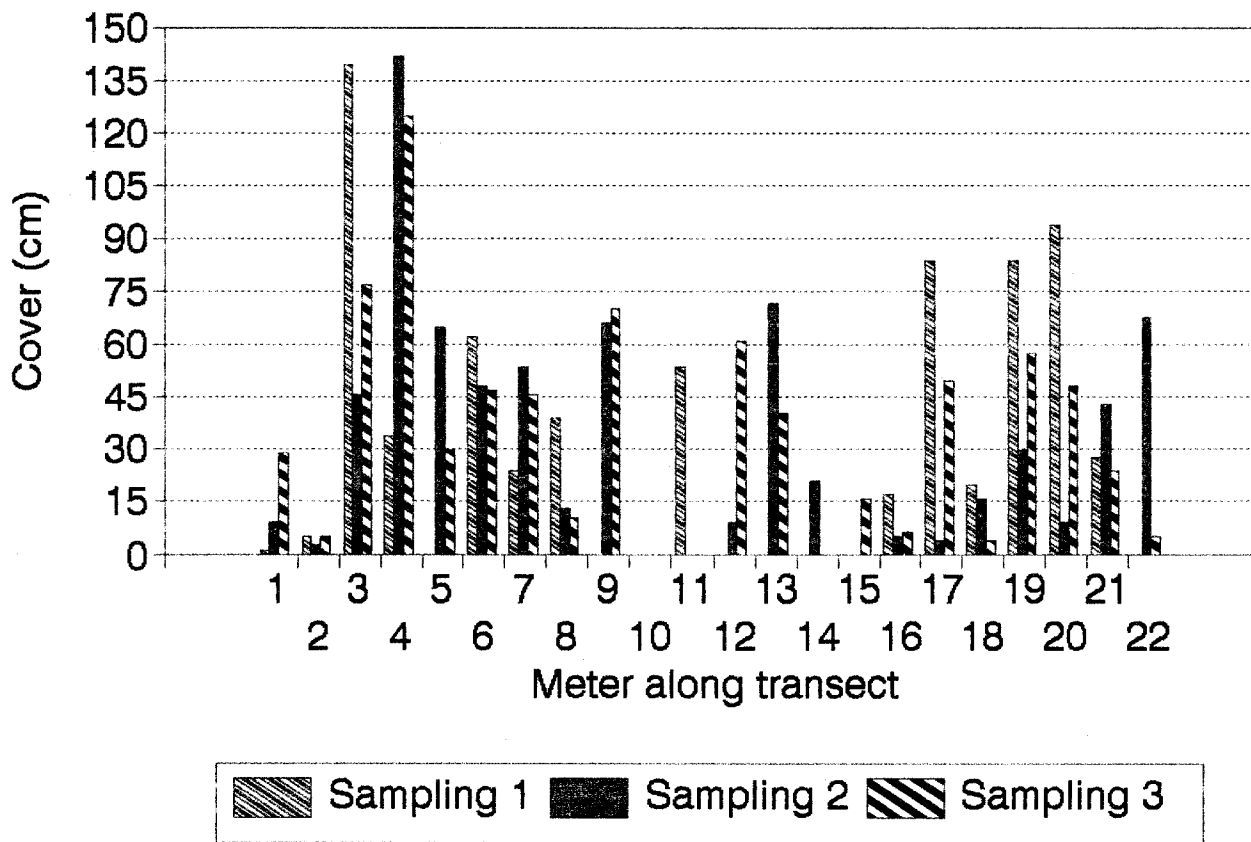


Figure 13

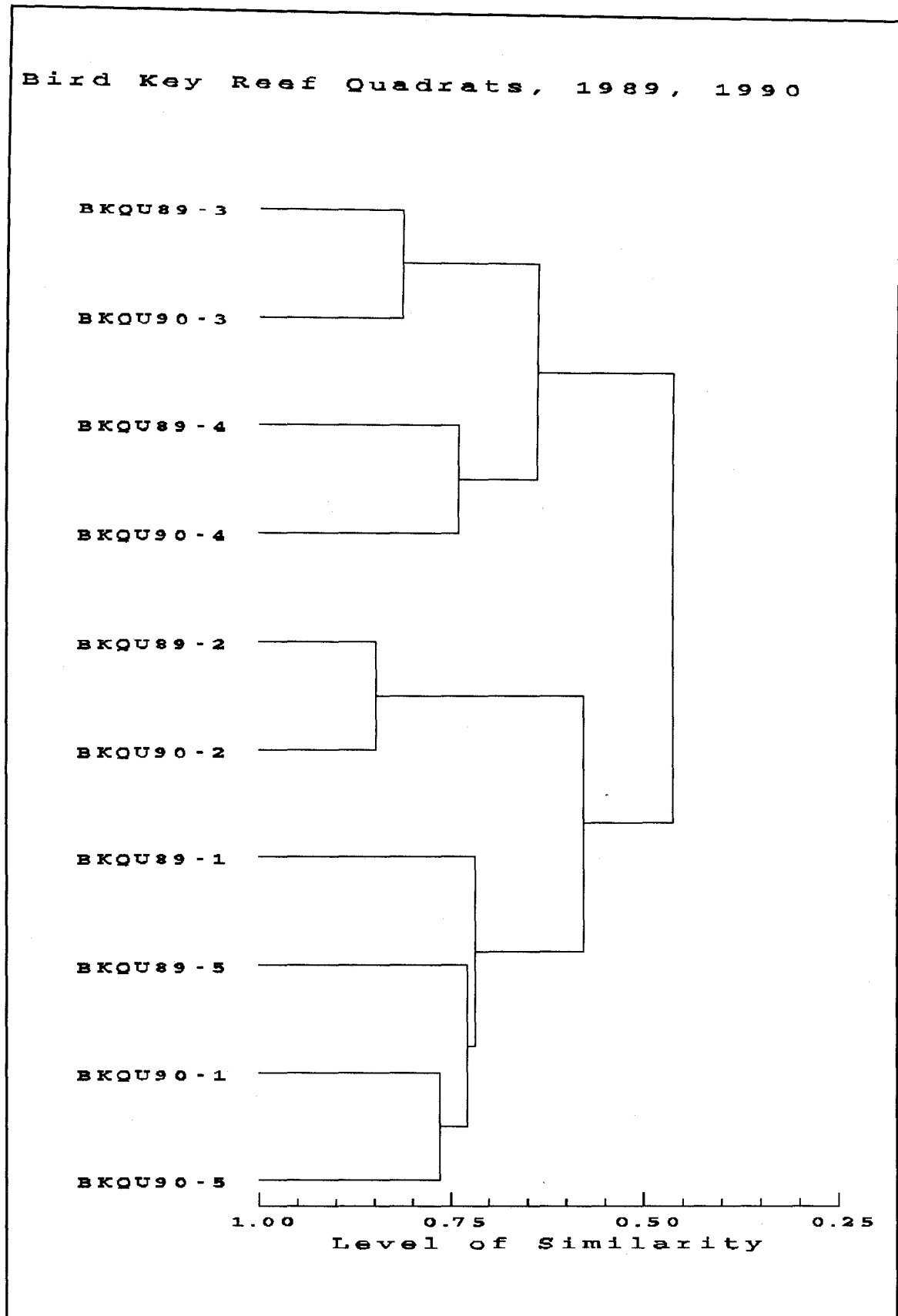


Figure 14

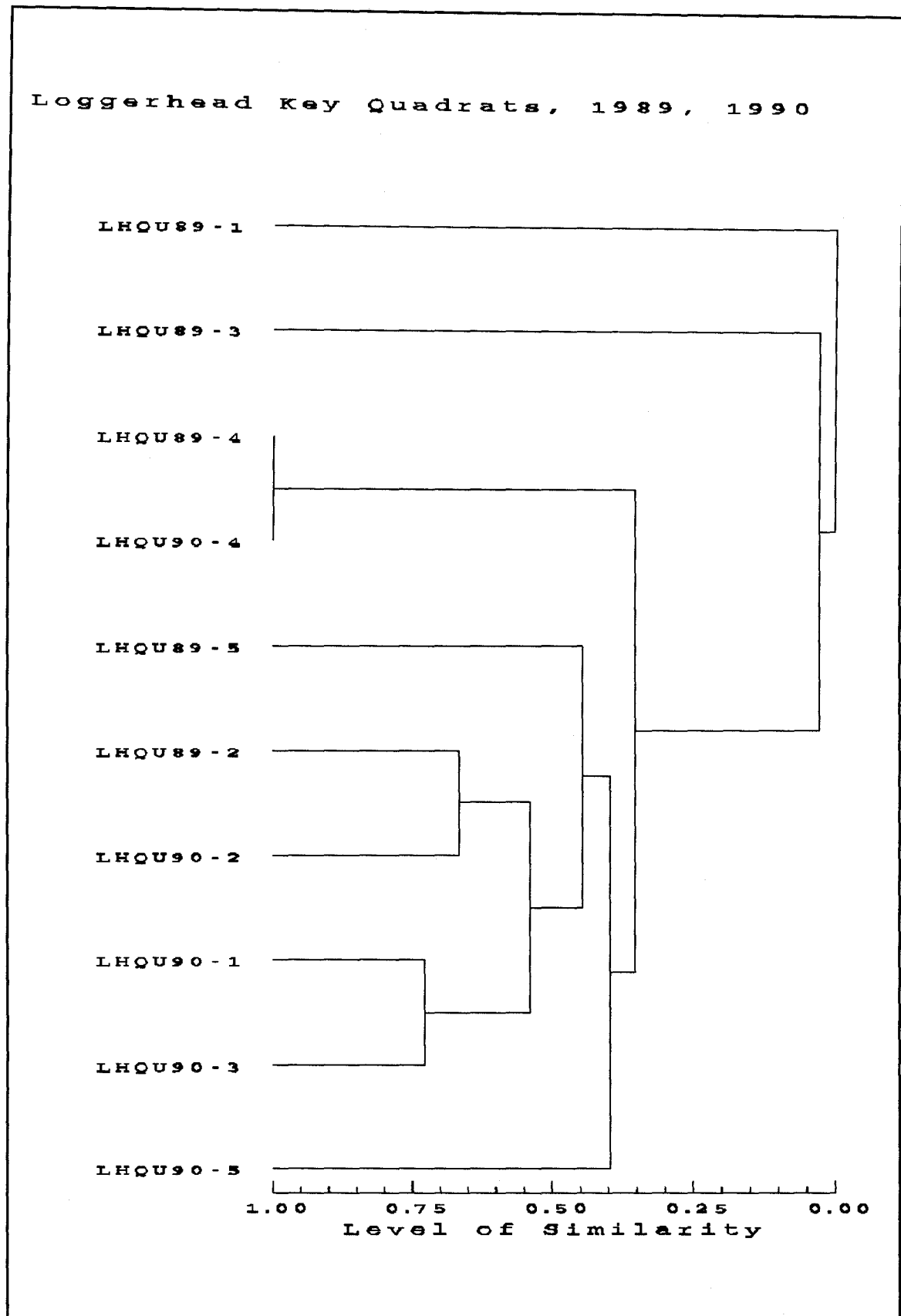


Figure 15

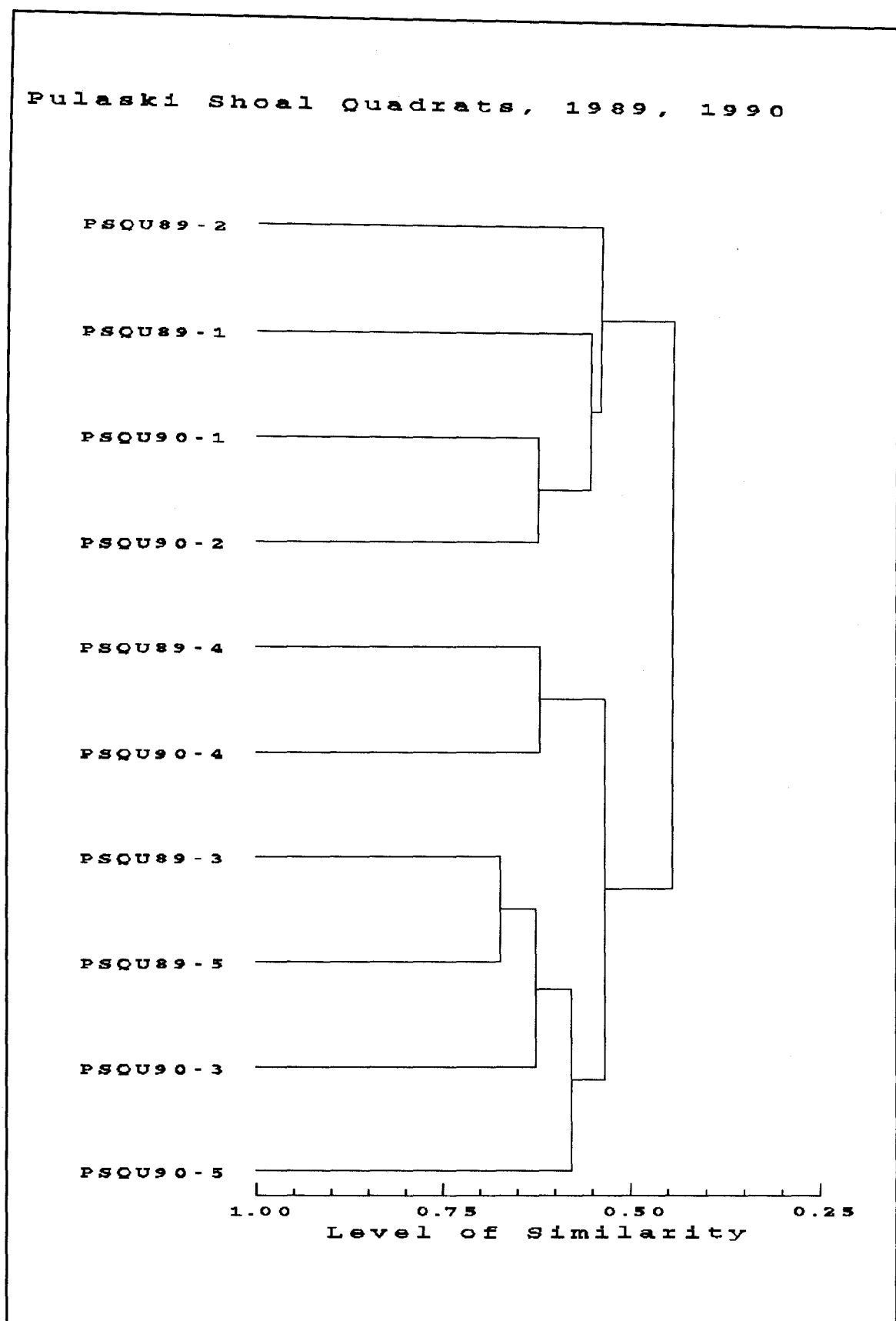


Figure 16

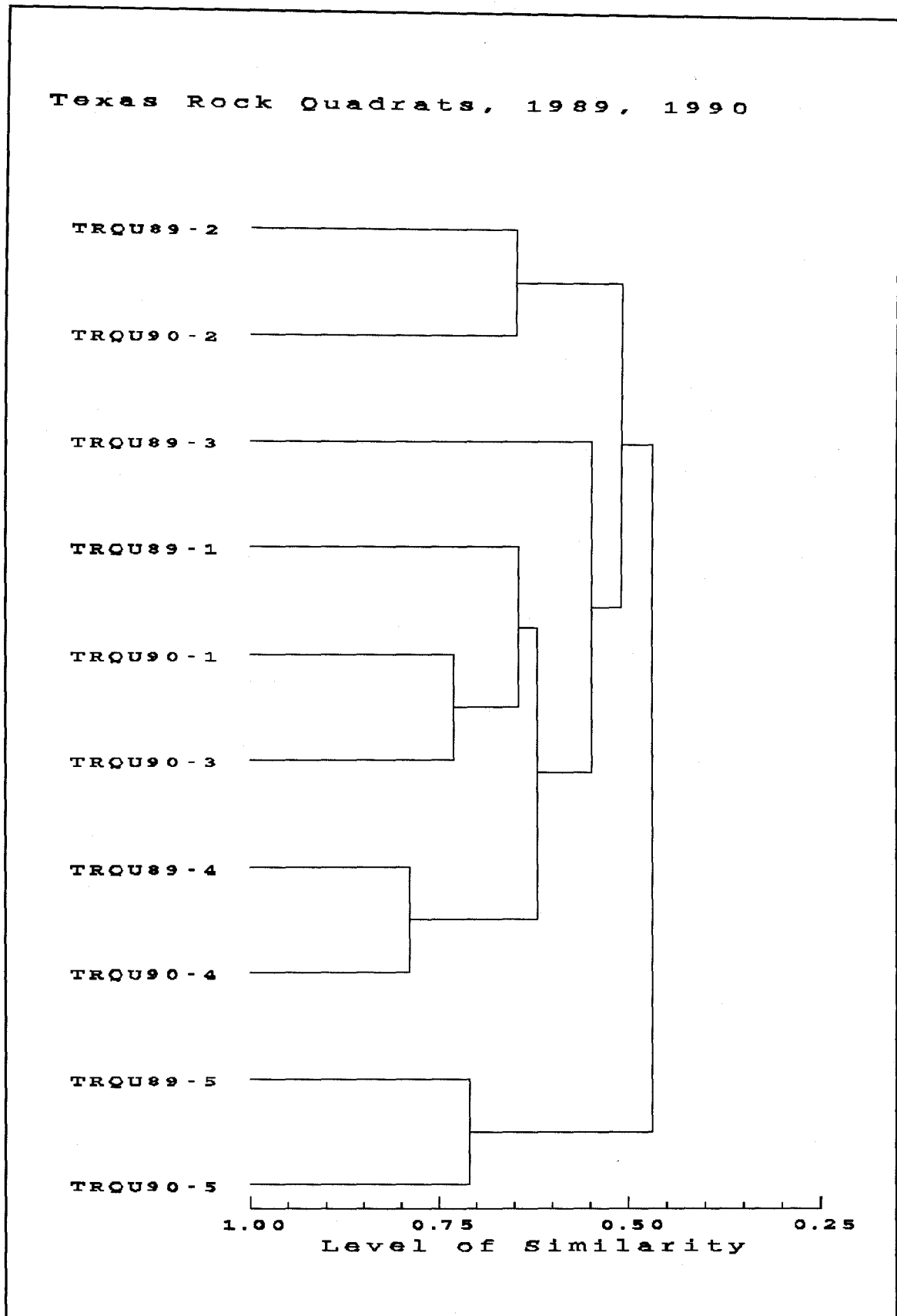


Figure 17

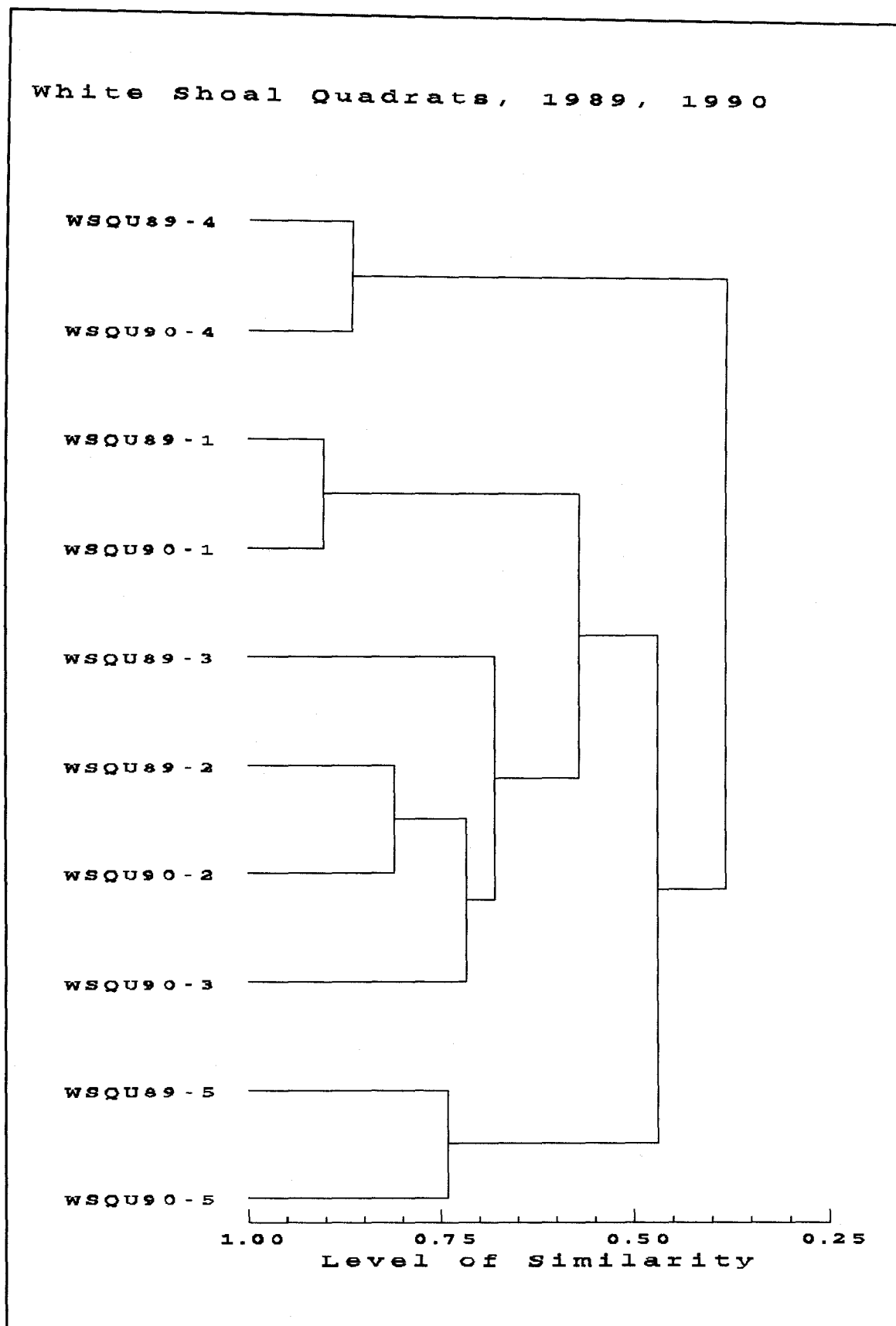


Table 17

Bird Key Reef Quadrats, 1989, 1990
Similarity Matrix

Transformation = None

Standardization = None

Index = Proportional or Czekanowski's Index

	BKQU89-1	BKQU89-2	BKQU89-3	BKQU89-4
BKQU89-2	0.52308			
BKQU89-3	0.57732	0.52414		
BKQU89-4	0.38235	0.34483	0.53012	
BKQU89-5	0.69767	0.46269	0.45545	0.38889
BKQU90-1	0.75556	0.59420	0.55238	0.39474
BKQU90-2	0.56410	0.84848	0.48485	0.36893
BKQU90-3	0.53763	0.45390	0.81481	0.58228
BKQU90-4	0.55172	0.44444	0.72549	0.73973
BKQU90-5	0.70213	0.56338	0.44037	0.37500
	BKQU89-5	BKQU90-1	BKQU90-2	BKQU90-3
BKQU90-1	0.72340			
BKQU90-2	0.56198	0.68800		
BKQU90-3	0.43299	0.55446	0.48438	
BKQU90-4	0.46154	0.48421	0.47541	0.71429
BKQU90-5	0.73469	0.76471	0.66667	0.41905
	BKQU90-4			
BKQU90-5	0.50505			

Table 18

Loggerhead Key Quadrats, 1989, 1990
Similarity Matrix

Transformation = None

Standardization = None

Index = Proportional or Czekanowski's Index

	LHQU89-1	LHQU89-2	LHQU89-3	LHQU89-4
LHQU89-2	0.00000			
LHQU89-3	0.00000	0.00000		
LHQU89-4	0.00000	0.66667	0.00000	
LHQU89-5	0.00000	0.44444	0.00000	0.25000
LHQU90-1	0.00000	0.66667	0.00000	0.40000
LHQU90-2	0.00000	0.66667	0.00000	0.40000
LHQU90-3	0.00000	0.44444	0.22222	0.25000
LHQU90-4	0.00000	0.66667	0.00000	1.00000
LHQU90-5	0.00000	0.28571	0.00000	0.15385
	LHQU89-5	LHQU90-1	LHQU90-2	LHQU90-3
LHQU90-1	0.36364			
LHQU90-2	0.54545	0.50000		
LHQU90-3	0.42857	0.72727	0.54545	
LHQU90-4	0.25000	0.40000	0.40000	0.25000
LHQU90-5	0.42105	0.37500	0.37500	0.52632
	LHQU90-4			
LHQU90-5	0.15385			

Table 19

Pulaski Shoal Quadrats, 1989, 1990
Similarity Matrix

Transformation = None

Standardization = None

Index = Proportional or Czekanowski's Index

	PSQU89-1	PSQU89-2	PSQU89-3	PSQU89-4
PSQU89-2	0.51948			
PSQU89-3	0.59574	0.48193		
PSQU89-4	0.44444	0.37736	0.58537	
PSQU89-5	0.54867	0.33333	0.67227	0.63380
PSQU90-1	0.59406	0.48889	0.57944	0.55385
PSQU90-2	0.51376	0.61224	0.53913	0.40580
PSQU90-3	0.52542	0.46729	0.58065	0.54422
PSQU90-4	0.29457	0.30508	0.40000	0.62025
PSQU90-5	0.38728	0.24675	0.44444	0.55670
	PSQU89-5	PSQU90-1	PSQU90-2	PSQU90-3
PSQU90-1	0.47619			
PSQU90-2	0.46269	0.62295		
PSQU90-3	0.67133	0.56489	0.57554	
PSQU90-4	0.51948	0.39437	0.34667	0.49057
PSQU90-5	0.66316	0.35955	0.40860	0.62564
	PSQU90-4			
PSQU90-5	0.54369			

Table 20

Texas Rock Quadrats, 1989, 1990
Similarity Matrix

Transformation = None				
Standardization = None				
Index = Proportional or Czekanowski's Index				
	TRQU89-1	TRQU89-2	TRQU89-3	TRQU89-4
TRQU89-2	0.56250			
TRQU89-3	0.52174	0.41379		
TRQU89-4	0.68966	0.51429	0.57692	
TRQU89-5	0.53731	0.37975	0.45902	0.41096
TRQU90-1	0.67857	0.50000	0.60000	0.58065
TRQU90-2	0.54237	0.64789	0.41509	0.52308
TRQU90-3	0.61017	0.45070	0.56604	0.61538
TRQU90-4	0.58462	0.51948	0.47458	0.78873
TRQU90-5	0.46875	0.42105	0.44828	0.45714
	TRQU89-5	TRQU90-1	TRQU90-2	TRQU90-3
TRQU90-1	0.53521			
TRQU90-2	0.37838	0.53968		
TRQU90-3	0.48649	0.73016	0.57576	
TRQU90-4	0.42500	0.63768	0.55556	0.61111
TRQU90-5	0.70886	0.50000	0.50704	0.59155
	TRQU90-4			
TRQU90-5	0.49351			

Table 21

White Shoal Quadrats, 1989, 1990
Similarity Matrix

Transformation = None				
Standardization = None				
Index = Proportional or Czekanowski's Index				
	WSQU89-1	WSQU89-2	WSQU89-3	WSQU89-4
WSQU89-2	0.68000			
WSQU89-3	0.59649	0.75472		
WSQU89-4	0.23810	0.47368	0.35556	
WSQU89-5	0.31579	0.47059	0.48780	0.46154
WSQU90-1	0.90196	0.68085	0.62963	0.25641
WSQU90-2	0.52174	0.80952	0.65306	0.47059
WSQU90-3	0.45833	0.68182	0.62745	0.50000
WSQU90-4	0.23810	0.36842	0.31111	0.86667
WSQU90-5	0.37209	0.51282	0.47826	0.38710
	WSQU89-5	WSQU90-1	WSQU90-2	WSQU90-3
WSQU90-1	0.34286			
WSQU90-2	0.53333	0.51163		
WSQU90-3	0.50000	0.48889	0.75000	
WSQU90-4	0.38462	0.25641	0.41176	0.55556
WSQU90-5	0.74074	0.40000	0.57143	0.64865
	WSQU90-4			
WSQU90-5	0.45161			