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Crown-of-thorns and Coral Trout Density on Three Central Section Reefs - 1983-1989

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LONG-TERM SURVEYS OF ACANTHASTER, CORAL TROUT AND CHAETODONTIDS ON THREE REEFS OFF TOWNSVILLE: 1983-1989.

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SUMMARY

Sea Research have carried out density surveys of crown of thorns stars, coral trout and chaetodontids on three reefs off Townsville: John Brewer, Lodestone and Davies, on a number of occasions since 1983. Initially, surveys were made on a single back reef slope site, but since November 1984 surveys were also made on front reef sites on each reef. Most sites were surveyed three times over a six year period but the back reef site at Lodestone has been visited four times in the same period and that on John Brewer five times. In the latest survey of these sites, in June 1989, lethrinids and lutjanids were also counted.

All counts were made along 10 replicate visually searched strip transects, 50 x 20m in size, positioned haphazardly within each site. The same personnel were responsible for the surveys of all time series.

Crown of thorns devastated coral communities on John Brewer and Lodestone in 1983/84, reaching densities of 200-260 per hectare (ha) at the peak of the infestation. This peak was short-lived, with numbers dropping to less than 10 per ha within 9 months. Davies, on the other hand, did not experience an outbreak until mid-1989 with lower densities of 34-64 per ha recorded at this time. Coral communities were beginning to recover on the front of Lodestone by June 1989, 6 years after the peak of infestation by crown of thorns.

A number of patterns in coral trout density on these 3 reefs were detected by these surveys. Numbers on the front reef were overall 76% less than on the back reef sites. Densities on the three reefs were consistently and significantly different, with overall grand means of 27, 35 and 46 per ha on Lodestone John Brewer and Davies respectively. Fluctuations in density were similar for all reefs, especially a significant drop in density of 21% that occurred between May 1986 and June 1989. Conversations with fishermen working on Davies Reef in mid-1989 suggest that this drop, and a corresponding drop in mean length of coral trout over the same period, was probably due to an increase in commercial fishing pressure on these reefs in recent months, especially on Davies.

The different survey sites supported similar densities of 0+ age class recruits in each of the three mid-year series of counts, but densities were consistently different at some sites. The John Brewer back reef site supported twice as many recruits as most other sites, while the Davies front reef site had half the density of other sites.

There were no changes in coral trout density or length structure over the 6 year period covered by these counts that could be attributed to the effects of crown of thorns infestations on the reefs.

It is postulated that each reef may have a normal carrying capacity for coral trout that is determined by the unique physical and biological characteristics of that reef and that while fishing pressure or recruitment success may cause fluctuations in coral trout density, other factors are acting to bring numbers back toward this carrying capacity. This would explain why numbers within each site were so consistent over the 6 year period covered by these surveys.

The density of chaetodontids was dramatically affected by crown of thorns devastation of coral communities, with numbers on damaged reefs around 20% of those on unaffected reefs. Although Davies Reef was suffering an infestation of crown of thorns in June 1989 numbers of chaetodontids were still relatively high at this time.

This type of strip transect can be used to estimate density of coral trout, crown of thorns and chaetodontids successfully, and to detect changes in space and time, but was not useful for counting lethrinids and lutjanids because of the very high variances that result from the clumped distribution of fishes in these families. It is suggested that a much longer strip transect, between 400-800m long and 20m wide might give a more precise estimate of the density of these fishes, and that tests of such a method be made in the near future.

It is proposed that monitoring of population density of crown of thorns, coral trout, chaetodontids and hard corals be continued and expanded on these reefs to take advantage of the long term data base already established. The advantages to management of being able to base any decisions on a long time series of density data for important reef organisms make such monitoring worthwhile.

INTRODUCTION

Information on the distribution and density of significant reef organisms such as hard corals, crown of thorns and commercially utilised fishes are an important aid to realistic management of reefs on the GBR. Data on long-term changes through time in the population density of these species is a particularly powerful tool in the management arnesnal.

There has been considerable interest, both by reef managers and the scientific community in the status of *Acanthaster* populations on the GBR. Widespread manta tow surveys have been made throughout the GBR by the Australian Institute of Marine Science but these can only reliably separate outbreak from non-outbreak reefs and can not be used to demonstrate patterns through time in any detail. Sea Research have used intensively searched replicate strip transect counts to estimate density of crown of thorns populations; a method better suited to the detection of temporal patterns.

With the increasing concern over the effect of fishing on target fish populations on the GBR there is a very real need for information on long term changes in the density of these populations.

The three reefs that were the subject of this study are mid-shelf reefs that are amongst the closest reefs to the city of Townsville. All three have been extensively used as study reefs for various projects by researchers from AIMS, with Davies Reef the most heavily used of the three. The reefs have been visited by recreational fishermen from Townsville for many years and recent discussions with commercial reef fishermen suggest that Davies is now receiving regular attention from Bowen based commercial fishermen. In addition John Brewer is regularly used as a daytime anchorage by prawn trawlers, with as many as 15 boats anchored off the back reef edge each day. John Brewer has been a heavily used tourist destination for many years, while Davies Reef is often used by recreational divers.

We have been surveying density of coral trout and crown of thorns stars on the GBR using replicate visual transect counts since 1982. Counts were first made on the back slope of John Brewer and Lodestone Reefs off Townsville in May 1983, although extensive diving observations were made on the front and back slopes of both reefs in October 1982. John Brewer was resurveyed in February 1984, and the front and back slope habitats of John Brewer, Lodestone and Davies Reefs were surveyed in November 1984. Both habitats of all three reefs were resurveyed by Sea Research in May 1986 as part of an AIMS project by D. McB. Williams looking at the long term effect of crown of thorns devastation on reef fish populations.

Of these three reefs John Brewer and Lodestone experienced an explosive crown of thorns outbreak in 1983/84 that reduced coral cover over the entire reef area to less than 5%. Crown of thorns population numbers then declined dramatically to almost zero by May 1986. In contrast, Davies Reef escaped this outbreak with the exception of very low numbers of crown of thorns in deep water on the front reef slope.

Coral trout density on these reefs during the November 1984 survey was within the range of 21-63 per ha recorded on 15 other mid-shelf reefs in the northern Central Section of the GBR Marine Park during the same period (Ayling and Ayling; 1985).

Surveys of chaetodontid density have been found to provide useful information on the status of coral populations on a reef and also to give a good indication of the type of water mass that usually surrounds a reef (see discussion by Ayling and Ayling; 1985, 1986a). Fishes in this family have been surveyed on these three reefs since November 1984 and have indicated the dramatic reduction in butterflyfish density caused by a crown of thorns

outbreak on a reef: numbers were much higher on Davies than on the devastated reefs John Brewer and Lodestone.

It was decided that a resurvey of crown of thorns, coral trout and chaetodontid density in the same sites on these three reefs in June 1989 would provide a considerable amount of useful information for reef managers. Such a survey would provide data on temporal patterns in the density of these organisms over a six year period. One important aspect on which information could be gained was the long term effect of crown of thorns devastation on coral trout and chaetodontid density. In light of the recent concern regarding the role of lethrinids in the development of crown of thorns outbreaks it was considered useful to try and get some idea of the present status of lethrinid and lutjanid populations on these reefs using the same methods employed for counting coral trout and chaetodontids.

It was also envisaged that a resurvey of sites that had been previously been censused at least twice over the previous 6 years would provide a good test of the power of visual transect data to detect change in the density of reef populations.

METHODS

The density estimates of reef organisms reported here were made on three of the closest reefs to the city of Townsville (see figure 1). The survey reefs were: John Brewer Reef 71km (31.3 nautical miles) to the NNE; Lodestone 67km (29.5nm) to the NE; and Davies 96km (42.5nm) to the ENE of Townsville. Because of their position all three reefs are regularly visited by recreational fishing and dive boats from Townsville, with episodic use by commercial reef fishing boats. The reefs are also utilised as daytime anchorages by prawn trawlers, especially John Brewer Reef.

On each reef the estimates of abundance of the target organisms or groups were made within sites that were arbitrarily limited to a relatively homogeneous length of reef slope between 0.5-1.0km long. If the back reef habitat was made up of an extensive bommie field the survey site was an area of about 25ha of the bommie field. Initial surveys (May 1983, February 1984) were made in a single restricted site on the leeward (NW facing) reef slope referred to here as the back reef slope. On subsequent surveys density estimates were also made in a single front reef site (SE facing). For each resurvey the counts were made within the same site that had been chosen for the initial survey.

Within each site abundance estimates were based on ten haphazardly positioned 50 x 20m transects (chaetodontids were only counted in five of these replicates). Each count was made along a 50m fibreglass tape run from the reef edge in 3-5m depth down the slope, at right angles to the reef edge where this was possible, but on a diagonal if depth at the end of the transect was likely to be over 20m. Similarly, transects were run diagonally if the sand floor was reached before the full 50m tape had been run out.

All *Plectropomus* spp. within 10m of the central tape were counted, the observer swimming a zig-zag path to search a 10m wide strip on one side of the tape before returning along the other side using the same search technique. *Plectropomus* spp. often shelter beneath plate corals and overhangs or in caves; all accessible hiding places within each transect were searched. The species, and the estimated total length (TL) in cm, were recorded for each individual seen. Other fish species counted within the same area were all members of the families chaetodontidae, lethrinidae and lutjanidae. Chaetodontids were counted in the 1984 and 1986 series of counts but lethrinids and lutjanids were only recorded in the 1989 survey. All *Acanthaster* present in the 50 x 20m area were recorded during a separate pass along the transect: these were recorded in all series of counts.

Coral cover was estimated in the survey site during the May 1983 surveys and was measured using 10 haphazard 10m line intersect transects in Nov. 1984.

The different survey components carried out during each visit to the reefs are summarised in Table 1.

Analysis of the data was carried out using anova techniques. One analysis with three factors: time; reef; and habitat, considered differences between the 1986 and 1989 surveys for all sites and reefs, while a second with two factors: time; and reef, looked at differences over the November 1984, May 1986 and June 1989 surveys for the back reef sites only on each reef.

TABLE 1. SURVEY COMPONENTS AT DIFFERENT SAMPLING DATES

Reef	Date	Corals	*Acanth-aster*	Coral Trout	Chaeto-dontids	Lethrinids Lutjanids
BACK REEF SLOPE						
John Brewer	20 May 1983	X	X	X		
	8 Feb. 1984	X	X	X		
	22 Nov. 1984	X	X	X	X	
	13 May 1986		X	X	X	
	8 June 1989		X	X	X	X
Lodestone	21 May 1983	X	X	X		
	21 Nov. 1984	X	X	X	X	
	15 May 1986		X	X	X	
	10 June 1989		X	X	X	X
Davies	10 Nov. 1984	X	X	X	X	
	16 May 1986		X	X	X	
	11 June 1989		X	X	X	X
FRONT REEF SLOPE						
John Brewer	21 Nov 84	X	X	X	X	
	14 May 86		X	X	X	
	9 June 89		X	X	X	X
Lodestone	15 May 86		X	X	X	
	9 June 89		X	X	X	X
Davies	11 Nov 84	X	X	X	X	
	17 May 86		X	X	X	
	11 June 89		X	X	X	X

RESULTS

CROWN OF THORNS

Mean *Acanthaster planci* density for each survey is recorded in table 2, along with data on the cover of coral and other encrusting organisms where this is available. Patterns through time are illustrated in figure 2. Raw data from the *Acanthaster* counts are included in the appendix.

TABLE 2. SUMMARY OF *ACANTHASTER* DENSITY: 1983-1989

Acanthaster density measured with ten 50 x 20m transect counts (five counts in 1983); estimates of the abundance of the major groups of encrusting organisms are also shown.

Reef	Date	*Acanthaster* density (no./ha)		Hard Coral	Dead Hard Coral	Soft Coral	Sponges
		mean	sd	(mean percentage cover)			
BACK REEF SLOPE							
John Brewer	May 83	12	18	30-50		5-15	
	Feb 84	192	155	15-30		5-15	
	Nov 84	7	7	6.8	23.9	2.0	<5
	May 86	6	7				
	June 89	0	0				
Lodestone	May 83	260	121	15-30		5-15	
	Nov 84	3	7	2.0	36.1	0.2	<5
	May 86	0	0				
	June 89	0	0				
Davies	Nov 84	1	3	27.7	<5	4.8	<5
	May 86	0	0				
	June 89	34	19				
FRONT REEF SLOPE							
John Brewer	Nov 84	18	11	5.6	28.3	0.5	<5
	May 86	1	3				
	June 89	0	0				
Lodestone	May 86	2	4				
	June 89	0	0				
Davies	Nov 84	5	13	46.1	<5	3.5	<5
	May 86	3	7				
	June 89	64	45				

The patterns of the *Acanthaster* infestation on John Brewer and Lodestone were similar, although the peak on Lodestone occurred about 8 months before that on John Brewer. In September 1982 no *Acanthaster* were evident on either reef. By May 1983 Lodestone was at the peak of an outbreak with densities of 260 per ha recorded on the back reef slope while a similar peak of almost 200 per ha occurred on John Brewer early in 1984. Small numbers remained on these reefs for the next few years. Similar outbreaks were apparently

experienced on the front reef slope of these reefs (personal observations), although counts were not made in this habitat during the peak of density on either reef.

Davies Reef showed a completely different pattern of *Acanthaster* abundance. In November 1984 there were a few scattered *Acanthaster* on the front reef slope in depths of more than 20m - the five individuals recorded in this series of counts were all at the deep end of the transects and others were seen on the deeper slope outside the transect area. This deep water population remained stable for the next few years (in 1986 the *Acanthaster* encountered were also toward the deep end of the transects), but moderately high numbers appeared in shallower water on both front and back reef in early 1989 and by June 1989 considerable damage to coral communities had occurred throughout Davies Reef.

Before these *Acanthaster* outbreaks all three reefs had a rich coral cover of between 30-50%, primarily fast growing acroporids. This was reduced to less than 5% within 12 months of the peak of the outbreaks on John Brewer and Lodestone Reefs. By June 1989, 6 years after the peak of infestation, there was considerable growth of new coral on the front reef of Lodestone and to a lesser extent on John Brewer (personal observations).

CORAL TROUT

TABLE 3. SUMMARY OF CORAL TROUT DATA: 1983-1989

Figures show mean and standard deviation from ten replicate 50 x 20m transect counts.

Reef and Habitat	Date	*P.leopardus* mean	sd	*P.laevis* mean	sd
BACK REEF SLOPE					
John Brewer	May 83	4.4	1.8	0.2	0.4
	Feb 84	4.0	1.8	0.1	0.3
	Nov 84	3.2	1.7	0.1	0.3
	May 86	4.6	1.6	0.1	0.3
	June 89	3.5	1.1	0.1	0.3
Lodestone	May 83	2.4	1.5	0.2	0.4
	Nov 84	2.8	1.1	0.2	0.6
	May 86	3.5	1.6	0.2	0.4
	June 89	2.7	1.3	0.1	0.3
Davies	Nov 84	5.3	2.5	0.2	0.6
	May 86	6.3	3.2	0.1	0.3
	June 89	5.0	2.1	0.3	0.5
FRONT REEF SLOPE					
John Brewer	Nov 84	0.8	0.9	0.1	0.3
	May 86	3.9	1.5	0.2	0.4
	June 89	3.3	1.5	0.1	0.3
Lodestone	May 86	2.3	1.3	0.2	0.6
	June 89	2.6	1.0	-	-
Davies	Nov 84	2.7	1.4	0.3	0.9
	May 86	5.0	2.1	0.2	0.4
	June 89	3.5	1.2	0.3	0.5

A summary of coral trout density from all the surveys is shown in table 3, and the trends through time in the density of *P. leopardus* are graphed in figure 3 with 95% confidence intervals. Raw data from the June 1989 series of counts are tabulated in appendix 1. The results of the analyses of variance to test for differences among reefs, habitats and times are shown in table 4. Coral trout density on these three reefs shows a number of general patterns.

Within each reef there are more coral trout on the back reef than on the front reef, a pattern consistent on all reefs at all survey periods. However, there appeared to be a seasonal difference in this pattern: in the November survey trout numbers on the front reef were only 40% of those on the back (a significant difference), whereas in both mid-year surveys the difference was not as pronounced, with the front reef supporting an average of 80% of the back reef numbers (not significant - see table 4). Over all surveys *P. leopardus* density on the front reef was 76% of that on the back reef.

The three reefs supported consistent and significantly different numbers of coral trout (see figure 3, table 4). Lodestone had the lowest numbers, with a grand mean over all habitats and times of 27 trout per ha, followed by John Brewer (grand mean 35), with Davies the highest, having a grand mean of 46 trout per ha.

TABLE 4. ANALYSIS OF VARIANCE RESULTS FOR CORAL TROUT

A. Anova table for all three reefs, back and front reef habitats, 1986-1989 surveys.

Source of Variation	SS	df	MS	F ratio	p	Significance
Reef (R)	6.114	2	3.057	19.976	0.0477	*
Habitat (H)	1.242	1	1.242	14.508	0.1634	NS
Time (T)	1.067	1	1.067	5.881	0.0170	*
RxH	0.148	2	0.074	0.552	0.6442	NS
RxT	0.306	2	0.153	0.843	0.4331	NS
HxT	0.086	1	0.086	0.472	0.4936	NS
RxHxT	0.268	2	0.134	0.740	0.4798	NS
Residual	19.597	108	0.181			
Total	28.829	119				

B. Avova table for all three reefs, 1984-1986-1989 surveys, back reef habitat only.

Source of Variation	SS	df	MS	F ratio	p	Significance
Reef (R)	101.267	2	50.663	108.500	0.0003	***
Time (T)	22.067	2	11.033	2.951	0.0580	NS
RxT	1.867	4	0.467	0.125	0.9731	NS
Residual	302.900	81	3.740			
Total	428.100	89				

In general the changes in density over the 6 year span of these surveys were not significant for any one reef (see figure 3), with the exception of the possibly seasonal low on the November 1984 front reef surveys. In most cases the direction and extent of the small changes that were recorded were consistent over all three reefs. For example density increased at all sites between November 1984 and May 1986, and decreased at all sites except Lodestone front reef between May 1986 and June 1989. This decrease was from a

grand mean for all habitats on all reefs of 43 to a grand mean of 34 trout per ha, a 21% reduction in density, and was significant in the overall analysis (see table 4). There were no changes in density that could be related to the status of crown of thorns populations on the reefs, or to the state of the coral communities.

The TL of all *P. leopardus* counted was estimated during these surveys, and this information is summarised in Table 5. Mean length of all individuals from the 10 counts in each site is shown, along with the number of fish in the 0+ age class (this is only possible for the mid-year counts; by November the 0+ age class is not easily separable from the remainder of the population). Also listed is the number of individuals smaller than the 35cm minimum retainable size for fishermen, the number accessible to the fishery (>35cm), and the mean size of this available sub-population. The largest fish recorded in each group of counts is also shown in this table and the total number of fish larger than 50cm TL. Length frequency distributions for each group of counts are shown in figures 4 and 5.

TABLE 5. LENGTH STRUCTURE OF CORAL TROUT POPULATIONS

Numbers are total number from each group of 10 counts, ie number per ha. All lengths are total lengths (TL) in cm. Note: na = not applicable.

Reef	Date	Mean TL	No. 0+ Fish	No. < 35cm	No. > 35cm	Mean TL > 35cm	No. > 50cm	Max. TL
BACK REEF SLOPE								
John Brewer	May 83	28.9	19	27	17	42.6	2	53
	Feb 84	29.0	na	29	11	42.8	1	54
	Nov 84	34.6	na	13	19	40.7	1	52
	May 86	29.3	15	28	18	41.6	1	53
	June 89	32.3	13	16	19	40.0	0	48
Lodestone	May 83	34.8	8	10	14	43.9	3	58
	Nov 84	36.4	na	15	13	45.6	3	62
	May 86	33.7	7	19	16	42.6	2	62
	June 89	32.5	8	14	13	39.1	0	46
Davies	Nov 84	35.9	na	28	25	43.0	2	55
	May 86	34.4	7	31	32	41.3	2	53
	June 89	31.7	12	32	18	40.3	0	48
FRONT REEF SLOPE								
John Brewer	Nov 84	32.5	na	4	4	41.0	0	46
	May 86	33.7	6	20	19	41.7	1	52
	June 89	33.5	8	17	16	42.7	1	54
Lodestone	May 86	33.3	2	14	9	43.4	1	52
	June 89	32.7	8	15	11	40.5	1	55
Davies	Nov 84	34.7	na	19	8	41.5	1	54
	May 86	36.2	4	28	22	45.7	6	61
	June 89	33.2	4	20	15	39.7	0	46

There are a number of features of the length structure of coral trout on the three reefs that are of interest. Mean TL of the fish recorded in each series of counts ranged from 28.9 to 36.4 cm. Mean length was lower in the mid-year counts when there were numbers of small 0+

year class fish in the counts. The majority of these recruits initially settle from the plankton in December/January (personal observations) and were a mean TL of 14.9 cm (range from 9-20 cm) on these reefs by mid-May when the mid-year counts were made. Mean length was lowest on the John Brewer back reef slope where there were consistently more 0+ age class fish than in the other sites. With one exception there was a reduction in mean length between May 1986 and June 1989, corresponding with the overall reduction in density over the same period. This reduction was most marked on Davies Reef were there was a decrease in mean TL from 35.2 to 32.3 between 1986 and 1989.

As was mentioned above it was possible to distinguish the 0+ age class from the rest of the population in the mid-year counts. This can be confirmed by examining the length frequency graphs in appendix 1 (page 53) for surveys in February, May and November from John Brewer Reef. The growth of the 0+ age class through the year can be clearly seen. The number of 0+ fish in each series of mid-year counts is shown in Table 5. In general there were more recruits on the back reef (grand mean of 11 per ha) than on the front reef (5.3 per ha). There were consistently more recruits on John Brewer, especially on the back reef, than on the other two reefs: a mean of 16 per ha on the back reef, almost double the mean of 8.4 per ha on the other back reef sites.

In many of the sites the number of fish available to fishermen (>35cm TL) was remarkably consistent through time (with the exception of the November 1984 front reef sites where overall numbers were very low). However, on Davies Reef the number of fish in this accessible population underwent a 32% increase between November 1984 and May 1986 (back reef site only), followed by an almost 40% reduction between May 1986 and June 1989, from a mean of 27 per ha to 16.5 per ha.

In general there were very few large coral trout on these reefs; only 4% of the fish recorded in 20 series of counts were over 50cm TL. Maximum length recorded in each set of counts ranged from 46-62 cm.

CHAETODONTIDS

The combined abundance of all chaetodontid species is shown in table 6, along with the total number of hard coral feeding chaetodontids and the total number of chaetodontid species encountered in each group of counts. Time trends are graphed in figure 6, and raw data from all counts are tabulated in the appendix.

The abundance of chaetodontid fishes reflected the state of the coral community on each reef. On John Brewer and Lodestone total numbers were generally around 50-100 per ha between November 1984 to June 1989, with the mean density of hard coral feeding chaetodontids around 50 per ha. Hard coral cover was approximately 5% or less during this period; unfortunately counts of chaetodontids were not made in the May 1983 surveys before *Acanthaster* had devastated corals on these two reefs. There was a slight increase in the density of hard coral feeders on the front of Lodestone Reef between May 1986 and June 1989 that was possibly related to the noticeable recovery of plate and clumping acroporids at this site over that period (personal observations).

On Davies Reef chaetodontid density was much higher, between 200 and 400 per ha, due to the good cover of live hard coral that was maintained throughout the survey period. There was an increase between 1984 and 1986, in both front and back reef sites. The substantial decrease between 1986 and 1989 was possibly related to the reduction in hard coral cover caused by the active outbreak of *Acanthaster* present on the reef in 1989.

TABLE 6. SUMMARY OF CHAETODONTID DENSITY DATA: 1984-1989

Figures show mean and standard deviation from five replicate 50 x 20m transect counts.

Reef and Habitat	Date	Total Chaetodontids mean	sd	Hard Coral Feeders mean	sd	No. Species
BACK REEF SLOPE						
John Brewer	Nov 84	12.6	3.4	9.0	3.7	10
	May 86	10.6	1.5	6.4	2.2	9
	June 89	8.0	1.2	3.4	1.1	9
Lodestone	Nov 84	9.2	2.8	5.6	1.5	9
	May 86	8.8	3.1	4.8	3.3	8
	June 89	7.4	2.7	4.8	2.2	8
Davies	Nov 84	19.6	3.6	16.2	3.5	10
	May 86	37.0	11.6	33.2	10.6	13
	June 89	21.8	6.1	18.0	6.4	9
FRONT REEF SLOPE						
John Brewer	Nov 84	7.0	3.1	4.2	2.4	10
	May 86	8.8	3.3	4.8	2.2	10
	June 89	6.6	3.4	3.6	2.5	9
Lodestone	May 86	5.0	1.2	1.8	1.6	6
	June 89	8.4	2.3	5.0	1.9	9
Davies	Nov 84	32.0	2.8	28.2	2.4	11
	May 86	43.2	8.0	38.4	8.3	14
	June 89	25.4	5.7	21.0	2.0	13

LETHRINIDS AND LUTJANIDS

A summary of the density of all species of lethrinids and lutjanids recorded in the 1989 series of counts is shown in table 7, with the raw data listed in the appendix.

At the sampling scale used in these surveys lethrinids and lutjanids showed a high level of variance. Only 2 species were recorded in all 6 sites, and almost without exception the standard deviation was greater than the mean. No meaningful patterns in abundance can be detected using these data. Although there were nominally greater densities of both families on Davies Reef this was due to large numbers of 5 species being encountered associated with a stand of high staghorn acroporids in a single back reef count.

TABLE 7. DENSITY OF LETHRINIDS AND LUTJANIDS: JUNE 1989

Figures record mean and standard deviation from ten 50 x 20m transect counts.

Species	John Brewer mean	sd	Lodestone mean	sd	Davies mean	sd
BACK REEF SLOPE						
Lethrinus chrysostomus	0.6	1.1	0.9	1.0	0.8	1.0
Lethrinus mahsena	-	-	-	-	-	-
Lethrinus nebulosus	-	-	0.3	0.9	1.6	2.5
Lethrinus ramak	-	-	-	-	1.9	6.0
Lethrinus variegatus	-	-	0.2	0.6	-	-
Monotaxis grandoculis	2.0	2.2	0.1	0.3	-	-
Total Lethrinids	2.6	3.0	1.5	1.3	4.3	6.3
Lutjanus bohar	0.1	0.3	-	-	0.1	0.3
Lutjanus carponotatus	1.4	1.3	0.5	0.7	0.6	0.8
Lutjanus fulviflamma	-	-	-	-	2.1	5.0
Lutjanus quinquelineatus	1.5	2.2	2.9	8.1	1.1	1.7
Lutjanus russelli	-	-	0.3	0.7	1.1	2.8
Lutjanus sebae	-	-	-	-	0.6	1.3
Total Lutjanids	3.0	3.6	3.7	9.0	5.6	9.3
FRONT REEF SLOPE						
Lethrinus chrysostomus	1.3	1.3	0.5	0.7	0.5	1.0
Lethrinus mahsena	0.1	0.3	-	-	0.3	0.7
Lethrinus nebulosus	-	-	0.5	1.1	-	-
Lethrinus ramak	0.3	0.7	0.2	0.4	-	-
Lethrinus variegatus	-	-	-	-	-	-
Monotaxis grandoculis	2.2	3.3	0.4	0.7	0.7	0.8
Total Lethrinids	3.9	2.8	1.6	1.2	1.5	1.2
Lutjanus bohar	-	-	-	-	-	-
Lutjanus carponotatus	0.6	1.1	0.4	0.8	0.1	0.3
Lutjanus fulviflamma	0.2	0.6	-	-	2.3	5.0
Lutjanus quinquelineatus	0.5	0.8	-	-	0.1	0.3
Lutjanus russelli	-	-	0.4	0.7	-	-
Lutjanus sebae	-	-	-	-	-	-
Total Lutjanids	1.3	1.6	0.8	1.3	2.5	4.9

DISCUSSION

CROWN OF THORNS

There were marked differences in the pattern of crown of thorns infestation on the three reefs. On John Brewer and Lodestone crown of thorns appeared on the reef in very high numbers (over 250 per ha) in 1983 and the populations rapidly declined over the next 12 months after coral communities had been devastated. It is possible that the populations on these two reefs, and those detected on other Central Section and southern Cairns Section reefs at this time (see Ayling and Ayling; 1985) resulted from a single recruitment episode of larvae derived from aggreagations on reefs off Cairns such as Green Island in 1979/80.

On Davies Reef at this time small numbers of crown of thorns were present in deep water, probably a less successful result of the same recruitment episode. Adult individuals remained at this low density until 1989 when moderate numbers (34-64 per ha) were recorded around much of the reef. It seems possible that while Davies Reef missed receiving large numbers of crown of thorns recruits when other reefs in this area were infected, subsequent spawnings from these adjacent infected reefs in the 1983-85 period resulted in at least one moderately successful recruitment episode onto Davies Reef. As the population numbers are lower it appears to be taking longer to completely devastate Davies than either John Brewer or Lodestone.

These data suggest that the use of replicate visual transect counts of crown of thorns at a few selected sites on a reef give a good indication of the pattern and severity of any outbreak, as well as enabling the detection of low density populations such as that present in deep water on the front reef slope of Davies Reef between 1984 and 1989.

CORAL TROUT

There were consistently less common coral trout (*Plectropomus leopardus*) on the front reef than on the back reef, a pattern that has also been detected on all other GBR reefs where front and back sites have been surveyed (Ayling and Ayling, 1986b). The reason for this difference is not clear, although it may have some relationship to the water mass characteristics of the two habitats. The front reef is usually bathed in clear water with 20-30m visibility, whereas the back reef is almost invariably more silty and turbid with 10-20m visibility. In this respect the front reef habitat is similar to outer shelf reef areas where *P. leopardus* is significantly less abundant than on mid-shelf reefs (Ayling and Ayling; 1985,1986a).

The consistent differences in coral trout density between the three reefs may have several explanations. These density differences may reflect consistent patterns of fishing pressure on the reefs with the highest fishing level on Lodestone and the lowest on Davies. Another explanation may be that the reefs receive consistently different numbers of larvae, but the limited data on 0+ numbers on these reefs tends to discredit this: John Brewer apparently received consistently more recruits than the other two reefs but did not have the highest overall density. On the other hand it is possible that the differences result from features of each reef that lead to consistent differences in the normal carrying capacity for coral trout, with Davies having the highest carrying capacity and Lodestone the lowest.

We find it strange that the changes in *P. leopardus* density over a period of six years should be so small in spite of the high turnover in the populations and the fishing pressure experienced on all three reefs. As suggested above it is possible that each reef has a normal carrying capacity for populations of reef dwelling piscivores (coral trout are the most important of these piscivores: see Ayling; 1982), and that while a successful recruitment episode may increase numbers temporarily, density dependent mortality quickly reduces

numbers to around this postulated normal carrying capacity. Conversely, although fishing pressure may reduce mean size it does not necessarily cause a significant reduction in overall density because of suggested enhanced survival of juvenile fish when large adults are removed (Ayling and Ayling; 1986a). Hence although fluctuations occur due to good recruitment episodes and fishing mortality these are damped out by other factors.

In the mid-year counts it was possible to separate the 0+ size class from the remainder of the population. The number of recruits detected at each site was consistent over all three mid-year count series, and differences between habitats and between reefs were similar for all groups of counts. The John Brewer back reef site supported twice as many recruits as any other site, and back reef sites on all reefs supported more recruits than front reef sites. It seems likely that, as suggested above for overall coral trout density, the number of successful recruits supported by any site is more dependent on the physical and biological features of the site itself than on outside factors such as the number of larvae available.

As has been mentioned fishing pressure can cause a significant reduction in mean length of coral trout populations (Ayling and Ayling; 1986a). With the exception of John Brewer back reef where large numbers of recruits affected mean length, there was a reduction in mean length on all reefs between 1986 and 1989. This was especially pronounced on Davies Reef, where there was also a marked reduction in the number of fish in the population accessible to fishermen (>35cm TL) over the same period. During the survey on Davies, and during subsequent surveys in August and September 1989 several commercial line fishing boats were seen on this reef. Conversations with the fishermen showed that they had been fishing Davies and other reefs in this region more intensively over 1989 than in previous years. It seems probable that this has resulted in the large reduction in mean length and the density of fish over 35cm TL on Davies Reef between 1986 and 1989.

CHAETODONTIDS

Not surprisingly for a group of fishes that are predominantly obligate hard coral feeders the density of chaetodontids on GBR reefs is strongly positively correlated with hard coral cover (Ayling and Ayling; 1985,1986a; see graphs in appendix 1, page 54). Over all series of counts in which chaetodontids were recorded during this study there were an average of over 5x as many hard coral feeding chaetodontids on the relatively undamaged Davies Reef (258 per ha) compared with John Brewer and Lodestone Reefs (49 per ha). Although there are no pre-devastation counts of this group on John Brewer and Lodestone it is apparent that densities drop very quickly after severe hard coral damage. Densities on John Brewer in November 1984, only 9 months after the peak of the crown of thorns infestation, were 90 per ha, while on Lodestone densities were only 56 per ha 18 months after the peak.

Although there was moderate hard coral damage on Davies in June 1989 caused by the recent crown of thorns outbreak the numbers of hard coral feeding chaetodontids are still about 4x the level on adjacent devastated reefs. However, it seems likely that numbers will drop rapidly over the next 12 months.

LETHRINIDS AND LUTJANIDS

The commercially important species *Lethrinus chrysostomus* (red-throat emperor) was the most abundant lethrinid recorded on these reefs in June 1989 with a grand mean over all reefs and habitats of 7.7 per ha. It is apparent that density data on these groups collected using the same methodology that can be applied successfully to crown of thorns and coral trout can not be used to detect differences or changes with any reliability. Very high levels of variance caused by the clumping behaviour of many of these species combined with the low numbers recorded at this scale of sampling defy standard analytical methods.

However, regular observations along several 800m long sections of reef slope on Davies Reef during recent surveys have suggested that it would be possible to reduce variance in counts of these groups by markedly increasing the size of the count area. A visual search of a previously marked 400-800m length of reef, recording all lethrinids and lutjanids in a 20m wide strip from the reef crest down the slope, could be made by 2 divers using a single scuba tank. Counts along such a large transect (between 1 and 1.6 ha in area) would probably encounter several clumps of each species and reduce variance to manageable levels. Four replicate counts of this size could be searched by two observers in a day.

IMPLICATIONS FOR MANAGEMENT

The time series of strip transect counts of crown of thorns populations reported here have provided a detailed and useful picture of the history and severity of outbreaks on these reefs. If management requires more detailed estimates of the status of *Acanthaster* populations on any reef than the outbreak/non-outbreak level provided by manta tow surveys then strip transect surveys of this type can be used to provide the information.

Using this strip transect method differences in coral trout density between sites or reefs and changes in density through time can be documented. Using a suitably powerful sampling design a measured change in density of 21% was detected as significant. The length estimations that are part of this method also provide valuable data for management. For example, the number of successful recruits in a population can be recorded as well as changes in length structure of coral trout populations that may be caused by factors such as fishing pressure.

The implications for management of the ideas on carrying capacity for both juvenile and adult coral trout expressed in the discussion are worth considering. If adult coral trout density or recruit density on any reef is more dependent on the unique characteristics of the physical and biological environment of that particular reef than on the level of fishing pressure or availability of recruits then the level of this theoretical carrying capacity for each reef is an important consideration for management.

Fishing pressure is popularly supposed to have a dramatic effect on target species numbers. We have all heard how we should have seen the fish populations as they used to be before they were 'fished out'. However, at present it is impossible to get any quantitative data on the overall level of fishing on any reef so as to be able to relate this to measures of density and size of the target populations. The implementation of some form of detailed log book system for both commercial and recreational fishermen would give reef managers some real information on which to base decisions concerning changes in fish numbers and lengths.

The method used here to detect changes and differences in coral trout populations is not suitable for assessing abundance of lethrinids and lutjanids, at least in this area of the GBR. Previous surveys using similar sized transect counts in the Capricorn and Capricornia Section support this conclusion (Ayling and Ayling; 1986a). In view of the recent interest in lethrinids as possible predators of juvenile crown of thorns, the development of some method of assessing their population density would seem to be a priority for management. As has been suggested above some form of extra long strip transect count could probably be used to assess lethrinid populations, but some testing of this type of count needs to be carried out to confirm this.

It is our contention that counts of crown of thorns, coral trout and chaetodontids should be continued on these reefs annually, or at least every two years, preferably in a slightly expanded format. In the present design, where surveys are made within the same site approximately one kilometre long at each survey date, we are really only looking at differences between the individual survey sites not the reefs themselves. To get around this problem the design needs to be expanded to include at least two sites within each habitat,

within each reef. In such a design the number of replicates counted at each site could probably be reduced from ten to five.

Alternatively, an expanded design could be adopted that used this data set and data from some other reefs surveyed in this area in November 1984 as the basis for a more comprehensive monitoring program looking at zoning effects on the reefs off Townsville. This program would incorporate 6 reefs (including the 3 the are the subject of this report): 2 zoned general use (Lodestone and Keeper); 2 zoned Marine National Park A (John Brewer and Davies); and two zoned Marine National Park B (Yankee, and either Wheeler or Spoon). Counts of the above groups of organisms, and additional surveys of encrusting communities, could be carried out in two front reef and two back reef sites on each reef.

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ACKNOWLEDGEMENTS

Ros Priest, Peter Stone and David Davenport provided field assistance during this survey and their help in very cold conditions is appreciated. Kim Prichard cooked warming meals and filled innumerable scuba tanks and without her help the work would have been much harder.

FIGURE 1. MAP OF PART OF THE CENTRAL SECTION OF THE GBR SHOWING THE POSITION OF THE STUDY REEFS.

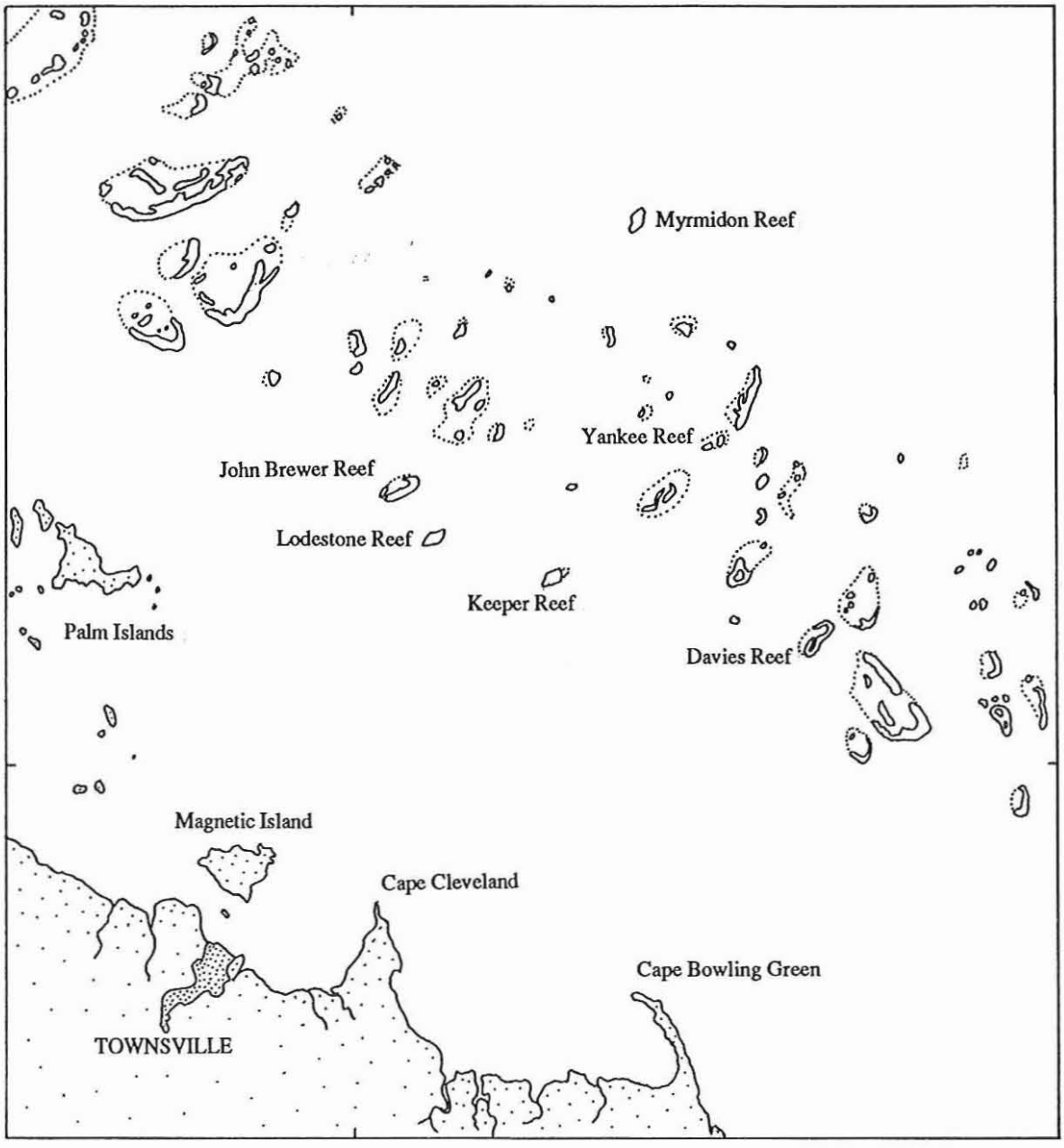


FIGURE 2. PATTERNS OF *ACANTHASTER* DENSITY FROM 1982-1989 ON THE BACK SLOPE OF THE STUDY REEFS

Density from ten 50 x 20m replicate counts. Counts were not made during the Sept. 1982 suvey but no *Acanthaster* were seen during intensive diving on several back reef sites on each reef.

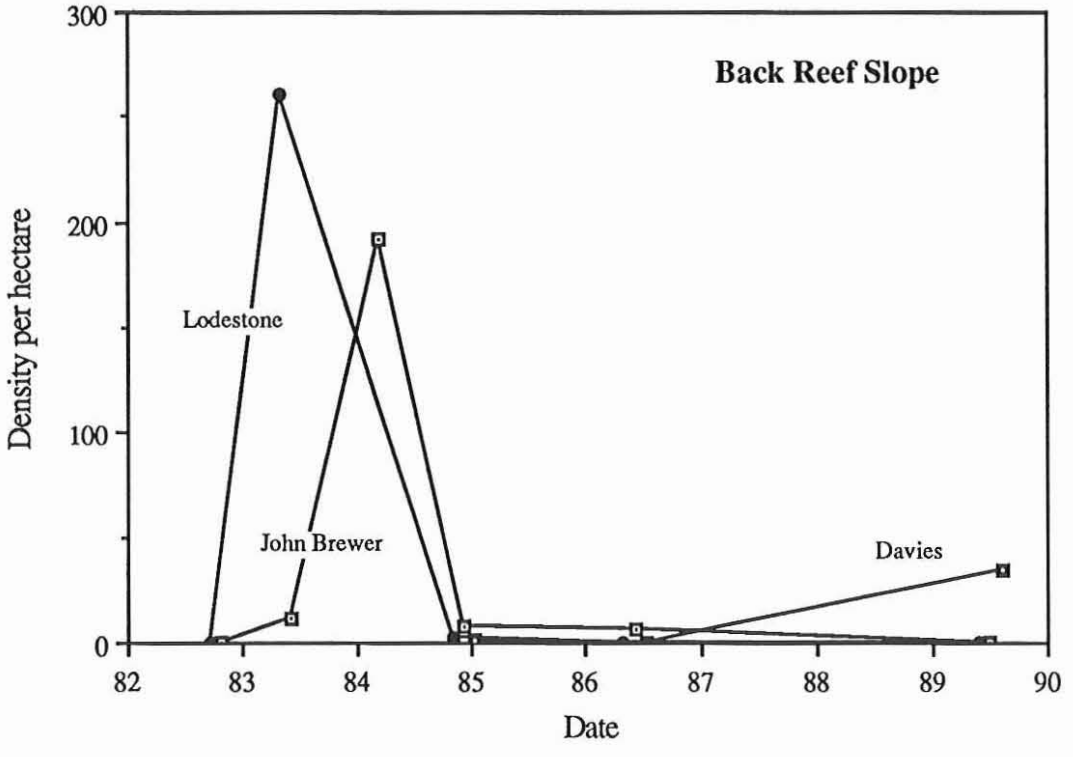
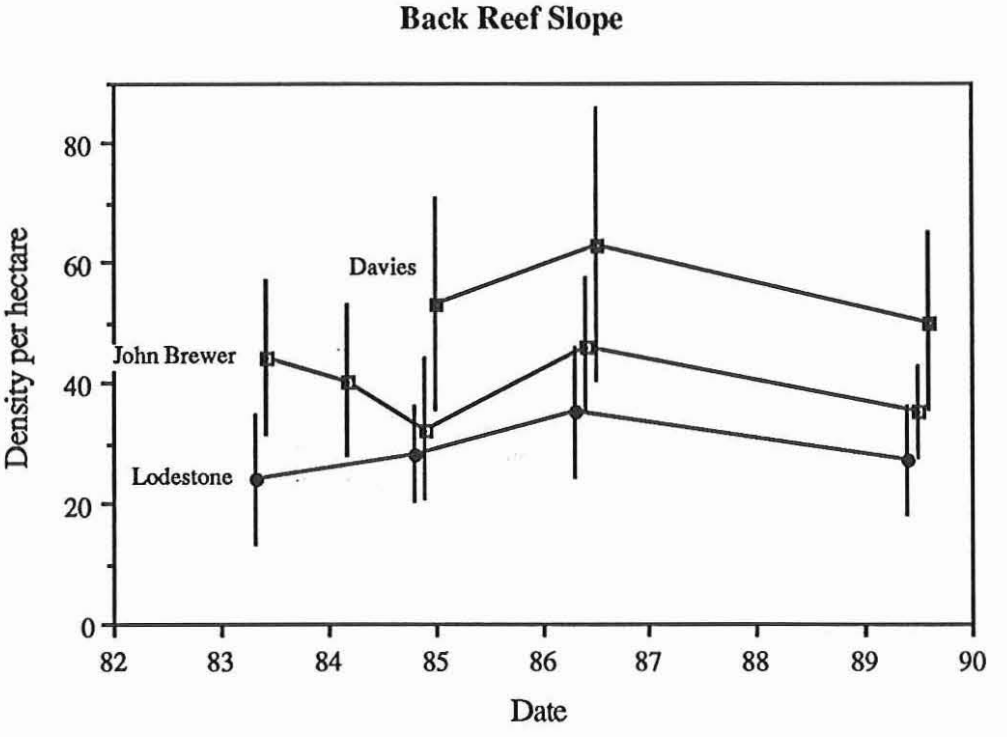


FIGURE 3. CHANGES THROUGH TIME IN THE DENSITY OF THE CORAL TROUT *PLECTROPOMUS LEOPARDUS* ON THE STUDY REEFS

Mean density from ten 50 x 20m replicate counts converted to number per hectare. Error bars show 95% confidence limits for the means.



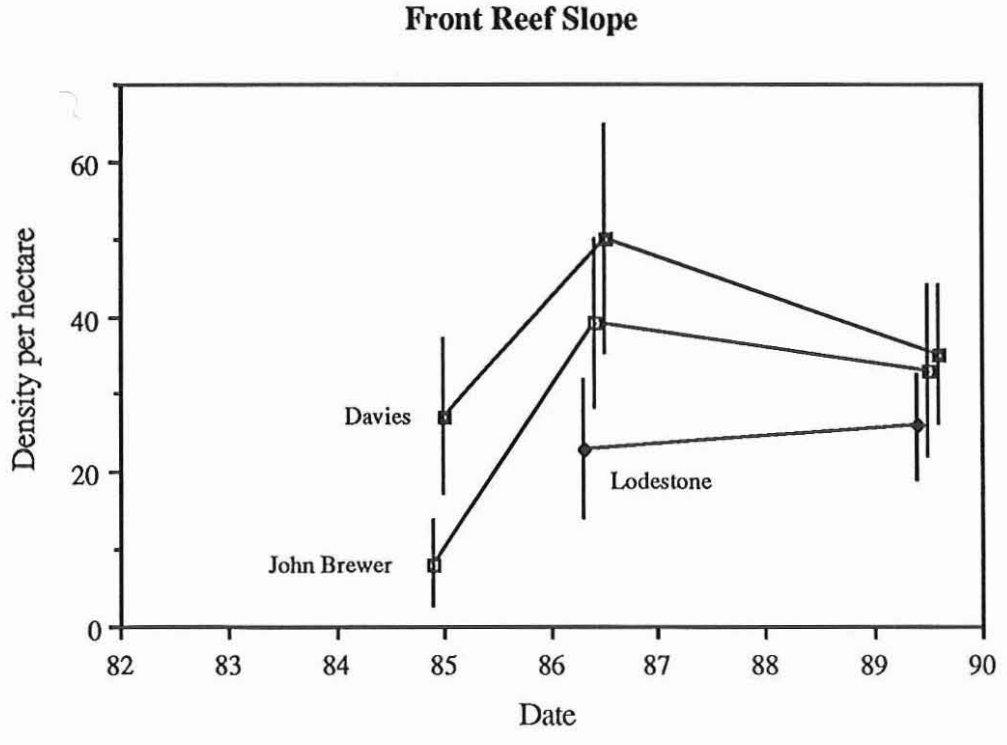


FIGURE 4. LENGTH FREQUENCIES FOR *PLECTROPOMUS LEOPARDUS* ON THE BACK SLOPE OF THE STUDY REEFS

Histograms show comparisons of length frequencies for mid-year surveys only: May 1983 (John Brewer and Lodestone only); May 1986; and June 1989. X axis shows 5cm length classes.

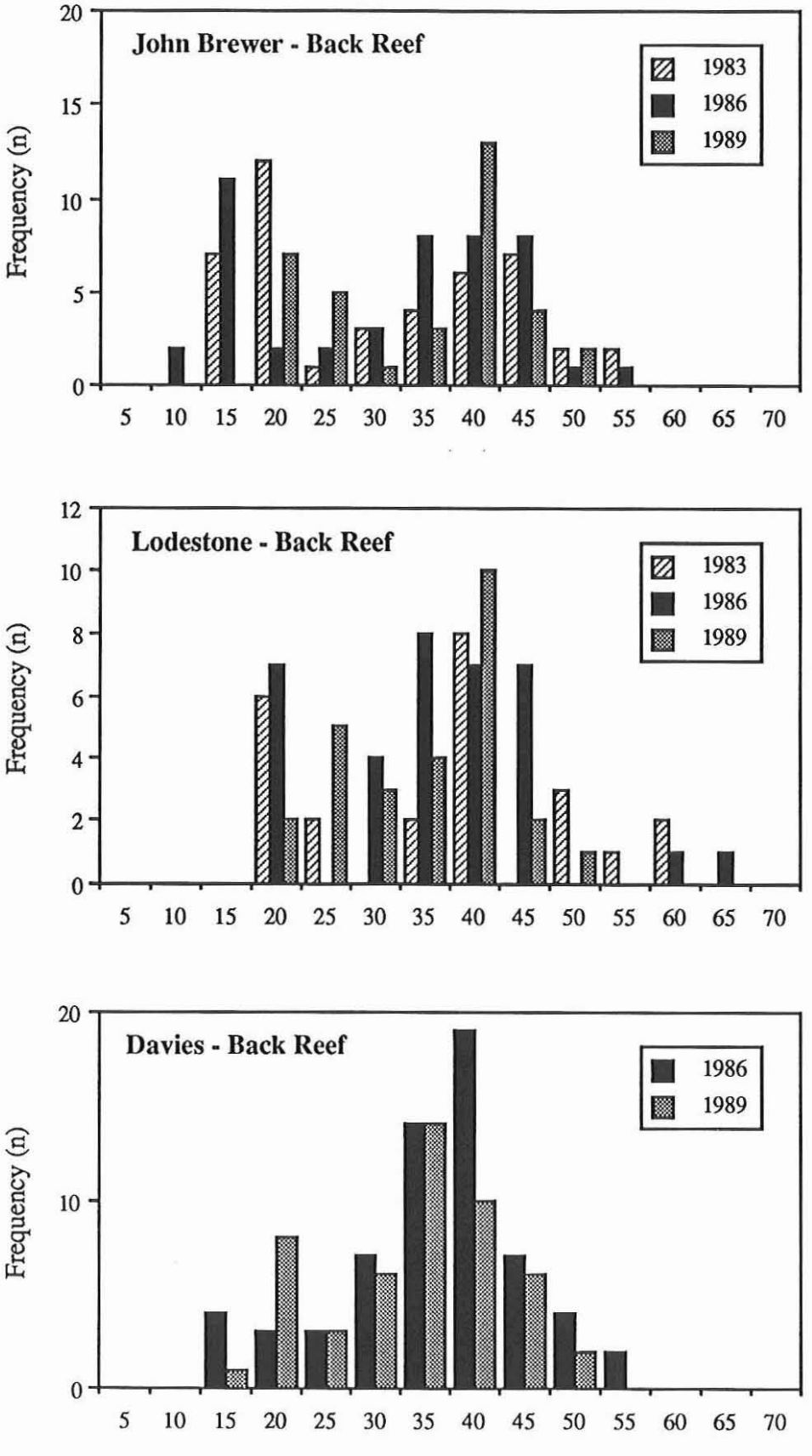


FIGURE 5. LENGTH FREQUENCIES FOR *PLECTROPOMUS LEOPARDUS* ON THE FRONT SLOPE OF THE STUDY REEFS

Histograms show comparisons of length frequencies for mid-year surveys only: May 1986; and June 1989. X axis shows 5cm length classes.

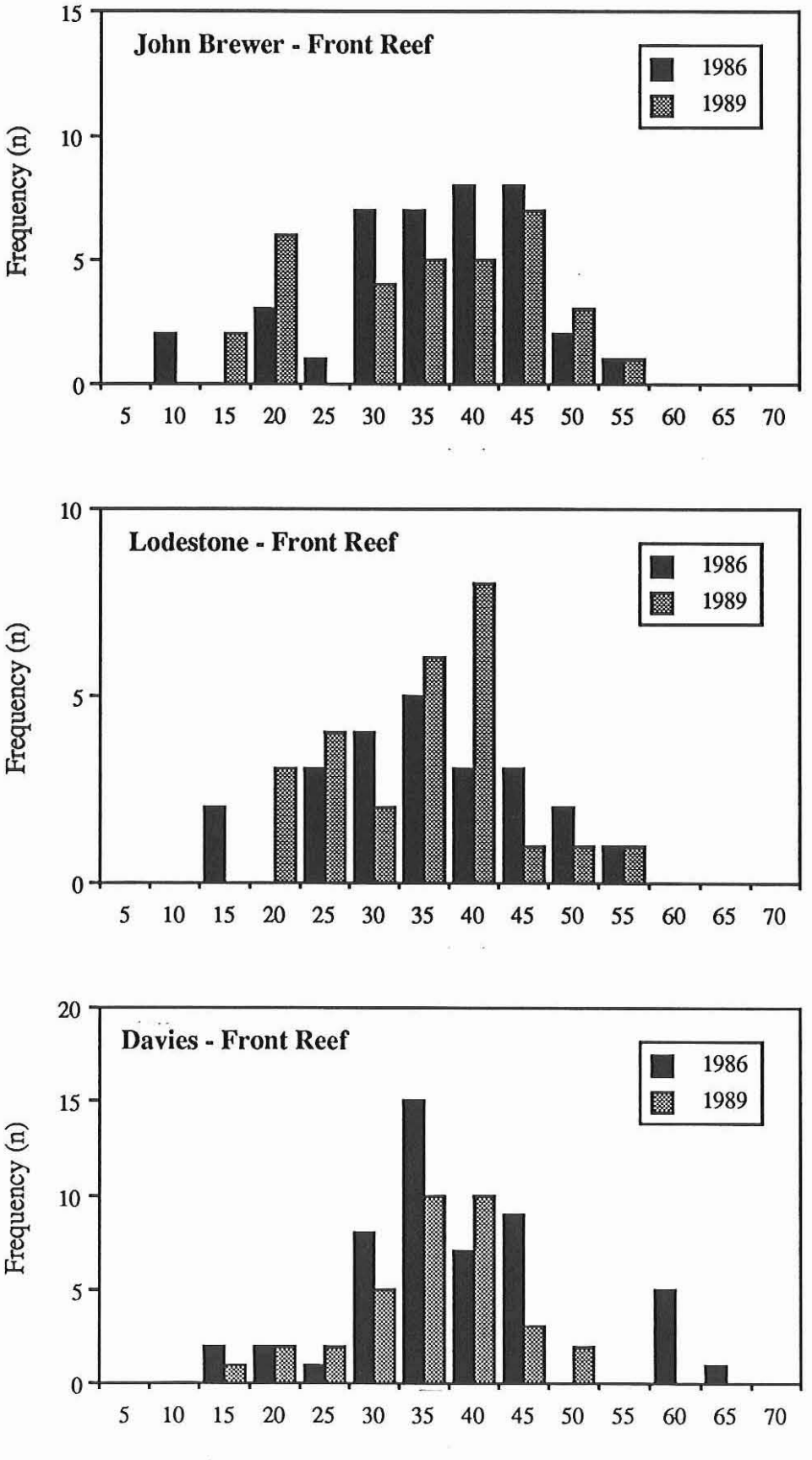
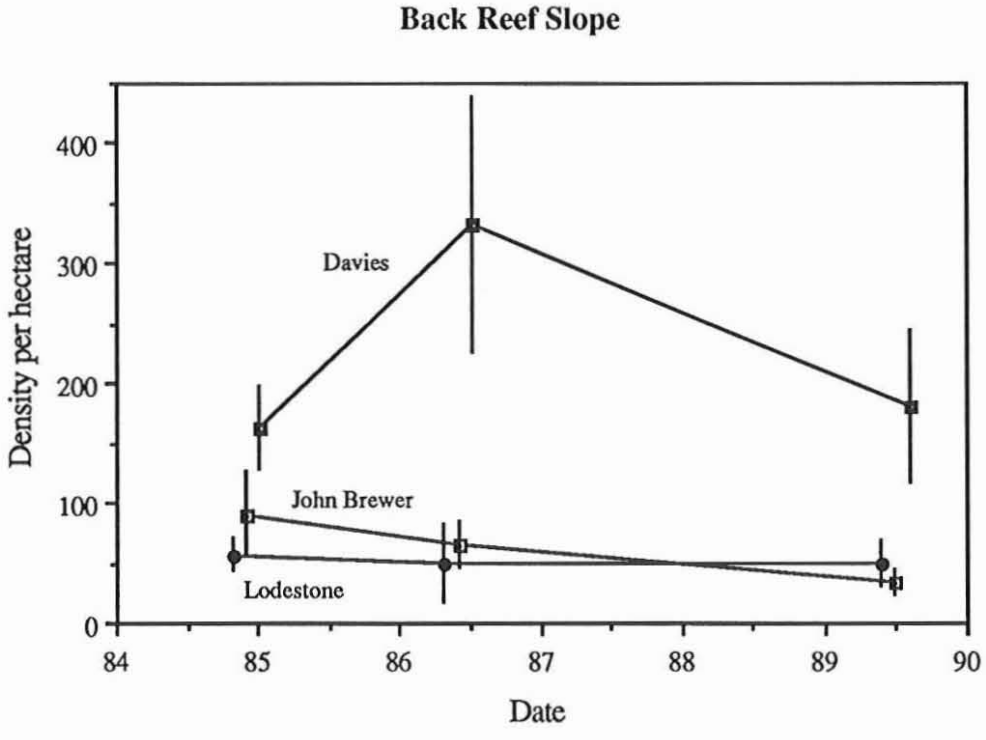
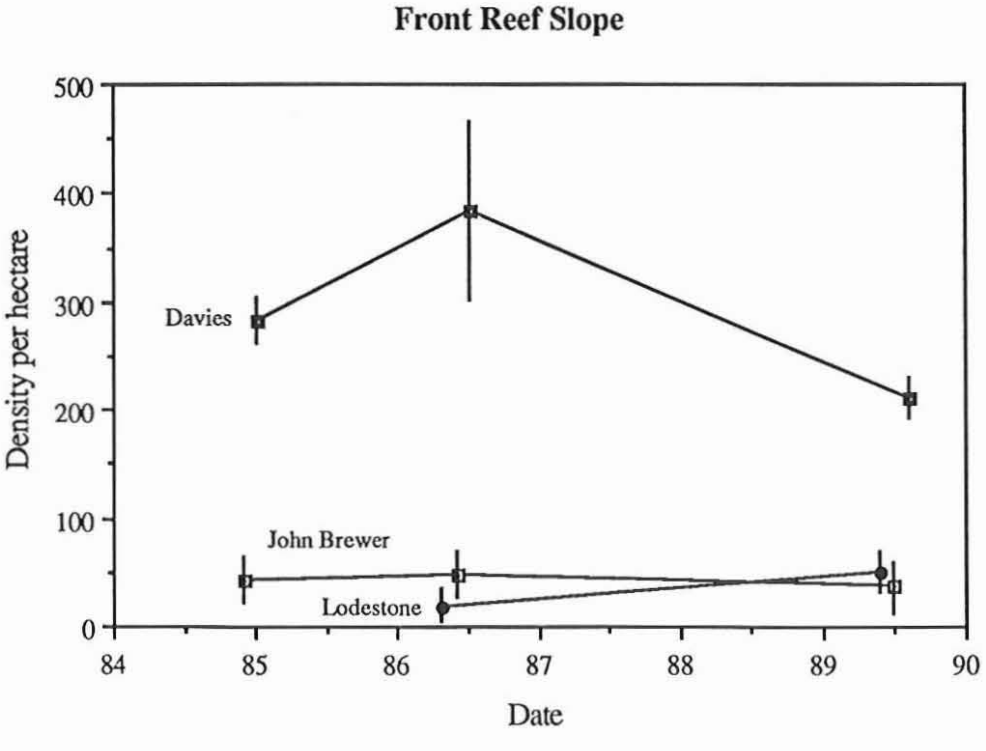


FIGURE 6. CHANGES THROUGH TIME IN CHAETODONTID DENSITY ON THE STUDY REEFS

Mean density from five 50 x 20m replicate counts converted to number per hectare. Error bars show 95% confidence limits for the means.





APPENDIX 1

RAW DATA FROM THE DENSITY SURVEYS OF CROWN OF THORNS, CORAL TROUT AND OTHER ORGANISMS MADE ON JOHN BREWER, LODESTONE AND DAVIES REEFS

Raw data fom the transect counts is shown for the following groups of organisms:

Transect #	1	2	3	4	5	6	7	8	9	10	mean	st.dev
JOHN BREWER REEF: BACK SLOPE												
23rd May 1983 *	4	0	0	2	0						**1.2**	**1.8**
6th Feb 1984	49	7	42	26	7	13	12	8	22	6	**19.2**	**15.5**
22nd Nov 1984	1	0	0	1	2	0	0	1	1	1	**0.7**	**0.7**
13th May 1986	2	0	1	0	1	1	0	1	0	0	**0.6**	**0.7**
8th June 1989	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
JOHN BREWER REEF: FRONT SLOPE												
21st Nov 1984	1	3	2	1	2	1	2	0	2	4	**1.8**	**1.1**
14th May 1986	0	1	0	0	0	0	0	0	0	0	**0.1**	**0.3**
9th June 1989	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
LODESTONE REEF: BACK SLOPE												
17th May 1983 *	42	32	26	20	10						**26.0**	**12.1**
21st Nov 1984	0	0	0	0	0	0	0	0	1	2	**0.3**	**0.7**
15th May 1986	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
10th June 1989	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
LODESTONE REEF: FRONT SLOPE												
15th May 1986	0	1	0	0	1	0	0	0	0	0	**0.2**	**0.4**
9th June 1989	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
DAVIES REEF: BACK SLOPE												
10th Nov 1984	0	0	0	1	0	0	0	0	0	0	**0.1**	**0.3**
16th May 1986	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
11th June 1989	7	3	4	5	3	5	1	1	2	3	**3.4**	**1.9**
DAVIES REEF: FRONT SLOPE												
11th Nov 1984	0	0	1	4	0	0	0	0	0	0	**0.5**	**1.3**
17th May 1986	0	0	0	0	2	0	1	0	0	0	**0.3**	**0.7**
11th June 1989	3	11	2	1	5	12	13	9	3	5	**6.4**	**4.5**

Data from ten (* five at these sites) 50 x 20m counts with mean and standard deviation

Transect #	1	2	3	4	5	6	7	8	9	10	mean	st.dev
JOHN BREWER REEF: BACK SLOPE												
23rd May 1983	6	6	7	5	5	4	2	2	5	2	**4.4**	**1.8**
6th Feb 1984	5	4	7	4	4	4	1	5	1	5	**4.0**	**1.8**
22nd Nov 1984	5	2	4	0	2	3	4	6	3	3	**3.2**	**1.7**
13th May 1986	7	3	5	2	4	6	6	6	4	3	**4.6**	**1.6**
8th June 1989	5	2	3	4	2	5	3	4	3	4	**3.5**	**1.1**
JOHN BREWER REEF: FRONT SLOPE												
21st Nov 1984	0	0	2	0	2	1	0	2	0	1	**0.8**	**0.9**
14th May 1986	2	7	3	5	4	5	2	3	4	4	**3.9**	**1.5**
9th June 1989	4	4	5	4	3	1	2	1	5	4	**3.3**	**1.5**
LODESTONE REEF: BACK SLOPE												
17th May 1983	2	5	1	1	4	4	1	1	3	2	**2.4**	**1.5**
21st Nov 1984	5	1	2	4	3	3	3	2	2	3	**2.8**	**1.1**
15th May 1986	6	4	1	3	4	5	5	2	3	2	**3.5**	**1.6**
10th June 1989	1	3	1	4	2	5	2	3	2	4	**2.7**	**1.3**
LODESTONE REEF: FRONT SLOPE												
15th May 1986	1	2	2	2	3	1	1	4	5	2	**2.3**	**1.3**
9th June 1989	2	2	3	1	4	3	3	2	4	2	**2.6**	**1.0**
DAVIES REEF: BACK SLOPE												
10th Nov 1984	7	10	1	7	7	4	5	4	5	3	**5.3**	**2.5**
16th May 1986	6	7	10	6	6	3	13	6	4	2	**6.3**	**3.2**
11th June 1989	3	7	5	3	10	4	5	4	4	5	**5.0**	**2.1**
DAVIES REEF: FRONT SLOPE												
11th Nov 1984	2	3	2	3	1	5	3	5	1	2	**2.7**	**1.4**
17th May 1986	2	3	6	10	5	5	5	5	4	5	**5.0**	**2.1**
11th June 1989	4	5	3	2	5	2	4	4	2	4	**3.5**	**1.2**

Data from ten 50 x 20m counts with mean and standard deviation

John Brewer Reef; ID no. 18-075; Central Section

Reef Position: Latitude 18°37'; N-S Index 0.547; Cross-Shelf Index 0.56
Survey Details: 8th June 1989; 1430-1700hrs; 0-18m; back reef slope

Plectropomus spp. Abundance Summary

Mean density per 1000 sq m recorded

species	mean	s.d.
P. leopardus	3.5	1.1
P. maculatus	-	-
P. laevis		
- footballer form	-	-
- bluespot form	0.1	0.3
- total	0.1	0.3
P. areolatus	-	-

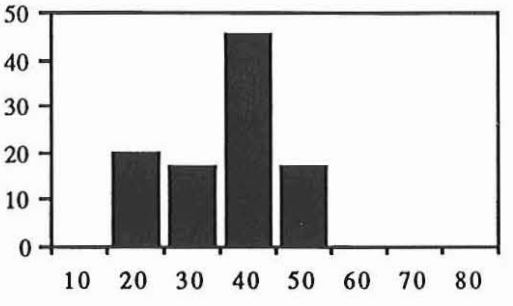
Plectropomus leopardus counts: Raw Data

upper box indicates count number;
middle box estimated TL of fish seen in cm;
lower box totals per count

1	2	3	4	5	6	7	8	9	10
48	21	31	41	43	47	22	37	36	28
22	16	40	36	38	38	44	18	22	37
45		24	35		20	35	17	36	38
18			40		20		39		20
37					40				

5	2	3	4	2	5	3	4	3	4

P. leopardus length frequency



P. leopardus length frequency tables

Below left: 10cm length classes
Below right: 5cm length classes

TL	f
1-10	0
11-20	7
21-30	6
31-40	16
41-50	6
51-60	0
61-70	0
71-80	0
81-90	0

TL	f
1-5	0
6-10	0
11-15	0
16-20	7
21-25	5
26-30	1
31-35	3
36-40	13
41-45	4
46-50	2
51-55	0
56-60	0
61-65	0
66-70	0
71-75	0
76-80	0
81-85	0
86-90	0

P. leopardus

Mean length	32.3
std. dev.	9.8

Raw Data for other species

Estimated TL in cm recorded

P. maculatus

P. laevis - footballer form

P. laevis - bluespot form
58

P. areolatus

John Brewer Reef; ID no. 18-075; Central Section

Reef Position: Latitude 18°37'; N-S Index 0.547; Cross-Shelf Index 0.56
Survey Details: 9th June 1989; 1000-1230hrs; 0-18m; front reef slope

Plectropomus spp. Abundance Summary

Mean density per 1000 sq m recorded

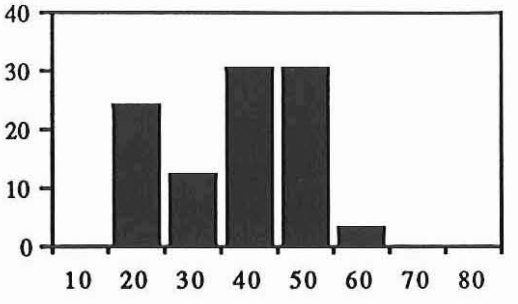
species	mean	s.d.
P. leopardus	3.3	1.5
P. maculatus	-	-
P. laevis		
- footballer form	0.1	0.3
- bluespot form	-	-
- total	0.1	0.3
P. areolatus	-	-

Plectropomus leopardus counts: Raw Data

upper box indicates count number;
middle box estimated TL of fish seen in cm;
lower box totals per count

1	2	3	4	5	6	7	8	9	10
42	14	45	48	35	45	36	36	43	54
18	16	35	37	44		17		27	44
29	30	38	29	19				19	33
46	20	46	34					15	43
		31						36	
4	4	5	4	3	1	2	1	5	4

P. leopardus length frequency



P. leopardus length frequency tables

Below left: 10cm length classes
Below right: 5cm length classes

TL	f
1-10	0
11-20	8
21-30	4
31-40	10
41-50	10
51-60	1
61-70	0
71-80	0
81-90	0

TL	f
1-5	0
6-10	0
11-15	2
16-20	6
21-25	0
26-30	4
31-35	5
36-40	5
41-45	7
46-50	3
51-55	1
56-60	0
61-65	0
66-70	0
71-75	0
76-80	0
81-85	0
86-90	0

P. leopardus

Mean length	33.5
std. dev.	11.2

Raw Data for other species

Estimated TL in cm recorded

P. maculatus

P. laevis - footballer form
48

P. laevis - bluespot form

P. areolatus

Lodestone Reef; ID no. 18-078; Central Section

Reef Position: Latitude 18°42'; N-S Index 0.550; Cross-Shelf Index 0.53
Survey Details: 10th June 1989; 0815-1045hrs; 0-15m; back reef slope

Plectropomus spp. Abundance Summary

Mean density per 1000 sq m recorded

species	mean	s.d.
P. leopardus	2.7	1.3
P. maculatus	-	-
P. laevis		
- footballer form	0.1	0.3
- bluespot form	-	-
- total	0.1	0.3
P. areolatus	-	-

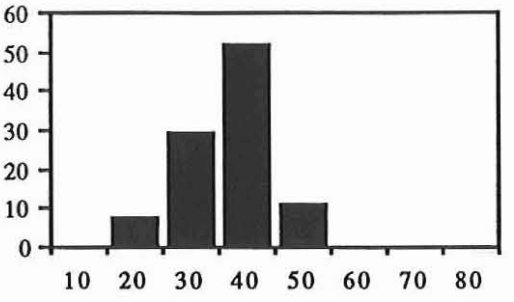
Plectropomus leopardus counts: Raw Data

upper box indicates count number;
middle box estimated TL of fish seen in cm;
lower box totals per count

1	2	3	4	5	6	7	8	9	10
21	23	22	37	18	45	30	34	38	37
	34		40	23	26	39	37	33	38
	20		46		33		41		22
			36		30				36
					38				

1	3	1	4	2	5	2	3	2	4

P. leopardus length frequency



P. leopardus length frequency tables

Below left: 10cm length classes
Below right: 5cm length classes

TL	f
1-10	0
11-20	2
21-30	8
31-40	14
41-50	3
51-60	0
61-70	0
71-80	0
81-90	0

P. leopardus

Mean length	32.5
std. dev.	8.0

TL	f
1-5	0
6-10	0
11-15	0
16-20	2
21-25	5
26-30	3
31-35	4
36-40	10
41-45	2
46-50	1
51-55	0
56-60	0
61-65	0
66-70	0
71-75	0
76-80	0
81-85	0
86-90	0

Raw Data for other species

Estimated TL in cm recorded

P. maculatus

P. laevis - footballer form
26

P. laevis - bluespot form

P. areolatus

Lodestone Reef; ID no. 18-078; Central Section

Reef Position: Latitude 18°42'; N-S Index 0.550; Cross-Shelf Index 0.53
Survey Details: 9th June 1989; 1500-1730hrs; 0-18m; front reef slope

Plectropomus spp. Abundance Summary

Mean density per 1000 sq m recorded

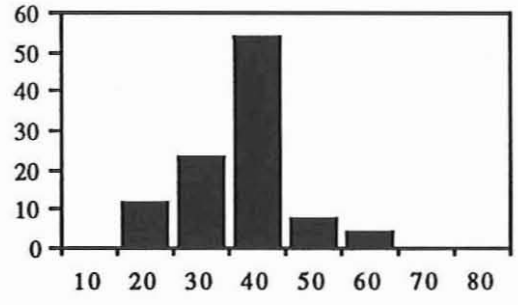
species	mean	s.d.
P. leopardus	2.6	1.0
P. maculatus	-	-
P. laevis		
- footballer form	-	-
- bluespot form	-	-
- total	-	-
P. areolatus	-	-

Plectropomus leopardus counts: Raw Data

upper box indicates count number;
middle box estimated TL of fish seen in cm;
lower box totals per count

1	2	3	4	5	6	7	8	9	10
39	21	37	55	34	38	36	46	35	36
38	24	27		17	42	20	19	32	30
		40		32	23	33		39	
				34				22	
2	2	3	1	4	3	3	2	4	2

P. leopardus length frequency



P. leopardus length frequency tables

Below left: 10cm length classes
Below right: 5cm length classes

TL	f
1-10	0
11-20	3
21-30	6
31-40	14
41-50	2
51-60	1
61-70	0
71-80	0
81-90	0

TL	f
1-5	0
6-10	0
11-15	0
16-20	3
21-25	4
26-30	2
31-35	6
36-40	8
41-45	1
46-50	1
51-55	1
56-60	0
61-65	0
66-70	0
71-75	0
76-80	0
81-85	0
86-90	0

P. leopardus

Mean length	32.7
std. dev.	9.1

Raw Data for other species

Estimated TL in cm recorded

P. maculatus

P. laevis - footballer form

P. laevis - bluespot form

P. areolatus

Davies Reef; ID no. 18-096; Central Section

Reef Position: Latitude 18°50'; N-S Index 0.575; Cross-Shelf Index 0.57
Survey Details: 11th June 1989; 1400-1630hrs; 0-18m; back reef slope

Plectropomus spp. Abundance Summary

Mean density per 1000 sq m recorded

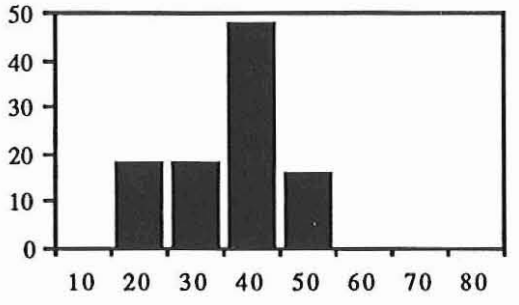
species	mean	s.d.
P. leopardus	5.0	2.1
P. maculatus	-	-
P. laevis		
- footballer form	0.2	0.4
- bluespot form	0.1	0.3
- total	0.3	0.5
P. areolatus	-	-

Plectropomus leopardus counts: Raw Data

upper box indicates count number;
middle box estimated TL of fish seen in cm;
lower box totals per count

1	2	3	4	5	6	7	8	9	10
26	38	34	17	44	18	32	43	36	33
37	38	37	38	26	40	36	48	37	33
47	29	20	23	35	33	44	31	27	27
	35	42		20	35	16	18	14	20
	35	43		35		19			42
	31			36					
	25			22					
				28					
				33					
				31					
3	7	5	3	10	4	5	4	4	5

P. leopardus length frequency



P. leopardus length frequency tables

Below left: 10cm length classes
Below right: 5cm length classes

TL	f
1-10	0
11-20	9
21-30	9
31-40	24
41-50	8
51-60	0
61-70	0
71-80	0
81-90	0

TL	f
1-5	0
6-10	0
11-15	1
16-20	8
21-25	3
26-30	6
31-35	14
36-40	10
41-45	6
46-50	2
51-55	0
56-60	0
61-65	0
66-70	0
71-75	0
76-80	0
81-85	0
86-90	0

P. leopardus
Mean length 31.7
std. dev. 8.7

Raw Data for other species

Estimated TL in cm recorded

P. maculatus

P. laevis - footballer form
22,48

P. laevis - bluespot form
62

P. areolatus

Davies Reef; ID no. 18-096; Central Section

Reef Position: Latitude 18°50'; N-S Index 0.575; Cross-Shelf Index 0.57
Survey Details: 11th June 1989; 0830-1130hrs; 0-25m; front reef slope

Plectropomus spp. Abundance Summary

Mean density per 1000 sq m recorded

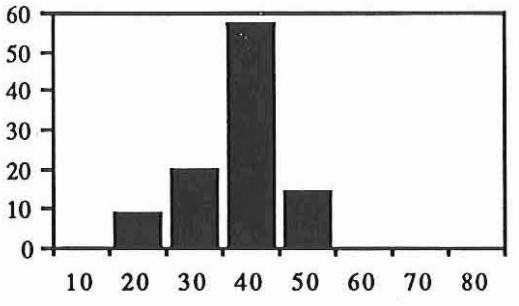
species	mean	s.d.
P. leopardus	3.5	1.2
P. maculatus	-	-
P. laevis		
- footballer form	0.1	0.3
- bluespot form	0.2	0.4
- total	0.3	0.5
P. areolatus	-	-

Plectropomus leopardus counts: Raw Data

upper box indicates count number;
middle box estimated TL of fish seen in cm;
lower box totals per count

1	2	3	4	5	6	7	8	9	10
41	26	36	37	42	39	30	40	28	37
46	38	33	24	46	34	13	42	20	31
38	17	40		37		32	28		27
36	25			31		33	34		35
	35			32					
4	5	3	2	5	2	4	4	2	4

P. leopardus length frequency



P. leopardus length frequency tables

Below left: 10cm length classes
Below right: 5cm length classes

TL	f
1-10	0
11-20	3
21-30	7
31-40	20
41-50	5
51-60	0
61-70	0
71-80	0
81-90	0

P. leopardus

Mean length	33.2
std. dev.	7.6

TL	f
1-5	0
6-10	0
11-15	1
16-20	2
21-25	2
26-30	5
31-35	10
36-40	10
41-45	3
46-50	2
51-55	0
56-60	0
61-65	0
66-70	0
71-75	0
76-80	0
81-85	0
86-90	0

Raw Data for other species

Estimated TL in cm recorded

P. maculatus

P. laevis - footballer form
45

P. laevis - bluespot form
46,52

P. areolatus

Count #	1	2	3	4	5	Mean	Std.dev.
Species							
HARD CORAL FEEDERS							
Chaetodon aureofasciatus	3	7	4	6	4	4.8	1.6
Chaetodon baronessa	0	0	0	0	0	0.0	0.0
Chaetodon bennetti	0	0	0	0	0	0.0	0.0
Chaetodon ornatissimus	0	0	0	0	0	0.0	0.0
Chaetodon pelewensis	0	0	0	0	0	0.0	0.0
Chaetodon plebeius	1	1	1	0	0	0.6	0.5
Chaetodon rafflesi	0	0	0	0	0	0.0	0.0
Chaetodon rainfordi	0	4	2	3	1	2.0	1.6
Chaetodon reticulatus	0	0	0	0	0	0.0	0.0
Chaetodon speculum	0	0	0	0	0	0.0	0.0
Chaetodon trifascialis	0	0	0	0	0	0.0	0.0
Chaetodon trifasciatus	2	2	2	2	0	1.6	0.9
Total hard coral feeders	**6**	**14**	**9**	**11**	**5**	**9.0**	**3.7**
SOFT CORAL FEEDERS							
Chaetodon kleinii	0	0	0	0	2	0.4	0.9
Chaetodon lineolatus	0	0	0	0	0	0.0	0.0
Chaetodon melannotus	2	0	2	2	2	1.6	0.9
Chaetodon unimaculatus	0	0	0	0	0	0.0	0.0
Total soft coral feeders	**2**	**0**	**2**	**2**	**4**	**2.0**	**1.4**
OMNIVORES							
Chaetodon auriga	0	0	0	1	0	0.2	0.4
Chaetodon citrinellus	0	0	0	0	0	0.0	0.0
Chaetodon ephippium	0	0	0	0	0	0.0	0.0
Chaetodon flavirostris	0	0	0	0	0	0.0	0.0
Chaetodon lunula	0	0	0	0	0	0.0	0.0
Chaetodon mertensii	0	0	0	0	0	0.0	0.0
Chaetodon ulietensis	0	1	1	0	0	0.4	0.5
Chaetodon vagabundus	0	1	0	0	0	0.2	0.4
Chelmon rostratus	0	0	0	2	2	0.8	1.1
Coradion altivelis	0	0	0	0	0	0.0	0.0
Coradion chrysozonus	0	0	0	0	0	0.0	0.0
Forcipiger flavissimus	0	0	0	0	0	0.0	0.0
Total omnivores	**0**	**2**	**1**	**3**	**2**	**1.6**	**1.1**
Grand total	**8**	**16**	**12**	**16**	**11**	**12.6**	**3.4**

Number of species:	**10**

Hard coral: 6.8%; Soft coral: 2.0%; Dead hard coral: 23.9%; Sponges: <5%

Count #	1	2	3	4	5	Mean	Std.dev.
Species							
HARD CORAL FEEDERS							
Chaetodon aureofasciatus	5	7	3	4	4	4.6	1.5
Chaetodon baronessa	0	0	0	0	0	0.0	0.0
Chaetodon bennetti	0	0	0	0	0	0.0	0.0
Chaetodon ornatissimus	0	0	0	0	0	0.0	0.0
Chaetodon pelewensis	0	0	0	0	0	0.0	0.0
Chaetodon plebeius	0	0	0	0	0	0.0	0.0
Chaetodon rafflesi	0	0	0	0	0	0.0	0.0
Chaetodon rainfordi	2	1	1	0	0	0.8	0.8
Chaetodon reticulatus	0	0	0	0	0	0.0	0.0
Chaetodon speculum	0	0	0	0	0	0.0	0.0
Chaetodon trifascialis	0	0	0	0	0	0.0	0.0
Chaetodon trifasciatus	1	0	4	0	0	1.0	1.7
Total hard coral feeders	**8**	**8**	**8**	**4**	**4**	**6.4**	**2.2**
SOFT CORAL FEEDERS							
Chaetodon kleinii	2	0	0	2	1	1.0	1.0
Chaetodon lineolatus	0	0	0	0	0	0.0	0.0
Chaetodon melannotus	0	2	1	0	0	0.6	0.9
Chaetodon unimaculatus	0	0	0	0	0	0.0	0.0
Total soft coral feeders	**2**	**2**	**1**	**2**	**1**	**1.6**	**0.5**
OMNIVORES							
Chaetodon auriga	0	0	0	0	0	0.0	0.0
Chaetodon citrinellus	0	0	0	0	0	0.0	0.0
Chaetodon ephippium	0	0	0	0	0	0.0	0.0
Chaetodon flavirostris	0	0	0	0	0	0.0	0.0
Chaetodon lunula	0	0	0	0	0	0.0	0.0
Chaetodon mertensii	0	0	0	0	0	0.0	0.0
Chaetodon ulietensis	0	1	0	0	0	0.2	0.4
Chaetodon vagabundus	0	0	2	2	0	0.8	1.1
Chelmon rostratus	0	1	0	3	3	1.4	1.5
Coradion altivelis	0	0	0	0	0	0.0	0.0
Coradion chrysozonus	1	0	0	0	0	0.2	0.4
Forcipiger flavissimus	0	0	0	0	0	0.0	0.0
Total omnivores	**1**	**2**	**2**	**5**	**3**	**2.6**	**1.5**
Grand total	**11**	**12**	**11**	**11**	**8**	**10.6**	**1.5**

Number of species:	**9**

Count #	1	2	3	4	5	Mean	Std.dev.
Species							
HARD CORAL FEEDERS							
Chaetodon aureofasciatus	2	1	2	0	1	1.2	0.8
Chaetodon baronessa	0	0	0	0	0	0.0	0.0
Chaetodon bennetti	0	0	0	0	0	0.0	0.0
Chaetodon ornatissimus	0	0	0	0	0	0.0	0.0
Chaetodon pelewensis	0	0	0	0	0	0.0	0.0
Chaetodon plebeius	0	0	0	0	0	0.0	0.0
Chaetodon rafflesi	0	0	0	0	0	0.0	0.0
Chaetodon rainfordi	1	2	0	2	2	1.4	0.9
Chaetodon reticulatus	0	0	0	0	0	0.0	0.0
Chaetodon speculum	0	0	0	0	0	0.0	0.0
Chaetodon trifascialis	0	0	0	0	0	0.0	0.0
Chaetodon trifasciatus	2	0	2	0	0	0.8	1.1
Total hard coral feeders	**5**	**3**	**4**	**2**	**3**	**3.4**	**1.1**
SOFT CORAL FEEDERS							
Chaetodon kleinii	0	1	0	2	3	1.2	1.3
Chaetodon lineolatus	0	0	0	0	0	0.0	0.0
Chaetodon melannotus	2	0	0	2	2	1.2	1.1
Chaetodon unimaculatus	0	0	0	0	0	0.0	0.0
Total soft coral feeders	**2**	**1**	**0**	**4**	**5**	**2.4**	**2.1**
OMNIVORES							
Chaetodon auriga	0	0	2	0	1	0.6	0.9
Chaetodon citrinellus	0	0	0	0	0	0.0	0.0
Chaetodon ephippium	0	0	0	0	0	0.0	0.0
Chaetodon flavirostris	0	0	0	0	0	0.0	0.0
Chaetodon lunula	0	0	0	0	0	0.0	0.0
Chaetodon mertensii	0	0	0	0	0	0.0	0.0
Chaetodon ulietensis	0	0	0	2	0	0.4	0.9
Chaetodon vagabundus	1	1	3	0	0	1.0	1.2
Chelmon rostratus	0	0	0	0	0	0.0	0.0
Coradion altivelis	0	0	0	0	0	0.0	0.0
Coradion chrysozonus	0	1	0	0	0	0.2	0.4
Forcipiger flavissimus	0	0	0	0	0	0.0	0.0
Total omnivores	**1**	**2**	**5**	**2**	**1**	**2.2**	**1.6**
Grand total	**8**	**6**	**9**	**8**	**9**	**8.0**	**1.2**

Number of species:	**9**

Count #	1	2	3	4	5	Mean	Std.dev.
Species							
HARD CORAL FEEDERS							
Chaetodon aureofasciatus	0	1	1	1	1	0.8	0.4
Chaetodon baronessa	0	0	1	0	0	0.2	0.4
Chaetodon bennetti	0	0	0	0	0	0.0	0.0
Chaetodon ornatissimus	0	0	0	0	0	0.0	0.0
Chaetodon pelewensis	0	0	0	0	0	0.0	0.0
Chaetodon plebeius	2	0	2	2	1	1.4	0.9
Chaetodon rafflesi	0	0	0	0	0	0.0	0.0
Chaetodon rainfordi	3	1	2	0	1	1.4	1.1
Chaetodon reticulatus	0	0	0	0	0	0.0	0.0
Chaetodon speculum	0	0	0	0	0	0.0	0.0
Chaetodon trifascialis	0	0	0	0	0	0.0	0.0
Chaetodon trifasciatus	0	0	2	0	0	0.4	0.9
Total hard coral feeders	**5**	**2**	**8**	**3**	**3**	**4.2**	**2.4**
SOFT CORAL FEEDERS							
Chaetodon kleinii	0	0	0	0	0	0.0	0.0
Chaetodon lineolatus	0	1	0	0	0	0.2	0.4
Chaetodon melannotus	1	0	0	0	2	0.6	0.9
Chaetodon unimaculatus	0	0	0	0	0	0.0	0.0
Total soft coral feeders	**1**	**1**	**0**	**0**	**2**	**0.8**	**0.8**
OMNIVORES							
Chaetodon auriga	0	0	0	0	0	0.0	0.0
Chaetodon citrinellus	1	0	0	0	0	0.2	0.4
Chaetodon ephippium	0	0	0	0	0	0.0	0.0
Chaetodon flavirostris	0	0	0	0	0	0.0	0.0
Chaetodon lunula	0	0	0	0	0	0.0	0.0
Chaetodon mertensii	0	0	0	0	0	0.0	0.0
Chaetodon ulietensis	0	0	0	0	0	0.0	0.0
Chaetodon vagabundus	2	2	2	0	2	1.6	0.9
Chelmon rostratus	1	0	0	0	0	0.2	0.4
Coradion altivelis	0	0	0	0	0	0.0	0.0
Coradion chrysozonus	0	0	0	0	0	0.0	0.0
Forcipiger flavissimus	0	0	0	0	0	0.0	0.0
Total omnivores	**4**	**2**	**2**	**0**	**2**	**2.0**	**1.4**
Grand total	**10**	**5**	**10**	**3**	**7**	**7.0**	**3.1**

Number of species:	**10**

Hard coral: 5.6%; Soft coral: 0.5%; Dead hard coral: 28.3%; Sponges: <5%

Count #	1	2	3	4	5	Mean	Std.dev.
Species							
HARD CORAL FEEDERS							
Chaetodon aureofasciatus	2	1	4	2	0	1.8	1.5
Chaetodon baronessa	0	0	1	0	0	0.2	0.4
Chaetodon bennetti	0	0	0	0	0	0.0	0.0
Chaetodon ornatissimus	0	0	0	0	0	0.0	0.0
Chaetodon pelewensis	0	0	0	0	0	0.0	0.0
Chaetodon plebeius	0	0	0	0	1	0.2	0.4
Chaetodon rafflesi	0	0	0	0	0	0.0	0.0
Chaetodon rainfordi	2	1	2	0	2	1.4	0.9
Chaetodon reticulatus	0	0	0	0	0	0.0	0.0
Chaetodon speculum	0	0	0	0	0	0.0	0.0
Chaetodon trifascialis	0	0	0	0	0	0.0	0.0
Chaetodon trifasciatus	2	0	0	4	0	1.2	1.8
Total hard coral feeders	**6**	**2**	**7**	**6**	**3**	**4.8**	**2.2**
SOFT CORAL FEEDERS							
Chaetodon kleinii	0	0	0	0	0	0.0	0.0
Chaetodon lineolatus	0	0	0	0	0	0.0	0.0
Chaetodon melannotus	0	0	1	0	0	0.2	0.4
Chaetodon unimaculatus	0	0	0	0	0	0.0	0.0
Total soft coral feeders	**0**	**0**	**1**	**0**	**0**	**0.2**	**0.4**
OMNIVORES							
Chaetodon auriga	2	1	0	0	1	0.8	0.8
Chaetodon citrinellus	0	0	0	0	0	0.0	0.0
Chaetodon ephippium	0	0	0	0	0	0.0	0.0
Chaetodon flavirostris	0	0	0	0	0	0.0	0.0
Chaetodon lunula	0	0	0	0	0	0.0	0.0
Chaetodon mertensii	0	0	0	0	0	0.0	0.0
Chaetodon ulietensis	0	0	0	0	0	0.0	0.0
Chaetodon vagabundus	2	1	2	1	2	1.6	0.5
Chelmon rostratus	0	1	2	1	0	0.8	0.8
Coradion altivelis	0	0	0	0	0	0.0	0.0
Coradion chrysozonus	0	1	2	0	0	0.6	0.9
Forcipiger flavissimus	0	0	0	0	0	0.0	0.0
Total omnivores	**4**	**4**	**6**	**2**	**3**	**3.8**	**1.5**
Grand total	**10**	**6**	**14**	**8**	**6**	**8.8**	**3.3**

Number of species:	**10**

Count #	1	2	3	4	5	Mean	Std.dev.
Species							
HARD CORAL FEEDERS							
Chaetodon aureofasciatus	0	0	0	0	1	0.2	0.4
Chaetodon baronessa	0	0	1	1	0	0.4	0.5
Chaetodon bennetti	0	0	0	0	0	0.0	0.0
Chaetodon ornatissimus	0	0	0	0	0	0.0	0.0
Chaetodon pelewensis	0	0	0	0	0	0.0	0.0
Chaetodon plebeius	0	0	0	0	0	0.0	0.0
Chaetodon rafflesi	0	0	0	0	0	0.0	0.0
Chaetodon rainfordi	1	2	4	1	0	1.6	1.5
Chaetodon reticulatus	0	0	0	0	0	0.0	0.0
Chaetodon speculum	0	0	0	0	0	0.0	0.0
Chaetodon trifascialis	0	0	0	0	0	0.0	0.0
Chaetodon trifasciatus	2	0	3	0	2	1.4	1.3
Total hard coral feeders	**3**	**2**	**8**	**2**	**3**	**3.6**	**2.5**
SOFT CORAL FEEDERS							
Chaetodon kleinii	0	0	0	0	0	0.0	0.0
Chaetodon lineolatus	0	0	1	0	0	0.2	0.4
Chaetodon melannotus	0	0	0	0	0	0.0	0.0
Chaetodon unimaculatus	0	0	0	0	0	0.0	0.0
Total soft coral feeders	**0**	**0**	**1**	**0**	**0**	**0.2**	**0.4**
OMNIVORES							
Chaetodon auriga	0	0	0	0	0	0.0	0.0
Chaetodon citrinellus	0	0	0	0	0	0.0	0.0
Chaetodon ephippium	0	0	0	0	0	0.0	0.0
Chaetodon flavirostris	0	0	0	1	0	0.2	0.4
Chaetodon lunula	0	0	0	0	0	0.0	0.0
Chaetodon mertensii	0	0	0	0	0	0.0	0.0
Chaetodon ulietensis	0	0	0	0	0	0.0	0.0
Chaetodon vagabundus	2	4	1	0	4	2.2	1.8
Chelmon rostratus	0	0	1	0	0	0.2	0.4
Coradion altivelis	0	0	0	0	0	0.0	0.0
Coradion chrysozonus	0	0	1	0	0	0.2	0.4
Forcipiger flavissimus	0	0	0	0	0	0.0	0.0
Total omnivores	**2**	**4**	**3**	**1**	**4**	**2.8**	**1.3**
Grand total	**5**	**6**	**12**	**3**	**7**	**6.6**	**3.4**

Number of species:	**9**

Count #	1	2	3	4	5	Mean	Std.dev.
Species							
HARD CORAL FEEDERS							
Chaetodon aureofasciatus	1	6	2	3	0	2.4	2.3
Chaetodon baronessa	0	0	0	0	2	0.4	0.9
Chaetodon bennetti	0	0	0	0	0	0.0	0.0
Chaetodon ornatissimus	0	0	0	0	0	0.0	0.0
Chaetodon pelewensis	0	0	0	0	0	0.0	0.0
Chaetodon plebeius	1	1	2	0	1	1.0	0.7
Chaetodon rafflesi	0	0	0	0	0	0.0	0.0
Chaetodon rainfordi	1	1	1	0	1	0.8	0.4
Chaetodon reticulatus	0	0	0	0	0	0.0	0.0
Chaetodon speculum	0	0	0	0	0	0.0	0.0
Chaetodon trifascialis	0	0	0	0	0	0.0	0.0
Chaetodon trifasciatus	2	0	0	1	2	1.0	1.0
Total hard coral feeders	**5**	**8**	**5**	**4**	**6**	**5.6**	**1.5**
SOFT CORAL FEEDERS							
Chaetodon kleinii	4	2	2	2	0	2.0	1.4
Chaetodon lineolatus	0	0	0	0	0	0.0	0.0
Chaetodon melannotus	1	0	0	0	0	0.2	0.4
Chaetodon unimaculatus	0	0	0	0	0	0.0	0.0
Total soft coral feeders	**5**	**2**	**2**	**2**	**0**	**2.2**	**1.8**
OMNIVORES							
Chaetodon auriga	0	0	0	0	0	0.0	0.0
Chaetodon citrinellus	0	0	0	0	0	0.0	0.0
Chaetodon ephippium	0	0	0	0	0	0.0	0.0
Chaetodon flavirostris	0	0	0	0	0	0.0	0.0
Chaetodon lunula	0	0	0	0	0	0.0	0.0
Chaetodon mertensii	0	0	0	0	0	0.0	0.0
Chaetodon ulietensis	0	0	0	0	0	0.0	0.0
Chaetodon vagabundus	2	2	0	0	2	1.2	1.1
Chelmon rostratus	0	0	0	0	1	0.2	0.4
Coradion altivelis	0	0	0	0	0	0.0	0.0
Coradion chrysozonus	0	0	0	0	0	0.0	0.0
Forcipiger flavissimus	0	0	0	0	0	0.0	0.0
Total omnivores	**2**	**2**	**0**	**0**	**3**	**1.4**	**1.3**
Grand total	**12**	**12**	**7**	**6**	**9**	**9.2**	**2.8**

Number of species:	**9**

Hard coral: 2.0%; Soft coral: 0.2%; Dead hard coral: 36.1%; Sponges: <5%

Count #	1	2	3	4	5	Mean	Std.dev.
Species							
HARD CORAL FEEDERS							
Chaetodon aureofasciatus	4	2	2	1	2	2.2	1.1
Chaetodon baronessa	0	0	0	0	0	0.0	0.0
Chaetodon bennetti	0	0	0	0	0	0.0	0.0
Chaetodon ornatissimus	0	0	0	0	0	0.0	0.0
Chaetodon pelewensis	0	0	0	0	0	0.0	0.0
Chaetodon plebeius	0	0	0	0	0	0.0	0.0
Chaetodon rafflesi	0	0	0	0	0	0.0	0.0
Chaetodon rainfordi	4	0	2	0	2	1.6	1.7
Chaetodon reticulatus	0	0	0	0	0	0.0	0.0
Chaetodon speculum	0	0	0	0	0	0.0	0.0
Chaetodon trifascialis	0	0	0	0	0	0.0	0.0
Chaetodon trifasciatus	2	2	1	0	0	1.0	1.0
Total hard coral feeders	**10**	**4**	**5**	**1**	**4**	**4.8**	**3.3**
SOFT CORAL FEEDERS							
Chaetodon kleinii	0	0	0	1	0	0.2	0.4
Chaetodon lineolatus	0	0	0	0	0	0.0	0.0
Chaetodon melannotus	0	1	0	1	0	0.4	0.5
Chaetodon unimaculatus	0	0	0	0	0	0.0	0.0
Total soft coral feeders	**0**	**1**	**0**	**2**	**0**	**0.6**	**0.9**
OMNIVORES							
Chaetodon auriga	1	0	0	0	0	0.2	0.4
Chaetodon citrinellus	0	0	0	0	0	0.0	0.0
Chaetodon ephippium	0	0	0	0	0	0.0	0.0
Chaetodon flavirostris	0	0	0	0	0	0.0	0.0
Chaetodon lunula	0	0	0	0	0	0.0	0.0
Chaetodon mertensii	0	0	0	0	0	0.0	0.0
Chaetodon ulietensis	0	0	0	0	0	0.0	0.0
Chaetodon vagabundus	0	1	1	2	2	1.2	0.8
Chelmon rostratus	1	6	2	0	1	2.0	2.3
Coradion altivelis	0	0	0	0	0	0.0	0.0
Coradion chrysozonus	0	0	0	0	0	0.0	0.0
Forcipiger flavissimus	0	0	0	0	0	0.0	0.0
Total omnivores	**2**	**7**	**3**	**2**	**3**	**3.4**	**2.1**
Grand total	**12**	**12**	**8**	**5**	**7**	**8.8**	**3.1**

Number of species:	8

Count #	1	2	3	4	5	Mean	Std.dev.
Species							
HARD CORAL FEEDERS							
Chaetodon aureofasciatus	0	3	0	1	1	1.0	1.2
Chaetodon baronessa	0	1	0	0	0	0.2	0.4
Chaetodon bennetti	0	0	0	0	0	0.0	0.0
Chaetodon ornatissimus	0	0	0	0	0	0.0	0.0
Chaetodon pelewensis	0	0	0	0	0	0.0	0.0
Chaetodon plebeius	0	0	0	0	0	0.0	0.0
Chaetodon rafflesi	0	0	0	0	0	0.0	0.0
Chaetodon rainfordi	2	3	4	1	4	2.8	1.3
Chaetodon reticulatus	0	0	0	0	0	0.0	0.0
Chaetodon speculum	0	0	0	0	0	0.0	0.0
Chaetodon trifascialis	0	0	0	0	0	0.0	0.0
Chaetodon trifasciatus	0	0	0	2	2	0.8	1.1
Total hard coral feeders	**2**	**7**	**4**	**4**	**7**	**4.8**	**2.2**
SOFT CORAL FEEDERS							
Chaetodon kleinii	2	0	1	0	0	0.6	0.9
Chaetodon lineolatus	0	0	0	0	0	0.0	0.0
Chaetodon melannotus	0	0	0	0	0	0.0	0.0
Chaetodon unimaculatus	0	0	0	0	0	0.0	0.0
Total soft coral feeders	**2**	**0**	**1**	**0**	**0**	**0.6**	**0.9**
OMNIVORES							
Chaetodon auriga	2	0	1	0	0	0.6	0.9
Chaetodon citrinellus	0	0	0	0	0	0.0	0.0
Chaetodon ephippium	0	0	0	0	0	0.0	0.0
Chaetodon flavirostris	0	0	0	0	0	0.0	0.0
Chaetodon lunula	0	0	0	0	0	0.0	0.0
Chaetodon mertensii	0	0	0	0	0	0.0	0.0
Chaetodon ulietensis	0	0	0	0	0	0.0	0.0
Chaetodon vagabundus	0	2	0	0	4	1.2	1.8
Chelmon rostratus	0	0	1	0	0	0.2	0.4
Coradion altivelis	0	0	0	0	0	0.0	0.0
Coradion chrysozonus	0	0	0	0	0	0.0	0.0
Forcipiger flavissimus	0	0	0	0	0	0.0	0.0
Total omnivores	**2**	**2**	**2**	**0**	**4**	**2.0**	**1.4**
Grand total	**6**	**9**	**7**	**4**	**11**	**7.4**	**2.7**

Number of species:	**8**

Count #	1	2	3	4	5	Mean	Std.dev.
Species							
HARD CORAL FEEDERS							
Chaetodon aureofasciatus	0	1	3	0	3	1.4	1.5
Chaetodon baronessa	0	0	0	0	0	0.0	0.0
Chaetodon bennetti	0	0	0	0	0	0.0	0.0
Chaetodon ornatissimus	0	0	0	0	0	0.0	0.0
Chaetodon pelewensis	0	0	0	0	0	0.0	0.0
Chaetodon plebeius	0	0	0	0	0	0.0	0.0
Chaetodon rafflesi	0	0	0	0	0	0.0	0.0
Chaetodon rainfordi	1	0	0	0	1	0.4	0.5
Chaetodon reticulatus	0	0	0	0	0	0.0	0.0
Chaetodon speculum	0	0	0	0	0	0.0	0.0
Chaetodon trifascialis	0	0	0	0	0	0.0	0.0
Chaetodon trifasciatus	0	0	0	0	0	0.0	0.0
Total hard coral feeders	**1**	**1**	**3**	**0**	**4**	**1.8**	**1.6**
SOFT CORAL FEEDERS							
Chaetodon kleinii	2	0	0	0	0	0.4	0.9
Chaetodon lineolatus	0	0	0	0	0	0.0	0.0
Chaetodon melannotus	0	0	0	0	0	0.0	0.0
Chaetodon unimaculatus	0	0	0	0	0	0.0	0.0
Total soft coral feeders	**2**	**0**	**0**	**0**	**0**	**0.4**	**0.9**
OMNIVORES							
Chaetodon auriga	0	0	0	1	1	0.4	0.5
Chaetodon citrinellus	0	0	0	0	0	0.0	0.0
Chaetodon ephippium	0	0	0	0	0	0.0	0.0
Chaetodon flavirostris	0	0	0	0	0	0.0	0.0
Chaetodon lunula	0	0	0	0	0	0.0	0.0
Chaetodon mertensii	0	0	0	0	0	0.0	0.0
Chaetodon ulietensis	0	0	0	0	0	0.0	0.0
Chaetodon vagabundus	2	2	0	3	2	1.8	1.1
Chelmon rostratus	0	2	1	0	0	0.6	0.9
Coradion altivelis	0	0	0	0	0	0.0	0.0
Coradion chrysozonus	0	0	0	0	0	0.0	0.0
Forcipiger flavissimus	0	0	0	0	0	0.0	0.0
Total omnivores	**2**	**4**	**1**	**4**	**3**	**2.8**	**1.3**
Grand total	**5**	**5**	**4**	**4**	**7**	**5.0**	**1.2**

Number of species:	6

Count #	1	2	3	4	5	Mean	Std.dev.
Species							
HARD CORAL FEEDERS							
Chaetodon aureofasciatus	1	0	2	0	0	0.6	0.9
Chaetodon baronessa	0	0	0	0	0	0.0	0.0
Chaetodon bennetti	0	0	0	0	0	0.0	0.0
Chaetodon ornatissimus	0	0	0	0	0	0.0	0.0
Chaetodon pelewensis	0	0	0	0	0	0.0	0.0
Chaetodon plebeius	0	0	0	0	0	0.0	0.0
Chaetodon rafflesi	0	0	0	0	0	0.0	0.0
Chaetodon rainfordi	3	4	3	1	2	2.6	1.1
Chaetodon reticulatus	0	0	0	0	0	0.0	0.0
Chaetodon speculum	0	0	0	0	0	0.0	0.0
Chaetodon trifascialis	0	0	0	0	0	0.0	0.0
Chaetodon trifasciatus	0	3	2	2	2	1.8	1.1
Total hard coral feeders	**4**	**7**	**7**	**3**	**4**	**5.0**	**1.9**
SOFT CORAL FEEDERS							
Chaetodon kleinii	0	0	0	2	0	0.4	0.9
Chaetodon lineolatus	0	0	1	0	0	0.2	0.4
Chaetodon melannotus	0	0	0	0	0	0.0	0.0
Chaetodon unimaculatus	0	0	0	0	0	0.0	0.0
Total soft coral feeders	**0**	**0**	**1**	**2**	**0**	**0.6**	**0.9**
OMNIVORES							
Chaetodon auriga	0	0	1	0	0	0.2	0.4
Chaetodon citrinellus	0	0	0	0	0	0.0	0.0
Chaetodon ephippium	0	0	0	0	0	0.0	0.0
Chaetodon flavirostris	0	0	0	0	0	0.0	0.0
Chaetodon lunula	0	0	0	0	0	0.0	0.0
Chaetodon mertensii	0	0	0	0	0	0.0	0.0
Chaetodon ulietensis	0	0	0	0	0	0.0	0.0
Chaetodon vagabundus	2	4	0	2	2	2.0	1.4
Chelmon rostratus	0	1	0	0	0	0.2	0.4
Coradion altivelis	0	0	0	0	0	0.0	0.0
Coradion chrysozonus	1	0	0	1	0	0.4	0.5
Forcipiger flavissimus	0	0	0	0	0	0.0	0.0
Total omnivores	**3**	**5**	**1**	**3**	**2**	**2.8**	**1.5**
Grand total	**7**	**12**	**9**	**8**	**6**	**8.4**	**2.3**

Number of species:	**9**

Count #	1	2	3	4	5	Mean	Std.dev.
Species							
HARD CORAL FEEDERS							
Chaetodon aureofasciatus	6	0	0	4	2	2.4	2.6
Chaetodon baronessa	2	2	4	2	3	2.6	0.9
Chaetodon bennetti	0	0	0	0	0	0.0	0.0
Chaetodon ornatissimus	0	0	0	0	0	0.0	0.0
Chaetodon pelewensis	0	0	0	0	0	0.0	0.0
Chaetodon plebeius	0	1	0	1	1	0.6	0.5
Chaetodon rafflesi	0	0	0	0	0	0.0	0.0
Chaetodon rainfordi	8	8	10	5	10	8.2	2.0
Chaetodon reticulatus	0	0	0	0	0	0.0	0.0
Chaetodon speculum	0	0	0	0	0	0.0	0.0
Chaetodon trifascialis	0	0	0	0	0	0.0	0.0
Chaetodon trifasciatus	2	2	4	0	4	2.4	1.7
Total hard coral feeders	**18**	**13**	**18**	**12**	**20**	**16.2**	**3.5**
SOFT CORAL FEEDERS							
Chaetodon kleinii	0	0	0	0	1	0.2	0.4
Chaetodon lineolatus	0	0	0	1	0	0.2	0.4
Chaetodon melannotus	0	0	0	0	0	0.0	0.0
Chaetodon unimaculatus	0	0	0	0	0	0.0	0.0
Total soft coral feeders	**0**	**0**	**0**	**1**	**1**	**0.4**	**0.5**
OMNIVORES							
Chaetodon auriga	0	0	0	0	0	0.0	0.0
Chaetodon citrinellus	0	0	0	0	0	0.0	0.0
Chaetodon ephippium	0	0	0	0	0	0.0	0.0
Chaetodon flavirostris	0	0	0	0	0	0.0	0.0
Chaetodon lunula	0	0	0	0	0	0.0	0.0
Chaetodon mertensii	0	0	0	0	0	0.0	0.0
Chaetodon ulietensis	0	0	0	0	0	0.0	0.0
Chaetodon vagabundus	1	2	0	2	0	1.0	1.0
Chelmon rostratus	2	2	0	1	2	1.4	0.9
Coradion altivelis	0	0	0	0	0	0.0	0.0
Coradion chrysozonus	3	0	0	0	0	0.6	1.3
Forcipiger flavissimus	0	0	0	0	0	0.0	0.0
Total omnivores	**6**	**4**	**0**	**3**	**2**	**3.0**	**2.2**
Grand total	**24**	**17**	**18**	**16**	**23**	**19.6**	**3.6**

Number of species:	**10**

Hard coral: 27.7%; Soft coral: 4.8%; Dead hard coral: <5%; Sponges: <5%

Count #	1	2	3	4	5	Mean	Std.dev.
Species							
HARD CORAL FEEDERS							
Chaetodon aureofasciatus	19	9	10	11	2	10.2	6.1
Chaetodon baronessa	9	4	5	4	12	6.8	3.6
Chaetodon bennetti	0	0	0	0	0	0.0	0.0
Chaetodon ornatissimus	0	0	0	0	0	0.0	0.0
Chaetodon pelewensis	0	0	0	0	0	0.0	0.0
Chaetodon plebeius	0	0	1	0	1	0.4	0.5
Chaetodon rafflesi	0	0	0	0	0	0.0	0.0
Chaetodon rainfordi	17	12	8	9	10	11.2	3.6
Chaetodon reticulatus	0	0	0	0	0	0.0	0.0
Chaetodon speculum	0	0	0	0	0	0.0	0.0
Chaetodon trifascialis	4	0	1	0	1	1.2	1.6
Chaetodon trifasciatus	3	2	2	5	5	3.4	1.5
Total hard coral feeders	**52**	**27**	**27**	**29**	**31**	**33.2**	**10.6**
SOFT CORAL FEEDERS							
Chaetodon kleinii	0	2	0	0	0	0.4	0.9
Chaetodon lineolatus	0	0	0	0	0	0.0	0.0
Chaetodon melannotus	0	0	0	0	0	0.0	0.0
Chaetodon unimaculatus	0	0	0	0	0	0.0	0.0
Total soft coral feeders	**0**	**2**	**0**	**0**	**0**	**0.4**	**0.9**
OMNIVORES							
Chaetodon auriga	1	0	0	2	0	0.6	0.9
Chaetodon citrinellus	0	0	0	0	0	0.0	0.0
Chaetodon ephippium	0	0	0	0	2	0.4	0.9
Chaetodon flavirostris	0	0	0	0	0	0.0	0.0
Chaetodon lunula	0	0	0	0	0	0.0	0.0
Chaetodon mertensii	0	0	0	0	0	0.0	0.0
Chaetodon ulietensis	1	0	0	0	0	0.2	0.4
Chaetodon vagabundus	1	0	0	2	0	0.6	0.9
Chelmon rostratus	2	2	0	2	1	1.4	0.9
Coradion altivelis	0	0	0	0	0	0.0	0.0
Coradion chrysozonus	0	1	0	0	0	0.2	0.4
Forcipiger flavissimus	0	0	0	0	0	0.0	0.0
Total omnivores	**5**	**3**	**0**	**6**	**3**	**3.4**	**2.3**
Grand total	**57**	**32**	**27**	**35**	**34**	**37.0**	**11.6**

Number of species:	**13**

Count #	1	2	3	4	5	Mean	Std.dev.
Species							
HARD CORAL FEEDERS							
Chaetodon aureofasciatus	5	7	4	6	8	6.0	1.6
Chaetodon baronessa	0	2	2	6	12	4.4	4.8
Chaetodon bennetti	0	0	0	0	0	0.0	0.0
Chaetodon ornatissimus	0	0	0	0	0	0.0	0.0
Chaetodon pelewensis	0	0	0	0	0	0.0	0.0
Chaetodon plebeius	0	0	0	0	0	0.0	0.0
Chaetodon rafflesi	0	0	0	0	0	0.0	0.0
Chaetodon rainfordi	6	2	6	1	4	3.8	2.3
Chaetodon reticulatus	0	0	0	0	0	0.0	0.0
Chaetodon speculum	0	0	0	0	0	0.0	0.0
Chaetodon trifascialis	0	0	0	0	1	0.2	0.4
Chaetodon trifasciatus	2	3	6	3	4	3.6	1.5
Total hard coral feeders	**13**	**14**	**18**	**16**	**29**	**18.0**	**6.4**
SOFT CORAL FEEDERS							
Chaetodon kleinii	0	0	0	0	0	0.0	0.0
Chaetodon lineolatus	1	0	0	1	0	0.4	0.5
Chaetodon melannotus	0	0	0	0	0	0.0	0.0
Chaetodon unimaculatus	0	0	0	0	0	0.0	0.0
Total soft coral feeders	**1**	**0**	**0**	**1**	**0**	**0.4**	**0.5**
OMNIVORES							
Chaetodon auriga	0	0	0	2	0	0.4	0.9
Chaetodon citrinellus	0	0	0	0	0	0.0	0.0
Chaetodon ephippium	0	0	0	0	0	0.0	0.0
Chaetodon flavirostris	0	0	0	0	0	0.0	0.0
Chaetodon lunula	0	0	0	0	0	0.0	0.0
Chaetodon mertensii	0	0	0	0	0	0.0	0.0
Chaetodon ulietensis	0	0	0	0	0	0.0	0.0
Chaetodon vagabundus	3	0	2	2	0	1.4	1.3
Chelmon rostratus	3	0	3	0	2	1.6	1.5
Coradion altivelis	0	0	0	0	0	0.0	0.0
Coradion chrysozonus	0	0	0	0	0	0.0	0.0
Forcipiger flavissimus	0	0	0	0	0	0.0	0.0
Total omnivores	**6**	**0**	**5**	**4**	**2**	**3.4**	**2.4**
Grand total	**20**	**14**	**23**	**21**	**31**	**21.8**	**6.1**

Number of species:	9

Count #	1	2	3	4	5	Mean	Std.dev.
Species							
HARD CORAL FEEDERS							
Chaetodon aureofasciatus	7	8	4	9	4	6.4	2.3
Chaetodon baronessa	4	2	10	2	7	5.0	3.5
Chaetodon bennetti	0	0	0	0	0	0.0	0.0
Chaetodon ornatissimus	0	0	0	0	0	0.0	0.0
Chaetodon pelewensis	0	0	0	0	0	0.0	0.0
Chaetodon plebeius	0	1	0	0	2	0.6	0.9
Chaetodon rafflesi	0	0	0	0	0	0.0	0.0
Chaetodon rainfordi	15	10	10	11	10	11.2	2.2
Chaetodon reticulatus	0	0	0	0	0	0.0	0.0
Chaetodon speculum	0	0	0	0	0	0.0	0.0
Chaetodon trifascialis	0	0	0	0	0	0.0	0.0
Chaetodon trifasciatus	6	6	5	4	4	5.0	1.0
Total hard coral feeders	**32**	**27**	**29**	**26**	**27**	**28.2**	**2.4**
SOFT CORAL FEEDERS							
Chaetodon kleinii	2	0	2	0	3	1.4	1.3
Chaetodon lineolatus	0	0	0	0	0	0.0	0.0
Chaetodon melannotus	0	0	0	1	0	0.2	0.4
Chaetodon unimaculatus	0	0	0	0	0	0.0	0.0
Total soft coral feeders	**2**	**0**	**2**	**1**	**3**	**1.6**	**1.1**
OMNIVORES							
Chaetodon auriga	0	1	2	0	1	0.8	0.8
Chaetodon citrinellus	0	0	0	0	0	0.0	0.0
Chaetodon ephippium	0	0	0	0	0	0.0	0.0
Chaetodon flavirostris	0	0	0	0	0	0.0	0.0
Chaetodon lunula	0	0	0	0	0	0.0	0.0
Chaetodon mertensii	0	0	0	0	0	0.0	0.0
Chaetodon ulietensis	0	0	0	0	0	0.0	0.0
Chaetodon vagabundus	0	0	0	0	2	0.4	0.9
Chelmon rostratus	0	0	2	1	0	0.6	0.9
Coradion altivelis	0	0	0	0	0	0.0	0.0
Coradion chrysozonus	0	1	0	1	0	0.4	0.5
Forcipiger flavissimus	0	0	0	0	0	0.0	0.0
Total omnivores	**0**	**2**	**4**	**2**	**3**	**2.2**	**1.5**
Grand total	**34**	**29**	**35**	**29**	**33**	**32.0**	**2.8**

Number of species:	**11**

Hard coral: 46.1%; Soft coral: 3.5%; Dead hard coral: <5%; Sponges: <5%

Count #	1	2	3	4	5	Mean	Std.dev.
Species							
HARD CORAL FEEDERS							
Chaetodon aureofasciatus	18	4	12	6	12	10.4	5.5
Chaetodon baronessa	7	8	3	7	8	6.6	2.1
Chaetodon bennetti	0	0	0	0	0	0.0	0.0
Chaetodon ornatissimus	0	0	0	0	0	0.0	0.0
Chaetodon pelewensis	0	0	0	0	0	0.0	0.0
Chaetodon plebeius	3	1	0	2	3	1.8	1.3
Chaetodon rafflesi	0	0	0	0	0	0.0	0.0
Chaetodon rainfordi	11	13	11	17	15	13.4	2.6
Chaetodon reticulatus	0	0	0	0	0	0.0	0.0
Chaetodon speculum	1	0	0	0	0	0.2	0.4
Chaetodon trifascialis	0	0	0	0	1	0.2	0.4
Chaetodon trifasciatus	8	4	4	7	6	5.8	1.8
Total hard coral feeders	**48**	**30**	**30**	**39**	**45**	**38.4**	**8.3**
SOFT CORAL FEEDERS							
Chaetodon kleinii	0	2	1	0	1	0.8	0.8
Chaetodon lineolatus	1	2	0	0	0	0.6	0.9
Chaetodon melannotus	0	0	1	0	0	0.2	0.4
Chaetodon unimaculatus	0	0	0	2	0	0.4	0.9
Total soft coral feeders	**1**	**4**	**2**	**2**	**1**	**2.0**	**1.2**
OMNIVORES							
Chaetodon auriga	3	0	2	0	2	1.4	1.3
Chaetodon citrinellus	0	0	0	0	0	0.0	0.0
Chaetodon ephippium	0	0	0	0	0	0.0	0.0
Chaetodon flavirostris	0	0	0	0	0	0.0	0.0
Chaetodon lunula	0	0	0	0	0	0.0	0.0
Chaetodon mertensii	0	0	0	0	0	0.0	0.0
Chaetodon ulietensis	0	0	0	0	0	0.0	0.0
Chaetodon vagabundus	0	0	2	0	0	0.4	0.9
Chelmon rostratus	1	0	0	4	0	1.0	1.7
Coradion altivelis	0	0	0	0	0	0.0	0.0
Coradion chrysozonus	0	0	0	0	0	0.0	0.0
Forcipiger flavissimus	0	0	0	0	0	0.0	0.0
Total omnivores	**4**	**0**	**4**	**4**	**2**	**2.8**	**1.8**
Grand total	**53**	**34**	**36**	**45**	**48**	**43.2**	**8.0**

Number of species:	14

Count #	1	2	3	4	5	Mean	Std.dev.
Species							
HARD CORAL FEEDERS							
Chaetodon aureofasciatus	3	4	2	2	4	3.0	1.0
Chaetodon baronessa	4	1	5	0	2	2.4	2.1
Chaetodon bennetti	0	0	0	0	0	0.0	0.0
Chaetodon ornatissimus	0	0	0	0	0	0.0	0.0
Chaetodon pelewensis	0	0	0	0	0	0.0	0.0
Chaetodon plebeius	2	1	0	2	0	1.0	1.0
Chaetodon rafflesi	0	0	0	0	0	0.0	0.0
Chaetodon rainfordi	10	9	10	11	11	10.2	0.8
Chaetodon reticulatus	0	0	0	0	0	0.0	0.0
Chaetodon speculum	0	0	0	1	2	0.6	0.9
Chaetodon trifascialis	0	0	0	0	0	0.0	0.0
Chaetodon trifasciatus	3	5	5	2	4	3.8	1.3
Total hard coral feeders	**22**	**20**	**22**	**18**	**23**	**21.0**	**2.0**
SOFT CORAL FEEDERS							
Chaetodon kleinii	2	0	0	0	4	1.2	1.8
Chaetodon lineolatus	0	0	0	0	1	0.2	0.4
Chaetodon melannotus	0	0	0	0	0	0.0	0.0
Chaetodon unimaculatus	0	0	0	0	2	0.4	0.9
Total soft coral feeders	**2**	**0**	**0**	**0**	**7**	**1.8**	**3.0**
OMNIVORES							
Chaetodon auriga	0	0	0	0	0	0.0	0.0
Chaetodon citrinellus	0	0	0	0	0	0.0	0.0
Chaetodon ephippium	0	0	0	0	0	0.0	0.0
Chaetodon flavirostris	0	0	0	0	0	0.0	0.0
Chaetodon lunula	0	0	0	0	0	0.0	0.0
Chaetodon mertensii	0	0	0	0	0	0.0	0.0
Chaetodon ulietensis	0	0	0	1	0	0.2	0.4
Chaetodon vagabundus	2	0	2	0	0	0.8	1.1
Chelmon rostratus	0	1	0	1	2	0.8	0.8
Coradion altivelis	0	0	0	0	0	0.0	0.0
Coradion chrysozonus	2	0	0	0	2	0.8	1.1
Forcipiger flavissimus	0	0	0	0	0	0.0	0.0
Total omnivores	**4**	**1**	**2**	**2**	**4**	**2.6**	**1.3**
Grand total	**28**	**21**	**24**	**20**	**34**	**25.4**	**5.7**

Number of species:	**13**

Count #	1	2	3	4	5	6	7	8	9	10	mean	st.dev
JOHN BREWER REEF: BACK SLOPE												
Lethrinidae												
Lethrinus nebulosus	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Lethrinus mahsena	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Lethrinus chrysostomus	1	0	3	0	0	0	0	2	0	0	**0.6**	**1.1**
Lethrinus variegatus	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Lethrinus ramak	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Monotaxis grandoculis	2	0	3	0	3	1	1	7	0	3	**2.0**	**2.2**
Total Lethrinids	3	0	6	0	3	1	1	9	0	3	**2.6**	**3.0**
Lutjanidae												
Lutjanus sebae	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Lutjanus carponotatus	0	1	2	0	0	2	2	1	2	4	**1.4**	**1.3**
Lutjanus bohar	0	0	0	0	0	0	0	0	0	1	**0.1**	**0.3**
Lutjanus fulviflamma	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Lutjanus quinquelineatus	0	0	0	0	1	2	3	1	1	7	**1.5**	**2.2**
Lutjanus russelli	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Total Lutjanids	0	1	2	0	1	4	5	2	3	12	**3.0**	**3.6**
JOHN BREWER REEF: FRONT SLOPE												
Lethrinidae												
Lethrinus nebulosus	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Lethrinus mahsena	1	0	0	0	0	0	0	0	0	0	**0.1**	**0.3**
Lethrinus chrysostomus	4	2	2	1	0	0	2	1	0	1	**1.3**	**1.3**
Lethrinus variegatus	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Lethrinus ramak	0	0	0	0	0	0	2	0	0	1	**0.3**	**0.7**
Monotaxis grandoculis	1	0	0	3	2	11	0	2	2	1	**2.2**	**3.3**
Total Lethrinids	6	2	2	4	2	11	4	3	2	3	**3.9**	**2.8**
Lutjanidae												
Lutjanus sebae	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Lutjanus carponotatus	0	0	0	0	0	1	2	0	0	3	**0.6**	**1.1**
Lutjanus bohar	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Lutjanus fulviflamma	0	0	0	0	0	2	0	0	0	0	**0.2**	**0.6**
Lutjanus quinquelineatus	2	0	0	0	0	0	2	0	1	0	**0.5**	**0.8**
Lutjanus russelli	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Total Lutjanids	2	0	0	0	0	3	4	0	1	3	**1.3**	**1.6**

Data from ten 50 x 20m counts with mean and standard deviation

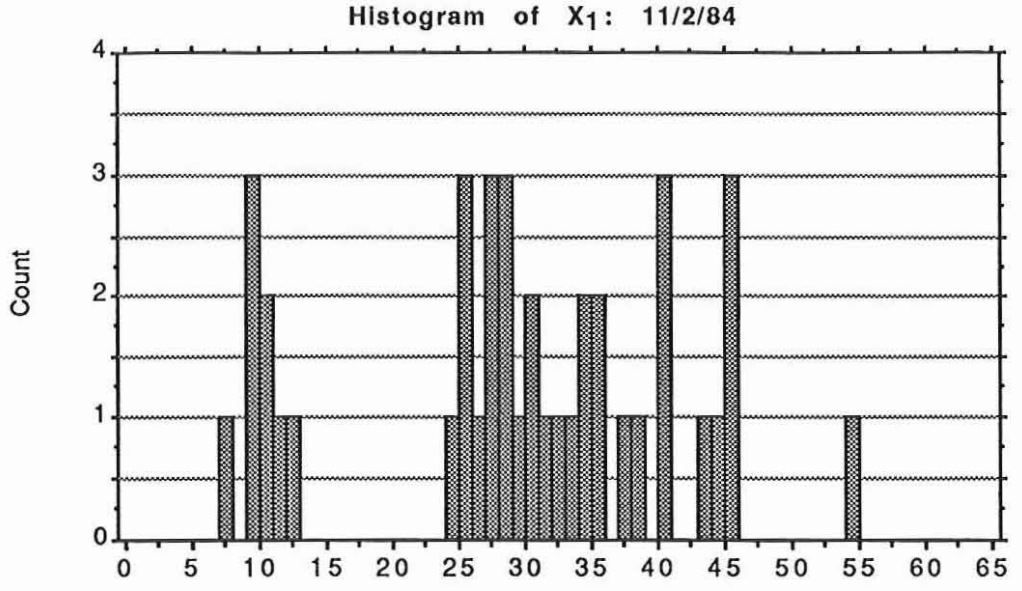
Count #	1	2	3	4	5	6	7	8	9	10	mean	st.dev
LODESTONE REEF: BACK SLOPE												
Lethrinidae												
Lethrinus nebulosus	0	3	0	0	0	0	0	0	0	0	**0.3**	**0.9**
Lethrinus mahsena	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Lethrinus chrysostomus	1	1	1	0	0	0	2	3	0	1	**0.9**	**1.0**
Lethrinus variegatus	0	0	0	0	2	0	0	0	0	0	**0.2**	**0.6**
Lethrinus ramak	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Monotaxis grandoculis	0	0	0	1	0	0	0	0	0	0	**0.1**	**0.3**
Total Lethrinids	1	4	1	1	2	0	2	3	0	1	**1.5**	**1.3**
Lutjanidae												
Lutjanus sebae	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Lutjanus carponotatus	0	2	1	1	0	0	1	0	0	0	**0.5**	**0.7**
Lutjanus bohar	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Lutjanus fulviflamma	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Lutjanus quinquelineatus	0	0	1	26	0	0	2	0	0	0	**2.9**	**8.1**
Lutjanus russelli	0	0	0	2	0	0	0	1	0	0	**0.3**	**0.7**
Total Lutjanids	0	2	2	29	0	0	3	1	0	0	**3.7**	**9.0**
LODESTONE REEF: FRONT SLOPE												
Lethrinidae												
Lethrinus nebulosus	3	0	0	0	0	0	0	2	0	0	**0.5**	**1.1**
Lethrinus mahsena	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Lethrinus chrysostomus	1	0	0	0	0	2	1	0	1	0	**0.5**	**0.7**
Lethrinus variegatus	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Lethrinus ramak	0	0	0	0	1	0	0	0	0	1	**0.2**	**0.4**
Monotaxis grandoculis	0	0	1	2	0	0	0	1	0	0	**0.4**	**0.7**
Total Lethrinids	4	0	1	2	1	2	1	3	1	1	**1.6**	**1.2**
Lutjanidae												
Lutjanus sebae	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Lutjanus carponotatus	2	0	0	0	0	0	0	0	2	0	**0.4**	**0.8**
Lutjanus bohar	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Lutjanus fulviflamma	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Lutjanus quinquelineatus	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Lutjanus russelli	2	0	0	0	1	0	0	1	0	0	**0.4**	**0.7**
Total Lutjanids	4	0	0	0	1	0	0	1	2	0	**0.8**	**1.3**

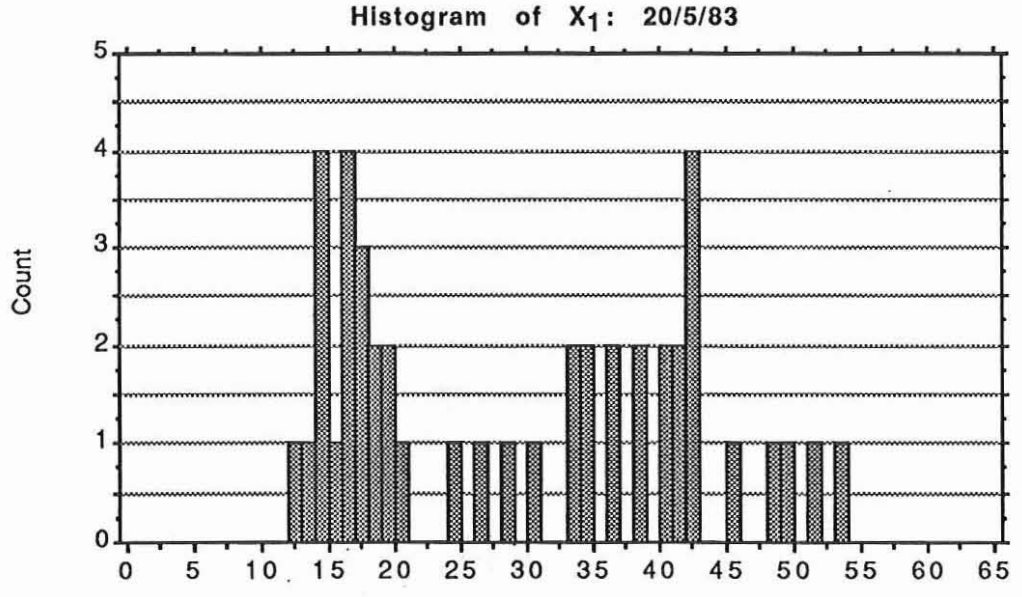
Data from ten 50 x 20m counts with mean and standard deviation

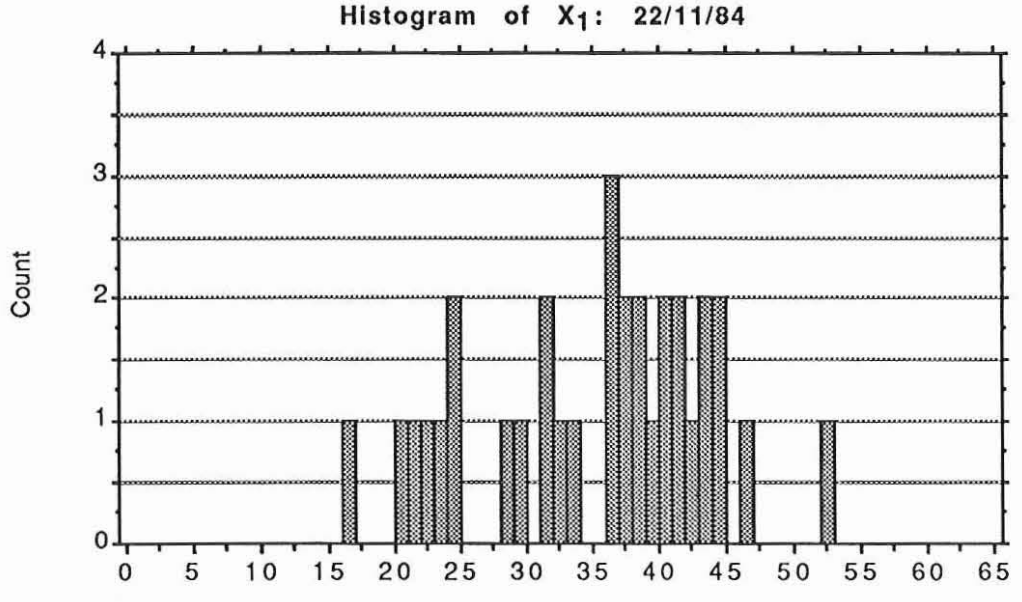
Count #	1	2	3	4	5	6	7	8	9	10	mean	st.dev
DAVIES REEF: BACK SLOPE												
Lethrinidae												
Lethrinus nebulosus	0	5	0	0	2	0	2	7	0	0	**1.6**	**2.5**
Lethrinus mahsena	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Lethrinus chrysostomus	1	0	0	1	0	2	3	0	0	1	**0.8**	**1.0**
Lethrinus variegatus	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Lethrinus ramak	0	0	0	0	19	0	0	0	0	0	**1.9**	**6.0**
Monotaxis grandoculis	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Total Lethrinids	1	5	0	1	21	2	5	7	0	1	**4.3**	**6.3**
Lutjanidae												
Lutjanus sebae	0	4	0	1	1	0	0	0	0	0	**0.6**	**1.3**
Lutjanus carponotatus	2	0	0	2	0	1	1	0	0	0	**0.6**	**0.8**
Lutjanus bohar	0	0	0	0	0	0	0	0	1	0	**0.1**	**0.3**
Lutjanus fulviflamma	0	0	0	4	16	0	1	0	0	0	**2.1**	**5.0**
Lutjanus quinquelineatus	1	0	3	0	5	0	1	0	1	0	**1.1**	**1.7**
Lutjanus russelli	0	0	0	2	9	0	0	0	0	0	**1.1**	**2.8**
Total Lutjanids	3	4	3	9	31	1	3	0	2	0	**5.6**	**9.3**
DAVIES REEF: FRONT SLOPE												
Lethrinidae												
Lethrinus nebulosus	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Lethrinus mahsena	0	1	0	2	0	0	0	0	0	0	**0.3**	**0.7**
Lethrinus chrysostomus	0	1	0	0	3	0	1	0	0	0	**0.5**	**1.0**
Lethrinus variegatus	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Lethrinus ramak	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Monotaxis grandoculis	0	0	0	1	0	2	1	0	2	1	**0.7**	**0.8**
Total Lethrinids	0	2	0	3	3	2	2	0	2	1	**1.5**	**1.2**
Lutjanidae												
Lutjanus sebae	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Lutjanus carponotatus	0	0	0	0	1	0	0	0	0	0	**0.1**	**0.3**
Lutjanus bohar	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Lutjanus fulviflamma	0	0	0	14	0	0	0	0	0	9	**2.3**	**5.0**
Lutjanus quinquelineatus	0	0	0	0	1	0	0	0	0	0	**0.1**	**0.3**
Lutjanus russelli	0	0	0	0	0	0	0	0	0	0	**0.0**	**0.0**
Total Lutjanids	0	0	0	14	2	0	0	0	0	9	**2.5**	**4.9**

Data from ten 50 x 20m counts with mean and standard deviation

LENGTH FREQUENCIES OF *P. LEOPARDUS* ON JOHN BREWER REEF



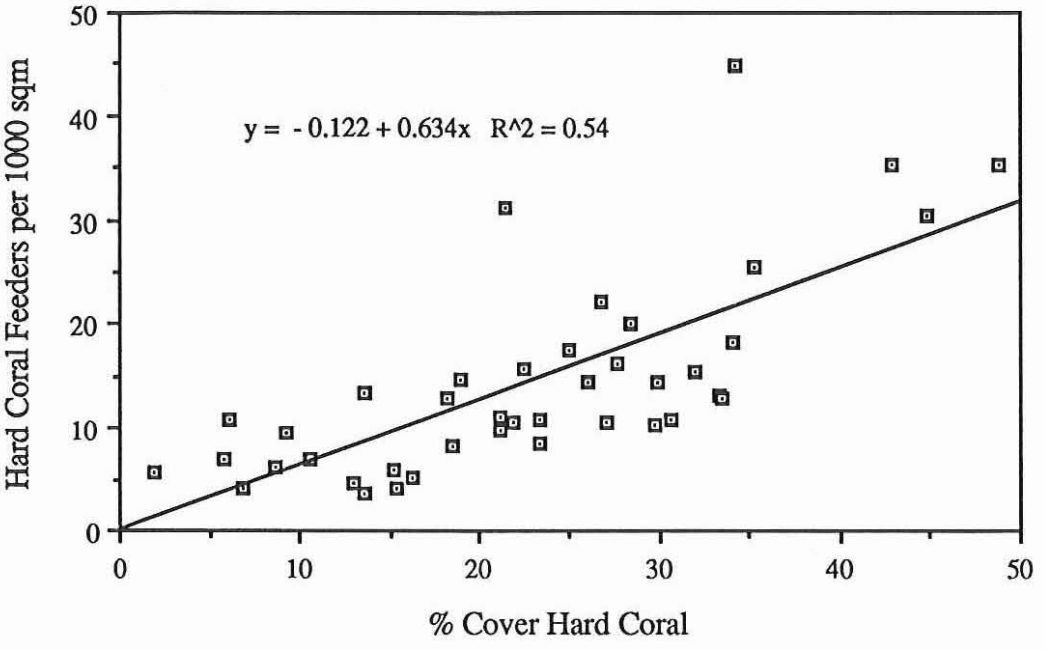




RELATIONSHIP BETWEEN HARD CORAL COVER AND DENSITY OF HARD CORAL FEEDING CHAETODONTIDS

Chaetodontid density from five 50 x 20m replicate counts. Coral cover from ten 10m line intersect transects. Counts were made at a single site on the back reef slope from about 40 reefs in the Central Section (A), and about 40 reefs in the Capricorn Section (B).

A. Central Section



B. Capricorn Section