GREAT BARRIER REEF
MARINE PARK AUTHORITY

RESEARCH PUBLICATION No. 59

Medium-term Changes in Coral Populations of Fringing Reefs at Cape Tribulation

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SUMMARY

The aims of this study were to investigate the medium-term effects of sediment run-off caused by the construction of a coastal road through rainforested catchments in late 1984 on the coral communities of the Cape Tribulation fringing reefs. In the absence of any pre-construction baseline we relied on surveys of two similar control locations, north and south of the potential impact location adjacent to the new road catchment, to determine the significance of any changes that occurred. The southern control was adjacent to the long-established portion of the road south of Cape Tribulation and the northern control adjacent to a small undisturbed catchment. A preliminary three-year study had suggested that the road construction had no effect of the fringing reefs of this region (Ayling and Ayling 1991). It was also hoped that this longer-term study would shed some light on the nature of on-going changes in the benthic communities of fringing reefs in the Great Barrier Reef region.

During the preliminary study we had decided to confine the surveys to the explanate *Montipora*/clumping *Acropora* assemblage that was dominant between 2–4 metres below Australian Height Datum (AHD). In shallower water *Sargassum* algae dominated, while in deeper water a suite of more massive corals such as *Galaxea* and *Hydnophora* was present, but this deeper depth strata was not represented at many of the sites and was not included in the regular surveys.

Four sites were established in each of the three locations, and five permanent 20 metre intersect line transects set up to survey coral communities at each site in 1985. These transects were resurveyed between October and December each year from 1985 to 1988 (Ayling and Ayling 1991), and from 1994 to 1997 (this report).

During the previous survey coral cover at all three locations decreased from an initial high of around 50% cover, due to a small cyclonic episode in April 1986, and a widespread coral-bleaching episode in February 1987. Both these disturbances caused consistent reductions across all three locations. No disturbances occurred in 1988 and coral cover increased by 33% back to the initial levels in all locations.

Surveys were also made using five random 20 metre line intersect transects at five sites where silt run-off from the road was observed to enter the reef community. These sites were all on narrow rocky reefs that supported a less-abundant coral community that was not dominated by *Montipora*/*Acropora* corals. Changes at these sites were generally similar to those recorded in the permanent transect sites.

Although there was at least one major disturbance in the six years between the 1988 survey and the first new survey in 1994 (cyclone Joy in 1990), coral cover either remained stable or increased over this period. There were other disturbances during the three years of this new study, including a major flood episode in March 1996, but coral cover either remained stable (location 1 and 3) or increased (location 2). Coral cover at the direct run-off sites also either remained stable or increased during this period. Coral cover in the potential impact location 2 has increased by 45% since 1985, a larger increase than in either control. This suggests that there has been no longer-term degradation of fringing reefs in this location that may have resulted from silt run-off from the new road.

This study suggests that these fringing reefs are healthy, supporting a rich growth of a wide variety of coral species, and able to cope with acute disturbances such as cyclones, floods and coral-bleaching episodes with only short-term disruption.

Although there have been no consistent increases in *Sargassum* cover during the 12 years covered by these projects, there was a suggestion that turf algae had increased in the permanent transects over the past three years.

We suggest that permanent monitoring sites be established and maintained on a variety of fringing reefs to look at long-term changes in coral communities that may be due to man-induced changes to the coastal environment in an attempt to test the widely held perception that many fringing reefs are either degraded or suffering chronic siltation stress.

INTRODUCTION

The Cape Tribulation region in the North Queensland Wet Tropics (approximately 16°S) is characterised by steep, rainforest-covered hills falling directly to the sea from over 1000 metres. Rainfall is high, averaging almost 4000 millimetres per year, with annual totals of more than 6000 millimetres not unusual. Most rainfall occurs between January and April and during this period 24-hour falls sometimes exceed 500 millimetres. This region supports an extensive system of coastal fringing reefs fronting over 60% of the coastline between the Daintree and Bloomfield Rivers.

Between April and October south-east trade winds blow onshore, resuspending the shallow shelf sediments and holding a wide band of turbid water against the coast. Water visibility in these prevailing conditions ranges from less than 50 centimetres to about two metres. During the remainder of the year extended calm periods may occur and during these calm spells water visibility usually ranges between two and six metres.

There was considerable controversy during 1984 over the decision to construct a coast road through rainforest from Cape Tribulation to the Bloomfield River in this region (Craik and Dutton 1987). This unsealed road was completed in late 1984 and subsequent observations during the 1985 wet season showed that there was heavy local run-off of silt into coastal waters from the road (Bonham 1985). There was concern that this silt run-off could cause permanent damage to the fringing reef communities in the area. As a result the Great Barrier Reef Marine Park Authority initiated a multidisciplinary study in the area during 1985 to look at the effects of silt run-off on the fringing reefs of the region. This study included sections on reef structure and development (Partain and Hopley 1989), the sedimentary framework of the reefs (Johnson and Carter 1987), sedimentation rates (Hopley et al. 1990), hydrology (Parnell 1989) and coral settlement and recruitment (Fisk and Harriott 1989). As part of this study we conducted a monitoring program on the Cape Tribulation fringing reefs between 1985 and 1988 to look at the potential effect of silt run-off from road construction on coral populations (Ayling and Ayling 1991).

In view of the absence of any pre-impact data from the area, the main problem we faced was how to resolve the question of whether any damage detected was actually the result of silt run-off from the newly constructed road. As the road was constructed in late 1984 there had been a full wet season of run-off before this study started. It was decided that the Cape Tribulation coast could be divided into three locations, two of which could be used as controls for the third in relation to this problem (figure 1).

Location 1. Coastline from Noah Creek north past Cape Tribulation, adjacent to the long-established section of the road that runs from the Daintree River to two kilometres north of Cape Tribulation (control 1).

Location 2. Coastline from two kilometres north of Cape Tribulation to Cowie Point where the newly constructed road runs adjacent to the coast and where silt laden run-off from the road was observed during the 1985 wet season (impact site).

Location 3. Coastline from Cowie Point to just south of the Bloomfield River where the new road is diverted inland and direct run-off is unaffected by any road construction (control 2).

There are potential problems with this approach. It could be argued that silt run-off into the impact site may also be affecting the immediately adjacent control areas. Such potential impact on the so-called controls is made less likely by the blocking action of Cowie Point between locations 2 and 3, and of Emmagen Point and Cape Tribulation between locations 1 and 2, but is still a possibility given the relatively small distances between major silt run-off points in the impact location and the nearest control sites (figure 1). This could be solved by the choice of more remote control sites, but it was decided that fringing reefs from further afield would not be strictly comparable with the Cape Tribulation impact site. To the south the nearest reefs are between Yule Point and the Daintree River mouth some 30–50 kilometres from the impact site. These reefs are somewhat similar to the Cape Tribulation impact sites (Ayling and Ayling 1995a) but are likely to suffer confounding impact from the extensive coastal development in the area, and from the adjacent large river catchments of the Daintree, Mossman and Mowbray Rivers. To the north the nearest appropriate potential control reefs are off the Cedar Bay coast. These reefs are wider, deeper and more extensive than those of the Cape Tribulation region and were considered not comparable with the impact location sites (Ayling and Ayling 1995a). Regular surveys of these remote northern reefs would also have posed logistic and cost problems. After discussions with the Great Barrier Reef Marine Park Authority it was decided to use the adjacent controls and that the risk of potential control impact was not serious.

Fringing reefs in the Cape Tribulation area occur in two main situations: along steep rocky shores and on coastal sediment bodies such as river mouth bars and beach shoals (Johnson and Carter 1987). The reefs developed on sediment banks are wider and more extensive than those on rocky shores in the region, and generally extended to the sand at a depth of 4–6 metres below AHD. The reef flat on all these fringing reefs is approximately 0.8 metres higher than modern coral growth. This raised flat was formed during the late post-glacial period around 6000 years BP when sea levels were about one metre higher than they are at present (Johnson and Carter 1987). Preliminary surveys on these fringing reefs suggested that they were rich and diverse. Veron (1987) reported 141 species in 50 genera, and this study recorded three species not previously reported from the Great Barrier Reef. We found that many of the reefs supported hard coral cover approaching 50% (Ayling and Ayling 1985).

We found a marked depth stratification in the benthic communities on these fringing reefs (Ayling and Ayling 1991). There was a narrow band of dense *Sargassum* spp. in an approximately metre deep band immediately below low tide level. Below this the cover of *Sargassum* decreased rapidly, while the cover of hard corals increased. From 2–4 metres depth was a stratum dominated by *Acropora* spp. and *Montipora* spp. In deeper water these two groups decreased rapidly in abundance while a number of massive and large explanate coral species became more common. These deep-water corals included the following species and genera: *Pachyseris speciosa, Podabacia crustacea, Goniopora, Alveopora, Platygyra, Hydnophora exesa, Galaxea, Merulina ampliata, Lobophyllia, Symphyllia, Echinopora, Echinophyllia, Oxypora, Mycedium elephantotus, Pectinia lactuca* and a number of faviid species.

The rocky shore reefs were generally shallow, and only included the *Sargassum* band and sometimes a narrow section of coral-dominated reef community. The wider, sediment bank reefs all had a well-developed *Acropora/Montipora* band but only a few of them extended deep enough to have a significant deep-water coral stratum (Ayling and Ayling 1991).

The basic monitoring design we used to detect change that may have been caused by sediment run-off was based on sites of five permanently marked 20 metre line intersect transects set up in the *Acropora/Montipora* community. We established four sites in each of the three locations described above, and surveyed them annually between 1985 and 1988. Mean coral cover in 1985 was almost 50%, and there were no differences between the three locations and no evidence of hard coral death that may have been caused by silt run-off during the previous wet season. Coral cover decreased in all locations during a small cyclonic episode in early 1986 and decreased again in 1987 due to a moderate bleaching event. Over the next 12 months, in the absence of disturbance, coral cover increased in all locations back to the level recorded in 1985.

During a flight over the Cape Tribulation area in the 1985 wet season observations were made of the points where most sediment run-off from the road actually entered the marine system, either through creeks or down gullies. These points are marked on the map in figure 1. None of these five run-off points impinged on the major fringing reef areas but rather occurred along the rocky shore sections of the coast where the reefs were narrow and fell abruptly to the inner shelf sediments at a depth of only a few metres. The depth stratum that was surveyed at the other 12 sites was not present at these shallow sites. To see if silt impinging directly on the reefs had any affect on benthic communities we surveyed five haphazard 20 metre line transects in the deepest part of each of these sites (sites 13–17) at the same times that the permanent transect surveys were carried out. Coral cover at these run-off sites averaged around 25% (range <5–40%), and changed in a similar pattern to the permanent sites during the 1985–1988 project (Ayling and Ayling 1991).

Although the sedimentation study suggested that sedimentation rates were much higher on the fringing reefs in the new road impact location (Hopley et al. 1990), there was no evidence from our study that this had affected the benthic communities on these reefs compared to the control reefs.

There was some concern that any effect of increased sedimentation rates may not have been evident over the relatively short period of our study (Hopley et al. 1990), and the Great Barrier Reef Marine Park Authority decided to continue the Cape Tribulation benthic community surveys with a three-year project starting in 1994. The decision to continue this project was also influenced by concern that fringing reefs were under stress due to deteriorating inshore water quality and likely to suffer degradation.

The main question we sought to answer with this project extension was whether there was any medium-term degradation of the Cape Tribulation fringing reefs that may have been due either to continuing silt run-off from the road, or to ongoing chronic changes in near-shore water quality.

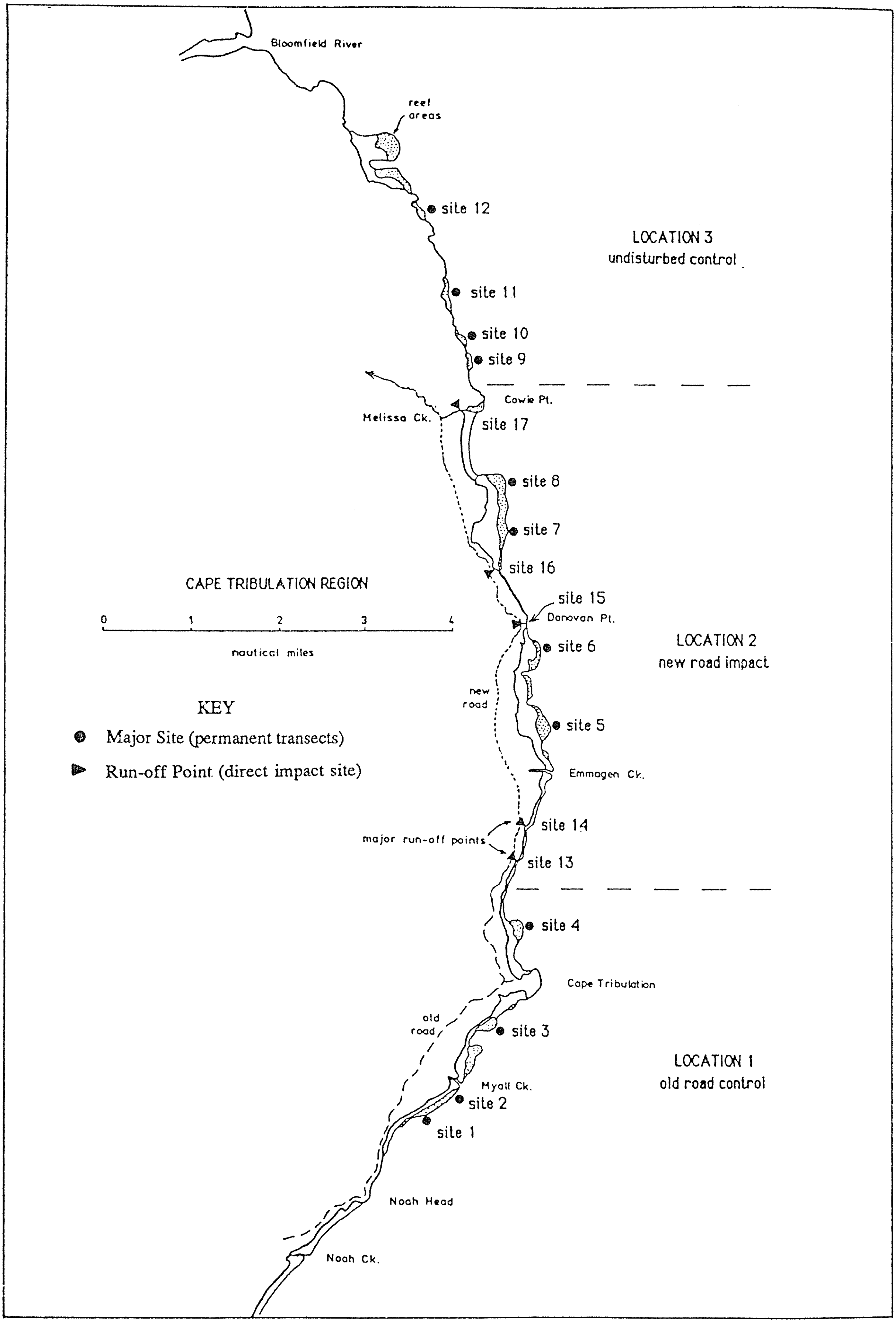


Figure 1. Map of the Cape Tribulation region showing the study locations and sites and the major points of sediment run-off

METHODS

Benthic Transects

At the start of the original project, five haphazardly positioned, permanent 20 metre line transects had been marked at each of the major sites (sites 1–12, figure 1), with reinforcing rod stakes every five metres. The transects were set up in a straight line so that missing stakes could be accurately replaced by measuring from remaining stakes. To survey coral cover a fiberglass tape was stretched tightly between the stakes and the intersection of this tape with each coral colony beneath it was recorded in centimetres (Ayling and Ayling 1991). Such intersect transects have been widely used to estimate the cover of benthic organisms (Loya 1976; Mapstone et al. 1989). At the time of the first re-survey for this extended project it was necessary to locate and re-establish the permanent transects using new marker stakes as the old markers had been in position for nine years and had suffered some deterioration. Underwater visibility during the first new survey in late 1994 was very good (between 5–10 metres) and the 12 sites of permanent 20 metre transects set up in 1985 were all relocated successfully. Of the 25 stakes marking the five transects at each site, between 10 and 22 were relocated enabling the re-marking of the transects to be as close as possible to the original transects. The survey techniques used to survey benthic organisms along the transects were the same as those used during the previous project.

The following organisms or groups of organisms were recorded along each transect:

- all hard corals to species level where possible or to genus or generic structural grouping otherwise (e.g. the genus *Acropora* was sub-divided into corymbose plate, staghorn, bottlebrush and tabulate growth forms);
- all soft corals to genus where possible;
- all sponges grouped together;
- all *Sargassum* species grouped together; and
- other macroalgae and turfing algae grouped together.

During 1985 the line transect surveys were carried out by A.M. Ayling and A.L. Ayling, but during all subsequent surveys all line transect surveys were made by A.M. Ayling. During each survey we noted the causes of any recent coral death if possible. Fungal disease and *Drupella* grazing were the most obvious causes but such incidences were not widespread — no crown-of-thorns starfish were seen on these reefs at any time.

Random transect surveys at the five run-off sites were also carried out for the first three years of this extended project. These sites were dropped from the 1997 survey because they were showing little change and were thought to provide very low power to detect change (Ayling and Ayling 1997a, b).

The permanent transects were relocated and first resurveyed in October 1994. The surveys were repeated in November 1995, November 1996 and December 1997.

Analysis

A repeated measures analysis of variance on the raw percentage cover data was used to look at changes over the four new surveys covered by this project, with a separate analysis carried out to check on changes that had occurred over all eight surveys made since 1985 (table 1). Kaly et al. (1994) looked at the different analytical techniques suitable for repeated surveys of permanent line transect data on fringing reefs and concluded that repeated measures analysis of raw data was the most powerful and appropriate method. For determining whether siltation impact had reduced cover at the impact location relative to the two controls, the term of most interest was the location by time interaction. However, given that we were also interested in documenting any overall trends that may have been due to more general degradation of the reefs, the time term was also of interest. Sphericity tests for homogeneity of the variances were done for these repeated measures analyses and Greenhouse-Geisser corrections to the degrees of freedom carried out when the data were non-homogeneous. This correction results in more conservative tests of effects involving time. The haphazard transects at the five run-off sites were analysed using a two factor analysis of variance (table 1). In this analysis the term 'site' was deemed to be fixed, rather than random as is usually the case, because we were interested in changes at those specific run-off sites and all the major run-off sites were included. Time was random, as each annual survey could have been made at any time during the four-month summer period. In this analysis, time was the factor of most interest as we were expecting a general decline in coral cover if sediment run-off was causing coral death.

Table 1. Analysis of variance models used for data analysis

A. Repeated measures analysis of permanent transects

df 1 applies to analysis of the four new surveys between 1994 and 1997
df 2 applies to analysis of all surveys between 1985 and 1997

Source of variation	**df 1**	**df 2**	**Denominator**
Between transects:			
Location	2	2	Site (location)
Site (location)	9	9	error (t)
Error (transects)	48	48	
Within transects:			
Time	3	7	error (t x t)
T x L	6	14	Site x time (location)
T x S(L)	27	63	error (t x t)
error (transects x time)	144	336	

B. Haphazard transects at run-off sites

Factor	**Source of variation**	**Fixed/Random**	**df**	**Denominator**
A	Site	F	4	A*B
B	Time	R	3	Residual
	A*B		12	Residual

RESULTS

Permanent Transects

There had been no significant differences in total coral cover among the three locations during any of the 1985–1988 surveys. However, at the time of the first new survey in 1994 there were significant differences among the locations (figure 2, separate analysis of 1994 data), although these differences were over-ridden by the significant site effect in the repeated measures analyses. Total coral cover had not changed in location 1, adjacent to the old road, but had increased significantly in both the other locations. This was primarily due to increases in the cover of *Acropora* spp. in location 3, and *Montipora* spp. in both locations 2 and 3. There were no changes in coral cover over the three surveys between 1994 and 1996, but a significant increase (mean of 6.5%) between 1996 and 1997 (figure 2, table 2). This was due mainly to a 32% increase in *Acropora* spp. cover in location 2 (figure 2), and gave a significant time effect for both total coral cover and *Acropora* spp. (table 2) and a significant time x location interaction for total hard coral. The other major groups of hard corals showed little change over the course of these studies (figure 2). There had been an increase in the cover of faviids in location 3 between 1988 and 1994 caused by an increase in the cover of explanate *Echinopora* species. This lead to a significant time effect and a significant time x location interaction in the eight-year analyses (table 3). Following this there was a slight but significant fall in faviid cover over the time of the new project (table 2). Significant location differences in the cover of pocilloporids (location 1 high, figure 2) were maintained through all surveys.

Table 2. Repeated measures analysis of variance of permanent transect data: 1994–1997
NS = not significant; * 0.05>p>0.01; ** = 0.01>p>0.001; *** = p<0.001

Family/Group	Location	Site (L)	Time	L * T	S * T
Total coral	NS	***	***	*	**
Pocilloporidae	NS	***	NS	NS	NS
Acropora spp.	NS	***	***	NS	NS
Montipora spp.	NS	***	NS	NS	NS
Poritidae	NS	***	NS	NS	NS
Faviidae	*	NS	*	NS	**
Turbinaria spp.	NS	***	NS	NS	NS
Deep water corals	NS	***	NS	NS	NS
Soft corals	NS	***	NS	NS	NS
Sargassum spp.	NS	NS	**	NS	NS
Algal turf	NS	***	***	***	***

Table 3. Repeated measures analysis of variance of permanent transect data: 1985–1997
NS = not significant; * 0.05>p>0.01; ** = 0.01>p>0.001; *** = p<0.001

Family/Group	Location	Site (L)	Time	L * T	S * T
Total Coral	NS	***	***	***	***
Pocilloporidae	*	**	***	NS	NS
Acropora spp.	NS	***	***	**	NS
Montipora spp.	NS	***	***	NS	**
Poritidae	NS	***	NS	NS	NS
Faviidae	NS	NS	*	**	NS
Turbinaria spp.	NS	***	NS	NS	NS
Deep Water Corals	NS	***	**	***	NS
Soft Corals	NS	***	NS	NS	NS
Sargassum spp.	NS	NS	*	**	NS

Cover of the large brown algae *Sargassum* spp. was relatively low in the depth stratum where the permanent transects were located (1–3% cover), and appeared to be somewhat variable from year to year (figure 2). Although there were no significant location or site differences (table 2, 3), overall cover was significantly higher in 1987, 1988 and 1997 compared with the other five surveys. There was no evidence that the cover of *Sargassum* had increased consistently over the time of these two projects. We recorded the cover of algal turf during this new project and although there were no location differences there was a significant increase in cover over the three years covered by these surveys (table 2). Grand mean cover apparently increased from 7.5% to over 18% during this time, although most of this increase was evident in location 1, giving a significant time x location interaction (figure 3).

Species composition of the benthic communities on these fringing reefs had been similar at most sites during the previous project (table 5, figure 4) with explanate and whorl forming *Montipora* spp. dominating with a grand mean cover of almost 25%. A number of species of corymbose plate and staghorn *Acropora* spp. were also important with a grand mean cover of 12.5%. These two groups between them accounted for 75–85% of all hard coral cover at most sites (figure 4). Other groups each accounted for less than 2% cover with the exception of the deep-water corals, a grouping of over 20 species that covered a mean of 7.4%. These community patterns were very similar in 1997, except that the cover of *Montipora* spp. (30%) and *Acropora* spp. (19%) had increased in all location 2 and 3 sites, as had the cover of deep-water corals (figure 4, table 5).

The only exception to this general pattern of species composition was site 5 in location 2 just north of the Emmagen Creek mouth. This site had lower total coral cover than at any of the other permanent sites (table 5). At this site *Montipora* and *Acropora* spp. each accounted for less than 2% cover while *Turbinaria* spp. were dominant with a combined cover of over 11% (figure 5). The deep-water corals were also important (>11%), as were soft corals with a cover twice that of any other site (30%). This site was particularly silty and it is possible that the different composition of the coral community reflects the proximity of Emmagen Creek.

Within the locations, site 1 was anomalous at location 1 in that the cover of hard coral decreased significantly over the 12 years covered by these two studies (table 5). Site 5 was very different in community composition from all other sites as has already been mentioned, but also had much lower overall coral cover than the other three sites in location 2 (table 5). As a result of these few anomalous sites there were significant site differences in most species groups (table 2, 3). Coral cover increases at some of the sites over the 12 years covered by these two projects have been quite spectacular, with site 8 in particular recording a 95% increase in hard coral cover.

Soft corals were not abundant at most sites with mean cover ranging from 5–10%. The dominant species was an encrusting soft coral at all sites except site 5 when the tufty low *Efflatenaria* sp. covered over 25% of the substratum; a far higher soft coral cover than at any of the other sites. These patterns remained consistent over the course of the study (table 5).

Run-off Sites

The run-off sites, surveyed using random transects in a patchy environment, show more variation in benthic community structure than the permanent transects (figure 6). There were consistent significant differences in hard coral cover among the sites (table 4), with very low coral cover at site 13, high coral cover at site 17 (over 60% in 1996), and similar, intermediate levels at the other three sites. There were also significant, but inverse, differences in *Sargassum* cover among these sites. Two sites were *Sargassum* dominated, two had moderate *Sargassum* cover, while the high coral cover site had very low *Sargassum* cover. Turf algae covered a significantly greater area at sites 13–15 than in the other two sites (figure 7).

Table 4. Analysis of variance results for run-off sites transect data . NS = not significant; * 0.05>p>0.01; ** = 0.01>p>0.001; *** = p<0.001

Family/Group	Site	Time	S x T
Total Coral	***	*	**
Pocilloporidae	*	NS	NS
Acropora spp.	***	NS	NS
Montipora spp.	***	NS	*
Poritidae	***	**	NS
Faviidae	***	NS	NS
Turbinaria spp.	***	***	***
Deep Water Corals	**	**	***
Soft Corals	*	*	NS
Sargassum spp.	***	***	***
Turf algae	**	**	NS

Table 5. Species composition of the coral community at each site at the beginning and end of these projects. Coral cover shown as mean percentage cover from five 20 metre permanent transects. Standard deviations and standard errors are shown in appendix 2.

Sample date	1985	1997	1985	1997	1985	1997	1985	1997	1985	1997
LOCATION 1	**Site 1**		**Site 2**		**Site 3**		**Site 4**		**Grand Mean**	
Total Hard Coral	40.4	29.6	53.4	60.1	62.6	63.2	56.0	59.4	**53.1**	**53.1**
Pocilloporidae	2.8	2.7	1.2	1.6	3.2	4.8	4.2	1.9	**2.9**	**2.8**
Acropora spp.	3.8	3.8	21.1	24.9	13.2	10.5	25.4	30.7	**15.9**	**17.5**
Montipora spp.	25.4	19.2	19.3	23.9	37.4	38.4	24.0	24.9	**26.5**	**26.6**
Poritidae	0.8	0.2	2.3	2.2	0.1	0.8	0.1	0.2	**0.8**	**0.9**
Faviidae	4.6	1.7	0.9	1.9	2.1	2.8	0.5	0.2	**2.0**	**1.6**
Turbinaria spp.	0.1	0.1	0.4	0.8	0.1	-	-	0.2	**0.1**	**0.3**
Deep Water Corals	2.0	0.9	6.7	5.5	7.7	8.6	1.6	1.4	**4.5**	**4.1**
Total Soft Corals	14.9	10.6	6.1	5.5	4.4	2.5	1.9	3.9	**6.8**	**5.6**
Total Sponges	-	0.2	-	-	0.1	-	0.4	-	**0.1**	**0.1**
LOCATION 2	**Site 5**		**Site 6**		**Site 7**		**Site 8**		**Grand Mean**	
Total Hard Coral	33.2	40.2	53.2	67.7	58.6	82.9	39.4	76.8	**46.1**	**66.9**
Pocilloporidae	2.0	1.6	0.4	1.0	1.8	1.2	2.5	1.5	**1.7**	**1.3**
Acropora spp.	2.0	5.3	9.5	15.7	19.3	29.8	11.2	24.8	**10.5**	**18.9**
Montipora spp.	1.5	4.5	19.2	23.3	30.8	46.1	21.8	45.8	**18.3**	**29.9**
Poritidae	1.3	2.8	2.3	1.5	0.1	0.4	0.3	0.6	**1.0**	**1.3**
Faviidae	1.9	3.1	3.7	3.1	1.3	0.5	0.2	0.4	**1.8**	**1.8**
Turbinaria spp.	11.3	9.1	-	0.9	4.0	1.1	0.2	0.1	**3.9**	**2.8**
Deep Water Corals	11.4	14.2	18.6	24.9	1.8	4.1	2.7	3.5	**8.6**	**11.7**
Total Soft Corals	29.8	24.9	3.5	0.8	3.1	1.9	0.1	2.9	**9.1**	**7.6**
Total Sponges	3.7	2.2	-	-	1.1	0.3	1.6	0.4	**1.6**	**0.7**
LOCATION 3	**Site 9**		**Site 10**		**Site 11**		**Site 12**		**Grand Mean**	
Total Hard Coral	54.2	64.6	51.9	76.3	47.3	65.7	59.1	77.3	**53.1**	**71.0**
Pocilloporidae	2.0	2.14	1.4	0.9	1.8	2.1	1.0	0.9	**1.5**	**1.5**
Acropora spp.	14.3	22.2	9.9	19.2	12.7	20.2	7.5	17.8	**11.1**	**19.8**
Montipora spp.	27.7	30.2	23.8	31.9	17.1	25.7	45.0	50.0	**28.4**	**34.5**
Poritidae	0.6	-	1.4	2.1	1.1	1.0	0.2	0.3	**0.8**	**0.9**
Faviidae	4.3	6.4	1.8	3.8	4.8	3.5	2.0	3.5	**3.2**	**4.3**
Turbinaria spp.	0.9	-	1.3	2.4	0.2	0.4	0.2	-	**0.7**	**0.7**
Deep Water Corals	8.2	9.0	12.7	19.2	10.6	14.0	4.6	8.2	**9.0**	**12.6**
Total Soft Corals	11.7	10.3	8.9	2.9	7.5	3.0	11.6	7.9	**9.9**	**6.0**
Total Sponges	-	0.5	-	-	0.2	0.3	0.1	-	**0.1**	**0.2**

There had been a slight but significant increase in total hard coral cover at these run-off sites over the last few surveys (table 4). This was driven mainly by an increase in the cover of *Turbinaria* spp. at site 17, although there had also been an increase in poritid coral cover over the last few surveys at several of the sites (figure 6). Soft coral cover was very low at these run-off sites (figure 6). As was the case in the permanent transect sites, the cover of *Sargassum* spp. appeared to fluctuate, with the years 1987, 1988 and 1996 being higher than average and 1985, 1994 and 1995 being lower than average (figure 6). Turf algae cover also fluctuated significantly, being higher in 1995 than in 1994 or 1996 (cover of turf algae was only recorded during these three surveys — figure 7).

Coral community composition at the run-off sites was different from that in the permanent transect sites, with higher representation of poritids, faviids and *Turbinaria* spp. and much lower cover of *Acropora* spp (figure 8). This composition changed between 1985 and 1996, mainly due to an increase in *Turbinaria* spp. cover and a corresponding decrease in *Montipora* cover at site 17 (figure 9).

Site 17, on the south side of Cowie Point was directly off the mouth of Melissa Creek and was completely inundated with sediment-laden water when observed from the air in February 1985. This site had a rich coral community with similar cover to the 12 main sites, but was unusual (as was site 5) in that there was a very high cover of *Turbinaria* spp. (over 35% in 1996) and massive *Porites* (6%). As in the case of site 5, it is possible that normal high silt levels at this site due to the proximity of Melissa Creek are responsible for the unusual species composition of the coral community.

There were no significant decreases in the cover of any species or species group at any of the direct run-off sites during the course of these projects (figure 6).

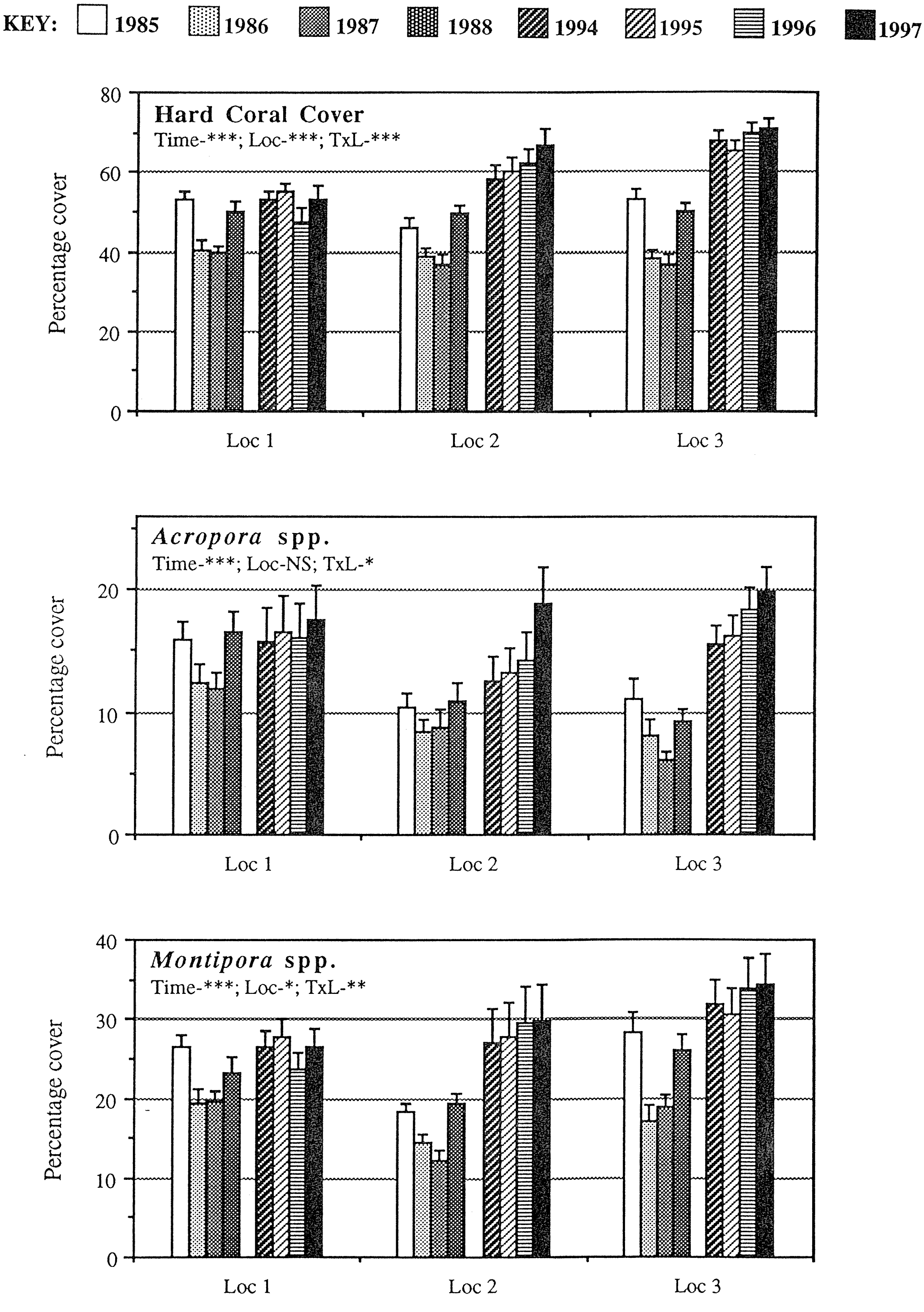
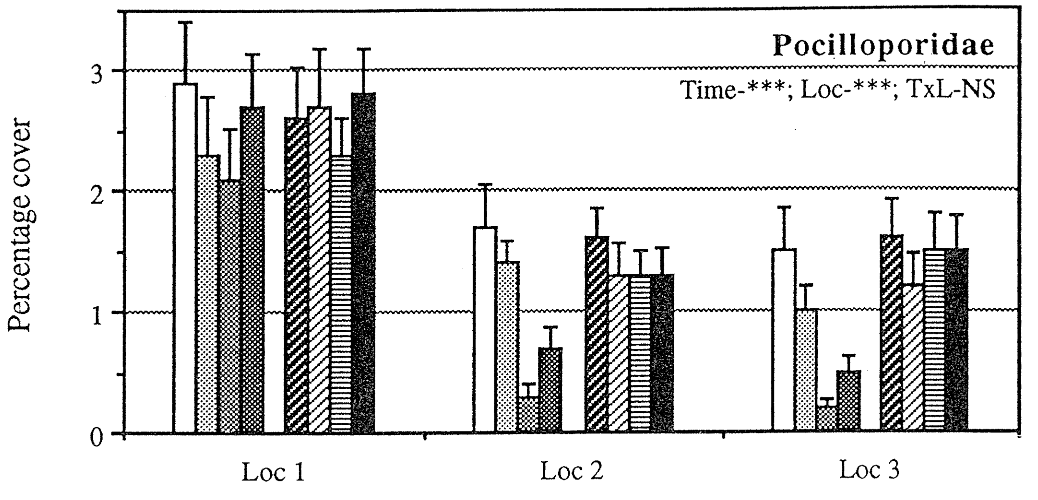
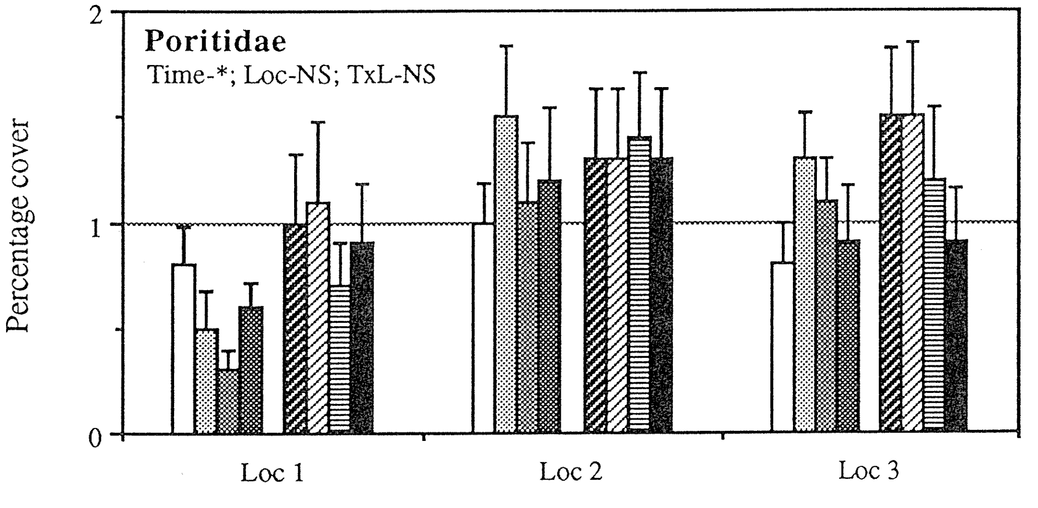


Figure 2. Benthic community changes at the major sites 1985–1997. Graphs show mean percentage cover on the vertical axis for all sites in each location. Error bars are standard errors. No surveys were made between 1989 and 1993. Significance of tests for time, location and the TxL interaction are shown.

Figure 2 cont.

KEY: 1985 1986 1987 1988 1994 1995 1996 1997





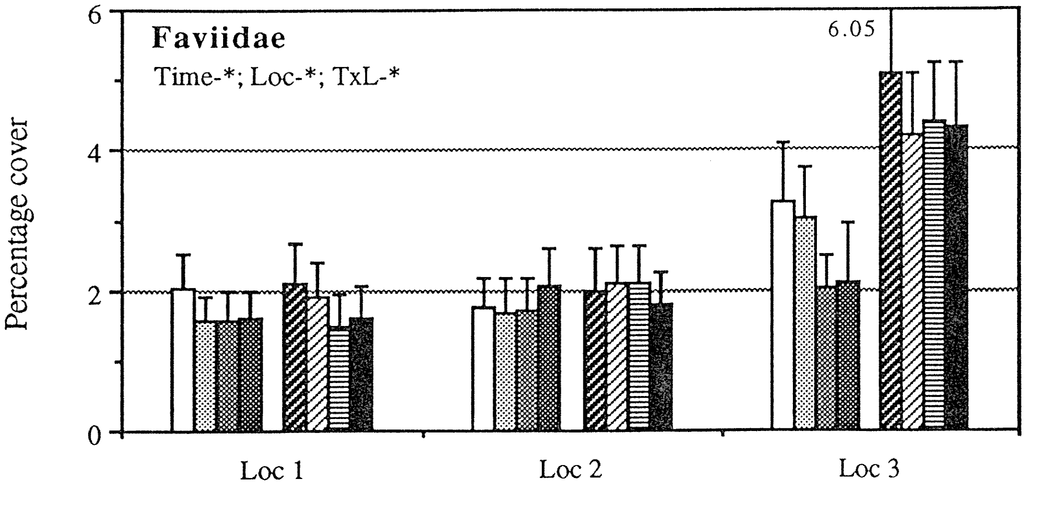
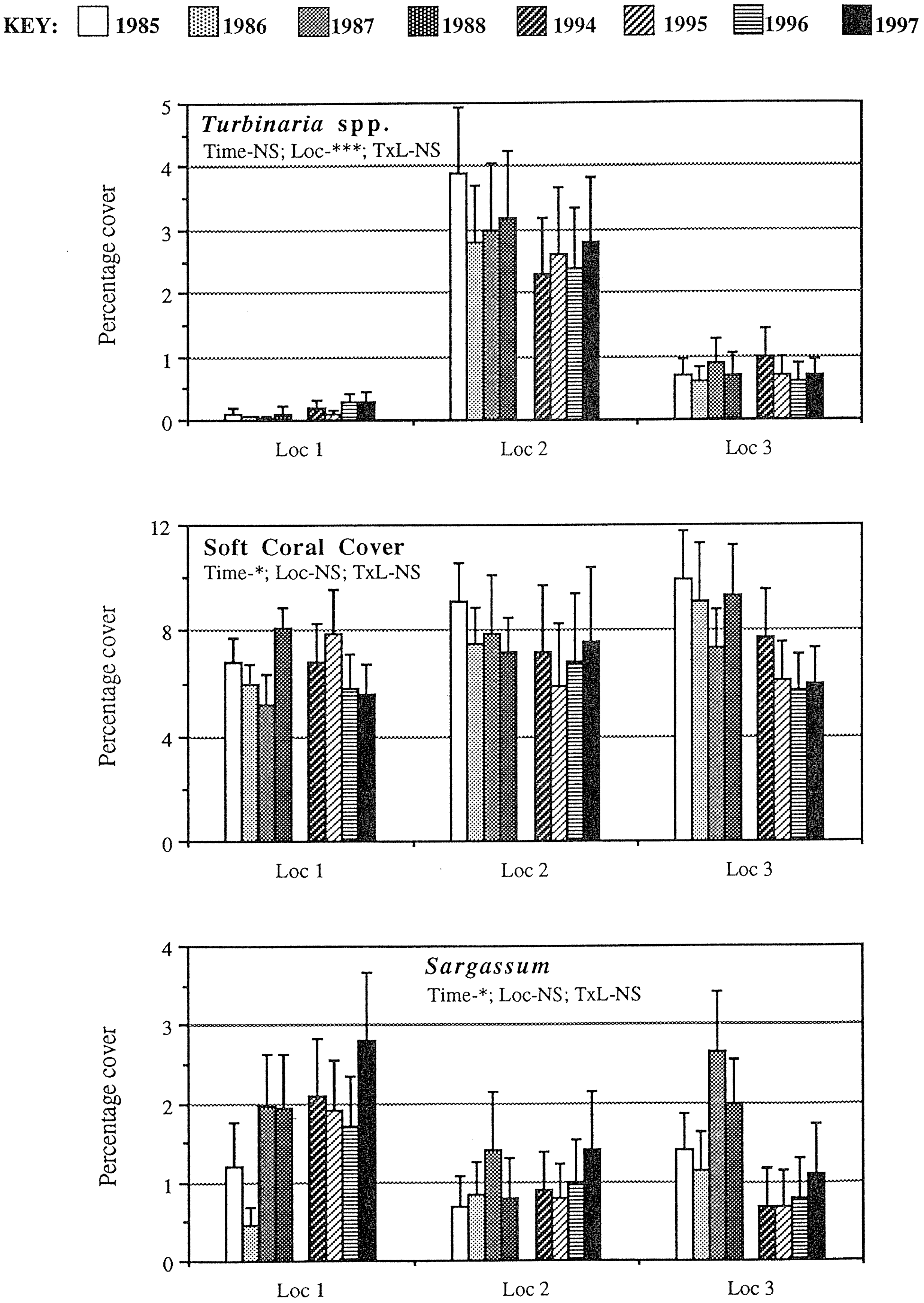


Figure 2 cont.



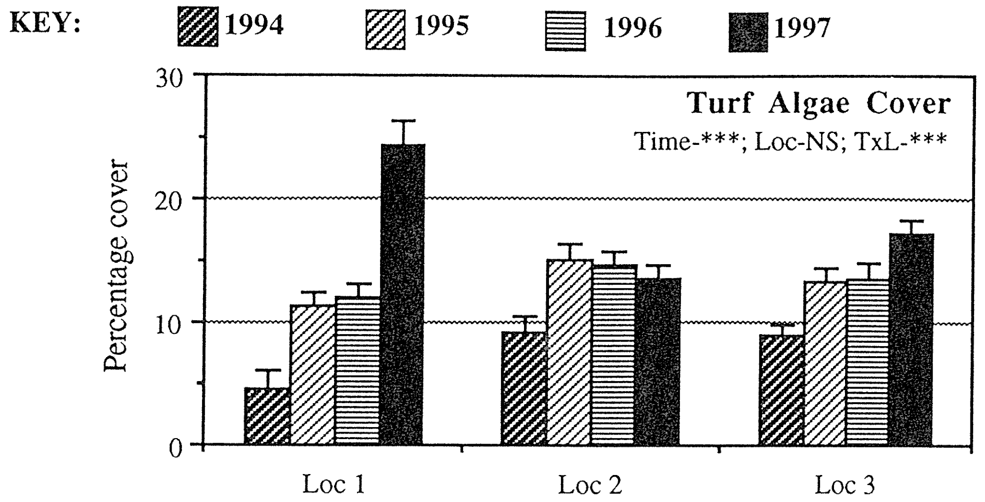


Figure 3. Changes in turf algae cover in the major sites. Mean percentage cover from the four sites of five permanent transects at each location is shown for the years 1994–1997.

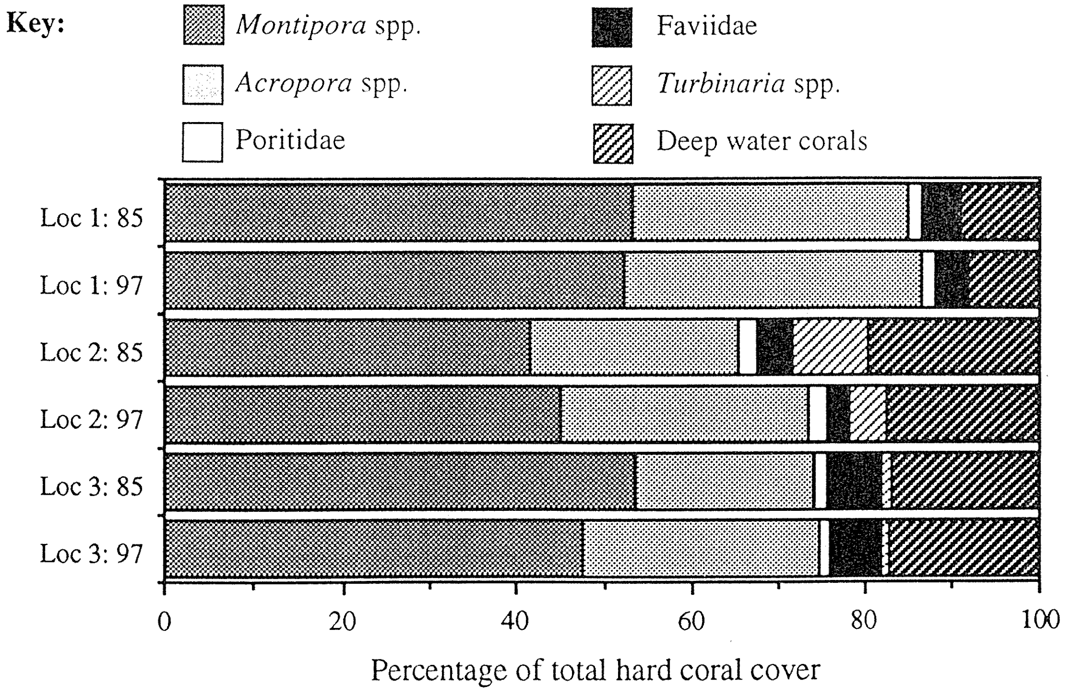


Figure 4. Coral community composition: 1985 and 1997. Percentage mean community representation of the major coral groups is shown from the four sites of permanent transects at each location at the start of the project in 1985 and during the last survey in 1997.

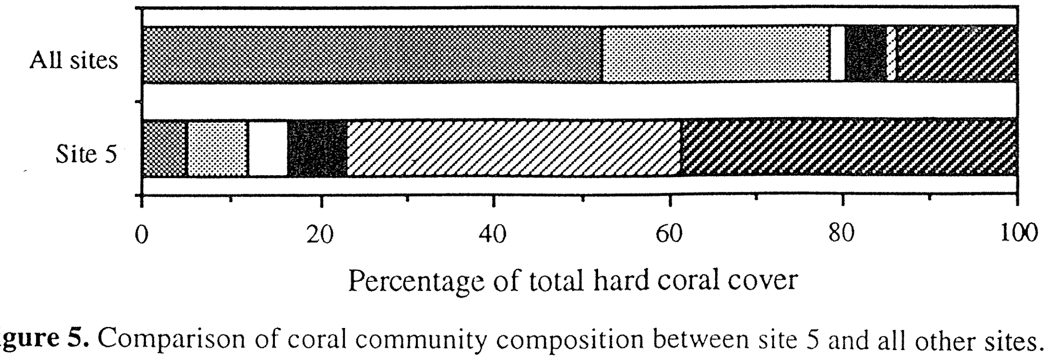


Figure 5. Comparison of coral community composition between site 5 and all other sites. Percentage mean community representation of the major coral groups is shown for site 5 along with the grand mean for all other sites from the 1985 survey. See figure 4 for key.

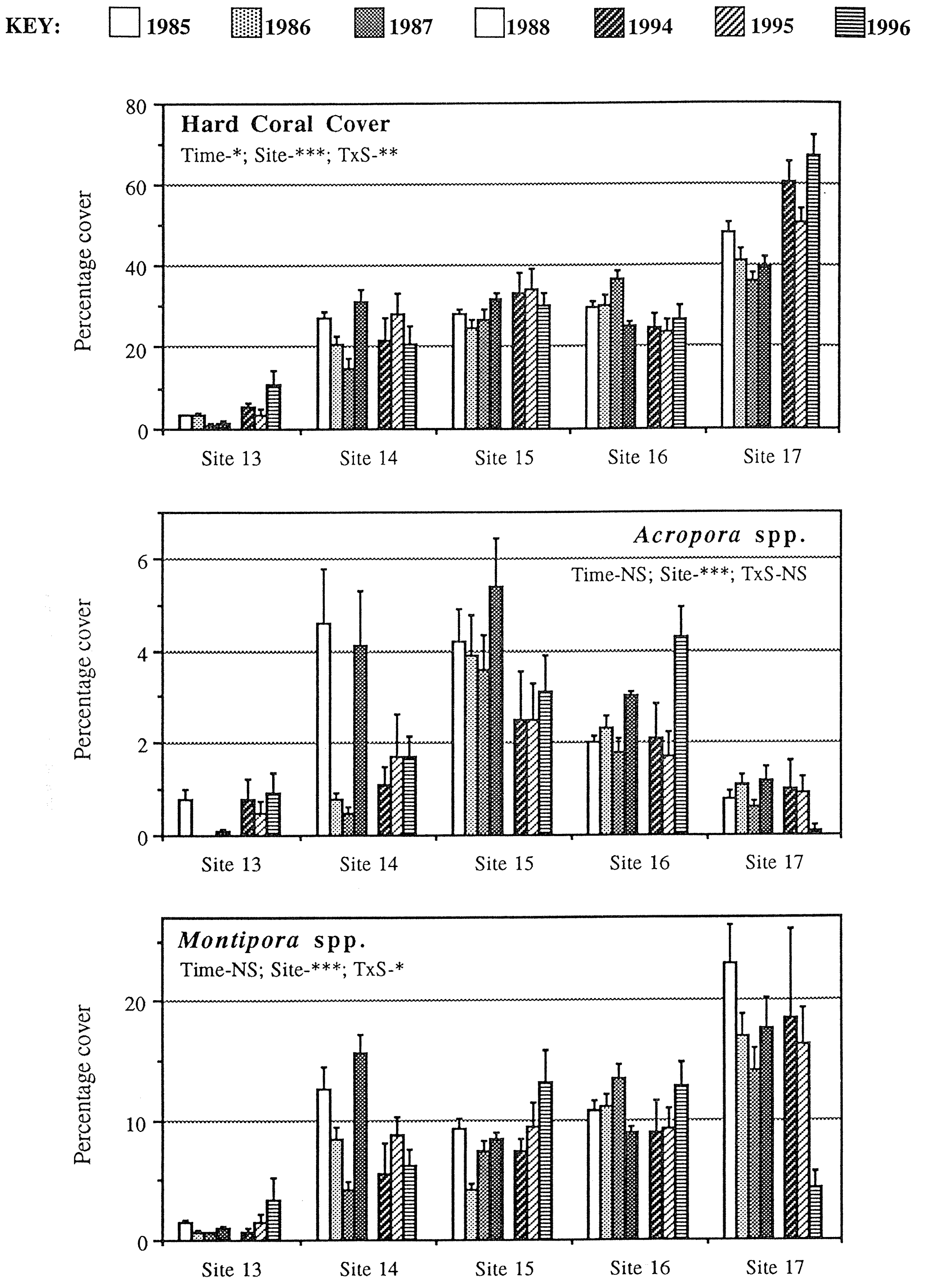


Figure 6. Benthic community changes at the run-off sites 1985–1996. Graphs show mean percentage cover on the vertical axis for all sites in each location. Error bars are standard errors. No surveys were made between 1989 and 1993. Significance of tests for time, site and the TxS interaction are shown.

Figure 6 cont.

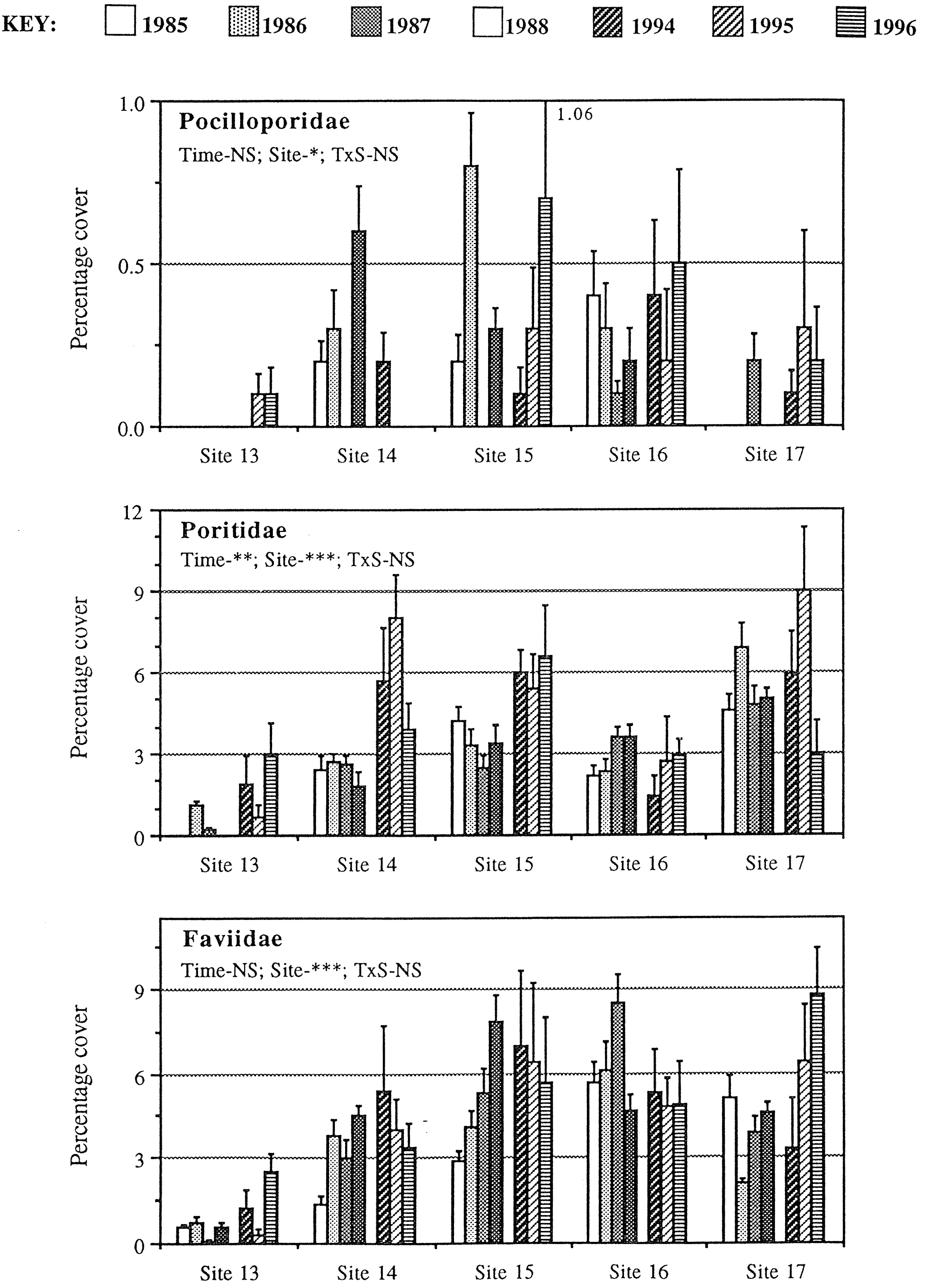
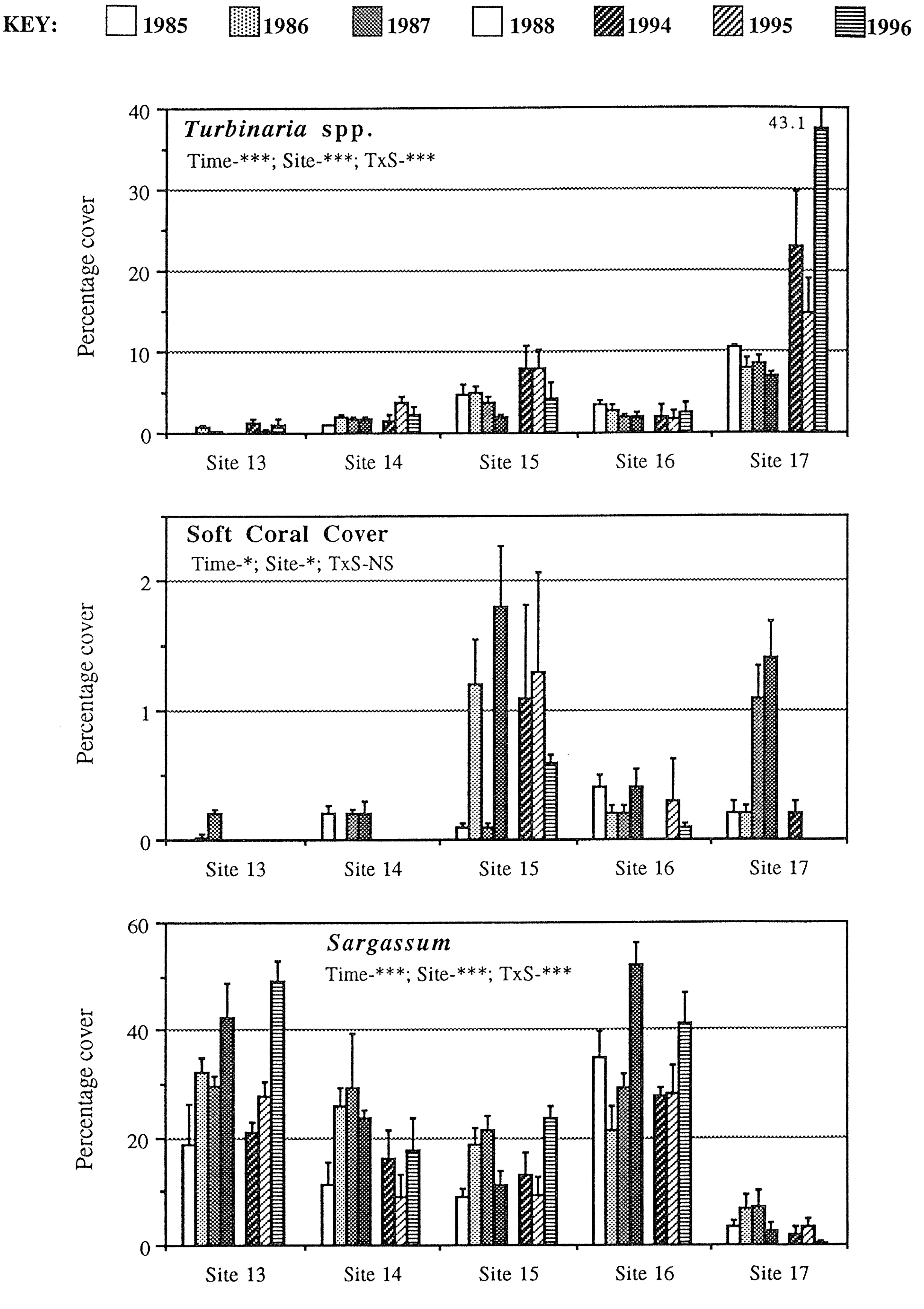


Figure 6 cont.



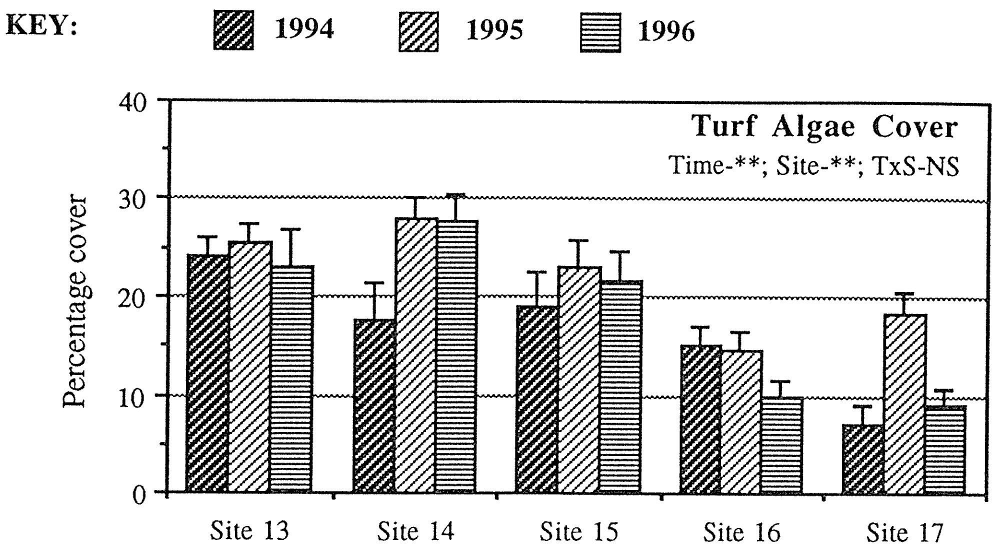


Figure 7. Changes in turf algae cover at the run-off sites. Mean percentage cover from the five sites of five random transects is shown for the years 1994–1996.

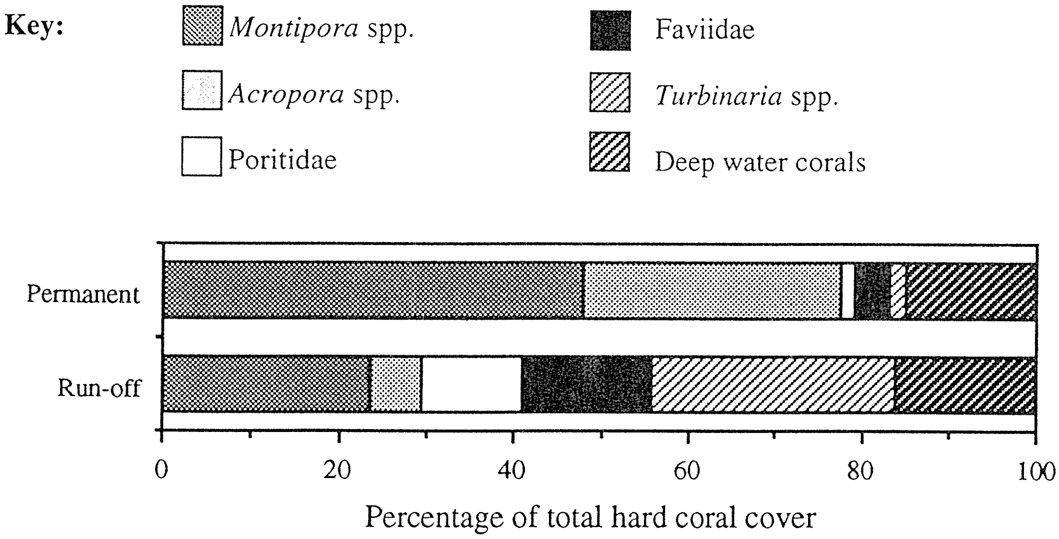


Figure 8. Comparison of coral community composition between the permanent transect sites and the run-off sites. Percentage mean community representation of the major coral groups is shown for all permanent transect sites and all run-off sites from the 1996 survey.

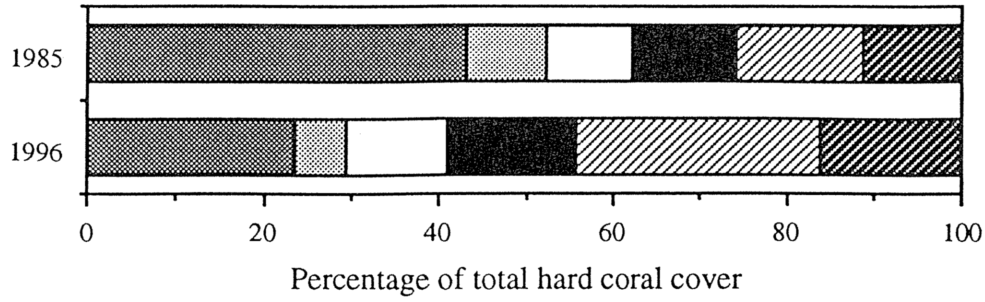


Figure 9. Comparison of coral community composition for the run-off sites: 1985 and 1996. Percentage mean community representation of the major coral groups is shown for all run-off sites from the 1985 and the 1996 survey. See figure 8 for key.

DISCUSSION

In our report on the first four annual surveys of the Cape Tribulation fringing reefs we argued that there was no evidence that there had been any effect on the coral communities that may have been due to silt run-off from the new road (Ayling and Ayling 1991). The only changes to the fringing reef communities during this time resulted from obvious natural disturbances. A small cyclone that crossed the coast near Cooktown in April 1986 gave rise to winds between 40–50 knots in this region and caused extensive coral breakage on the study reefs. This resulted in a 25% overall reduction in coral cover, mainly of the dominant *Acropora/Montipora* species, between 1985 and 1986. In early 1987 a coral bleaching episode bleached a mean of around 33% of the corals on these fringing reefs and resulted in some coral death. There was an average 4% decrease in overall coral cover between 1986 and 1987, probably as a result of this bleaching event. Both these disturbances affected all locations equally and coral cover remained similar at all locations. During 1988 there were no disturbances and coral cover increased markedly at all locations back to the levels of around 50% cover that were recorded in 1985. This previous study showed that all these fringing reefs exhibited a combination of high coral cover, high coral diversity, high coral growth rates and good recovery following disturbance. We suggested that this indicated that the Cape Tribulation reefs were in a healthy state and not suffering from chronic siltation stress as had been suggested by Hopley et al. (1990).

At the time of the first of the new round of surveys in 1994 coral cover in the southern location 1 was the same as that recorded in 1988, whereas cover in the other two locations was up by about 25% on 1988 levels. Although we have no record of changes during the six-year gap between these surveys, it seems clear that there had been significant disturbances during this time. Tropical cyclone Joy affected reefs in the Cairns area in December 1990 with strong south-east winds and coral damage recorded on offshore reefs as far north as Cooktown (A.M. Ayling, unpublished data). This episode would have affected the Cape Tribulation reefs at least as severely as the 1986 cyclonic episode. Given the level of damage recorded on Low Isles, Undine and Mackay Reefs, coral damage was probably especially severe at the three sites of location 1 south of Cape Tribulation itself. It seems likely that the reefs of location 1 had been so badly damaged by this episode that they had only recovered to 1988 coral cover levels by the time of the 1994 survey four years later. At the time of the 1994 survey there was also evidence in shallow water at many of the sites that there had been a low level of wave damage to corals during the previous half year, and some evidence of a bleaching episode over the past year.

Over the three years covered by this new project coral cover remained stable in location 1 (but with a level 13% below the other years in 1996), increased by about 15% at location 2, and stayed the same in location 3. There were several other disturbances during this time that may have negated or reduced any increase caused by normal coral growth. At the time of the 1995 survey there was evidence at most sites of recently repaired wave damage to the corals, probably caused by several strong wind episodes (winds over 30 knots) that occurred during the June to August period. At the time of the survey in November 1995 the damaged corals had already repaired themselves and appeared to be in good condition.

In March 1996 this region received flood rains, with 24 hour falls of between 500–1000 millimetres and four-day totals of around 1500 millimetres. This gave rise to huge fresh water run-off from local catchments, and the flood plume from the Daintree River caused extensive coral death down to about four metres below AHD around the south face of Snapper Island, immediately to the south of the Cape Tribulation region (Ayling and Ayling 1997a, b). There are a number of moderate sized creeks that may impinge on the Cape Tribulation study area including Myall Creek, Emmagen Creek, Tachalbadga Creek, Donovan Creek and Melissa Creek. The Daintree flood plume flowed north from the mouth, and we may assume northward movement of the much smaller plumes from the Cape Tribulation catchments given the south-east winds that prevailed at the time. If that was the case the sites at most risk would be sites 1–

3, site 5 and site 6. Any plume from Melissa Creek would probably be deflected off the coast by Cowie Point and hence away from sites 9 and 10. At the time of the 1996 survey, nine months after this event, we noted many dead coral colonies at sites 1–3 and site 5. These corals had been dead for some time and may have resulted from freshwater inundation during the March flood event. Coral cover decreased by between 5% and 32% at these four sites between 1995 and 1996 (mean 16%) and this was responsible for the reduced coral cover recorded in location 1 in 1996. There was also evidence of recent wave damage at most sites in 1996, probably from a strong south-east wind episode in October.

This recent study confirmed the findings from the previous study, suggesting that these reefs are able to maintain rich coral communities despite being subject to regular disturbance from a variety of sources. At the time of the last survey in December 1997 overall coral cover was almost 64% in the major study sites, 30% higher than the mean recorded in 1985 at the start of this project. Over the intervening 12 years these reefs have been subject to at least two close cyclone approaches, a moderate bleaching event, a severe flood event, and a number of strong south-east wind episodes.

As mentioned in the methods section there were some other sources of coral death observed in these communities. During the 1985–1988 project we regularly found small dead patches on explanate *Montipora* colonies that were apparently caused by a fungal or bacterial infection, but this was not a significant source of coral death and was rarely observed during the present series of surveys. *Drupella* grazing was another minor source of coral death, but the grazed patches were always small and involved only one to three *Drupella* individuals. The voracious coral predator *Acanthaster planci* has never been observed on these reefs. These sources of coral mortality are insignificant compared to the physical disturbances discussed previously.

As has been pointed, out these surveys have been confined to the shallow *Montipora/Acropora* coral stratum that was present at all the major sites. At the time of the 1994 and 1997 surveys clear water conditions let us check on the condition of corals in the deep-water coral stratum from 4–6 metres below AHD that was only present at about five of the sites. This deeper stratum is dominated by more massive corals of a number of genera, including *Galaxea*, *Podabacia*, *Hydnophora*, *Favia*, *Platygyra* and *Pectinia*. Corals in this depth strata also looked healthy in the four sites where they were checked (sites 2, 6, 8, 12).

Although most of the run-off sites are not positioned in the coral-dominated depth strata they also either maintained or increased coral cover over the course of this project. Grand mean coral cover from the five sites was 27% in 1985 and 31% in 1996, a 15% overall increase. At site 17, the one site that was located in the coral-dominated community, coral cover increased from 48% to 67%, a 40% increase. As these were the sites where most sediment from the new road entered the near-shore reef community, it might be expected that any long-term detrimental effect caused by silt run-off would be first felt here.

The composition of the coral communities at the run-off sites was different from that at most of the permanent transect sites. Poritids, faviids and *Turbinaria* spp. were more strongly represented at the run-off sites than in the permanent sites (with the exception of the aberrant site 5). Although the run-off sites were in shallower water than the permanent sites this was not a depth-related difference. These three coral groups only made up 13% of total hard coral cover in the similar 0–2 metre depth stratum at the permanent transect sites (Ayling and Ayling 1991), compared to 54% in the combined run-off sites in 1996. The coral community composition at site 5 was similar to that in the run-off sites, with a larger contribution to coral cover by these three groups (almost 50%) compared to the other permanent sites. We have previously suggested that this was due to the presence of fine silt at site 5 resulting from the proximity of the Emmagen Creek mouth. The same feature was a characteristic of site 17, at the mouth of Melissa Creek — the major contributor to the coral cover of the run-off sites.

There has been some concern that increased nutrient levels in the near-shore water mass may be leading to an increase in the cover of algae and a corresponding reduction in coral cover. Although the cover of *Sargassum* has fluctuated significantly over the 12 years of this study, both in the permanent transect sites and in the run-off sites, there has been no trend toward increasing cover. The cover of turfing algae has only been recorded since the 1994 survey. There has been a significant increase in the cover of algal turf in the permanent transect sites since that time, primarily in location 1. It is possible that this relates to the timing of the surveys. Algal turf flourishes during summer and decreases during winter. The 1994 survey, when cover was lowest, was made in early October, the 1995 and 1996 surveys in November and the 1997 survey in December. It is possible that the turf cover had not increased to its full extent at the time of the October survey. Turf usually covers most available space, including some living coral, by mid-summer. It is too early to say whether this increase represents a real, nutrient-driven change or is just a function of the timing of the surveys as suggested.

Hopley et al. (1990) found that siltation rates in the new road location during the previous study were six times higher than in the northern control location 3, and over three times higher than in the old road location 1. They found that the mud component was similar at all sites in all three locations but the sand component was significantly higher in the new road location. Correlation of siltation rates with weather factors suggested that sand siltation rates were related to maximum wind speed; extensive resuspension of sand only occurred at wind speeds over 20 knots. They considered that silt run-off from the new road had increased the amount of sand lying on the reefs of the new road location and it was resuspension of this that resulted in the six-times difference in siltation rates. Siltation rates were high in all locations (mean of 110 mg sediment per square centimetre per day) and they suggested that the reefs were suffering siltation stress and would be unable to recover from any future disturbances. In a related study Partain and Hopley (1989) reported that these reefs ceased prograding about 5000 years ago and claimed that this was because sedimentation levels had passed beyond the threshold that allowed for active reef growth.

At the conclusion of our latest project the new road had been in position for 13 years. We found no evidence that the apparent increase in sediment available in location 2 had any effect on the fringing reefs in this area. Coral cover in location 2 had increased by 45% since 1985, a higher increase than in the other two locations. Coral cover in site 7, in location 2, was 82.9% in 1997, higher than at any other site and an increase of 95% over 1985 levels. It is hard to escape the conclusion that these reefs are healthy and vigorous. They have been subjected to a number of natural impacts over the past 13 years and have continued to show increases in coral cover.

In conclusion we would reiterate that our studies, now covering a moderate 12-year time period, indicate that the Cape Tribulation fringing reefs are apparently healthy with a high cover of a wide variety of corals, high growth rates and the ability to recover rapidly from major disturbances.

The Cape Tribulation fringing reefs are closely comparable with those of most other coastal regions of the Great Barrier Reef, with the exception of those in the area of big tides between Mackay and Port Clinton where maximum tide range is more than five metres (table 6). Coral cover is usually very high on the reef slope of fringing reefs with the exception of reefs within the big-tide area mentioned above. Grand mean coral cover from over 100 sites between Cape Flattery and Keppel Islands was over 62% (excluding the big-tide sites), very similar to that recorded on the Cape Tribulation reefs.

Cape Tribulation fringing reefs have a similar community composition to those studied in other regions. Coral cover on fringing reefs in other areas is also usually dominated by acroporids on the upper slope (60–80% of total coral cover), as it was at Cape Tribulation. In most regions explanate *Montipora* spp. are usually more important than *Acropora* spp., accounting for between 50–90% of acroporid cover. In deeper water (more than five metres below AHD), or in particularly silty sites, faviids and *Turbinaria* spp. may also be abundant, sometimes covering up to 20% of the substratum (e.g. Blind Rock in Shoalwater Bay; see Ayling et al. 1998). This is similar to the community composition at the silty Cape Tribulation sites (sites 5 and 17).

Table 6. Summary of hard coral cover on Great Barrier Reef fringing reefs. Figures show grand mean percentage cover from groups of 20 metre line transects. [1] Ayling et al. 1996; [2] This report; [3] Ayling and Ayling 1995a; [4] Ayling and Ayling 1998; [5] Kaly et al. 1993; [6] Ayling and Ayling 1995b; [7] Ayling et al. 1998; [8] Van Woesik 1992. na = not available.

Region	Date	Latitude °S	No. Sites	Hard coral cover mean	Hard coral cover sd
Cape Flattery[1]	Feb 1996	14.9	5	**46.2**	12.2
Cape Tribulation[2]	Dec 1997	16.0	12	**63.7**	15.2
Cairns Section Nth[3]	Jan 1995	16.5	34	**81.0**	7.5
Magnetic Island[4]	Feb 1998	19.2	24	**55.6**	15.8
Middle Reef[5]	Aug 1993	19.2	5	**74.6**	3.9
Hamilton Island[6]	Mar 1995	20.3	6	**54.4**	5.7
Sir James Smith Gp.[8]	1991	20.7	56	**22.0**	na
Northumberland Is.[8]	1991	21.5	20	**11.7**	na
Shoalwater Bay[7]	Dec 1995	22.3	34	**37.8**	16.2
Keppel Islands[8]	1991	23.2	8	**54.3**	na

No fish counts were carried out during this project but the clear water that was encountered during the 1994 and 1997 surveys enabled large fish to be observed easily. It was our impression that there were more large fishes on all reefs (not just on the protected reefs north of Cape Tribulation) during these surveys than during the previous round of surveys, especially the grass emperor *Lethrinus laticaudis*, the bar-cheek coral trout *Plectropomus maculatus* and several species of cod. Of particular note was a sighting of a potato cod *Epinephelus tukula* about 75 centimetres long, a species we have previously only seen in the passes and front reef faces of the outer barrier reefs north of Cooktown.

IMPLICATIONS FOR MANAGEMENT AND SUGGESTIONS FOR FURTHER WORK

Extensive surveys on fringing reefs between Cape Flattery and the Keppel Islands over the past decade have shown that most of these reefs have very rich coral communities with live coral cover usually ranging from 50 to 75%. These means are comparable to the maximum coral cover recorded on the upper windward slope of the richest, undisturbed offshore reefs measured using the same technique (Ayling and Ayling, unpublished data).

The present study also indicates that corals in these fringing reef communities are fast growing and able to recover quickly from repeated disturbance. These fringing reefs are present in environments where the normal levels of sedimentation may be several orders of magnitude higher than those regarded as normal for offshore reefs. In spite of these studies it still seems to be widely believed that fringing reefs are degraded, or severely stressed and on the brink of degradation (Hopley et al. 1990). However, it is certainly true that these fringing reef communities will undoubtedly be affected by nutrient enrichment, or increased siltation, before offshore reefs.

If sensible decisions on coastal development are to be made it is extremely important for Great Barrier Reef managers to know if fringing reefs are being degraded. We suggest that it is vital that a number of permanent monitoring sites be set up on a range of fringing reefs at varying distances from potential human influences to establish if degradation is in fact occurring in these communities. The sites should be monitored in the long term; the 12-year term of this study is a good start but should be continued in the future. Management response, if degradation of fringing reefs is shown to be occurring in the future, is complicated by the fact that the major of impacts are terrestrially derived. Control of practices that lead to nutrient run-off or catchment disturbance would have to be implemented along large areas of the Queensland coast, and well inland to the south where rivers such as the Fitzroy and Burdekin drain huge catchments.

In addition a comparative study of the growth rates of a range of coral species on fringing and offshore reefs would provide useful information to help resolve this question. If growth rates on fringing reefs are greater than on offshore reefs, as our observations suggest, then it would indicate that present conditions on fringing reefs are suitable for good fringing reef development.

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APPENDIX 1. ANALYSIS OF VARIANCE TABLES

A. Repeated measures analysis of permanent transects: 1985–1997

Source of Variation	df	MS	F	p	MS	F	p
		Total coral cover			Pocilloporids		
Location	2	2245.39	0.615	0.574	99.505	5.521	0.028
Site (L)	9	3650.5	13.463	<0.001	18.023	3.677	0.002
Error (transect)	48	271.148			4.902		
Time	7	5998.41	92.938	<0.001	8.642	6.190	<0.001
Time x Location	14	584.101	4.235	<0.001	1.210	0.806	0.603
Time x Site (L)	63	137.917	2.137	<0.001	1.500	1.075	0.359
Error (time x tran.)	336	64.542			1.396		
		Acropora			*Montipora*		
Location	2	464.093	0.201	0.831	1103.24	0.225	0.811
Site (L)	9	2313.59	13.915	<0.001	4908.37	14.150	<0.001
Error (transect)	48	166.263			346.89		
Time	7	674.322	22.600	<0.001	1814.88	38.938	<0.001
Time x Location	14	78.987	2.977	0.002	153.956	1.630	0.097
Time x Site (L)	63	26.528	0.889	0.631	94.460	2.027	<0.001
Error (time x tran.)	336	29.837			46.610		
		Poritids			Faviids		
Location	2	12.071	0.422	0.681	176.280	2.237	0.182
Site (L)	9	28.597	6.590	<0.001	78.785	1.984	0.062
Error (transect)	48	4.339			39.715		
Time	7	1.718	2.219	0.065	9.565	3.670	0.014
Time x Location	14	0.776	0.875	0.628	6.087	2.555	0.005
Time x Site (L)	63	0.887	1.146	0.272	2.382	0.914	0.592
Error (time x tran.)	336	0.774			2.606		
		Turbinaria			Deep water corals		
Location	2	329.429	1.396	0.286	2273.14	1.505	0.276
Site (L)	9	236.033	11.207	<0.001	1510.40	6.867	<0.001
Error (transect)	48	21.061			219.936		
Time	7	1.478	0.534	0.614	121.303	5.474	0.0013
Time x Location	14	2.229	1.534	0.130	29.567	3.690	<0.001
Time x Site (L)	63	1.453	0.525	0.954	8.011	0.361	0.999
Error (time x tran.)	336	2.769			22.161		
		Soft corals			*Sargassum*		
Location	2	53.208	0.025	0.979	25.930	0.492	0.642
Site (L)	9	2096.16	11.298	<0.001	52.651	1.655	0.127
Error (transect)	48	185.526			31.822		
Time	7	47.362	2.212	0.079	9.312	3.196	0.020
Time x Location	14	23.751	1.499	0.145	5.711	2.779	0.003
Time x Site (L)	63	15.849	0.740	0.839	2.055	0.705	0.872
Error (time x tran.)	336	21.409			2.914		

B. Repeated measures analysis of permanent transects: 1994–1997

Source of Variation	df	MS	F	p	MS	F	p
		Total coral cover			Pocilloporids		
Location	2	5331.82	1.755	0.223	36.933	2.174	0.189
Site (L)	9	3037.95	12.243	<0.001	16.988	5.720	<0.001
Error (transect)	48	248.146			2.970		
Time	3	228.999	8.186	<0.001	0.648	0.596	0.580
Time x Location	6	194.450	3.239	0.018	0.487	1.085	0.423
Time x Site (L)	27	60.037	2.146	0.006	0.449	0.412	0.989
Error (time x tran.)	144	27.973			1.088		
		Acropora			*Montipora*		
Location	2	172.002	0.116	0.902	817.880	0.224	0.811
Site (L)	9	1483.87	7.715	<0.001	3644.51	9.514	<0.001
Error (transect)	48	192.345			383.062		
Time	3	174.342	11.110	<0.001	41.908	1.730	0.174
Time x Location	6	34.391	2.240	0.074	50.872	1.445	0.241
Time x Site (L)	27	15.350	0.978	0.496	35.200	1.453	0.104
Error (time x tran.)	144	15.692			24.218		
		Poritids			Faviids		
Location	2	3.886	0.199	0.832	180.148	4.45	0.047
Site (L)	9	19.475	4.714	<0.001	40.476	1.242	0.293
Error (transect)	48	4.132			32.601		
Time	3	1.190	2.557	0.068	2.630	4.378	0.011
Time x Location	6	0.751	1.520	0.220	1.127	0.879	0.592
Time x Site (L)	27	0.494	1.062	0.397	1.282	2.134	0.006
Error (time x tran.)	144	0.465			0.601		
		Turbinaria			Deep water corals		
Location	2	115.719	0.961	0.439	1846.13	1.839	0.230
Site (L)	9	120.372	11.264	<0.001	1003.93	4.586	<0.001
Error (transect)	48	10.686			218.903		
Time	3	0.251	1.101	0.344	12.482	1.373	0.258
Time x Location	6	0.734	2.245	0.073	4.492	2.414	0.055
Time x Site (L)	27	0.327	1.433	0.115	1.861	0.205	0.999
Error (time x tran.)	144	0.228			9.094		
		Soft Corals			*Sargassum*		
Location	2	5.161	0.005	0.999	40.799	1.243	0.345
Site (L)	9	1004.64	7.566	<0.001	32.817	1.289	0.268
Error (transect)	48	132.789			25.467		
Time	3	14.830	2.555	0.084	5.188	6.124	0.006
Time x Location	6	17.787	2.284	0.069	0.835	0.769	0.674
Time x Site (L)	27	7.786	1.342	0.182	1.086	1.282	0.233
Error (time x tran.)	144	5.803			0.847		
		Turf Algae					
Location	2	0.895	0.004	0.998			
Site (L)	9	221.707	5.316	<0.001			
Error (transect)	48	41.704					
Time	3	1158.93	64.610	<0.001			
Time x Location	6	278.431	6.00	<0.001			
Time x Site (L)	27	46.404	2.587	<0.001			
Error (time x tran.)	144	17.937					

C. Haphazard transects at run-off sites: 1985–1996

Source of Variation	df	MS	F	p	df	MS	F	p
		Total coral cover				*Acropora*		
Time	6	200.352	2.232	0.044		7.763	1.481	0.189
Site	4	8928.17	43.102	<0.001		57.798	13.778	<0.001
Time x Site	24	207.14	2.307	0.0013		4.195	0.800	0.731
Residual	140	89.773				5.241		
		Montipora				Poritids		
Time	6	45.982	1.130	0.348		21.898	3.022	0.008
Site	4	965.076	14.615	<0.001		109.672	10.305	<0.001
Time x Site	24	66.035	1.623	0.044		10.643	1.469	0.088
Residual	140	40.680				7.247		
		Turbinaria				Faviids		
Time	6	157.076	7.084	<0.001		10.883	0.973	0.446
Site	4	1309.93	10.48	<0.001		148.158	12.511	<0.001
Time x Site	24	124.993	5.637	<0.001		11.842	1.059	0.398
Residual	140	22.174				11.183		
		Deep water corals				Soft Corals		
Time	6	28.486	3.229	0.005		1.372	2.385	0.032
Site	4	166.150	5.566	0.003		3.364	4.065	0.012
Time x Site	24	29.850	3.384	<0.001		0.828	1.439	0.998
Residual	140	8.821				0.575		
		Sargassum spp.				Turf Algae		
Time	6	615.617	7.700	<0.001	2	3774.12	5.562	0.006
Site	4	5322.61	20.981	<0.001	4	11377.4	9.604	0.004
Time x Site	24	253.691	3.173	<0.001	8	1184.66	1.746	0.106
Residual	140	79.952			60	678.55		

APPENDIX 2: RAW DATA FROM THE 1994–1997 SURVEYS

The following spreadsheets show summaries of raw data from these four surveys for both the permanent transect sites and the run-off sites. Data from the 1985–1988 surveys are already held by the Great Barrier Reef Marine Park Authority.

CAPE TRIBULATION: SUMMARY: LOCATION 1: October 1994

Transect #	1	2	3	4	5	mean	std.dev.	se
SITE 1								
Sargassum spp.	45	15	5	55	0	1.2	1.2	0.55
Algal turf	65	65	40	15	30	2.2	1.1	0.49
Sponges	0	0	9	12	0	0.2	0.3	0.13
Total Hard Coral	855	809	918	689	712	39.8	4.8	2.15
Pocilloporidae	51	58	90	64	29	2.9	1.1	0.49
Acroporidae	684	674	705	515	461	30.4	5.6	2.49
Acropora spp.	133	22	17	128	69	3.7	2.8	1.24
Montipora spp.	551	652	688	387	392	26.7	7.1	3.16
Poritidae	6	25	13	0	18	0.6	0.5	0.22
Faviidae	24	48	76	24	159	3.3	2.8	1.26
Turbinaria spp.	0	0	0	0	0	0.0	0.0	0.00
Deep water corals	27	0	45	32	24	1.3	0.8	0.37
Total Soft Coral	354	332	194	242	434	15.6	4.7	2.12
SITE 2								
Sargassum spp.	115	0	70	0	0	1.9	2.7	1.19
Algal turf	55	45	0	0	95	2.0	2.0	0.90
Sponges	0	0	0	0	0	0.0	0.0	0.00
Total Hard Coral	1105	1212	1275	1181	1137	59.1	3.3	1.48
Pocilloporidae	4	36	12	0	59	1.1	1.2	0.56
Acroporidae	914	1020	883	926	959	47.0	2.6	1.17
Acropora spp.	458	534	291	423	773	24.8	8.9	3.98
Montipora spp.	456	486	592	503	186	22.2	7.7	3.43
Poritidae	108	6	93	14	27	2.5	2.4	1.06
Faviidae	8	13	101	8	0	1.3	2.1	0.94
Turbinaria spp.	5	8	38	33	0	0.8	0.9	0.39
Deep water corals	12	119	203	148	92	5.7	3.5	1.58
Total Soft Coral	34	184	20	106	216	5.6	4.4	1.96
SITE 3								
Sargassum spp.	0	0	120	0	0	1.2	2.7	1.20
Algal turf	75	270	0	15	0	3.6	5.7	2.57
Sponges	0	0	0	14	0	0.1	0.3	0.14
Total Hard Coral	1232	967	1049	1252	1237	57.4	6.5	2.92
Pocilloporidae	182	73	81	54	30	4.2	2.9	1.30
Acroporidae	1042	889	754	589	904	41.8	8.6	3.83
Acropora spp.	117	250	132	67	131	7.0	3.4	1.50
Montipora spp.	925	639	622	522	773	34.8	7.8	3.49
Poritidae	0	5	0	17	19	0.4	0.5	0.21
Faviidae	0	0	64	136	139	3.4	3.4	1.54
Turbinaria spp.	0	0	0	0	0	0.0	0.0	0.00
Deep water corals	8	0	189	548	289	10.3	11.3	5.07
Total Soft Coral	0	10	39	88	10	1.5	1.8	0.80
SITE 4								
Sargassum spp.	105	255	0	20	20	4.0	5.3	2.37
Algal turf	10	40	405	215	410	10.8	9.6	4.28
Sponges	0	0	40	0	0	0.4	0.9	0.40
Total Hard Coral	1016	879	1150	1252	1233	55.3	7.9	3.52
Pocilloporidae	40	52	53	44	29	2.2	0.5	0.22
Acroporidae	956	776	983	1165	1133	50.1	7.8	3.49
Acropora spp.	581	429	630	701	430	27.7	6.1	2.72
Montipora spp.	375	347	353	464	703	22.4	7.5	3.35
Poritidae	0	38	5	7	11	0.6	0.7	0.33
Faviidae	0	0	32	0	6	0.4	0.7	0.31
Turbinaria spp.	0	0	0	0	0	0.0	0.0	0.00
Deep water corals	20	13	73	23	54	1.8	1.3	0.58
Total Soft Coral	215	33	55	30	135	4.7	4.0	1.79
GRAND MEANS								
Sargassum spp.						2.1	3.3	0.73
Algal turf						4.6	6.4	1.43
Sponges						0.2	0.5	0.11
Total Hard Coral						52.9	9.5	2.13
Pocilloporidae						2.6	1.9	0.43
Acroporidae						42.3	9.8	2.19
Acropora spp.						15.8	12.1	2.70
Montipora spp.						26.5	8.7	1.93
Poritidae						1.0	1.5	0.33
Faviidae						2.1	2.6	0.59
Turbinaria spp.						0.2	0.5	0.12
Deep water corals						4.8	6.6	1.48
Total Soft Coral						6.8	6.5	1.45

Data from five permanent 20m intersect line transects in cm with mean % cover

CAPE TRIBULATION: SUMMARY: LOCATION 2: October 1994

Transect #	1	2	3	4	5	mean	std.dev.	se
SITE 5								
Sargassum spp.	0	30	15	0	0	0.5	0.7	0.30
Algal turf	80	130	110	45	105	4.7	1.6	0.73
Sponges	40	33	55	112	75	3.2	1.6	0.71
Total Hard Coral	803	431	443	1043	684	34.0	12.9	5.76
Pocilloporidae	45	59	48	18	21	1.9	0.9	0.40
Acroporidae	148	129	63	62	88	4.9	1.9	0.87
Acropora spp.	58	22	63	40	55	2.4	0.8	0.37
Montipora spp.	90	107	0	22	33	2.5	2.3	1.03
Poritidae	76	17	13	37	54	2.0	1.3	0.59
Faviidae	84	16	41	49	80	2.7	1.4	0.63
Turbinaria spp.	188	77	54	244	216	7.8	4.3	1.90
Deep water corals	270	90	224	662	267	15.1	10.7	4.78
Total Soft Coral	245	602	872	218	348	22.9	13.9	6.20
SITE 6								
Sargassum spp.	0	185	55	30	25	3.0	3.7	1.63
Algal turf	45	110	160	85	180	5.8	2.7	1.23
Sponges	0	0	0	0	0	0.0	0.0	0.00
Total Hard Coral	1351	897	1342	1301	1210	61.0	9.5	4.23
Pocilloporidae	42	0	56	0	57	1.6	1.4	0.65
Acroporidae	666	655	570	234	928	30.5	12.5	5.58
Acropora spp.	286	131	109	87	407	10.2	6.9	3.08
Montipora spp.	380	524	461	147	521	20.3	7.8	3.50
Poritidae	30	25	34	106	0	2.0	2.0	0.89
Faviidae	59	39	219	128	28	4.7	4.0	1.78
Turbinaria spp.	0	0	0	0	0	0.0	0.0	0.00
Deep water corals	605	178	547	968	180	24.8	16.6	7.40
Total Soft Coral	0	46	48	37	27	1.6	1.0	0.44
SITE 7								
Sargassum spp.	0	0	0	0	0	0.0	0.0	0.00
Algal turf	110	370	270	510	370	16.3	7.4	3.31
Sponges	36	0	0	0	35	0.7	1.0	0.43
Total Hard Coral	1401	1207	1183	1112	1574	64.8	9.4	4.23
Pocilloporidae	40	0	44	19	7	1.1	1.0	0.44
Acroporidae	988	1131	936	1086	1548	56.9	12.1	5.41
Acropora spp.	308	369	515	266	451	19.1	5.1	2.28
Montipora spp.	680	762	421	820	1097	37.8	12.2	5.46
Poritidae	60	0	8	0	0	0.7	1.3	0.59
Faviidae	26	20	21	0	0	0.7	0.6	0.28
Turbinaria spp.	117	0	0	0	0	1.2	2.6	1.17
Deep water corals	170	49	160	7	19	4.1	3.9	1.75
Total Soft Coral	29	0	62	95	0	1.9	2.1	0.92
SITE 8								
Sargassum spp.	0	0	0	0	0	0.0	0.0	0.00
Algal turf	270	170	140	180	180	9.4	2.4	1.09
Sponges	0	0	0	0	0	0.0	0.0	0.00
Total Hard Coral	1365	1527	1570	1382	1343	71.9	5.2	2.31
Pocilloporidae	41	45	0	62	16	1.6	1.2	0.55
Acroporidae	1266	1449	1312	1312	1278	66.2	3.7	1.64
Acropora spp.	505	113	301	496	474	18.9	8.5	3.80
Montipora spp.	761	1336	1011	816	804	47.3	11.9	5.33
Poritidae	18	7	10	0	6	0.4	0.3	0.15
Faviidae	0	0	0	0	0	0.0	0.0	0.00
Turbinaria spp.	0	0	12	0	0	0.1	0.3	0.12
Deep water corals	23	6	220	0	21	2.7	4.7	2.09
Total Soft Coral	85	52	27	0	96	2.6	2.0	0.89
GRAND MEANS								
Sargassum spp.						0.9	2.1	0.47
Algal turf						9.1	6.0	1.35
Sponges						1.0	1.6	0.35
Total Hard Coral						57.9	17.2	3.84
Pocilloporidae						1.6	1.1	0.25
Acroporidae						39.6	25.9	5.79
Acropora spp.						12.6	9.0	2.02
Montipora spp.						27.0	19.6	4.38
Poritidae						1.3	1.5	0.33
Faviidae						2.0	2.7	0.61
Turbinaria spp.						2.3	4.0	0.90
Deep water corals						11.7	13.2	2.95
Total Soft Coral						7.2	11.3	2.53

Data from five permanent 20m intersect line transects in cm with mean % cover

CAPE TRIBULATION: SUMMARY: LOCATION 3: October 1994

Transect #	1	2	3	4	5	mean	std.dev.	se
SITE 9								
Sargassum spp.	0	0	0	0	185	1.9	4.1	1.85
Algal turf	340	235	180	260	290	13.1	3.0	1.34
Sponges	0	37	0	45	35	1.2	1.1	0.48
Total Hard Coral	1471	1290	1029	776	1137	57.0	13.2	5.88
Pocilloporidae	56	61	84	65	25	2.9	1.1	0.48
Acroporidae	936	1037	725	443	1031	41.7	12.6	5.65
Acropora spp.	513	230	121	166	257	12.9	7.6	3.41
Montipora spp.	423	807	604	277	774	28.9	11.4	5.08
Poritidae	31	16	8	0	12	0.7	0.6	0.26
Faviidae	342	64	85	107	0	6.0	6.5	2.92
Turbinaria spp.	0	9	53	0	0	0.6	1.2	0.51
Deep water corals	448	167	152	254	69	10.9	7.2	3.23
Total Soft Coral	0	314	361	558	22	12.6	11.9	5.31
SITE 10								
Sargassum spp.	0	0	0	0	0	0.0	0.0	0.00
Algal turf	130	60	195	95	185	6.7	2.9	1.29
Sponges	0	18	0	0	0	0.2	0.4	0.18
Total Hard Coral	1579	1456	1107	1290	1564	70.0	10.0	4.47
Pocilloporidae	12	25	0	30	13	0.8	0.6	0.26
Acroporidae	944	823	700	733	875	40.8	5.0	2.24
Acropora spp.	359	390	223	267	398	16.4	3.9	1.75
Montipora spp.	585	433	477	466	477	24.4	2.9	1.28
Poritidae	104	53	94	47	12	3.1	1.9	0.84
Faviidae	59	25	33	197	64	3.8	3.5	1.56
Turbinaria spp.	125	0	0	114	38	2.8	3.0	1.36
Deep water corals	386	507	259	301	548	20.0	6.3	2.81
Total Soft Coral	0	20	179	42	47	2.9	3.5	1.57
SITE 11								
Sargassum spp.	0	0	0	0	15	0.2	0.3	0.15
Algal turf	175	225	70	250	230	9.5	3.6	1.62
Sponges	0	0	0	0	0	0.0	0.0	0.00
Total Hard Coral	1564	1173	1673	1461	1326	72.0	9.8	4.39
Pocilloporidae	66	0	22	46	73	2.1	1.5	0.68
Acroporidae	1038	649	1037	870	990	45.8	8.2	3.68
Acropora spp.	186	333	499	368	438	18.2	5.9	2.65
Montipora spp.	852	316	538	502	552	27.6	9.6	4.31
Poritidae	49	41	24	0	30	1.4	0.9	0.42
Faviidae	135	101	89	159	124	6.1	1.4	0.62
Turbinaria spp.	31	0	0	17	0	0.5	0.7	0.31
Deep water corals	242	374	590	414	218	18.4	7.5	3.35
Total Soft Coral	55	214	38	121	48	4.8	3.7	1.65
SITE 12								
Sargassum spp.	50	0	10	15	0	0.8	1.0	0.46
Algal turf	105	195	140	85	110	6.4	2.1	0.96
Sponges	0	0	0	0	0	0.0	0.0	0.00
Total Hard Coral	1629	1026	1421	1387	1702	71.7	13.2	5.90
Pocilloporidae	0	12	36	0	0	0.5	0.8	0.35
Acroporidae	1438	866	1151	1018	1656	61.3	16.0	7.14
Acropora spp.	444	103	237	547	161	14.9	9.5	4.24
Montipora spp.	994	763	914	471	1495	46.4	18.7	8.38
Poritidae	34	0	27	15	12	0.9	0.7	0.30
Faviidae	39	0	136	238	25	4.4	4.9	2.21
Turbinaria spp.	0	0	0	0	0	0.0	0.0	0.00
Deep water corals	157	148	207	327	34	8.7	5.3	2.37
Total Soft Coral	211	491	116	206	25	10.5	8.7	3.91
GRAND MEANS								
Sargassum spp.						0.7	2.1	0.47
Algal turf						8.9	3.9	0.87
Sponges						0.3	0.7	0.16
Total Hard Coral						67.7	12.4	2.78
Pocilloporidae						1.6	1.4	0.31
Acroporidae						47.4	13.4	2.99
Acropora spp.						15.6	6.8	1.51
Montipora spp.						31.8	14.1	3.16
Poritidae						1.5	1.4	0.32
Faviidae						5.1	4.3	0.95
Turbinaria spp.						1.0	1.9	0.42
Deep water corals						14.5	7.8	1.75
Total Soft Coral						7.7	8.2	1.84

Data from five permanent 20m intersect line transects in cm with mean % cover

CAPE TRIBULATION: SUMMARY: LOCATION 1: November 1995

Transect #	1	2	3	4	5	mean	std.dev.	se
SITE 1								
Sargassum spp.	45	35	20	10	0	1.1	0.9	0.41
Algal turf	225	115	290	300	170	11.0	3.9	1.76
Sponges	0	0	0	0	0	0.0	0.0	0.00
Total Hard Coral	769	863	718	955	655	39.6	5.9	2.65
Pocilloporidae	58	36	70	70	38	2.7	0.8	0.37
Acroporidae	610	718	597	746	433	31.0	6.2	2.76
Acropora spp.	102	114	51	12	78	3.6	2.1	0.92
Montipora spp.	508	604	546	734	355	27.5	6.9	3.09
Poritidae	8	9	7	12	31	0.7	0.5	0.22
Faviidae	15	0	30	89	128	2.6	2.7	1.21
Turbinaria spp.	0	5	0	0	0	0.1	0.1	0.05
Deep water corals	44	22	21	39	32	1.6	0.5	0.23
Total Soft Coral	274	365	449	236	516	18.4	5.8	2.62
SITE 2								
Sargassum spp.	70	0	100	0	0	1.7	2.4	1.07
Algal turf	220	210	220	170	190	10.1	1.1	0.48
Sponges	0	0	0	0	0	0.0	0.0	0.00
Total Hard Coral	1146	1181	1052	1159	1336	58.7	5.1	2.30
Pocilloporidae	28	60	20	0	42	1.5	1.1	0.51
Acroporidae	851	966	669	868	1170	45.2	9.1	4.09
Acropora spp.	485	591	109	488	917	25.9	14.4	6.46
Montipora spp.	366	375	560	380	253	19.3	5.5	2.46
Poritidae	129	29	96	0	16	2.7	2.8	1.24
Faviidae	22	16	87	41	0	1.7	1.7	0.75
Turbinaria spp.	7	0	22	12	0	0.4	0.5	0.21
Deep water corals	36	110	213	188	77	6.2	3.7	1.66
Total Soft Coral	0	170	12	84	216	4.8	4.8	2.13
SITE 3								
Sargassum spp.	0	0	75	0	0	0.8	1.7	0.75
Algal turf	380	190	120	160	140	9.9	5.2	2.35
Sponges	0	0	0	8	0	0.1	0.2	0.08
Total Hard Coral	1087	1417	1159	1311	1349	63.2	6.9	3.07
Pocilloporidae	74	206	83	65	27	4.6	3.4	1.51
Acroporidae	1013	1208	866	691	1071	48.5	9.9	4.43
Acropora spp.	334	130	163	117	183	9.3	4.4	1.95
Montipora spp.	679	1078	703	574	888	39.2	10.0	4.46
Poritidae	0	0	16	12	0	0.3	0.4	0.17
Faviidae	0	0	58	122	124	3.0	3.1	1.38
Turbinaria spp.	0	0	0	0	0	0.0	0.0	0.00
Deep water corals	0	3	167	534	251	9.6	11.0	4.92
Total Soft Coral	63	0	121	102	52	3.4	2.4	1.05
SITE 4								
Sargassum spp.	90	230	0	75	20	4.2	4.5	2.02
Algal turf	210	310	390	320	240	14.7	3.5	1.59
Sponges	0	0	25	0	0	0.3	0.6	0.25
Total Hard Coral	1013	1005	1102	1360	1291	57.7	8.1	3.64
Pocilloporidae	73	28	6	29	57	1.9	1.3	0.59
Acroporidae	910	916	998	1298	1165	52.9	8.5	3.79
Acropora spp.	483	424	651	751	449	27.6	7.1	3.19
Montipora spp.	427	492	347	547	716	25.3	7.0	3.11
Poritidae	0	50	0	0	13	0.6	1.1	0.48
Faviidae	6	0	27	0	12	0.5	0.6	0.25
Turbinaria spp.	6	0	0	0	0	0.1	0.1	0.06
Deep water corals	18	20	54	20	44	1.6	0.8	0.37
Total Soft Coral	199	15	99	99	100	5.1	3.3	1.46
GRAND MEANS								
Sargassum spp.						1.9	2.8	0.64
Algal turf						11.4	4.0	0.89
Sponges						0.1	0.3	0.06
Total Hard Coral						54.8	11.1	2.48
Pocilloporidae						2.7	2.2	0.48
Acroporidae						44.4	11.5	2.57
Acropora spp.						16.6	13.1	2.94
Montipora spp.						27.8	10.1	2.26
Poritidae						1.1	1.7	0.38
Faviidae						1.9	2.3	0.51
Turbinaria spp.						0.1	0.3	0.06
Deep water corals						4.7	6.4	1.42
Total Soft Coral						7.9	7.4	1.65

Data from five permanent 20m intersect line transects in cm with mean % cover

CAPE TRIBULATION: SUMMARY: LOCATION 2: November 1995

Transect #	1	2	3	4	5	mean	std.dev.	se
SITE 5								
Sargassum spp.	0	25	0	0	0	**0.3**	**0.6**	**0.25**
Algal turf	110	350	315	290	270	**13.4**	**4.6**	**2.07**
Sponges	18	35	35	144	30	**2.6**	**2.6**	**1.16**
Total Hard Coral	912	542	494	1197	831	**39.8**	**14.4**	**6.43**
Pocilloporidae	41	59	37	0	42	**1.8**	**1.1**	**0.49**
Acroporidae	277	177	80	85	155	**7.7**	**4.0**	**1.80**
Acropora spp.	127	50	55	60	125	**4.2**	**2.0**	**0.87**
Montipora spp.	150	127	25	25	30	**3.6**	**3.1**	**1.38**
Poritidae	62	16	12	69	64	**2.2**	**1.4**	**0.63**
Faviidae	115	20	48	63	89	**3.4**	**1.8**	**0.82**
Turbinaria spp.	221	86	64	288	260	**9.2**	**5.1**	**2.29**
Deep water corals	196	118	222	736	275	**15.5**	**12.3**	**5.48**
Total Soft Coral	184	525	830	160	237	**19.4**	**14.4**	**6.43**
SITE 6								
Sargassum spp.	0	160	55	30	30	**2.8**	**3.1**	**1.38**
Algal turf	200	120	190	105	210	**8.3**	**2.4**	**1.09**
Sponges	0	0	0	0	0	**0.0**	**0.0**	**0.00**
Total Hard Coral	1095	1103	1442	1326	1307	**62.7**	**7.6**	**3.38**
Pocilloporidae	38	0	34	0	63	**1.4**	**1.4**	**0.60**
Acroporidae	422	791	698	218	968	**31.0**	**14.9**	**6.68**
Acropora spp.	215	189	220	81	367	**10.7**	**5.1**	**2.28**
Montipora spp.	207	602	478	137	601	**20.3**	**11.0**	**4.92**
Poritidae	27	32	61	93	0	**2.1**	**1.8**	**0.79**
Faviidae	68	47	169	90	52	**4.3**	**2.5**	**1.11**
Turbinaria spp.	0	4	0	0	0	**0.0**	**0.1**	**0.04**
Deep water corals	622	180	575	1025	237	**26.4**	**17.0**	**7.61**
Total Soft Coral	0	15	43	66	0	**1.2**	**1.4**	**0.65**
SITE 7								
Sargassum spp.	0	0	0	0	0	**0.0**	**0.0**	**0.00**
Algal turf	560	120	430	530	380	**20.2**	**8.7**	**3.91**
Sponges	0	28	0	0	0	**0.3**	**0.6**	**0.28**
Total Hard Coral	1163	1375	1319	1284	1403	**65.4**	**4.7**	**2.10**
Pocilloporidae	0	31	35	18	7	**0.9**	**0.8**	**0.34**
Acroporidae	1107	988	1108	1258	1396	**58.6**	**7.9**	**3.53**
Acropora spp.	302	344	618	341	353	**19.6**	**6.4**	**2.86**
Montipora spp.	805	644	490	917	1043	**39.0**	**10.9**	**4.89**
Poritidae	0	8	0	0	0	**0.1**	**0.2**	**0.08**
Faviidae	0	16	22	0	0	**0.4**	**0.5**	**0.24**
Turbinaria spp.	0	99	0	0	0	**1.0**	**2.2**	**0.99**
Deep water corals	42	233	142	8	0	**4.3**	**5.0**	**2.24**
Total Soft Coral	0	22	0	82	0	**1.0**	**1.8**	**0.79**
SITE 8								
Sargassum spp.	0	0	0	0	0	**0.0**	**0.0**	**0.00**
Algal turf	320	330	360	430	330	**17.7**	**2.3**	**1.01**
Sponges	0	12	0	0	0	**0.1**	**0.3**	**0.12**
Total Hard Coral	1630	1484	1258	1387	1518	**72.8**	**7.0**	**3.14**
Pocilloporidae	0	20	68	28	12	**1.3**	**1.3**	**0.58**
Acroporidae	1413	1326	1086	1359	1468	**66.5**	**7.3**	**3.28**
Acropora spp.	308	66	344	528	621	**18.7**	**10.7**	**4.81**
Montipora spp.	1105	1260	742	831	847	**47.9**	**10.8**	**4.85**
Poritidae	13	12	45	0	8	**0.8**	**0.9**	**0.38**
Faviidae	12	15	0	0	0	**0.3**	**0.4**	**0.17**
Turbinaria spp.	16	0	0	0	0	**0.2**	**0.4**	**0.16**
Deep water corals	165	68	33	0	30	**3.0**	**3.2**	**1.43**
Total Soft Coral	0	48	33	0	100	**1.8**	**2.1**	**0.92**
GRAND MEANS								
Sargassum spp.						**0.8**	**1.9**	**0.42**
Algal turf						**14.9**	**6.7**	**1.49**
Sponges						**0.8**	**1.7**	**0.37**
Total Hard Coral						**60.2**	**15.2**	**3.40**
Pocilloporidae						**1.3**	**1.1**	**0.25**
Acroporidae						**41.0**	**25.4**	**5.68**
Acropora spp.						**13.3**	**9.0**	**2.01**
Montipora spp.						**27.7**	**19.6**	**4.39**
Poritidae						**1.3**	**1.5**	**0.33**
Faviidae						**2.1**	**2.3**	**0.52**
Turbinaria spp.						**2.6**	**4.7**	**1.05**
Deep water corals						**12.3**	**14.0**	**3.12**
Total Soft Coral						**5.9**	**10.5**	**2.34**

Data from five permanent 20m intersect line transects in cm with mean % cover

CAPE TRIBULATION: SUMMARY: LOCATION 3: November 1995

Transect #	1	2	3	4	5	mean	std.dev.	se
SITE 9								
Sargassum spp.	0	0	0	0	165	1.7	3.7	1.65
Algal turf	220	360	350	480	260	16.7	5.0	2.26
Sponges	17	5	8	25	21	0.8	0.4	0.19
Total Hard Coral	1265	1418	943	866	1094	55.9	11.4	5.08
Pocilloporidae	60	69	68	43	10	2.5	1.2	0.55
Acroporidae	1098	909	692	542	1017	42.6	11.5	5.16
Acropora spp.	311	590	117	240	189	14.5	9.1	4.08
Montipora spp.	787	319	575	302	828	28.1	12.5	5.57
Poritidae	0	20	0	0	18	0.4	0.5	0.23
Faviidae	57	335	78	113	0	5.8	6.4	2.88
Turbinaria spp.	10	6	30	0	0	0.5	0.6	0.28
Deep water corals	97	409	145	256	49	9.6	7.2	3.22
Total Soft Coral	303	0	328	429	35	11.0	9.5	4.26
SITE 10								
Sargassum spp.	0	5	0	0	0	0.1	0.1	0.05
Algal turf	240	280	320	355	350	15.5	2.4	1.09
Sponges	0	16	0	0	0	0.2	0.4	0.16
Total Hard Coral	1422	1353	1149	1277	1442	66.4	6.0	2.67
Pocilloporidae	18	23	0	16	0	0.6	0.5	0.24
Acroporidae	765	720	748	806	796	38.4	1.8	0.79
Acropora spp.	257	399	278	289	403	16.3	3.5	1.57
Montipora spp.	508	321	470	517	393	22.1	4.2	1.86
Poritidae	102	59	109	36	37	3.4	1.8	0.78
Faviidae	58	0	33	178	72	3.4	3.4	1.50
Turbinaria spp.	97	8	0	75	32	2.1	2.1	0.94
Deep water corals	414	466	251	312	532	19.8	5.7	2.54
Total Soft Coral	0	47	120	20	95	2.8	2.5	1.13
SITE 11								
Sargassum spp.	0	0	0	25	0	0.3	0.6	0.25
Algal turf	190	310	260	360	180	13.0	3.9	1.72
Sponges	0	0	0	0	0	0.0	0.0	0.00
Total Hard Coral	1479	1116	1477	1047	1314	64.3	10.0	4.48
Pocilloporidae	0	7	60	39	45	1.5	1.3	0.57
Acroporidae	957	746	1032	806	781	43.2	6.2	2.76
Acropora spp.	429	404	243	349	282	17.1	3.9	1.76
Montipora spp.	528	342	789	457	499	26.2	8.2	3.68
Poritidae	29	29	46	15	0	1.2	0.9	0.39
Faviidae	100	53	54	57	84	3.5	1.1	0.48
Turbinaria spp.	0	8	24	0	0	0.3	0.5	0.23
Deep water corals	483	254	220	175	403	15.4	6.5	2.92
Total Soft Coral	60	93	30	45	130	3.6	2.0	0.90
SITE 12								
Sargassum spp.	70	0	20	0	0	0.9	1.5	0.68
Algal turf	110	230	160	180	100	7.8	2.7	1.19
Sponges	0	0	0	0	0	0.0	0.0	0.00
Total Hard Coral	1537	1192	1619	1308	1726	73.8	11.1	4.94
Pocilloporidae	0	6	18	0	0	0.2	0.4	0.17
Acroporidae	1354	1067	1268	996	1654	63.4	13.0	5.82
Acropora spp.	443	113	350	667	176	17.5	11.1	4.94
Montipora spp.	911	954	918	329	1478	45.9	20.3	9.10
Poritidae	36	0	19	35	8	1.0	0.8	0.36
Faviidae	32	0	165	183	37	4.2	4.2	1.88
Turbinaria spp.	0	0	0	0	0	0.0	0.0	0.00
Deep water corals	135	119	287	256	64	8.6	4.8	2.12
Total Soft Coral	83	405	106	118	0	7.1	7.7	3.44
GRAND MEANS								
Sargassum spp.						0.7	2.0	0.44
Algal turf						13.2	4.8	1.08
Sponges						0.2	0.4	0.09
Total Hard Coral						65.1	11.2	2.50
Pocilloporidae						1.2	1.3	0.28
Acroporidae						46.9	13.1	2.93
Acropora spp.						16.3	7.1	1.59
Montipora spp.						30.6	15.0	3.36
Poritidae						1.5	1.5	0.35
Faviidae						4.2	4.0	0.90
Turbinaria spp.						0.7	1.3	0.30
Deep water corals						13.3	7.3	1.63
Total Soft Coral						6.1	6.7	1.49

Data from five permanent 20m intersect line transects in cm with mean % cover

CAPE TRIBULATION: SUMMARY: LOCATION 1: November 1996

Transect #	1	2	3	4	5	mean	std.dev.	se
SITE 1								
Sargassum spp.	35	45	15	35	0	1.3	0.9	0.41
Algal turf	140	130	240	290	180	9.8	3.4	1.52
Sponges	0	0	0	0	0	0.0	0.0	0.00
Total Hard Coral	609	663	559	320	527	26.8	6.6	2.93
Pocilloporidae	38	51	56	22	28	2.0	0.7	0.32
Acroporidae	493	559	417	236	367	20.7	6.2	2.77
Acropora spp.	108	49	27	71	42	3.0	1.6	0.70
Montipora spp.	385	510	390	165	325	17.8	6.3	2.81
Poritidae	8	21	0	8	31	0.7	0.6	0.28
Faviidae	0	14	40	20	78	1.5	1.5	0.68
Turbinaria spp.	0	5	9	0	5	0.2	0.2	0.09
Deep water corals	18	25	30	18	18	1.1	0.3	0.12
Total Soft Coral	270	376	225	135	333	13.4	4.7	2.10
SITE 2								
Sargassum spp.	60	0	65	0	0	1.3	1.7	0.77
Algal turf	290	270	150	210	310	12.3	3.3	1.46
Sponges	0	0	0	0	0	0.0	0.0	0.00
Total Hard Coral	769	1182	1242	895	1046	51.3	9.8	4.40
Pocilloporidae	18	71	22	0	63	1.7	1.5	0.69
Acroporidae	616	1020	910	674	902	41.2	8.6	3.84
Acropora spp.	226	565	300	399	612	21.0	8.3	3.71
Montipora spp.	390	455	610	275	290	20.2	6.8	3.06
Poritidae	65	7	49	18	14	1.5	1.3	0.56
Faviidae	0	0	100	30	0	1.3	2.2	0.97
Turbinaria spp.	5	0	38	28	0	0.7	0.9	0.39
Deep water corals	17	84	168	145	67	4.8	3.0	1.36
Total Soft Coral	0	136	0	95	246	4.8	5.2	2.31
SITE 3								
Sargassum spp.	0	0	80	0	0	0.8	1.8	0.80
Algal turf	220	210	280	90	150	9.5	3.6	1.62
Sponges	0	0	0	0	0	0.0	0.0	0.00
Total Hard Coral	949	1162	1206	1228	846	53.9	8.5	3.81
Pocilloporidae	48	107	96	65	65	3.8	1.2	0.55
Acroporidae	871	1055	881	765	586	41.6	8.6	3.85
Acropora spp.	246	155	126	130	161	8.2	2.4	1.08
Montipora spp.	625	900	755	635	425	33.4	8.8	3.93
Poritidae	19	0	0	0	0	0.2	0.4	0.19
Faviidae	5	0	56	97	120	2.8	2.7	1.20
Turbinaria spp.	0	0	0	5	0	0.1	0.1	0.05
Deep water corals	6	0	222	386	189	8.0	8.1	3.62
Total Soft Coral	60	0	70	95	20	2.5	1.9	0.86
SITE 4								
Sargassum spp.	80	245	10	20	0	3.6	5.1	2.28
Algal turf	350	160	370	430	330	16.4	5.1	2.26
Sponges	0	0	0	0	0	0.0	0.0	0.00
Total Hard Coral	930	1053	1275	1224	1353	58.4	8.6	3.85
Pocilloporidae	33	35	25	44	24	1.6	0.4	0.18
Acroporidae	897	981	1177	1154	1277	54.9	7.7	3.46
Acropora spp.	512	576	837	744	502	31.7	7.5	3.34
Montipora spp.	385	405	340	410	775	23.2	8.8	3.95
Poritidae	0	25	0	0	0	0.3	0.6	0.25
Faviidae	0	0	26	0	10	0.4	0.6	0.25
Turbinaria spp.	0	0	0	26	0	0.3	0.6	0.26
Deep water corals	0	12	60	0	42	1.1	1.3	0.60
Total Soft Coral	65	20	85	0	75	2.5	1.8	0.83
GRAND MEANS								
Sargassum spp.						1.7	2.9	0.64
Algal turf						12.0	4.6	1.02
Sponges						0.0	0.0	0.00
Total Hard Coral						47.6	14.8	3.31
Pocilloporidae						2.3	1.3	0.30
Acroporidae						39.6	14.4	3.23
Acropora spp.						16.0	12.7	2.83
Montipora spp.						23.6	9.4	2.10
Poritidae						0.7	0.9	0.20
Faviidae						1.5	2.0	0.44
Turbinaria spp.						0.3	0.6	0.12
Deep water corals						3.8	5.0	1.12
Total Soft Coral						5.8	5.8	1.29

Data from five permanent 20m intersect line transects in cm with mean % cover

CAPE TRIBULATION: SUMMARY: LOCATION 2: November 1996

Transect #	1	2	3	4	5	mean	std.dev.	se
SITE 5								
Sargassum spp.	0	35	0	10	10	0.6	0.7	0.32
Algal turf	120	320	310	230	270	12.5	4.0	1.81
Sponges	10	20	110	111	35	2.9	2.5	1.11
Total Hard Coral	915	621	406	1040	827	38.1	12.5	5.61
Pocilloporidae	45	40	26	26	35	1.7	0.4	0.19
Acroporidae	316	304	25	98	164	9.1	6.4	2.85
Acropora spp.	123	56	25	62	119	3.9	2.1	0.95
Montipora spp.	193	248	0	36	45	5.2	5.5	2.44
Poritidae	38	0	9	65	56	1.7	1.4	0.64
Faviidae	97	18	55	42	115	3.3	2.0	0.89
Turbinaria spp.	223	101	60	220	250	8.5	4.2	1.89
Deep water corals	196	110	195	639	255	14.0	10.4	4.65
Total Soft Coral	311	585	895	170	275	22.4	14.7	6.56
SITE 6								
Sargassum spp.	0	190	100	40	25	3.6	3.8	1.70
Algal turf	240	260	140	170	270	10.8	2.9	1.29
Sponges	0	12	0	0	0	0.1	0.3	0.12
Total Hard Coral	1362	1075	1432	1391	1386	66.5	7.2	3.23
Pocilloporidae	44	0	32	0	41	1.2	1.1	0.49
Acroporidae	613	856	762	265	1067	35.6	15.0	6.70
Acropora spp.	226	226	297	83	572	14.0	9.0	4.03
Montipora spp.	387	630	465	182	495	21.6	8.2	3.69
Poritidae	48	33	73	88	0	2.4	1.7	0.77
Faviidae	73	37	159	103	68	4.4	2.3	1.03
Turbinaria spp.	0	0	0	5	0	0.1	0.1	0.05
Deep water corals	621	157	530	1045	211	25.6	17.9	8.01
Total Soft Coral	0	25	35	70	12	1.4	1.3	0.60
SITE 7								
Sargassum spp.	0	0	0	0	0	0.0	0.0	0.00
Algal turf	160	450	430	510	410	19.6	6.7	3.02
Sponges	25	0	0	0	0	0.3	0.6	0.25
Total Hard Coral	1427	1374	1453	1261	1530	70.5	5.0	2.24
Pocilloporidae	8	26	17	42	18	1.1	0.6	0.29
Acroporidae	1174	1272	1216	1199	1512	63.7	6.9	3.07
Acropora spp.	419	357	766	284	377	22.0	9.4	4.21
Montipora spp.	755	915	450	915	1135	41.7	12.7	5.67
Poritidae	12	0	10	20	0	0.4	0.4	0.19
Faviidae	17	0	29	0	0	0.5	0.7	0.30
Turbinaria spp.	90	0	0	0	0	0.9	2.0	0.90
Deep water corals	126	54	191	0	0	3.7	4.2	1.86
Total Soft Coral	22	0	0	90	0	1.1	1.9	0.87
SITE 8								
Sargassum spp.	0	0	0	0	0	0.0	0.0	0.00
Algal turf	260	210	390	310	340	15.1	3.5	1.56
Sponges	0	22	0	0	0	0.2	0.5	0.22
Total Hard Coral	1519	1611	1389	1231	1625	73.8	8.3	3.71
Pocilloporidae	14	13	66	18	14	1.3	1.2	0.51
Acroporidae	1242	1518	1251	1164	1551	67.3	8.8	3.95
Acropora spp.	252	98	411	524	441	17.3	8.5	3.80
Montipora spp.	990	1420	840	640	1110	50.0	14.7	6.56
Poritidae	0	27	51	10	0	0.9	1.1	0.48
Faviidae	26	12	0	0	0	0.4	0.6	0.26
Turbinaria spp.	15	0	0	0	0	0.2	0.3	0.15
Deep water corals	209	45	12	39	50	3.6	3.9	1.76
Total Soft Coral	10	55	25	55	65	2.1	1.2	0.52
GRAND MEANS								
Sargassum spp.						1.0	2.3	0.52
Algal turf						14.5	5.4	1.20
Sponges						0.9	1.7	0.38
Total Hard Coral						62.2	16.6	3.71
Pocilloporidae						1.3	0.8	0.19
Acroporidae						43.9	25.8	5.77
Acropora spp.						14.3	9.9	2.22
Montipora spp.						29.6	20.5	4.59
Poritidae						1.4	1.4	0.31
Faviidae						2.1	2.3	0.52
Turbinaria spp.						2.4	4.2	0.95
Deep water corals						11.7	13.6	3.03
Total Soft Coral						6.8	11.5	2.57

Data from five permanent 20m intersect line transects in cm with mean % cover

CAPE TRIBULATION: SUMMARY: LOCATION 3: November 1996

Transect #	1	2	3	4	5	mean	std.dev.	se
SITE 9								
Sargassum spp.	0	0	0	0	180	1.8	4.0	1.80
Algal turf	220	330	480	470	230	17.3	6.3	2.80
Sponges	12	0	0	25	0	0.4	0.6	0.25
Total Hard Coral	1258	1562	1018	991	1337	61.7	11.8	5.30
Pocilloporidae	55	37	21	84	0	2.0	1.6	0.72
Acroporidae	1051	1145	803	656	1232	48.9	12.0	5.39
Acropora spp.	281	755	153	366	232	17.9	11.8	5.26
Montipora spp.	770	390	650	290	1000	31.0	14.4	6.42
Poritidae	13	0	0	0	16	0.3	0.4	0.18
Faviidae	67	330	69	81	47	5.9	5.9	2.65
Turbinaria spp.	8	0	26	0	0	0.3	0.6	0.25
Deep water corals	131	373	151	236	42	9.3	6.2	2.79
Total Soft Coral	255	0	270	385	25	9.4	8.4	3.74
SITE 10								
Sargassum spp.	0	0	0	0	0	0.0	0.0	0.00
Algal turf	90	270	290	310	510	14.7	7.5	3.34
Sponges	0	22	0	0	0	0.2	0.5	0.22
Total Hard Coral	1838	1442	1333	1421	1305	73.4	10.7	4.80
Pocilloporidae	16	32	8	26	13	1.0	0.5	0.22
Acroporidae	1200	828	938	964	761	46.9	8.4	3.75
Acropora spp.	348	473	238	384	306	17.5	4.4	1.96
Montipora spp.	852	355	700	580	455	29.4	9.8	4.39
Poritidae	96	87	83	17	9	2.9	2.1	0.93
Faviidae	59	0	30	191	72	3.5	3.6	1.63
Turbinaria spp.	89	0	0	85	0	1.7	2.4	1.07
Deep water corals	425	449	262	306	472	19.1	4.7	2.08
Total Soft Coral	0	55	125	30	105	3.2	2.6	1.16
SITE 11								
Sargassum spp.	0	0	0	0	70	0.7	1.6	0.70
Algal turf	180	370	190	220	370	13.3	4.8	2.15
Sponges	0	0	0	0	0	0.0	0.0	0.00
Total Hard Coral	1483	1261	1496	1217	1226	66.8	7.0	3.14
Pocilloporidae	82	38	12	76	53	2.6	1.4	0.64
Acroporidae	1046	850	927	781	982	45.9	5.2	2.34
Acropora spp.	276	535	497	301	512	21.2	6.2	2.79
Montipora spp.	770	315	430	480	470	24.7	8.4	3.76
Poritidae	37	37	6	0	22	1.0	0.9	0.38
Faviidae	84	64	92	128	80	4.5	1.2	0.53
Turbinaria spp.	0	13	0	0	0	0.1	0.3	0.13
Deep water corals	226	270	545	290	135	14.7	7.6	3.42
Total Soft Coral	45	95	15	105	0	2.6	2.3	1.05
SITE 12								
Sargassum spp.	80	0	0	0	0	0.8	1.8	0.80
Algal turf	140	210	140	300	30	8.2	5.0	2.23
Sponges	0	0	0	0	0	0.0	0.0	0.00
Total Hard Coral	1529	1287	1564	1351	1907	76.4	12.1	5.41
Pocilloporidae	18	9	0	0	0	0.3	0.4	0.18
Acroporidae	1341	1121	1277	1117	1873	67.3	15.5	6.94
Acropora spp.	436	141	247	662	203	16.9	10.6	4.74
Montipora spp.	905	980	1030	455	1670	50.4	21.7	9.72
Poritidae	35	0	13	0	0	0.5	0.8	0.34
Faviidae	47	0	148	142	17	3.5	3.5	1.56
Turbinaria spp.	0	0	0	0	0	0.0	0.0	0.00
Deep water corals	126	157	274	228	34	8.2	4.6	2.08
Total Soft Coral	105	415	90	120	20	7.5	7.7	3.42
GRAND MEANS								
Sargassum spp.						0.8	2.2	0.50
Algal turf						13.4	6.5	1.44
Sponges						0.1	0.4	0.08
Total Hard Coral						69.6	11.4	2.55
Pocilloporidae						1.5	1.4	0.31
Acroporidae						52.2	13.5	3.02
Acropora spp.						18.4	8.2	1.84
Montipora spp.						33.9	16.7	3.74
Poritidae						1.2	1.5	0.34
Faviidae						4.4	3.8	0.84
Turbinaria spp.						0.6	1.3	0.30
Deep water corals						12.8	7.1	1.58
Total Soft Coral						5.7	6.2	1.38

Data from five permanent 20m intersect line transects in cm with mean % cover

CAPE TRIBULATION: SUMMARY: LOCATION 1: December 1997

Transect #	1	2	3	4	5	mean	std.dev.	se
SITE 1								
Sargassum spp.	50	40	110	110	0	3.1	2.4	1.07
Algal turf	430	610	690	1040	610	33.8	11.2	5.02
Sponges	0	11	0	4	0	0.2	0.2	0.11
Total Hard Coral	762	711	541	260	683	29.6	10.1	4.53
Pocilloporidae	28	87	59	36	61	2.7	1.2	0.52
Acroporidae	651	606	420	165	462	23.0	9.6	4.28
Acropora spp.	191	66	10	45	72	3.8	3.4	1.53
Montipora spp.	460	540	410	120	390	19.2	7.9	3.54
Poritidae	0	0	0	0	23	0.2	0.5	0.23
Faviidae	10	18	32	12	95	1.7	1.8	0.79
Turbinaria spp.	0	0	10	0	0	0.1	0.2	0.10
Deep water corals	10	0	34	0	42	0.9	1.0	0.44
Total Soft Coral	290	305	170	55	235	10.6	5.1	2.28
SITE 2								
Sargassum spp.	185	0	150	0	0	3.4	4.6	2.07
Algal turf	400	320	180	420	360	16.8	4.8	2.13
Sponges	0	0	0	0	0	0.0	0.0	0.00
Total Hard Coral	1120	1313	1319	1070	1191	60.1	5.6	2.51
Pocilloporidae	23	79	0	10	49	1.6	1.6	0.71
Acroporidae	939	1151	975	824	987	48.8	5.9	2.63
Acropora spp.	349	601	330	534	677	24.9	7.7	3.43
Montipora spp.	590	550	645	290	310	23.9	8.3	3.69
Poritidae	42	0	50	65	67	2.2	1.4	0.61
Faviidae	35	0	113	43	0	1.9	2.3	1.03
Turbinaria spp.	10	0	49	20	0	0.8	1.0	0.45
Deep water corals	35	83	187	156	88	5.5	3.0	1.36
Total Soft Coral	0	152	15	155	230	5.5	5.0	2.22
SITE 3								
Sargassum spp.	0	0	140	0	0	1.4	3.1	1.40
Algal turf	570	480	380	360	640	24.3	6.0	2.69
Sponges	0	0	0	0	0	0.0	0.0	0.00
Total Hard Coral	1024	1219	1459	1516	1100	63.2	10.8	4.85
Pocilloporidae	86	81	126	117	74	4.8	1.2	0.52
Acroporidae	925	1116	1073	907	859	48.8	5.6	2.50
Acropora spp.	270	306	153	77	239	10.5	4.6	2.08
Montipora spp.	655	810	920	830	620	38.4	6.3	2.81
Poritidae	0	22	0	55	0	0.8	1.2	0.54
Faviidae	0	0	72	109	95	2.8	2.6	1.16
Turbinaria spp.	0	0	0	0	0	0.0	0.0	0.00
Deep water corals	13	0	260	422	167	8.6	8.8	3.95
Total Soft Coral	60	0	55	135	0	2.5	2.8	1.24
SITE 4								
Sargassum spp.	40	270	0	20	20	3.5	5.6	2.52
Algal turf	430	340	320	640	510	22.4	6.6	2.94
Sponges	0	0	0	0	0	0.0	0.0	0.00
Total Hard Coral	1012	1067	1321	1243	1297	59.4	7.0	3.13
Pocilloporidae	61	38	0	52	37	1.9	1.2	0.52
Acroporidae	944	1009	1245	1156	1204	55.6	6.5	2.89
Acropora spp.	534	373	900	716	544	30.7	10.0	4.49
Montipora spp.	410	636	345	440	660	24.9	7.1	3.16
Poritidae	0	20	0	0	0	0.2	0.4	0.20
Faviidae	0	0	14	0	8	0.2	0.3	0.14
Turbinaria spp.	7	0	8	0	0	0.2	0.2	0.09
Deep water corals	0	0	54	35	48	1.4	1.3	0.58
Total Soft Coral	158	25	125	0	85	3.9	3.3	1.48
GRAND MEANS								
Sargassum spp.						2.8	3.9	0.87
Algal turf						24.3	9.4	2.09
Sponges						0.0	0.1	0.03
Total Hard Coral						53.1	16.1	3.60
Pocilloporidae						2.8	1.8	0.39
Acroporidae						44.0	14.3	3.20
Acropora spp.						17.5	12.8	2.85
Montipora spp.						26.6	10.0	2.24
Poritidae						0.9	1.2	0.28
Faviidae						1.6	2.0	0.45
Turbinaria spp.						0.3	0.6	0.13
Deep water corals						4.1	5.4	1.22
Total Soft Coral						5.6	4.9	1.10

Data from five permanent 20m intersect line transects in cm with mean % cover

CAPE TRIBULATION: SUMMARY: LOCATION 2: December 1997

Transect #	1	2	3	4	5	mean	std.dev.	se
SITE 5								
Sargassum spp.	0	40	20	0	0	**0.6**	**0.9**	**0.40**
Algal turf	140	160	180	190	280	**9.5**	**2.7**	**1.20**
Sponges	45	30	10	130	0	**2.2**	**2.6**	**1.16**
Total Hard Coral	882	655	485	1110	892	**40.2**	**12.0**	**5.38**
Pocilloporidae	30	37	25	22	47	**1.6**	**0.5**	**0.22**
Acroporidae	312	301	55	103	203	**9.7**	**5.8**	**2.58**
Acropora spp.	177	110	33	54	155	**5.3**	**3.1**	**1.39**
Montipora spp.	135	191	22	49	48	**4.5**	**3.6**	**1.59**
Poritidae	94	50	15	77	46	**2.8**	**1.5**	**0.68**
Faviidae	91	21	52	35	110	**3.1**	**1.9**	**0.84**
Turbinaria spp.	213	122	45	248	282	**9.1**	**4.9**	**2.17**
Deep water corals	142	112	231	690	246	**14.2**	**11.7**	**5.23**
Total Soft Coral	455	680	905	205	245	**24.9**	**14.8**	**6.62**
SITE 6								
Sargassum spp.	0	245	180	70	0	**5.0**	**5.5**	**2.46**
Algal turf	320	220	140	170	320	**11.7**	**4.2**	**1.87**
Sponges	0	0	0	0	0	**0.0**	**0.0**	**0.00**
Total Hard Coral	1424	1111	1518	1394	1327	**67.7**	**7.6**	**3.41**
Pocilloporidae	47	0	31	0	21	**1.0**	**1.0**	**0.45**
Acroporidae	697	883	878	293	1149	**39.0**	**15.8**	**7.07**
Acropora spp.	207	243	388	73	659	**15.7**	**11.2**	**4.99**
Montipora spp.	490	640	490	220	490	**23.3**	**7.6**	**3.40**
Poritidae	20	8	60	64	0	**1.5**	**1.5**	**0.67**
Faviidae	36	26	144	82	22	**3.1**	**2.6**	**1.16**
Turbinaria spp.	6	35	40	4	0	**0.9**	**0.9**	**0.42**
Deep water corals	646	159	469	1055	157	**24.9**	**18.8**	**8.40**
Total Soft Coral	0	25	20	35	0	**0.8**	**0.8**	**0.35**
SITE 7								
Sargassum spp.	0	0	0	0	0	**0.0**	**0.0**	**0.00**
Algal turf	210	310	190	450	270	**14.3**	**5.2**	**2.31**
Sponges	28	0	0	0	0	**0.3**	**0.6**	**0.28**
Total Hard Coral	1741	1682	1772	1375	1724	**82.9**	**8.1**	**3.62**
Pocilloporidae	22	8	50	0	40	**1.2**	**1.1**	**0.47**
Acroporidae	1393	1617	1525	1375	1684	**75.9**	**6.8**	**3.03**
Acropora spp.	563	527	975	435	484	**29.8**	**10.8**	**4.85**
Montipora spp.	830	1090	550	940	1200	**46.1**	**12.6**	**5.62**
Poritidae	31	0	8	0	0	**0.4**	**0.7**	**0.30**
Faviidae	26	15	11	0	0	**0.5**	**0.5**	**0.25**
Turbinaria spp.	108	0	0	0	0	**1.1**	**2.4**	**1.08**
Deep water corals	182	42	186	0	0	**4.1**	**4.7**	**2.12**
Total Soft Coral	15	0	30	140	0	**1.9**	**2.9**	**1.32**
SITE 8								
Sargassum spp.	0	0	0	0	0	**0.0**	**0.0**	**0.00**
Algal turf	540	310	270	330	350	**18.0**	**5.2**	**2.35**
Sponges	35	0	0	0	0	**0.4**	**0.8**	**0.35**
Total Hard Coral	1528	1505	1631	1639	1379	**76.8**	**5.3**	**2.38**
Pocilloporidae	18	32	73	8	20	**1.5**	**1.3**	**0.57**
Acroporidae	1265	1439	1488	1546	1320	**70.6**	**5.8**	**2.61**
Acropora spp.	405	159	518	656	745	**24.8**	**11.5**	**5.12**
Montipora spp.	860	1280	970	890	575	**45.8**	**12.6**	**5.65**
Poritidae	0	17	40	0	0	**0.6**	**0.9**	**0.39**
Faviidae	44	0	0	0	0	**0.4**	**1.0**	**0.44**
Turbinaria spp.	12	0	0	0	0	**0.1**	**0.3**	**0.12**
Deep water corals	198	17	12	85	39	**3.5**	**3.9**	**1.72**
Total Soft Coral	25	30	65	95	75	**2.9**	**1.5**	**0.67**
GRAND MEANS								
Sargassum spp.						**1.4**	**3.3**	**0.74**
Algal turf						**13.4**	**5.2**	**1.17**
Sponges						**0.7**	**1.5**	**0.34**
Total Hard Coral						**66.9**	**18.5**	**4.14**
Pocilloporidae						**1.3**	**1.0**	**0.21**
Acroporidae						**48.8**	**28.7**	**6.41**
Acropora spp.						**18.9**	**13.1**	**2.94**
Montipora spp.						**29.9**	**20.0**	**4.47**
Poritidae						**1.3**	**1.5**	**0.33**
Faviidae						**1.8**	**2.1**	**0.46**
Turbinaria spp.						**2.8**	**4.5**	**1.01**
Deep water corals						**11.7**	**13.8**	**3.09**
Total Soft Coral						**7.6**	**12.4**	**2.77**

Data from five permanent 20m intersect line transects in cm with mean % cover

CAPE TRIBULATION: SUMMARY: LOCATION 3: December 1997

Transect #	1	2	3	4	5	mean	std.dev.	se
SITE 9								
Sargassum spp.	0	0	0	0	180	**1.8**	**4.0**	**1.80**
Algal turf	410	370	460	410	240	**18.9**	**4.2**	**1.87**
Sponges	12	0	0	40	0	**0.5**	**0.9**	**0.39**
Total Hard Coral	1392	1547	1062	1091	1363	**64.6**	**10.4**	**4.66**
Pocilloporidae	54	30	12	93	17	**2.1**	**1.7**	**0.74**
Acroporidae	1231	1110	876	770	1255	**52.4**	**10.8**	**4.84**
Acropora spp.	441	820	246	420	295	**22.2**	**11.3**	**5.04**
Montipora spp.	790	290	630	350	960	**30.2**	**14.3**	**6.37**
Poritidae	0	0	0	0	0	**0.0**	**0.0**	**0.00**
Faviidae	73	367	77	58	62	**6.4**	**6.7**	**3.00**
Turbinaria spp.	0	0	0	0	0	**0.0**	**0.0**	**0.00**
Deep water corals	87	407	161	215	29	**9.0**	**7.3**	**3.25**
Total Soft Coral	270	0	310	355	90	**10.3**	**7.6**	**3.41**
SITE 10								
Sargassum spp.	0	20	0	0	0	**0.2**	**0.4**	**0.20**
Algal turf	240	230	350	330	490	**16.4**	**5.2**	**2.35**
Sponges	0	0	0	0	0	**0.0**	**0.0**	**0.00**
Total Hard Coral	1715	1423	1428	1742	1320	**76.3**	**9.5**	**4.26**
Pocilloporidae	20	24	0	32	12	**0.9**	**0.6**	**0.27**
Acroporidae	1079	1008	1020	1273	729	**51.1**	**9.8**	**4.36**
Acropora spp.	269	458	300	563	329	**19.2**	**6.2**	**2.76**
Montipora spp.	810	550	720	710	400	**31.9**	**8.1**	**3.64**
Poritidae	68	41	63	41	0	**2.1**	**1.3**	**0.60**
Faviidae	76	0	37	206	60	**3.8**	**3.9**	**1.75**
Turbinaria spp.	61	27	24	92	32	**2.4**	**1.5**	**0.65**
Deep water corals	487	323	294	278	535	**19.2**	**5.9**	**2.66**
Total Soft Coral	0	118	90	35	50	**2.9**	**2.3**	**1.04**
SITE 11								
Sargassum spp.	0	0	0	0	30	**0.3**	**0.7**	**0.30**
Algal turf	320	400	380	330	610	**20.4**	**5.9**	**2.63**
Sponges	25	0	0	0	0	**0.3**	**0.6**	**0.25**
Total Hard Coral	1399	1219	1488	1404	1057	**65.7**	**8.7**	**3.88**
Pocilloporidae	77	17	0	71	46	**2.1**	**1.7**	**0.75**
Acroporidae	976	829	978	932	871	**45.9**	**3.3**	**1.47**
Acropora spp.	266	519	678	252	301	**20.2**	**9.4**	**4.20**
Montipora spp.	710	310	300	680	570	**25.7**	**9.9**	**4.42**
Poritidae	42	22	32	0	0	**1.0**	**0.9**	**0.42**
Faviidae	70	55	68	126	35	**3.5**	**1.7**	**0.76**
Turbinaria spp.	10	13	0	16	0	**0.4**	**0.4**	**0.17**
Deep water corals	217	283	478	314	105	**14.0**	**6.8**	**3.06**
Total Soft Coral	35	135	30	95	0	**3.0**	**2.7**	**1.22**
SITE 12								
Sargassum spp.	190	0	0	0	0	**1.9**	**4.2**	**1.90**
Algal turf	270	270	300	330	110	**12.8**	**4.3**	**1.91**
Sponges	0	0	0	0	0	**0.0**	**0.0**	**0.00**
Total Hard Coral	1459	1354	1553	1445	1919	**77.3**	**11.0**	**4.92**
Pocilloporidae	22	0	12	24	28	**0.9**	**0.6**	**0.25**
Acroporidae	1314	1201	1278	1160	1828	**67.8**	**13.5**	**6.05**
Acropora spp.	424	141	268	730	218	**17.8**	**11.7**	**5.21**
Montipora spp.	890	1060	1010	430	1610	**50.0**	**21.1**	**9.44**
Poritidae	25	0	8	0	0	**0.3**	**0.5**	**0.24**
Faviidae	35	0	135	146	38	**3.5**	**3.3**	**1.46**
Turbinaria spp.	0	0	0	0	0	**0.0**	**0.0**	**0.00**
Deep water corals	98	153	255	246	63	**8.2**	**4.3**	**1.93**
Total Soft Coral	140	420	125	70	35	**7.9**	**7.6**	**3.41**
GRAND MEANS								
Sargassum spp.						**1.1**	**2.8**	**0.63**
Algal turf						**17.1**	**5.4**	**1.21**
Sponges						**0.2**	**0.5**	**0.12**
Total Hard Coral						**71.0**	**10.9**	**2.44**
Pocilloporidae						**1.5**	**1.3**	**0.29**
Acroporidae						**54.3**	**12.5**	**2.79**
Acropora spp.						**19.8**	**9.2**	**2.06**
Montipora spp.						**34.5**	**16.2**	**3.61**
Poritidae						**0.9**	**1.2**	**0.26**
Faviidae						**4.3**	**4.1**	**0.92**
Turbinaria spp.						**0.7**	**1.2**	**0.27**
Deep water corals						**12.6**	**7.3**	**1.63**
Total Soft Coral						**6.0**	**6.1**	**1.37**

Data from five permanent 20m intersect line transects in cm with mean % cover

CAPE TRIBULATION: SUMMARY: RUN-OFF LOCATIONS: October 1994

Transect #	1	2	3	4	5	mean	std.dev.	se
SITE 13								
Sargassum spp.	400	510	420	290	470	20.9	4.2	1.87
Algal turf	370	480	570	560	420	24.0	4.3	1.94
Sponges	0	25	0	15	0	0.4	0.6	0.26
Total Hard Coral	74	196	90	50	120	5.3	2.8	1.26
Pocilloporidae	0	0	0	0	0	0.0	0.0	0.00
Acroporidae	48	0	53	40	0	1.4	1.3	0.58
Acropora spp.	33	0	8	40	0	0.8	0.9	0.42
Montipora spp.	15	0	45	0	0	0.6	1.0	0.44
Poritidae	26	115	11	0	41	1.9	2.3	1.02
Faviidae	0	21	26	0	20	0.7	0.6	0.28
Turbinaria spp.	0	60	0	10	52	1.2	1.5	0.65
Deep water corals	0	0	0	0	7	0.1	0.2	0.07
Total Soft Coral	0	0	0	0	0	0.0	0.0	0.00
SITE 14								
Sargassum spp.	440	400	75	60	620	16.0	12.2	5.46
Algal turf	440	225	160	340	590	17.6	8.6	3.83
Sponges	150	22	45	250	48	5.2	4.8	2.14
Total Hard Coral	259	647	731	288	216	21.4	12.1	5.40
Pocilloporidae	0	8	7	0	0	0.2	0.2	0.09
Acroporidae	25	325	202	13	86	6.5	6.6	2.96
Acropora spp.	0	45	27	13	21	1.1	0.8	0.37
Montipora spp.	25	280	175	0	65	5.5	5.8	2.61
Poritidae	118	0	241	116	92	5.7	4.3	1.92
Faviidae	33	270	153	51	33	5.4	5.2	2.31
Turbinaria spp.	45	0	25	70	5	1.5	1.5	0.65
Deep water corals	17	91	142	48	0	3.0	2.9	1.29
Total Soft Coral	0	0	0	0	0	0.0	0.0	0.00
SITE 15								
Sargassum spp.	0	305	220	270	510	13.1	9.1	4.09
Algal turf	95	420	510	460	390	18.8	8.1	3.64
Sponges	210	20	35	90	50	4.1	3.8	1.71
Total Hard Coral	1024	518	688	625	441	33.0	11.3	5.03
Pocilloporidae	8	0	0	0	0	0.1	0.2	0.08
Acroporidae	202	202	215	203	160	9.8	1.1	0.47
Acropora spp.	52	0	122	18	55	2.5	2.3	1.04
Montipora spp.	150	202	93	185	105	7.4	2.4	1.07
Poritidae	126	67	106	173	124	6.0	1.9	0.86
Faviidae	331	95	64	163	42	7.0	5.8	2.61
Turbinaria spp.	313	67	253	57	115	8.1	5.8	2.58
Deep water corals	90	95	75	51	0	3.1	1.9	0.87
Total Soft Coral	71	40	0	0	0	1.1	1.6	0.72
SITE 16								
Sargassum spp.	480	570	630	590	490	27.6	3.2	1.45
Algal turf	310	160	365	360	305	15.0	4.1	1.86
Sponges	15	35	45	0	0	1.0	1.0	0.46
Total Hard Coral	505	593	478	622	227	24.3	7.8	3.49
Pocilloporidae	0	0	13	22	0	0.4	0.5	0.23
Acroporidae	217	366	198	234	97	11.1	4.8	2.15
Acropora spp.	7	6	73	62	62	2.1	1.6	0.73
Montipora spp.	210	360	125	172	35	9.0	6.0	2.68
Poritidae	35	87	10	9	0	1.4	1.8	0.79
Faviidae	76	35	98	218	107	5.3	3.4	1.52
Turbinaria spp.	160	0	0	25	0	1.9	3.5	1.56
Deep water corals	17	81	80	86	23	2.9	1.7	0.77
Total Soft Coral	0	0	0	0	0	0.0	0.0	0.00
SITE 17								
Sargassum spp.	0	0	90	0	110	2.0	2.8	1.23
Algal turf	65	145	220	50	225	7.1	4.1	1.85
Sponges	135	115	235	25	15	5.3	4.5	2.01
Total Hard Coral	1105	1231	952	1567	1196	60.5	11.3	5.07
Pocilloporidae	7	0	0	0	0	0.1	0.2	0.07
Acroporidae	113	114	258	612	861	19.6	16.6	7.43
Acropora spp.	0	0	61	0	34	1.0	1.4	0.62
Montipora spp.	113	114	197	612	827	18.6	16.4	7.32
Poritidae	112	42	179	58	202	5.9	3.6	1.59
Faviidae	207	31	46	10	36	3.3	4.0	1.79
Turbinaria spp.	477	722	347	744	22	23.1	14.9	6.65
Deep water corals	209	350	122	165	126	9.7	4.7	2.10
Total Soft Coral	0	8	8	0	0	0.2	0.2	0.10
GRAND MEANS								
Sargassum spp.						15.9	11.0	2.19
Algal turf						16.5	8.0	1.60
Sponges						3.2	3.8	0.76
Total Hard Coral						28.9	20.5	4.11
Pocilloporidae						0.1	0.3	0.05
Acroporidae						9.7	9.7	1.95
Acropora spp.						1.5	1.6	0.31
Montipora spp.						8.2	9.7	1.94
Poritidae						4.2	3.4	0.68
Faviidae						4.3	4.4	0.89
Turbinaria spp.						7.1	10.9	2.18
Deep water corals						3.8	4.1	0.82
Total Soft Coral						0.3	0.8	0.16

Data from five 20m intersect line transects in cm with mean % cover

CAPE TRIBULATION: SUMMARY: RUN-OFF LOCATIONS: November 1995

Transect #	1	2	3	4	5	mean	std.dev.	se
SITE 13								
Sargassum spp.	670	660	520	530	410	27.9	5.4	2.43
Algal turf	430	450	560	630	490	25.6	4.1	1.85
Sponges	55	35	0	23	0	1.1	1.2	0.53
Total Hard Coral	23	81	111	8	136	3.6	2.8	1.23
Pocilloporidae	0	6	0	0	0	0.1	0.1	0.06
Acroporidae	23	39	35	0	100	2.0	1.9	0.83
Acropora spp.	0	19	7	0	23	0.5	0.5	0.24
Montipora spp.	23	20	28	0	77	1.5	1.4	0.64
Poritidae	0	36	36	0	0	0.7	1.0	0.44
Faviidae	0	0	18	8	0	0.3	0.4	0.18
Turbinaria spp.	0	0	22	0	0	0.2	0.5	0.22
Deep water corals	0	36	0	0	36	0.7	1.0	0.44
Total Soft Coral	0	0	0	0	0	0.0	0.0	0.00
SITE 14								
Sargassum spp.	45	40	170	160	480	9.0	9.0	4.00
Algal turf	510	430	600	540	710	27.9	5.2	2.34
Sponges	231	95	108	85	10	5.3	4.0	1.78
Total Hard Coral	532	885	456	638	289	28.0	11.1	4.96
Pocilloporidae	0	0	0	0	0	0.0	0.0	0.00
Acroporidae	108	301	150	311	181	10.5	4.6	2.04
Acropora spp.	10	39	21	103	0	1.7	2.0	0.91
Montipora spp.	98	262	129	208	181	8.8	3.2	1.45
Poritidae	204	252	117	153	73	8.0	3.5	1.58
Faviidae	91	148	65	82	13	4.0	2.4	1.09
Turbinaria spp.	117	64	92	70	22	3.7	1.8	0.79
Deep water corals	100	266	44	30	10	4.5	5.2	2.32
Total Soft Coral	0	0	0	0	0	0.0	0.0	0.00
SITE 15								
Sargassum spp.	0	180	370	120	280	9.5	7.1	3.19
Algal turf	330	340	590	480	560	23.0	6.1	2.71
Sponges	76	45	62	85	50	3.2	0.8	0.38
Total Hard Coral	954	594	373	810	657	33.9	11.0	4.93
Pocilloporidae	0	0	18	12	0	0.3	0.4	0.19
Acroporidae	281	144	173	184	420	12.0	5.6	2.52
Acropora spp.	27	27	42	43	110	2.5	1.7	0.77
Montipora spp.	254	117	131	141	310	9.5	4.3	1.93
Poritidae	50	137	82	193	80	5.4	2.8	1.27
Faviidae	299	218	0	45	74	6.4	6.3	2.82
Turbinaria spp.	196	95	86	325	83	7.9	5.3	2.35
Deep water corals	170	245	21	54	80	5.7	4.6	2.05
Total Soft Coral	70	0	55	0	0	1.3	1.7	0.77
SITE 16								
Sargassum spp.	630	580	730	710	180	28.3	11.2	5.01
Algal turf	340	320	180	230	380	14.5	4.1	1.84
Sponges	0	0	0	15	79	0.9	1.7	0.77
Total Hard Coral	288	403	443	598	604	23.4	6.7	3.01
Pocilloporidae	0	0	0	0	22	0.2	0.5	0.22
Acroporidae	164	144	240	229	313	10.9	3.4	1.50
Acropora spp.	68	42	12	8	43	1.7	1.2	0.55
Montipora spp.	96	102	228	221	270	9.2	4.0	1.77
Poritidae	0	92	0	163	12	2.7	3.6	1.62
Faviidae	86	62	170	55	110	4.8	2.3	1.04
Turbinaria spp.	12	38	0	121	0	1.7	2.5	1.14
Deep water corals	26	74	33	38	116	2.9	1.9	0.84
Total Soft Coral	0	0	0	0	32	0.3	0.7	0.32
SITE 17								
Sargassum spp.	0	60	155	115	10	3.4	3.3	1.49
Algal turf	220	450	470	380	310	18.3	5.2	2.31
Sponges	146	132	100	30	132	5.4	2.3	1.05
Total Hard Coral	1253	884	915	923	1060	50.4	7.7	3.43
Pocilloporidae	0	30	0	0	0	0.3	0.7	0.30
Acroporidae	113	383	347	488	380	17.1	6.9	3.10
Acropora spp.	23	0	28	35	0	0.9	0.8	0.36
Montipora spp.	90	383	319	453	380	16.3	7.0	3.12
Poritidae	250	107	301	201	45	9.0	5.2	2.33
Faviidae	151	172	53	22	238	6.4	4.4	1.98
Turbinaria spp.	629	175	192	202	285	14.8	9.5	4.26
Deep water corals	138	39	22	10	187	4.0	3.9	1.76
Total Soft Coral	0	0	0	0	0	0.0	0.0	0.00
GRAND MEANS								
Sargassum spp.						15.6	12.8	2.55
Algal turf						21.9	6.7	1.35
Sponges						3.2	2.9	0.58
Total Hard Coral						27.8	17.3	3.46
Pocilloporidae						0.2	0.4	0.08
Acroporidae						10.5	6.6	1.33
Acropora spp.						1.5	1.5	0.29
Montipora spp.						9.0	6.2	1.24
Poritidae						5.2	4.5	0.91
Faviidae						4.4	4.1	0.83
Turbinaria spp.						5.7	7.1	1.42
Deep water corals						3.6	3.8	0.76
Total Soft Coral						0.3	0.9	0.18

Data from five 20m intersect line transects in cm with mean % cover

CAPE TRIBULATION: SUMMARY: RUN-OFF LOCATIONS: November 1996

Transect #	1	2	3	4	5	mean	std.dev.	se
SITE 13								
Sargassum spp.	970	910	860	920	1270	**49.3**	**8.2**	**3.66**
Algal turf	580	600	530	410	190	**23.1**	**8.5**	**3.78**
Sponges	30	0	65	55	20	**1.7**	**1.3**	**0.59**
Total Hard Coral	30	49	291	321	394	**10.9**	**8.3**	**3.72**
Pocilloporidae	0.	8	0	0	0	**0.1**	**0.2**	**0.08**
Acroporidae	0	0	72	143	215	**4.3**	**4.7**	**2.09**
Acropora spp.	0	0	26	50	13	**0.9**	**1.0**	**0.47**
Montipora spp.	0	0	46	93	202	**3.4**	**4.2**	**1.88**
Poritidae	0	19	95	116	71	**3.0**	**2.5**	**1.10**
Faviidae	27	18	50	62	92	**2.5**	**1.5**	**0.66**
Turbinaria spp.	3	4	74	0	16	**1.0**	**1.6**	**0.70**
Deep water corals	0	0	0	88	0	**0.9**	**2.0**	**0.88**
Total Soft Coral	0	0	0	0	0	**0.0**	**0.0**	**0.00**
SITE 14								
Sargassum spp.	0	390	740	430	190	**17.5**	**13.9**	**6.21**
Algal turf	690	470	530	390	680	**27.6**	**6.6**	**2.93**
Sponges	130	55	130	15	97	**4.3**	**2.5**	**1.12**
Total Hard Coral	561	427	209	643	219	**20.6**	**9.8**	**4.39**
Pocilloporidae	0	0	0	0	0	**0.0**	**0.0**	**0.00**
Acroporidae	194	203	81	229	74	**7.8**	**3.7**	**1.63**
Acropora spp.	43	52	0	37	34	**1.7**	**1.0**	**0.44**
Montipora spp.	151	151	81	192	40	**6.2**	**3.1**	**1.37**
Poritidae	122	69	34	119	41	**3.9**	**2.1**	**0.94**
Faviidae	82	102	54	89	8	**3.4**	**1.9**	**0.84**
Turbinaria spp.	78	0	40	17	96	**2.3**	**2.0**	**0.90**
Deep water corals	158	53	0	227	21	**4.6**	**4.8**	**2.17**
Total Soft Coral	0	0	0	0	0	**0.0**	**0.0**	**0.00**
SITE 15								
Sargassum spp.	290	490	500	530	540	**23.5**	**5.1**	**2.30**
Algal turf	300	490	280	620	470	**21.6**	**7.1**	**3.18**
Sponges	145	140	85	65	75	**5.1**	**1.9**	**0.84**
Total Hard Coral	563	522	776	442	698	**30.0**	**6.8**	**3.02**
Pocilloporidae	10	0	0	24	37	**0.7**	**0.8**	**0.36**
Acroporidae	267	280	366	169	555	**16.4**	**7.3**	**3.25**
Acropora spp.	87	64	39	16	107	**3.1**	**1.8**	**0.81**
Montipora spp.	180	216	327	153	448	**13.2**	**6.1**	**2.73**
Poritidae	234	95	107	195	28	**6.6**	**4.1**	**1.84**
Faviidae	20	137	277	54	78	**5.7**	**5.1**	**2.26**
Turbinaria spp.	254	33	37	56	41	**4.2**	**4.8**	**2.13**
Deep water corals	44	10	262	25	0	**3.4**	**5.5**	**2.45**
Total Soft Coral	0	0	0	0	0	**0.0**	**0.0**	**0.00**
SITE 16								
Sargassum spp.	1250	660	610	790	830	**41.4**	**12.6**	**5.65**
Algal turf	160	90	210	290	230	**9.8**	**3.8**	**1.69**
Sponges	30	60	0	0	110	**2.0**	**2.3**	**1.04**
Total Hard Coral	478	587	793	373	423	**26.5**	**8.3**	**3.73**
Pocilloporidae	0	21	0	0	26	**0.5**	**0.6**	**0.29**
Acroporidae	322	427	414	254	293	**17.1**	**3.8**	**1.69**
Acropora spp.	85	107	64	118	51	**4.3**	**1.4**	**0.63**
Montipora spp.	237	320	350	136	242	**12.9**	**4.2**	**1.87**
Poritidae	67	37	90	75	18	**2.9**	**1.5**	**0.66**
Faviidae	49	102	208	44	86	**4.9**	**3.3**	**1.48**
Turbinaria spp.	133	32	0	12	82	**2.6**	**2.8**	**1.23**
Deep water corals	40	35	121	0	18	**2.1**	**2.3**	**1.04**
Total Soft Coral	0	0	0	0	0	**0.0**	**0.0**	**0.00**
SITE 17								
Sargassum spp.	0	30	0	0	0	**0.3**	**0.7**	**0.30**
Algal turf	280	230	150	120	130	**9.1**	**3.5**	**1.56**
Sponges	44	115	100	65	140	**4.6**	**1.9**	**0.86**
Total Hard Coral	1135	1112	1528	1399	1548	**67.2**	**10.5**	**4.69**
Pocilloporidae	16	0	0	0	0	**0.2**	**0.4**	**0.16**
Acroporidae	72	0	106	163	112	**4.5**	**3.0**	**1.35**
Acropora spp.	0	0	0	10	0	**0.1**	**0.2**	**0.10**
Montipora spp.	72	0	106	153	112	**4.4**	**2.9**	**1.28**
Poritidae	33	147	57	66	0	**3.0**	**2.7**	**1.22**
Faviidae	182	103	238	254	102	**8.8**	**3.6**	**1.61**
Turbinaria spp.	644	465	827	701	1120	**37.6**	**12.2**	**5.45**
Deep water corals	188	458	363	338	316	**16.6**	**4.9**	**2.18**
Total Soft Coral	0	0	0	0	0	**0.0**	**0.0**	**0.00**
GRAND MEANS								
Sargassum spp.						**26.4**	**19.8**	**3.95**
Algal turf						**18.2**	**9.5**	**1.89**
Sponges						**3.5**	**2.3**	**0.47**
Total Hard Coral						**31.0**	**21.2**	**4.24**
Pocilloporidae						**0.3**	**0.5**	**0.11**
Acroporidae						**10.0**	**7.2**	**1.44**
Acropora spp.						**2.0**	**1.9**	**0.38**
Montipora spp.						**8.0**	**5.8**	**1.16**
Poritidae						**3.9**	**2.9**	**0.57**
Faviidae						**5.0**	**3.8**	**0.75**
Turbinaria spp.						**9.5**	**15.4**	**3.08**
Deep water corals						**5.5**	**6.9**	**1.39**
Total Soft Coral						**0.0**	**0.0**	**0.00**

Data from five 20m intersect line transects in cm with mean % cover