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Characteristics and Significance of a Sub-tropical 'Low Wooded Island': Green Island, Moreton Bay, Australia

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ABSTRACT

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Green Island, Moreton Bay (latitude 27°25′S), lies 9° south of the highest latitude previously reported for low wooded islands, which are noteworthy among reef islands for their geomorphic complexity and rarity. Green Island's geomorphic and ecological characteristics closely resemble those of low wooded islands (LWIs) of the northern Great Barrier Reef. Those characteristics which differ from the northern Great Barrier Reef examples can be largely explained by biological response to the latitudinal temperature gradient and to the low energy environment. As a low wooded island 1 200 km south of the southern-most LWI on the GBR and close to the latitudinal limits of both coral reef growth and high mangrove diversity, Green Island may be unique. Previously, low wooded islands have been reported only from coral reef environments between latitude 18°N and 16°23′S, on high elevation reef flats close to mainland coasts. Although a serious threat to Green Island's geomorphic and ecological integrity (ie. coral dredging) has been averted, management provisions to ensure the preservation of this complex reef island require enhancement.

ADDITIONAL INDEX WORDS: *Coral reef, coral cay, coral dredging, mangrove, reef island.*

INTRODUCTION

Low wooded islands (STEERS, 1929) are formed in coral reef environments and have particular distributional, energetic, morphological and ecological characteristics. They have played a major role in the development of scientific understanding of coral reefs as a result of the choice of Low Isles, the southern-most low wooded island (LWI) on the Great Barrier Reef (GBR), as the site of the 1928–1929 Great Barrier Reef Expedition. Results of this expedition were published over several decades and provided a basis for coral reef research world-wide (HOPLEY, 1982).

In the first half of this century considerable debate arose as to the origin of LWIs and their various geomorphic components, and their place in a reef island formation sequence. This debate was largely resolved by STODDART (1965) who concluded that LWIs could be explained in terms of exposure conditions and reef geometry, were not a transitional stage in the formation of other island types and did not require resort to tectonic or eustatic movements for explanation. All of these discussions were based on LWIs which occurred within a narrow latitudinal band straddling the equator.

In this paper, the distribution of LWIs is outlined and a model of their geomorphic and ecological characteristics, based on descriptions from the northern GBR, is presented. Hereinafter, this model, based largely on STODDART *et al.,* 1978 and HOPLEY, 1982, will be referred to as the GBR model. The characteristics of Green Island, Moreton Bay, Australia some 11° south of Low Isles are described and contrasted with the GBR model. The objectives of this paper are: (i) to determine whether Green Island is best classified as a Low Wooded Island, and (ii) to outline the significance of this classification.

Study Area

Green Island (Figure 1) lies in Moreton Bay, on the east coast of Australia at latitude 27°25′S (Figure 2). The bay is 150 km long (north to south) and about 15 km wide at the northern end where it opens to the South Pacific Ocean. It is enclosed on its eastern margin by large islands of Pleistocene and Holocene dune sands (dune-island barriers (STEPHENS, 1982). The southern bay is congested with low deltaic mangrove islands. In the central bay there are several high islands of similar lithology to the adjacent mainland. Green Island lies in the more open, northern bay, 5 km from the mainland and 20 km west of the adjacent dune-island barrier. Prevailing winds are from the southeast, with an available fetch of 20 km to Green Island. The island is also exposed to significant wave energy from the north because of greater fetch in that direction and because Moreton Bay is open to the ocean in the north. The close proximity of the extensive dune-island barriers and the low cyclone frequency (LOURENSZ, 1981) result in wave energies at Green Island which are lower than those of the LWIs of the northern GBR, although wave energies outside the bay are considerably greater than those in the GBR lagoon (HOPLEY, 1982). Tidal range at springs is 1.8 m (*cf.* about 2.5 m for the northern GBR). Carbonate deposits on a Tertiary basalt core form the island's reef platform (JONES *et al.,* 1978). Although Green Island lies at the poor quality end of a strong gradient of the environmental conditions conducive to coral growth (JOHNSON and

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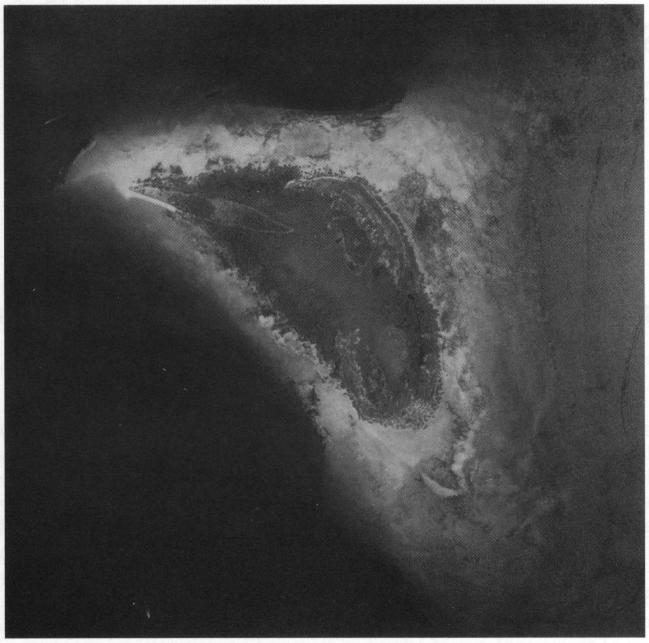

Figure 1. Vertical airphoto of Green Island (photograph courtesy of Brisbane City Council).

NEIL, 1998), there is active coral growth around the subtidal margins of the reef flat (NEIL and MCEWAN, 1991).

GLOBAL AND REGIONAL DISTRIBUTION OF LOW WOODED ISLANDS

The documented global distribution of this island type is restricted to sites in Jamaica (STEERS, 1940), British Honduras, now Belize, (STODDART, 1965) and Java (VERSTAPPEN, 1954), with the greatest morphological complexity evident in the low wooded islands of the northern Great Barrier Reef (STODDART *et al.,* 1978; HOPLEY, 1982). This distribution lies entirely between latitude 18°N and 16°23′S. SALOMON (1980) describes complex, high latitude (21°S), biogenic reef islands on the southwest coast of Madagascar. However, the geomorphology of these islands differs considerably from the LWIs of the northern GBR (GUILCHER, 1988).

On a regional scale, LWIs develop on reef platforms of relatively high elevation, in areas protected from high energy waves and close to mainland coasts. Reef platform elevations decrease offshore in the northern Great Barrier Reef and wave energy is reduced behind the outer reefs. Consequently, on the GBR 95% of LWIs lie between 11° and 15°S (HOPLEY, 1982), with none more than 16°23′S, and 94% are within 20 km of the mainland coast (STODDART *et al.,* 1978). LWIs are absent from the central GBR, probably due to a high tidal range (>4 m) and high incidence of cyclones. Their absence from the southern GBR is attributed to greater exposure to ocean swells in this region than in the north (HOPLEY, 1982). On the other hand, reef islands, including LWIs, are poorly developed in areas of very low wave energy because insufficient energy is available to fragment corals except during ex-

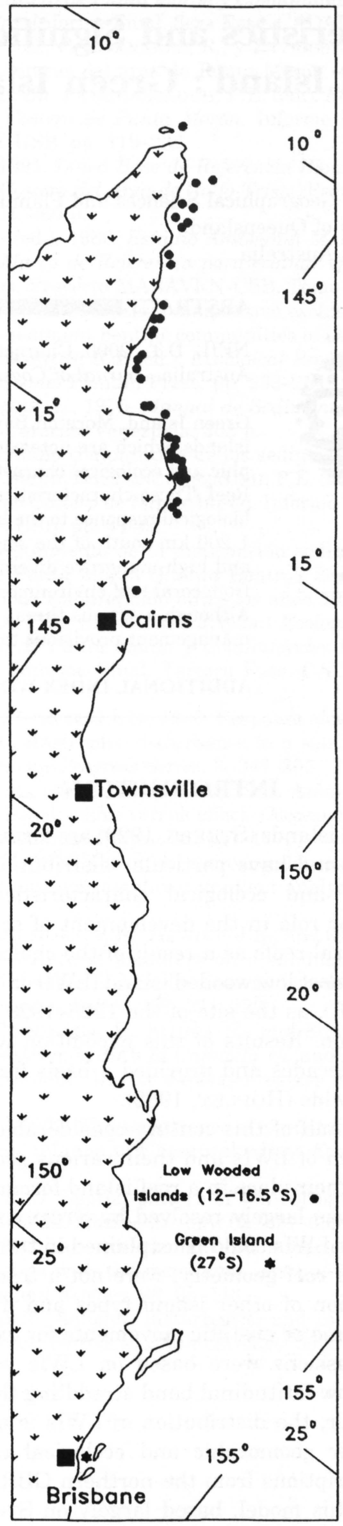

Figure 2. Distribution of low wooded islands on the northern Great Barrier Reef, and the location of Green Island, Moreton Bay (based on Hopley, 1982).

treme events, or to build supra-tidal sedimentary structures (STODDART, 1965). The pattern of distribution of LWIs in the GBR region, concentrated in the north and absent in the centre and south, is shown in Figure 2.

COMPARISON OF GREEN ISLAND WITH THE LOW WOODED ISLANDS OF THE NORTHERN GREAT BARRIER REEF

In this section, the geomorphic and ecological characteristics of Green Island are compared with those of the descriptive model (GBR model) of the low wooded islands of the northern Great Barrier Reef. The area of the Green Island reef top is 1.9 km^2, about 60% larger than LWIs of the northern GBR (1.22 ± 0.27 km^2, n = 22; STODDART *et al.,* 1978), although three of these are much larger (3.2, 3.3 and 5.4 km^2) than Green Island. The mangrove area on Green Island is 0.56 km^2 compared with 0.16 ± 0.05 km^2 on northern GBR LWIs. On average the mangrove area of the northern GBR LWIs is c. 14% of the area of the reef top, whereas at Green Island about 30% is mangrove covered. The total area of the supra-tidal islands on Green Island is 0.14 km^2, 7.5% of the reef top.

Reef Flat Characteristics

The GBR Model

On northern GBR LWIs, the reef flat slopes seaward, dries at low tide and has no algal ridges at the seaward margin. It has a cover of green and brown algae and corals are uncommon. Inshore of the reef flat, and best developed on the windward side, are shingle ramparts, often with shingle tongues extending further inshore and with *Acropora spp.* detritus the major constituent. The ramparts may form a moat which may be colonised by corals, Tridacnid clams or mangroves.

A boulder zone may be present, generally on the leeward reef flat either adjacent to the reef edge or the shore of the sand cay, with boulders (mainly individual coral colonies) thrown up by storm wave action.

Green Island

The Green Island reef flat slopes seaward and dries at low tide. There are no algal ridges at the seaward margin. In this respect it is consistent with the LWI morphology. However, cover on the reef flat differs in that there are extensive, though generally sparse, seagrass beds on the eastern and northern sides (seagrass beds also occur on reef flats of northern GBR LWIs). There is a bare reef flat with coral rubble from the southwest to northwest. There is no shingle rampart evident on Green Island (a feature also absent from about 30% of LWIs on the northern GBR (STODDART *et al.,* 1978)), and consequently there is no associated moat structure.

Reef Island Characteristics

The GBR Model

A drying shingle island, constructed of overlapping and coalescing shingle ridges, forms the first (windward) terrestrial environment of the islands of the GBR model. These shingle islands may be vegetated or unvegetated, depending largely on the time since deposition.

Toward the leeward reef flat, in the region of refracted wave focusing, a sand cay is constructed by wave action. Leeward cays on LWIs may be unvegetated or vegetated, and may be largely surrounded by mangroves or separate from them. Sand cays of the northern GBR often have an outer low terrace seaward of a higher one, the difference in elevation being about 1.05 m (BUCKLEY, 1988). The two morphological units are distinguished by elevation, soil development and sedimentology (STODDART *et al.,* 1978), the lower terrace being a relatively recently aggraded unit. Beach rock is often associated with the sand cay or shingle island.

Green Island

The major geomorphic and ecological features of Green Island are illustrated in Figure 3, and Figure 4 presents cross-sections of each of the three islets showing the major topographic features and associated vegetation. The morphology of the islet on the southeast of the reef flat is predominantly a series of parallel sediment tongues, roughly normal to the alignment of the seaward reef flat margin and connected at their windward ends. Variations in soil development indicate significant age differences between these sediment tongues. Vegetation on this islet is a littoral thicket including *Casuarina* and *Pandanus* species.

There are two nested ridge sequences on the northeast of the reef flat, three ridges in the inner sequence and two in the outer. Soil development shows clearly the much greater age of the inner sequence, which has a notophyll littoral rainforest cover with epiphytes and lianes. The contrast with the vegetation of the outer ridge, which is similar to that on the sediment tongues of the southeast islet, confirms the much younger age of the outer ridge. A series of vegetated sediment tongues extend landward from the outer islet, their orientations varying systematically with the aspect of the adjacent reef flat. The northern and southern ends of the inner ridge sequence and the northern extremity of the outer ridge sequence each have well-developed recurved spits. Aerial photographs show that the spit at the northern end of the outer ridge sequence has prograded about 150 m during the period 1958–1991, in a similar manner to the spit progradation which often occurs on shingle ridges of LWIs of the northern GBR.

Morphologically, the ridges and tongues of the southeast and northeast islets of the Green Island reef flat are quite consistent with the documented morphology of shingle ridges and tongues on LWIs, as is the postulated age sequence. However, the sedimentology differs. Each of the ridges and tongues is largely composed of coarse sand and granular particles (Figure 5), rather than the predominantly pebble-sized particles found on northern GBR windward islands (MCLEAN and STODDART, 1978). This difference may in part be the result of a higher proportion of the sediments being composed of shell, rather than coral, detritus than on islands of the northern Great Barrier Reef.

Sediments in the size range 2.0 to 2.8 mm were sorted into three biogenic provenance classes ('coral', 'shell', and 'other').

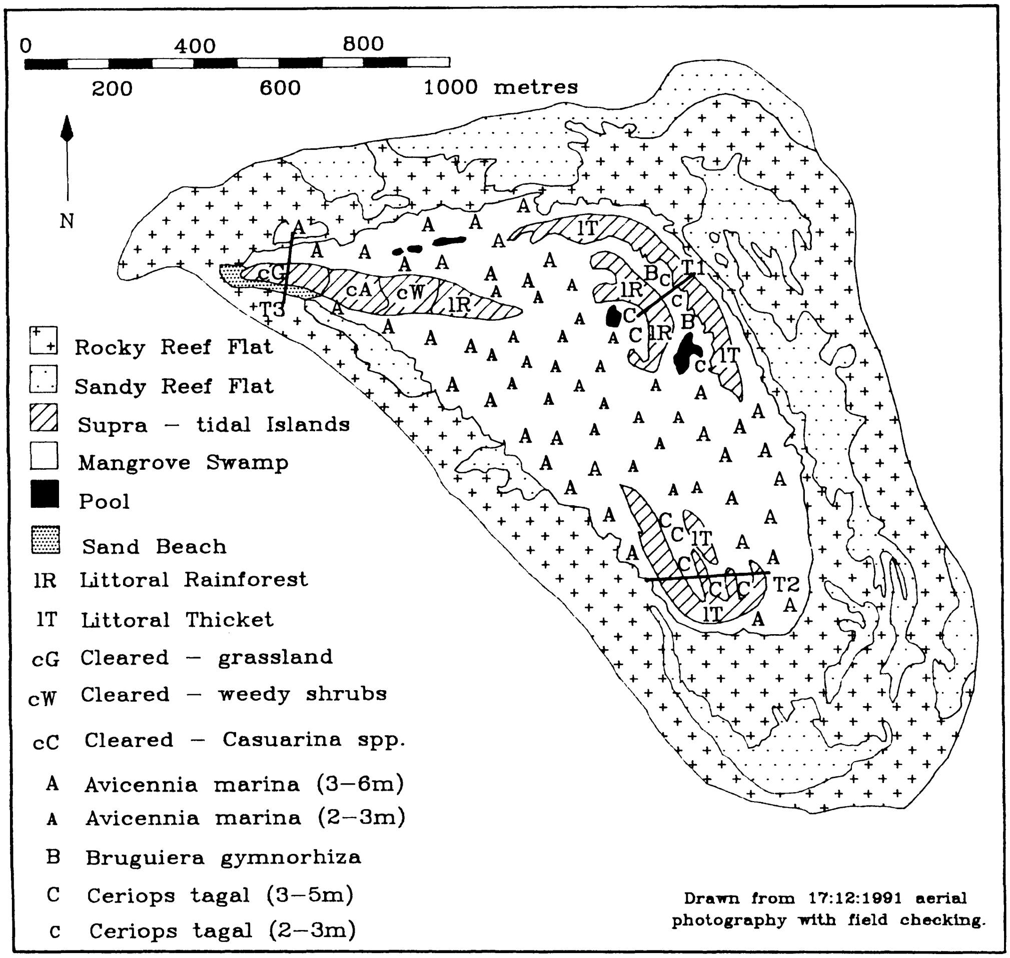

Figure 3. Geomorphic and ecological features of Green Island.

Coral and shell detritus comprised about 88% of the sediments analysed, the coral:shell ratio being 1.27:1 (n = 22). There is some evidence that the coral:shell ratio has declined with time. The ratio for older sediments with strong pedogenesis in the core of the northeast islet is 1.36:1 (n = 6), whereas for recently deposited sediments with minimal pedogenesis at the islet margins it is 0.84:1 (n = 4). This result is consistent with a decline in water quality during the late Holocene reducing the vigour of coral growth (JOHNSON and NEIL, 1998).

A leeward sand cay has accumulated on the Green Island reef flat with a low terrace surrounding a central, higher island core. The elevation difference between the upper and lower terrace is 1 m on the southern side of the cay. This morphology is consistent with the GBR model. The sand cay is about 720 m long and 90 m wide at its greatest width. These dimensions compare with 316 ± 54 m and 135 ± 25 m, respectively, for discrete sand cays of LWIs of the northern GBR (STODDART *et al.*, 1978), showing that the Green Island sand cay is considerably more elongated than those of the northern GBR (L:W = 8, cf. L:W = 2.3). The mangrove swamp largely surrounds the sand cay. Sequential aerial photographs and field observation show that marked changes in the morphology of the unvegetated, leeward end of the cay occur in response to variations in wind direction, as occurs on sand cays of the GBR (FLOOD, 1986; 1988). Natural vegetation on the cay, remnants of which occur at its eastern end, is littoral rainforest, similar to that of the inner northeast islet. The soils of the island core (Munsell colour typically 10YR 2.5/1) are also similar to those of the inner northeast islet. Lower terrace soils are clearly younger (typically 10YR 6/2) and similar to those of the outer, northeast islet. Beach rock is not exposed at Green Island, although it does occur in Moreton Bay and is exposed at St Helena Island, 3 km to the north.

Mangrove Community Characteristics

The GBR Model

In the lee of the shingle ridges a mangrove swamp of widely varying extent may develop, dependent on the location and dynamics of the shingle island and ramparts and their to-

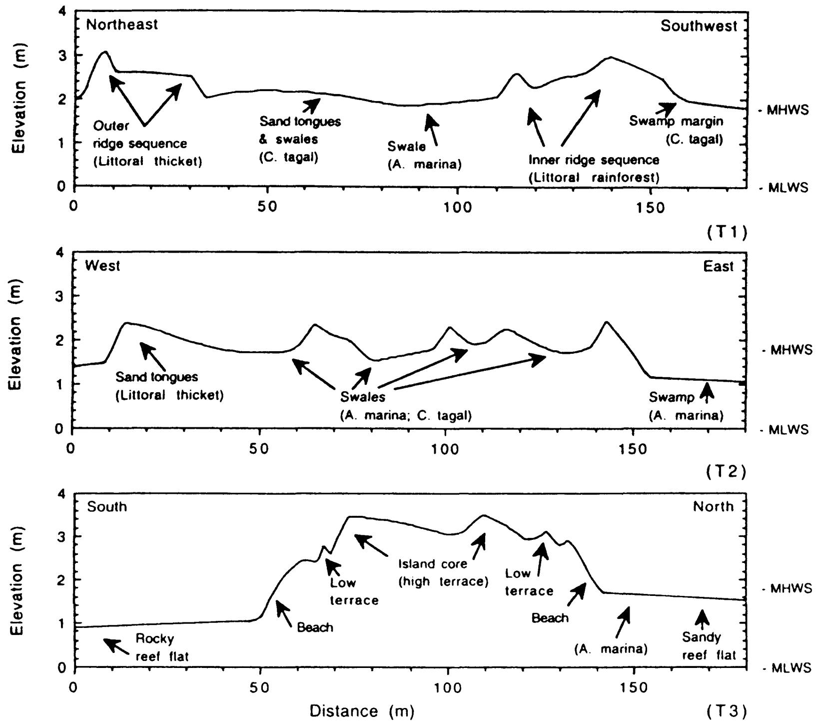

Figure 4. Cross-sections of Green Island showing the major topographic features and associated vegetation (T1–T3 refer to transects shown on Fig. 3).

pography. Within the mangrove swamp a vegetation toposequence is common: *Avicennia marina* (with some *Aegialitis annulata*) occurs at the exposed margins, *Rhizophora stylosa* is dominant over most of the vegetated area of the reef top (with a few *Sonneratia alba*), at higher elevations *Ceriops tagal* with *Bruguiera* and *Xylocarpus* species and at the highest elevations *Osbornia octodonta* and *Excoecaria agallocha* are most common (STODDART *et al.,* 1978).

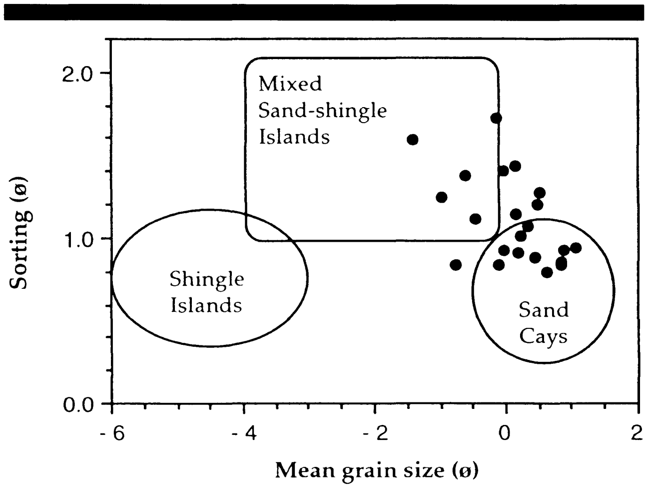

Figure 5. Grain size characteristics of Green Island sediments (black dots), compared with those from northern GBR reef islands (based on McLean and Stoddart, 1978).

Green Island

An extensive mangrove swamp, 0.56 km^2 in area, occupies the reef flat area partially enclosed by the three islets. Four species of mangrove occur in the swale between the inner and outer ridge sequences of the northeast islet. *C. tagal, B. gymnorrhiza* and *E. agallocha* occur at higher elevations immediately in the lee of the outer sequence and on the sediment tongues, with an *A. marina* -dominated mangal to their leeward (Figure 3). The toposequence observed and the high species richness (by comparison with the mangrove swamp proper) leeward of the windward ridge is consistent with the GBR model. The toposequence is also consistent with patterns of mangrove zonation in relation to elevation elsewhere in southern Queensland (LEAR and TURNER, 1977; DAVIE, 1983).

In the lee of the southeast islet and of the inner ridge of the northeast islet are dense stands of *C. tagal.* The remainder of the mangrove swamp area is dominated by *A. marina* which reaches a height of >5 m at the outer margins, but is a low (2–3 m), stunted shrubland in the interior. A few individuals of *C. tagal* and *R. stylosa* also occur in the mangrove swamp. The characteristics of the mangrove swamp on Green Island are generally consistent with the GBR model but differ in a number of interesting respects.

On LWIs of the GBR the dominant species of the mangrove swamp is *R. stylosa,* although this is not invariably the case. On Turtle Island, for example, the dominant species is *C. tagal* (HOPLEY, 1982). The dominant species in mangrove communities of northeastern Australia is *R. stylosa,* replaced by *A. marina* south of about 26°S (DAVIE, 1983) due to the higher productivity of *A. marina* at cooler temperatures (DAVIE, 1983; HUTCHINGS and SAENGER, 1987). The replacement of *R. stylosa* by *A. marina* in the Green Island mangrove swamp is apparently a consequence of these species' differing physiological response to the latitudinal temperature gradient.

Fifteen species of mangrove occur on GBR low wooded islands (STODDART, 1980) by comparison with a regional species richness of 28 (LEAR and TURNER, 1977). Seven of these 28 species occur in Moreton Bay (CLIFFORD and SPECHT, 1979). The relatively low species diversity on Green Island (five observed) by comparison with LWIs of the northern GBR is apparently a function of diversity decline with increasing latitude.

On Green Island the *A. marina* community completely encloses the northeast and southeast (windward) islands which apparently does not occur on the northern GBR LWIs, although isolated individuals and clumps of mangroves do colonise reef flats. This ability of the Green Island *A. marina* community to colonise the windward reef flat, which also occurs on adjacent islands, may be a result of the low energy wave environment of Moreton Bay. Entrapment of coarse sediments in the pneumatophores of these trees, which extend up to 20 m seaward of their canopy, also acts to reduce the particle size of sediments forming the windward ridge sequences.

Enclosed pools occur on four of 23 LWIs on the northern GBR (STODDART *et al.*, 1978). Although there are many pools on Green Island obscured beneath the mangrove canopy, there are five pools visible on air photos in which dead trees in growth position indicate that, at least in part, they were formerly vegetated. The pools are generally 0.20–0.40 m deep in mangrove swamp sediments which are consistently ≥0.90 m thick. By comparison, sediments colonised by *A. marina* on the inner reef flat are generally 0.15–0.20 m thick.

DISCUSSION AND CONCLUSIONS

Status and Significance

The Green Island complex is consistent with the general geomorphic and ecological characteristic of northern GBR low wooded islands previously described. It differs with respect to the characteristics of the reef flat and the composition of sediments in the windward islands. It is likely that differences in water quality (colder and more turbid in western Moreton Bay by comparison with the northern GBR) have resulted in markedly different sub-tidal faunal assemblages and therefore differences in the type of sediment supplied to the reef flat and islands. Lower wave energies may result in smaller calibre sediment supply as insufficient energy is available to shift large particles above water level (STODDART, 1965), although evidence from Mud Island, 10 km to the north, shows that large coral boulders up to 0.95 m in diameter and weighing 36 kg may form supratidal ridges after disturbance by dredging (*pers. obsv.*). Composition and distribution of mangrove communities at Green Island differ from those of the GBR model in ways which can be explained by differing wave energies and latitudinal variation in climate, particularly temperature. When these factors are taken into account, the mangrove community is consistent with the pattern observed in LWIs.

It is concluded that Green Island is a low wooded island similar to those of the northern Great Barrier Reef and exhibiting the morphological complexity which sets the north Queensland low wooded islands apart from similar landforms elsewhere in the world (STODDART *et al.*, 1978). It appears to lie on a continuum which is interrupted in the central GBR by high energy and tidal range conditions and the absence of suitable reef platforms. To the extent that the area of the mangrove swamp calibrates the evolutionary phase of a low wooded island (STODDART, 1980; STEERS, 1937; FAIRBRIDGE and TEICHERT, 1948), Green Island represents a completely developed example. It has unique geomorphic and ecological characteristics which are a function of its particular location. Given the absence of reports of low wooded islands in subtropical locations and exhibiting these characteristics, Green Island as a holistic geomorphic and ecological system may be unique.

The significance of the Green Island ecosystem arises from a number of factors. Firstly, it is significant as a completely developed example of a low wooded island, 9°S of the maximum latitude previously reported. Secondly, it exists close to the latitudinal limits of photic coral growth and of high mangrove species richness.

A third factor relates to the characteristics of Moreton Bay itself. In the absence of extensive reef growth at this latitude combined with high wave energies, Green Island, in its present form, owes its existence to the offshore dune-island barriers in their role as breakwaters. There are no similar embayments at higher latitude on either the east or west Australian coasts.

In addition, Green Island is of geomorphic significance because its particular characteristics (wave climate, sediment type) differ sufficiently from the northern GBR examples to provide an opportunity to better understand geomorphic processes on reef islands generally. Terrace elevations on the northern GBR have been used to make inferences about past environments (BUCKLEY, 1988) and similar features on Green Island have the potential to extend this analysis. Green Island's biogeographical significance arises from its latitudinal position as a reef island at the overlap of tropical and temperate floras. More significantly, however, recent investigations have revealed much greater species richness in the island floras of the northern GBR, and greater contrasts between northern and southern GBR reef island floras than previously recognised (FOSBERG and STODDART, 1991; STODDART and FOSBERG, 1991). Lying to the south of the GBR, but with similarities to the northern GBR reef islands in terms of distance from the mainland and morphology, research at Green Island has the potential to enhance understanding of the biogeography of reef island flora and fauna. Green Island is also a potentially suitable site for monitoring geomorphic and ecological responses to possible global sea-level rise, as previously discussed for coral atoll (ROY and CONNELL, 1991) and mangrove (ELLISON and STODDART, 1991) systems.

Use and Management

Human impacts on the terrestrial environment of Green Island have been concentrated on the northwest islet. Proposals to establish a resort there in the mid-nineteenth century came to nothing. Apart from a fisherman and his family, who lived on the islet in the period 1923–1930, Green Island has remained uninhabited (LUDLOW, 1997). The northwest islet has been used as a picnic area by members of the recreational boating community over the last century. Most of the endemic littoral rainforest has been cleared from the northwest islet and infestations of introduced weed species occur on each of the islets (JOHNSON *et al.,* 1993). *Opuntia* and *Lantana* sp. have apparently been present on the northwest islet since at least 1912 (FINGER, 1987).

The most significant threat to the integrity of the Green Island ecosystem was the granting of mining leases for extraction of limestone by dredging the intertidal and subtidal reef flat, notwithstanding the presence of live corals in the area. Justification for this was partly on the basis of reports that total mortality of corals occurred during the major flood of January, 1974. However, field observations indicate that many colonies survived this event. Furthermore, recovery of the Green Island coral community since the 1974 flood has resulted in densities of live coral colonies up to 1 m^{-2} in some areas (NEIL and MCEWAN, 1991).

The likely consequences of coral dredging at Green Island are indicated by the effects of coral dredging at Mud Island, 10 km north of Green Island. Coral rubble, mobilised by the dredging operation, has been transported to the inner reef flat forming ridges up to c. 2 m high around the margins of the mangroves (ALLINGHAM and NEIL, 1995). Hydrological and sedimentation regimes in the lee of these ridges have been markedly altered as a result. Tidal circulation in the mangrove communities has been reduced leading to extensive mangrove mortality (HEGERL, 1991; ALLINGHAM and NEIL, 1995). It is also likely that the dredging permanently modifies the supply of natural sediments to the island and constructs a sediment sink around the island perimeter. In turbid Moreton Bay waters, corals have only a limited ability to recolonise the −5 to −7 m platform left after dredging. These factors, in association with the adverse effects of dredging on coral growth due to sedimentation (DODGE, *et al.,* 1974; DODGE and VAISNYS, 1977) suggest that dredging could lead to catastrophic modification of the, possibly unique, Green Island system, the geomorphic features and mangrove communities of which are presently unaltered by human impact. Surrender of the Green Island leases in 1997 has averted this threat to the integrity of the system.

Human impacts on the marine environment of Green Island and its reef are largely undocumented but include anchor damage to corals (HARRISON *et al.,* 1991) and displacement of the dugong (*Dugong dugon*). Reduction of the dugong population in western Moreton Bay, whether by past hunting pressure (FAIRHOLME, 1856) or present-day disturbance by boat traffic (PREEN, 1992), is likely to have changed seagrass community characteristics over the last 150 years. Dugong grazing ("cultivation" grazing (PREEN, 1992, 1995)) encourages growth of the seagrass *Halophila ovalis,* and retards the expansion of *Zostera capricorni* (PREEN, 1992, 1995).

Degradation of benthic communities, particularly coral and seagrass, is a likely consequence of the deteriorating water quality of adjacent catchments. It seems likely that the critical period for sedimentation effects resulting from land clearing for agriculture was the first few decades of the twentieth century (NEIL, 1998), although there is also evidence for increases in river turbidity since the 1940s, largely due to urbanisation and river dredging (STOCK and NELLER, 1990). NEIL (1998) estimated an increase in flow-weighted mean sediment concentration from 150 mg/L to 525 mg/L as a consequence of anthropogenic disturbance of adjacent catchments. The major threat to future water quality in the waters adjacent to Green Island arises from increased nutrient inputs. Agricultural use of fertilisers increased markedly in the 1960s, with some tapering off in the rate of increase in the 1990s (NEIL, 1998). MCEWAN *et al.* (1998) predict chlorophyll *a* increases at reef sites in Moreton Bay of the order of 40 to 60% over the next three decades. A marked decline in the viability of Green Islands coral communities is likely if the increasing nutrient input trend is not arrested.

The *Moreton Bay Strategic Plan* (ANON., 1993) contained provisions for the protection of Green Island's terrestrial and mangrove ecosystems. However, coral dredging was permitted on leases within a "Special Management" zone which covered the eastern half of the reef flat and reef slope. Subsequent lobbying by local government and non-government organisations resulted in abandonment of these leases by the mining company prior to commencement of coral dredging. The recently gazetted *Moreton Bay Marine Park Zoning Plan* (ANON., 1997), subordinate legislation to the Queensland *Marine Parks Act 1982*, zones Green Island as Conservation Park Zone. The stated purpose of the zone is to conserve the resources, amenity, and natural condition of the environment so designated, to allow members of the public to enjoy the relatively undisturbed nature of the zone and to ensure ecologically sustainable use of the zone's natural resources. This zone prohibits trawl fishing, restricts jet skis to (undefined) navigation channels, disallows carrying out of organised events and tourism programs and construction of "facilities". In practice, these provisions result in little difference between the patterns of resource utilisation at Green Island and the majority of the area of Moreton Bay which is zoned as General Use, the least restrictive zone. There are no provisions such as catch limits or restrictions on boat disturbance which are likely to contribute to sustainability or recovery, although taking of marine products (such as corals) is not permitted. There are no provisions under the zoning scheme for managing water quality at reef sites such as Green Island, although some progress in relation to water quality is likely given effective implementation of the Brisbane River and Moreton Bay Waterways Management Plan (ANON., 1998).

Furthermore, few resources have been allocated for the management of this system or the rehabilitation of Green Island's damaged terrestrial environments. Such a commitment seems warranted given the particular significance of this complex reef/reef island system.

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