The biological status of fringing reefs in the Great Barrier Reef World Heritage Area

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Fringing coral reefs occur along the coast and around inshore islands throughout most of the Great Barrier Reef (GBR) region. If terrestrial human activities are degrading reefs in the GBR region then this effect is most likely to be felt on these fringing reefs. Impacts of most concern are nutrient enrichment from fertiliser and sewage run-off, increased siltation and increased turbidity from disturbed river catchments, but anchor damage is increasingly seen as a threat to fringing reefs in heavily used areas. Some fringing reef areas are close to large centres of population and are likely to be subjected to general industrial pollution in addition to those more widespread impacts mentioned above. Over the past 15 years surveys of the state of fringing reefs have been made over much of the GBR region, in areas ranging from Cape Flattery (14.9°S) to the Keppel Islands (23.2°S). Most of these studies have presented quantitative data on the percentage cover of benthic organisms, and also made some attempt to measure biodiversity (Ayling and Ayling 1991a, 1995a, 1995b, 1996 and unpublished data; Kaly et al. 1993; Mapstone et al. 1989; van Woesik 1992). Some studies have looked at changes in community structure on fringing reefs over time periods of from 4-10 years (Ayling and Ayling 1995b, 1995c; Kaly et al. 1993). This paper presents a summary of the results from these surveys and discusses the current state of these fringing reef areas in the light of the information currently available.

These studies used replicate 20 m transects to measure benthic cover, either line intersect transects (see Ayling and Ayling 1996 for full description), 20 m video belt transects (Kaly et al. 1993), or a combination of line intersect transects and belt transects (van Woesik 1992).

The majority of fringing reefs in the GBR region (> 95%) are algal dominated on the reef flat and the upper few metres of the reef slope (Fig. 1), with extensive stands of *Sargassum* spp. and a dense turf of smaller algal species covering over 50% of the substratum (Ayling and Ayling 1991a, 1991b). Hard corals generally cover only around 5% of the substratum on the reef flat. Hard coral cover increases rapidly down the reef slope, and at a depth of five m below Australian Height Datum (AHD: approximately the level of the lowest spring tides) cover of living corals is usually between 40 and 80% (Fig. 1). On some fringing reefs in the area of big tides between Mackay and Port Clinton, where maximum tide range is more than 5 m, macroalgae often cover more than 50% of the substratum to depths well below the normal 2-4 m below AHD, sometimes down to 8 m or more (Ayling and Ayling 1996; van Woesik 1992).

Coral cover is usually very high on the reef slope of fringing reefs, with the exception of reefs within the big tide area mentioned below (Table 1). Grand mean coral cover from over 100 sites between Cape Flattery and Keppel Islands was almost 62%. In comparison grand mean cover from the 110 sites within the big tide area was only 25%, although individual sites from this area had over 60% cover (Ayling and Ayling 1996). The reasons for the lower coral cover in the big tide area are unclear, but probably relate to turbidity and siltation caused by strong tidal currents, rather than to lower temperatures (Ayling and Ayling 1996; van Woesik 1992).

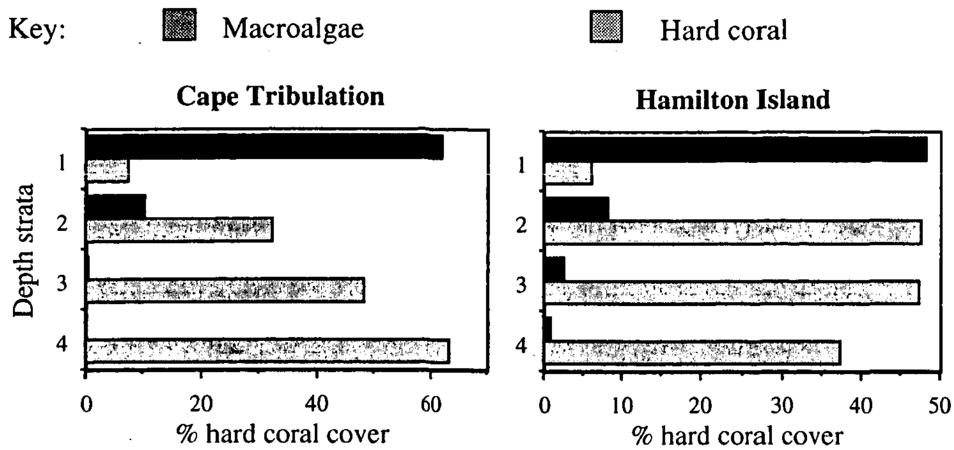

Figure 1. Depth stratification in fringing reef communities. Two typical examples are shown. For Cape Tribulation (Ayling and Ayling 1991a) depth strata are: 1 - reef flat; 2 - reef crest 0-1 m below AHD; 3 - reef slope 2-4 m; 4 - slope 4-6 m. Hamilton Island (Ayling and Ayling 1991b): 1 - flat; 2 - crest 0-1 m; 3 - slope 4-6 m; 4 - slope 10-12 m.

Table 1. Summary of hard coral cover on GBR fringing reef slopes. Figures show grand mean percentage cover from groups of 20 m line transects. [1]Ayling and Ayling unpublished data; [2]Ayling and Ayling 1991a; [3]Ayling and Ayling 1995a; [4]Kaly et al. 1993; [5]Ayling and Ayling 1995b; [6]Ayling and Ayling 1996; [7]van Woesik 1992. na = not available.

Region	Date	Latitude °S	No. sites	Hard coral cover mean	sd
Cape Flattery[1]	Feb 1996	14.9	5	**46.2**	12.2
Cape Tribulation[2]	Nov 1995	16.0	12	**60.0**	12.5
Cairns Section Nth[3]	Jan 1995	16.5	34	**81.0**	7.5
Magnetic Island[4]	Aug 1993	19.2	36	**48.4**	18.8
Middle Reef[4]	Aug 1993	19.2	5	**74.6**	3.9
Hamilton Island[5]	Mar 1995	20.3	6	**54.4**	5.7
Sir James Smith Gp.[7]	1991	20.7	56	**22.0**	na
Northumberland Is.[7]	1991	21.5	20	**11.7**	na
Shoalwater Bay[6]	Dec 1995	22.3	34	**37.8**	16.2
Keppel Islands[7]	1991	23.2	8	**54.3**	na

Coral cover on fringing reefs is usually dominated by acroporids on the upper slope (60-80% of total coral cover). Explanate *Montipora* spp. are usually more important than *Acropora* spp., accounting for between 50-90% of acroporid cover. In deeper water (more than 5 m 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 and Ayling 1996). Poritid corals usually only cover 1-2% of the substratum on fringing reefs, but occasionally a site will be encountered that supports large areas of these corals, usually *Porites* massive or *Porites rus* colonies. Examples of high poritid cover fringing reefs are the south side of Snapper Island and Normanby Island in the Frankland Island Group south of Cairns (Ayling and Ayling 1995a).

A comparison of fringing reef coral cover measurements with those recorded on offshore reefs is interesting (Table 2). Grand mean coral cover from 330 sites recorded throughout the GBR region over the past 5 years is only around 30%. This is half of that from fringing reefs outside

the strong tide area, and only marginally higher than that from fringing reefs in the strong tide area.

Table 2. Comparative coral cover on offshore reefs. Grand mean coral covers from: [1]data from AIMS long term monitoring program (personal communication from W. Oxley); [2]data from Bramble Reef replenishment area survey (Ayling and Ayling 1996b); [3]data from CRC Effects of Fishing survey (Ayling and Ayling unpublished data)

Region	Date	No. survey reefs	Total no. sites	Hard coral cover
				mean
GBR (AIMS reefs)[1]	1993-94	34	102	**23**
Offshore Townsville[2]	Aug 1995	7	84	**29**
Lizard Is. to Swains[3]	late 1995	24	144	**37**

Fringing reefs are also diverse. Over 140 species of hard corals were recorded from the Cape Tribulation fringing reefs (Veron 1987), while between 50 and 100 species were recorded on each of 15 Cairns Section fringing reefs in only an hour search (Ayling and Ayling 1995a). A 2 hour search of one site on Dent Island in the Whitsunday Group recently recorded over 130 species of hard corals (Ayling and Ayling 1995b).

Another feature of fringing reefs is that there are many large coral colonies in reef slope communities (Ayling and Ayling 1991b, 1995a, 1996). Notable examples include *Acropora* staghorn colonies 30-50 m across, tabulate *Acropora* colonies 3-5 m across, massive *Porites* heads over 10 m diameter, *Goniopora* colonies 20-30 m across, a *Pavona minuta* colony 15 m across and over 5 m high and *Turbinaria* colonies over 5 m in diameter. Although large colonies are sometimes seen on offshore reefs they occur more frequently on fringing reefs.

Over the past decade there has been no evidence of any decrease in hard coral cover, or change in coral composition, on fringing reefs that have been subject to more than one survey (Fig. 2). Changes recorded have been from 51% (1985) to 60% (1995) on 12 reefs in the Cape Tribulation area (Ayling and Ayling 1995c); from 56% (1988) to 88% (1995) from two sites on the north side of Snapper Island (Ayling and Ayling 1995a); from 43% (1989) to 44% (1993) from 12 sites around Magnetic Island (Kaly et al. 1993); and from 47% (1990) to 57% (1995) on nine sites around Hamilton Island (Ayling and Ayling 1991b, 1995b). There have also been no significant increases in algal cover on the reef slopes in these locations over the same period (Ayling and Ayling 1995c). Although there are no historical data from the reef slopes of fringing reefs with which to compare these data over a longer time period, i.e. > 15 yrs, there is to date no evidence of continuing degradation in coral communities on fringing reefs.

The available evidence suggests that the recovery of coral cover on fringing reefs after major disturbance is very rapid. During the monitoring program established on Cape Tribulation fringing reefs to look at the effects of sediment run-off from road construction, cyclonic waves and a bleaching event caused a major reduction in coral cover over two successive years (Fig. 2, Cape Tribulation 1985-1988). In the following 12 months, in the absence of any disturbance, coral cover increased by 33%, from 37.5 to 49.8% (Ayling and Ayling 1991a).

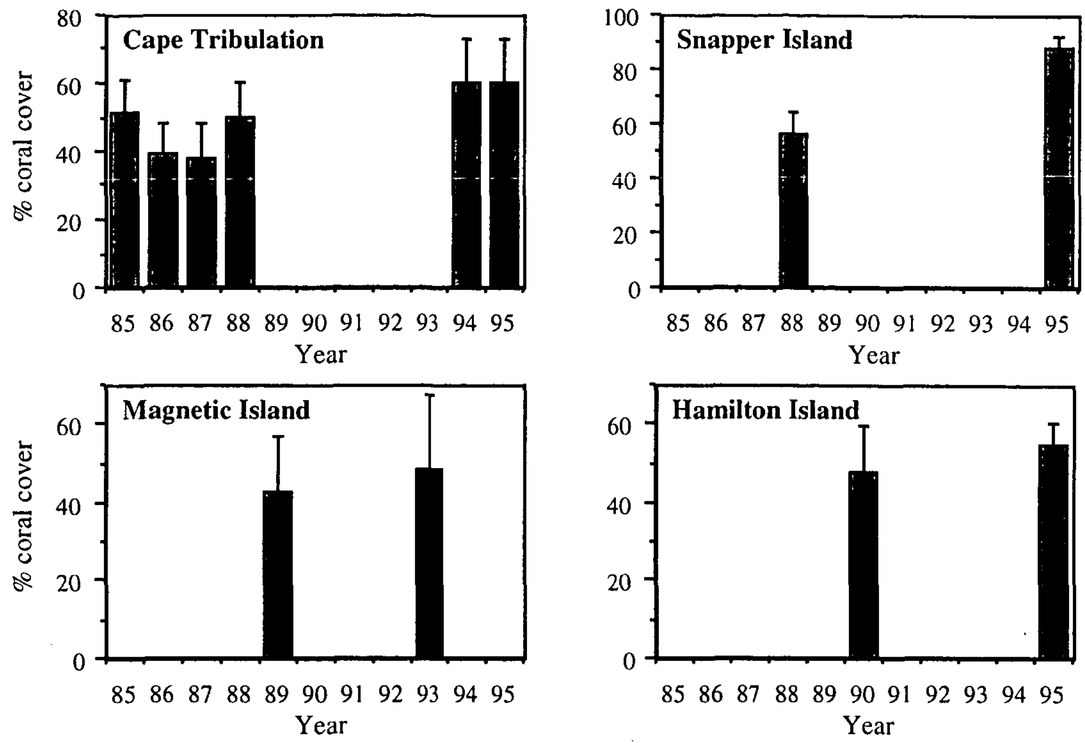

Figure 2. Changes in coral cover on fringing reefs: 1985-1995. Data summarised from: Cape Tribulation - Ayling and Ayling 1995c; Snapper Is. - unpublished data and Ayling and Ayling 1995a; Magnetic Is. - Kaly et al. 1993; Hamilton Is. - Ayling and Ayling 1991b, 1995b. Error bars are standard deviations.

In summary, fringing reef slopes support high cover of hard corals, are relatively diverse in terms of number of coral species present, have many large, old coral colonies, and recover quickly from major disturbance episodes. There is no evidence to date, either that coral cover is decreasing in any fringing reef area, or that algal cover is increasing. All this suggests that fringing reefs are not presently being degraded by the terrestrial derived impacts mentioned previously. However, it is important to continue long-term monitoring of fringing reef areas, as these communities will undoubtable be affected by nutrient enrichment, or increased siltation before offshore reefs. Management response, if degradation of fringing reefs is shown to be occurring in the future, is complicated by the fact that the major 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.

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