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