Chapter 1 THE CAY

LOCATION AND DIMENSIONS

Green Island (16°45'S, 145°59'E), 27 kilometres north-east of Cairns [Fig.1.1], is a vegetated sand cay on a planar reef (Hopley, 1982). The dimensions of the cay vary between publications, which is probably due in part to real changes in sediment distribution and in part to the adoption of differing definitions of the cay's boundary between authors.

Stoddart *et al.* (1978) utilised a compass-and-pacing method to survey Green Island in 1973 and estimated the total sand mass forming the cay to have maximum dimensions of 690m x 300m, covering an area of 13.91ha. Kuchler (1978) adopted the extent of an undefined parameter - the nearshore sand accumulation shoreline - as a measure of cay size. From aerial photographs, nearshore sand accumulation areas were estimated for several years within the 1936 - 1978 period [Table 1.1]. Both the Green Island Management Committee (1980) and the Australian Littoral Society (1982) list the cay's area as approximately 12ha, with a circumference of about 1.6km and maximum dimensions of 660m x 260m (the long axis lying roughly east-west). These dimensions appear to be derived from a Lands Department of Queensland report and thus would be relative to Mean High Water Level. The Australian Littoral Society (1990) lists an undated area of 12ha.

The Beach Protection Authority (1989) give the cay dimensions as a maximum length of 650m and a maximum width of 300m (with the major axis oriented approximately east-south-east to west-north-west), with an area of approximately 15ha above Mean Sea Level and a circumference of 1.6km. From a study of the behaviour of Green Island, the Beach Protection Authority (1989) concluded that there had been a progressive and steady loss of sand from the cay between 1980 and 1988, with about 1000m^3 per year lost. Some of this loss was attributed to accretion occurring in deeper water at the north-western corner of the cay, with the other possible losses to the reef flat west of the cay and into the navigation channel and swing basin.

Table 1.1 Areas and dimensions of Green Island cay and associated features

VEG = vegetated area; B'ROCK = exposed beachrock area; MAX DIM = maximum cay dimensions. K = from Kuchler (1978); S = from Stoddart *et al.* (1978); GIMC/ALS = from Green Island Management Committee (1980) and Australian Littoral Society (1982); BPA = from Beach Protection Authority (1989), ALS90 = from Australian Littoral Society (1990).

YEAR	CAY (ha)	VEG (ha)	B'ROCK (ha)	MAX DIM (m)
1936 (K)	15.6		0.006	
1945 (K)	16.5	10.8		
1946 (K)	15.6			
1950 (K)	15.6		0.025	
1959 (K)	14.4	10.8	0.039	
1963 (K)		10.8		
1964 (K)	16.1			
1969 (K)	16.2			
1972 (K)	16.5	11.6	0.069	
1973 (K)			0.068	
1973 (S)	13.9	11.7	0.854	690x300
1975 (K)	17.5	11.5		
1976 (K)	19.1			
1976 (K)	18.2			
1978 (K)	19.1	11.7	0.085	
Undated:				
GIMC/ALS	12			660x260
BPA	15			650x300
ALS90	12			

Variations in datum levels adopted by authors may also lead to some confusion when comparing elevations listed in different publications. The Australian Littoral Society (1982) gives the maximum elevation as 4.5m above Mean High Water Springs, while Stoddart *et al.* (1978) refer to distinct terraces at 3.5-4.0m and 4.3m above Mean Lower Low Water Springs. There is a considerable difference between these datum levels - the Department of Harbours and Marine (1989) lists the level of Mean High Water Springs at Green Island as 2.2m above Local Low Water Datum (Mean Lower Low Water Springs). The Australian Littoral Society (1990) gives the elevation as 5m, with no reference to datum level.

GEOMORPHOLOGY

The Green Island Management Committee (1980) described soil on the cay as calcareous sandy loam, with the top 10 - 20m of the cay surface a fairly porous layer of dead coral and algae overlying a reasonably consolidated older reef surface. However, the source of this information is not given and I have been unable to locate any specific investigation into the geological structure of Green Island cay. Gourlay (pers. comm.) suggests it is the Holocene reef deposits which are likely to be 10 - 20m thick and overlie the consolidated Pleistocene reef surface. Stoddart *et al.* (1978) noted the presence of superficial broken phosphorites under the 'dense broadleaf woodland' in the centre of the cay.

Beachrock has formed through lithification along most of the southern and north-eastern sides of the cay [Fig.1.2] (Green Island Management Committee, 1980; Beach Protection Authority, 1989). Kuchler (1978) calculated the areas of exposed beachrock apparent in a number of aerial photographs in the 1936 - 1978 period [Table 1.1]. Using their compass-and-pacing method, Stoddart *et al.* (1978) estimated the 1973 beachrock cover to be 0.85ha - an order of magnitude higher than the estimates of Kuchler (1978). While beachrock is exposed and covered regularly due to wind and wave action, thus leading to seasonal and annual variations in exposed area, I suspect that one of the above publications carries a typographical error.

Kuchler (1978) noted that the lower of the terraces described by Stoddart *et al.* (1978) was absent on the windward (southern) side of the cay, where the beach was steep with extensive well-cemented beachrock. On the leeward (northern) side, the beach profile was slightly convex with patchy less-cemented beachrock formed lower into the inter-tidal zone.

The Beach Protection Authority (1989) described the southern side of the cay as exposed beachrock, partially covered by sand at the eastern end. At the eastern end of the northern shoreline, the sandy shoreline landward of the exposed beachrock had eroded to the extent that High Water Mark was beneath overhanging vegetation including established trees. The western end of the northern shoreline was described as an accreting sandy beach, with a sandy bulge or spit at the north-western tip of the cay. The western side comprised a sandbag and rubble seawall approximately 150m in length, with the nearshore sand seaward of the wall sloping gradually towards the mooring basin adjacent to the jetty.

A dredged channel led in a westerly direction from the head of the jetty to the reef edge and a small beach existed to the north of a groyne at the south-western corner of the cay.

VEGETATION

The Green Island Management Committee (1980) describes the vegetation on Green Island as that of a closed vine forest similar to those of tropical mainland Queensland.

Stoddart *et al.* (1978), from their compass-and-pace survey, estimated the 1973 vegetation coverage to be 11.7ha (84% of the cay area). Table 1.1 includes the vegetated areas for several years within the 1936 - 1978 period, as estimated from aerial photographs by Kuchler (1978). Although Stoddart *et al.* (1978) recorded 114 species of vascular plants at Green Island, the published species lists I have located - in Kuchler (1978), Green Island Management Committee (1980) and Cornelius (1982) - cover a maximum of 90 species (listed in Appendix 1). There is no indication within these reports of the relative abundances of the various species.

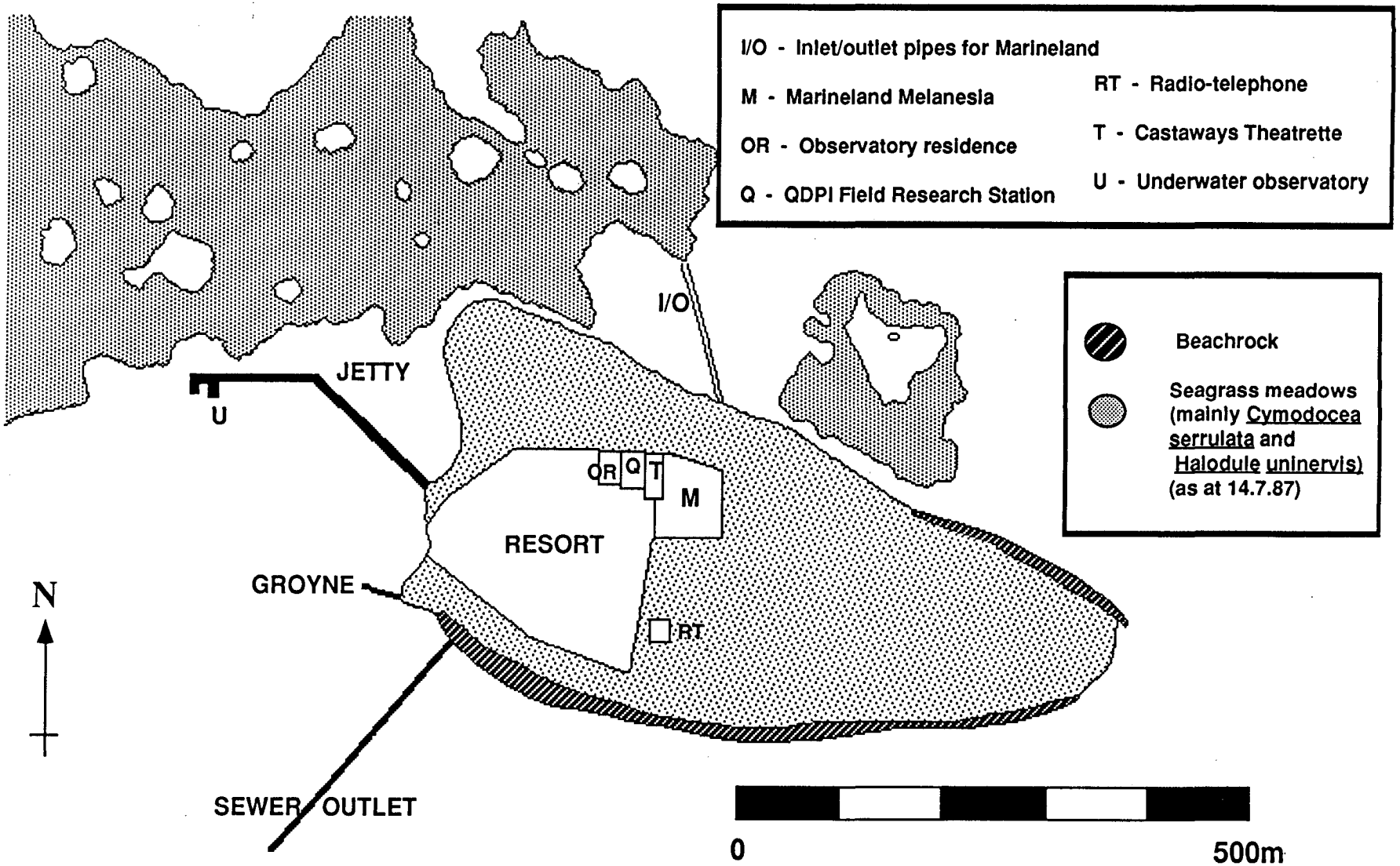

Figure 1.2 Green Island, showing leases and geomorphological features

The majority of the cay's present-day vegetation has presumably developed only since the late 1850s. According to Jones (1976), one of the first settlers on the cay cleared its centre in 1857 and planted seeds from the Sydney Botanical Gardens. By the 1880s, beche-de-mer fishermen had apparently accounted for all the timber and shoulder-high burrs covered the cay, making it possible to overlook the whole area (Jones, 1976). Coconuts were planted in 1889 (Green Island Management Committee, 1980). In 1937, Green Island was declared a National Park (Jones, 1976) but the Park's caretaker subsequently felled some of the vegetation and is reported to have set fire to the whole cay in a very dry year (Kuchler, 1978).

FAUNA

Birds

Appendix 2 lists the species of birds recorded for Green Island in Kikkawa (1976), Kuchler (1978) and Australian Littoral Society (1982). Thirteen species of seabirds were recorded, with no significant breeding taking place on the cay. Of the 38 species of land and shore birds occurring, 7 breeding colonies were identified. These were the Reef Heron, White-breasted Sea Eagle, Torres Strait Pigeon (estimated 3500 - 4500 birds), Grey-breasted Silver-eye, Yellow-breasted Sunbird, Mangrove Honeyeater and White-breasted Wood-swallow (Australian Littoral Society, 1990). King (1983) describes bird surveys conducted on the northern Great Barrier Reef islands, including Green Island, by the Queensland National Parks and Wildlife Service - a species list is not given.

Other vertebrates

The Australian Littoral Society (1982) lists 3 species of skink for Green Island:

Lepidodactylus lugubris
Carlia rhomboidalis
Cryptoblepharus virgatus

Also listed by the Australian Littoral Society (1982) are a colony of the spectacled flying fox (Pteropus conspicillatus) and introduced cats and rats.

Invertebrates

Terrestrial invertebrates recorded for Green Island are the Capaneus butterfly (Papillo fuscus capaneus) (Australian Littoral Society, 1982) and the ant Pheidole megacephala (Heatwole, 1976). The latter is an African species which Heatwole concluded had 'almost certainly' reached the cay via human agency and was the only ant species occurring on the cay - presumably through elimination of the original ant fauna (Heatwole, 1976).

HYDROLOGY

The average annual rainfall (1949 - 1989, using all available data) at Green Island is 2111mm (Australian Bureau of Meteorology, pers. comm.). The monthly averages for this period are given in Table 1.2. Brandon (1973) compared rainfall data for Green Island and Cairns Airport over an unspecified sixteen year period and found Green Island to have a 9.4% higher average annual rainfall.

Table 1.2: Monthly average rainfall data for Green Island (1949 -1989, using all available data). Source: Australian Bureau of Meteorology (pers. comm.).

MONTH	AV. (mm)
January	419
February	398
March	424
April	217
May	129
June	84
July	60
August	43
September	33
October	33
November	96
December	175
Annual av.	2111

The Green Island Management Committee (1980) referred to the existence of a shallow lens of fresh groundwater overlying more dense saline water during the wet season, with the lens almost entirely utilised by the native vegetation during the dry season. Consequently, in the dry season the groundwater would become quite saline due to seawater intrusion. However, inquiries made of the Queensland Water Resources Commission by Dr. M. Gourlay (University of Queensland) revealed this information to be 'a preliminary statement on the basis of inferred data and broad assumptions and allegedly factual data, some of which has since been shown to be incorrect' (Gourlay, pers. comm.).

WIND REGIME

In December 1982, the Queensland Beach Protection Authority installed an automatic wind recorder on the telecommunications tower at Green Island at a height of approximately 30m above Mean Sea Level. The device measured both wind speed and direction each minute, and a data logger recorded minimum, mean and maximum wind speed and average wind direction over each 60 minute period (Beach Protection Authority, 1989). While wind data from the Green Island recorder was analysed by the Beach Protection Authority (1989), data from a recorder at Low Isles was used in their analyses of shoreline dynamics as data from both stations showed comparable patterns and the Low Isles station had a longer history of operation. The Green Island wind recorder was still in operation at August 9, 1990 (Beach Protection Authority, pers. comm.).

From the Low Isles data, the Beach Protection Authority (1989) describe the predominant winds throughout the year to be south-easterly, to a greater degree from April to October and predominantly in the afternoon. In the mornings, south-westerly winds occurred to some degree throughout the year, north-westerly winds occurred to some degree from October to March and north-easterly winds were found to occur rarely. In the afternoons, north-easterly winds occurred significantly during the October to March period with south-westerly and north-westerly winds a rare occurrence.

SHORELINE DYNAMICS

Coral cays, the products of complex physical, geological and biological processes, are geologically temporary features of considerable instability which may respond dramatically to fluctuations in their environment (Gourlay, 1983). This inherent instability is well illustrated at Green Island, which has a long history of shoreline construction and erosion.

Kuchler's study

Kuchler (1978, 1979) studied the shoreline movements of Green Island on long-term and seasonal scales, identifying an approximate cyclic oscillation of the western end of the cay with periodicity of 30 years duration. Just prior to 1938 the main depositional area was to the north-west; from 1938 to 1964 it was the south-west corner, and from 1964 onwards it had again been the north-west corner. The primary agents for sediment transport appeared to be wind and waves, with wind velocity and angle of incidence of wave approach considered important parameters. Accordingly, most long-term changes in the nearshore sand accumulation had been due to cyclones. On a seasonal scale the pattern was one of windward recession and leeward advance, the windward shoreline being the southern in winter and the northern in summer. However, most probably due to anthropogenic influences described below, there was an overall pattern of erosion of the south-western corner and accretion of the north-western corner (Kuchler 1978, 1979).

Pannell Kerr Forster (1971) felt the jetty was responsible for erosion around the cay end of the jetty and recommended the construction of a marina to stabilise the erosion. However, Kuchler (1978, 1979) found the construction of various groynes and jetties to have had little apparent impact on the shoreline movements on a historical scale.

The expansion of the north-west spit on a scale not evident in the historical data was deemed by Kuchler (1978, 1979) to be due to the beach replenishment programs of 1973 and 1975. In these programs sand was pumped from the nearshore lagoon to the beaches of the cay's south-western corner, an action which proved ineffective due to inadequate protection from the strong south-easterly winds prevalent during winter. The added sand was rapidly transported to the north-west corner of the cay (Hayles, 1982) and the resultant extensive spit disrupted the northerly wind-generated waves which had previously been responsible for sediment transport to the south-western corner during summer. As a result, the south-western corner experienced winter erosion without summer accretion (Kuchler, 1978).

There are several other factors which may have been responsible for retarding overall sediment accumulation by the cay. Devastation of the hard coral community by the crown-of-thorns starfish, A. planci, may have reduced the rate of sediment production within the reef system (Kuchler, 1979; Gourlay, 1988). Seagrass beds, with their associated mats of blue-green algae, are known to accumulate sediment, and at Green Island they may have done so at the expense of the cay by trapping the fine sediment normally transported to shore by northerly winds during summer (Kuchler, 1978; Gourlay, 1983, 1988). The dredged navigation channel and swing basin may have been partially responsible for non-replenishment of the cay's beaches through their potential to act as sediment traps (O'Keeffe, 1979) or by changing the sediment flow and movement (comment from reviewer of draft Green Island Information Review). Gourlay (1988) proposed that climatic variations influencing hydrodynamic conditions, and rising sea level associated with the 'greenhouse' effect, may also have contributed to the net loss of sand from the cay.

Beach Protection Authority surveys

In 1972 the advice of the Queensland Government Beach Protection Authority was sought on erosion problems at Green Island and they became involved in collecting data on coral cay behaviour (Beach Protection Authority, 1987, 1989). Between November 1972 and July 1977, beach profile surveys were conducted at four stations on the south-western corner of the cay [P1, P2, P12, P13: Fig.1.3].

From July 1977 to September 1980, beach profiles were monitored at a total of thirteen stations around the cay [P1 - P13: Fig.1.3]. A further five survey lines [P1.5, P2.5, P3.5, P11.5, P13.5: Fig.1.3] were added to the beach monitoring program in September 1980 to monitor the effects of a newly constructed groyne at the south-western corner (Beach Protection Authority, 1989).

Profiles extended from several metres landward of the vegetation line to the toe of the beach slope at its interface with the underlying reef platform. Vertical datum for the surveys was Local Low Water Datum and horizontal datum was arbitrarily chosen at the time of the initial survey to be 'several metres landward of the vegetation line' (Beach Protection Authority, 1989).

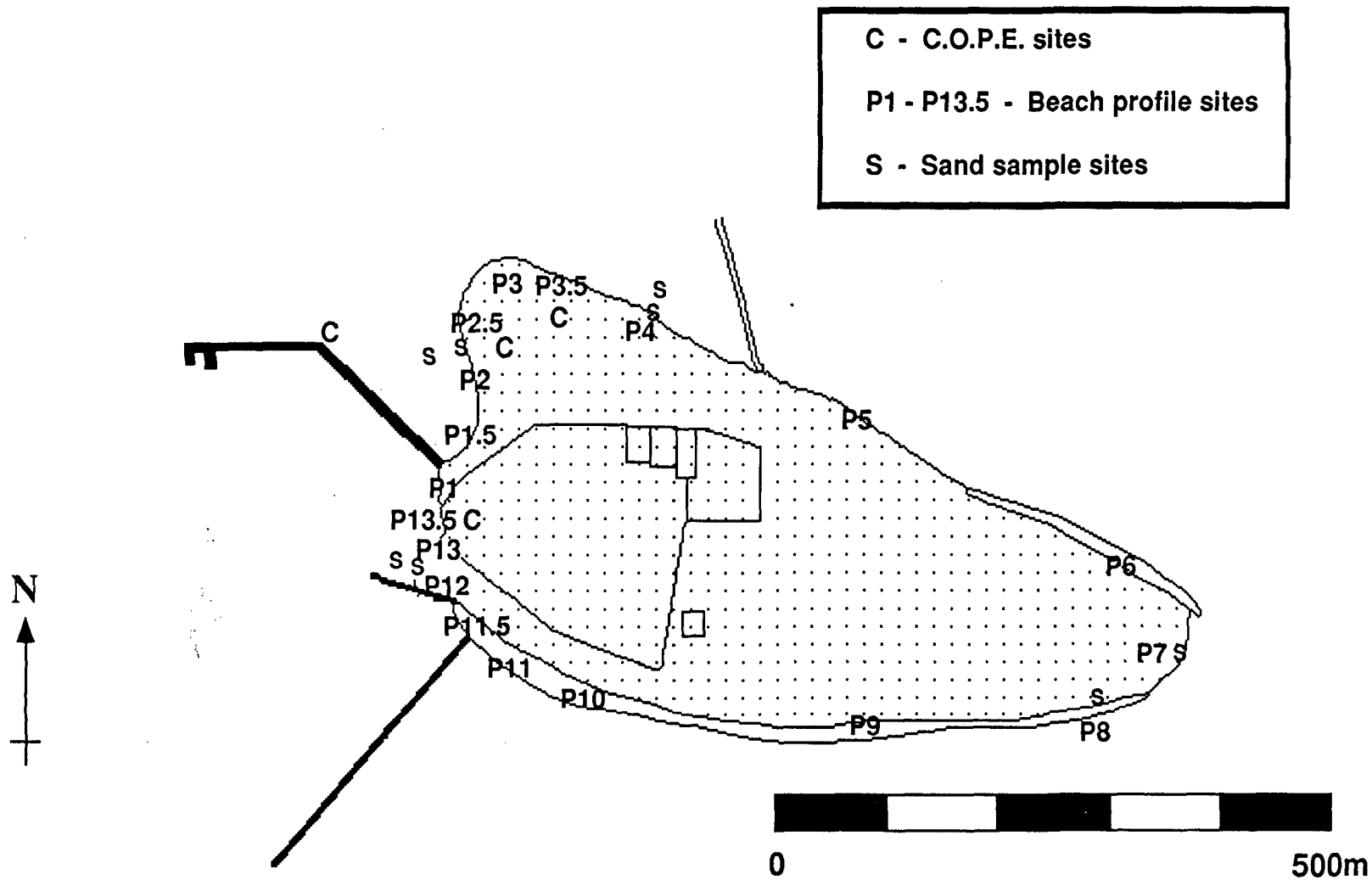

Figure 1.3 Location of Beach Protection Authority survey sites

Until September 1979 the surveys were undertaken by officers of the Queensland Boating and Fisheries Patrol. From November 1979 to March 1986 officers of the Queensland National Parks and Wildlife Service monitored beach profiles on a monthly basis, continuing on a twice yearly basis (before and after the cyclone season) from March 1986 to February 1989. In addition, annual surveys were conducted by surveyors from the Queensland Department of Harbours and Marine, who also checked and re-established control points where necessary (Beach Protection Authority, 1989).

Vertical aerial photographs were taken 'as near as practicable to low water' in 1972 and annually from 1978 to 1987 at low level (455m), medium level (915m), high level (1830m) and very high level (7600m). Details of the photographs are included in Chapter 12. Photogrammetric analysis of seven series of aerial photographs (4/72, 6/78, 10/80, 9/81, 9/82, 10/83 and 8/85) was undertaken to provide beach contours relative to Australian Height Datum (Derived) (Beach Protection Authority, 1989).

Erosion or accretion of the beaches was quantified in terms of changes in sand volume and horizontal movement of the beaches. Changes to the cay as a whole were quantified in terms of changes in sand distribution and changes in total sand quantity (Beach Protection Authority, 1989).

Between April 1972 and June 1978 there was little net change in sand volume in the southern sector of the cay, losses from the south-western and eastern sectors, a net increase in the northern sector and a very large increase in the north-western sector. Dramatic changes in the western sector took place during this period as a consequence of the beach replenishment programs undertaken by the Queensland Department of Harbours and Marine (Beach Protection Authority, 1989).

Between July and September 1977 an estimated $3000m^3$ of sand was lost from above low water mark (Green Island Management Committee, 1980). From July 1977 to September 1980 the western side and eastern tip of the cay experienced erosion while the northern beach accreted at its western end. The southern shoreline showed only slight erosion and accretion in parts during this period (Beach Protection Authority, 1989).

From September 1980 to July 1986 the shoreline from the newly constructed groyne to the jetty remained relatively unaltered following the initial build up of sand to the north of the groyne, apart from erosion at the jetty abutment. The beach to the north of the jetty eroded substantially during this time and the north-western spit moved to the north. The western part of the northern beach accreted while the eastern half had slowly eroded, and the eastern tip of the cay continued to erode. The southern side of the cay remained relatively stable over this period, with only slight erosion and accretion in parts (Beach Protection Authority, 1989).

In August 1986 and December 1987, sand samples were collected by the Beach Protection Authority (1989) at eight sites around Green Island [Fig.1.3]. At five sites the samples were collected from the 'beach ramp' approximately half way between normal high water level and mid-tide level. At three more seaward sites, samples were collected from the nearshore slope approximately 20m seaward of the toe of the beach ramp. The sand samples were graded as fine (particle size diameter 0.06 - 0.2mm), medium (0.2 - 0.6mm) or coarse (0.6 - 2.0mm) on the basis of predominant particle size. Between the two sampling dates the Beach Protection Authority (1989) found the sand retained by the groyne and the sand at the eastern end of the cay had become coarser, while the sand around the north-western spit had become finer.

Muir's study

Muir (1986) compared beach profiles before and after Cyclone Winifred had passed in the vicinity in February 1986. When compared with the November 1985 survey, the post-cyclone survey showed the north-west corner had up to 17m of beach crest removed, with a corresponding net foreshore beach face erosion of 60m. Accretion in the nearshore intertidal zone was greatest at the south-west corner, with a 20m net change (Muir, 1986).

Shoreline construction and erosion history

This summary is based on information in Kuchler (1978), Green Island Management Committee (1980) and Beach Protection Authority (1989). The information on cyclones in these publications appears to have been derived from Lourensz (1977) which has since been superseded, with some corrections, by Lourensz (1981) and I have made the appropriate corrections here. While the cyclones listed all passed within approximately 100km of Green Island, not all have had their effect documented in the published literature.

1906 - First jetty built by Cairns Harbour Board.

1912 - Cyclone (998mb) passes to east during April.

1918 - Cyclone (928mb) passes to south in March.

1931 - Jetty constructed by Cairns City Council.

1932 - Cyclone (994mb) passes to south-west in January.

1934 - Three cyclones: 984mb to south in January, 1002mb to east in February and 968mb to north-west in March.

1936 - New jetty built. Sandy beach around entire western end of the cay, with vegetation line truncated on the south-western corner.

1939 - First groynes built to protect foreshore - one major and four minor on western side, constructed mainly of timber.

1945 - Sandy beach from the jetty around the north-western corner of the cay, but a lack of sand on the south-western corner. Beach rock exposed in the centre of the northern beach.

1946 - Cyclone (996mb) passes in very close proximity - groynes damaged and jetty destroyed, all reconstructed within the year by the Cairns Harbour Board. New jetty to the north of the original and almost a mirror image in shape.

1950 - Cyclone (994mb) passes to north-east

1956 - A Queensland Department of Harbours and Marine report refers to cyclone damage during the year (Gourlay, pers. comm.), but there are no cyclones recorded in Lourensz (1981).

1957 - Restoration of existing groynes.

1959 - Two cyclones in the immediate vicinity, in January (980mb) and December (990mb). Slight recession of north-western corner of cay (relative to 1945) and a significant accretion to the south of the original jetty abutment.

1960/61 - Present (1990) jetty constructed by the Cairns Harbour Board immediately adjacent to the northern side of the previous jetty.

1962 - High water mark at south-west corner was 90m from the main building of the Coral Cay Hotel.

1963 - Inshore end of major groyne re-instated, remainder of groyne and four minor groynes in state of disrepair.

1966 - Queensland Department of Harbours and Marine surveys reveal recession of High Water Mark at south-western corner to be 25m landward since 1959. Evidence that some of eroded sand migrated northwards along beach.

1970 - Construction of retaining wall to protect resort approved.

1971 - Severe erosion around retaining wall construction site, work suspended to permit reappraisal. Old timber groynes removed.

1972 - Accretion commences on north-western corner of cay and on western part of northern beach.

1973 - Sand replenishment program (2,300m^3) on beach at south-western corner undertaken by Queensland Department of Harbours and Marine.

1974 - Sand used for beach replenishment eroded.

1975 - Cyclone Gloria (980mb) passes to north-east in January.
Old dining room of Coral Cay Hotel begins to collapse due to erosion.
Sand replenishment program (16,000m^3) on beach adjacent to hotel complex undertaken by Queensland Department of Harbours and Marine, extends beach approximately 30m seaward of 1972 position. Short experimental sand-bag groyne constructed at south-western corner.

1976 - Cyclone Dawn (988mb) in immediate vicinity in March.
Sand-bag groyne ineffective in protecting south-western corner from erosion. Erosion near jetty head, concrete pathway collapses.

1977 - Cyclone Keith (992mb) passes to south-west in close proximity in January - top layer of groyne washed off by wave action.
High water mark at south-western corner 3m from main building of Coral Cay Hotel (cf. 1962).
State Cabinet decides no further funds are to be made available for shore protection works.
Construction of sandbag revetment commenced by Hayles Pty Ltd.
Queensland National Parks and Wildlife Service commences beach monitoring program for the Beach Protection Authority.

1979 - Application by Hayles Ltd to install groyne on south-western side of cay approved by the Marine Board of Queensland.

1980 - Concrete groyne constructed by Hayles Pty Ltd at south-western corner of cay, just south of the 1975 sandbag groyne.

1982/83 - Progressive extension and rebuilding of the seawall along the western side of the cay.

1986 - Cyclone Winifred (970mb) passes to south-east at a distance of about 100km in February.
Some erosion, particularly on the north-west spit.

Comments made on an earlier draft of this review indicated that most of the current cement bag wall around the jetty base was constructed after 1985/86.

RESERVES AND LEASES

Green Island Management Committee (1980), Economic Associates Australia (1983) and Australian Littoral Society (1990) provide detailed information on the public reserves and private leases shown in Figure 1.2.

The eastern end of the cay is occupied by a 7ha National Park (N.P.836 Trinity, declared 1937) administered by the Queensland National Parks and Wildlife Service. A 20m esplanade, under the control of the Cairns City Council, was provided around the western perimeter of the cay to separate private lease development from the beach foreshore. The date of provision of the esplanade is unspecified in both reports, but they do note that sand movement has led to the disappearance of the esplanade in the south-west corner and its considerable extension in the north-west corner.

There are three perpetual and three special leases held on Green Island, all within the western half of the cay [Fig.1.2]. The largest of the perpetual leases (2.9ha) is the site of the Green Island Reef Resort (formerly the Coral Cay Hotel) owned by Great Adventures Pty Ltd., a division of the Dreamworld Corporation. The first lease for a tourist resort development was a 20-year special lease (S.L. 11234) granted to Hayles Magnetic Island Pty Ltd in 1938. The current lease (N.C.L. 2048), was granted to the Hayles company on January 1 1965, replacing a 30-year special lease (S.L. 25519) granted in 1961. The Cairns operations of the Hayles company were bought by the Dreamworld Corporation in 1988, and in 1989 the Dreamworld Corporation was placed in the hands of receivers. At present, a change in ownership of the resort is still to be finalised.

The other perpetual leases cover a marine zoological garden (Marineland Melanesia, N.C.L. 2590, 0.4ha, granted 1 January 1974) and a theatrette (Castaways Theatre, N.C.L. 2331, 0.08ha, granted 1 October 1968).

Two of the special leases cover an underwater observatory (S.L. 25496, 0.1ha, granted for 30 years from 1 March 1961) and an associated residence (S.L. 40190, 0.06ha, granted for 15 years from 1 March 1976). The third (S.L. 36573) covers a 0.04 ha area of National Park excised on 1 March 1972 for use by the Commonwealth Government as a radio-telephone installation under a 30-year lease.

The remaining development is situated within a 0.06ha reserve (R. 1695) voluntarily acquired by the Queensland Department of Primary Industries in 1979. This lease contained the residence of pioneer underwater photographer Noel Monkman and his wife Kitty, who held a perpetual residential lease (N.C.L. 2551). The lease was to be developed by the Queensland Fisheries Service (now the Fisheries Branch of the Queensland Department of Primary Industries) as a marine park ranger station, interpretive centre and reef biological research base (Haysom, 1981), but is currently used only as a field research station.

WATER SUPPLY AND DRAINAGE

The Green Island Management Plan (Green Island Management Committee, 1980) provides the following information, which is derived from a 1979 report by Gutteridge, Haskins and Davey Pty Ltd for the Queensland Department of Works. From a conversation in July 1988 with Mr D. Rogers, a former engineer at Hayles' Coral Cay Hotel, it appeared the water supply, sewerage and drainage works had changed little since the report.

Fresh water supplies for Green Island's lessees were derived from rainwater storage, with that of the Hayles lease supplemented by water carted from the mainland by their ferries. Additional groundwater was obtained by Hayles from a well on their lease and used for general cleaning and toilet flushing at the resort and for the toilets, hand basins and showers in the public toilet block on the esplanade. The other lessees pumped sea water to supplement fresh water used in toilet flushing. There were no underground storm-water drains on Green Island and drainage was by run-off and by natural infiltration into the groundwater.

A desalination plant operated on the Hayles lease for about two years around the period 1978 to 1980 (Rogers, pers. comm.). It was located in a generator shed, with a feeder tank adjacent to the bore. Initially, bore water was used for the desalinator but this was found to be contaminated with bacteria (probably from septic tank seepage) and minerals (notably sulphur) which were presumed to originate from the coral substrate. Subsequently, salt water was pumped to the feeder tank from the end of the jetty. Operation of the plant ceased when the expensive filters for the reverse-osmosis system were cleaned with kerosene and consequently badly damaged. There have been no other desalination plants in operation on Green Island since (Rogers, pers. comm.).

SEWERAGE

All buildings on the Green Island Reef Resort lease are connected to a sewerage system which also incorporates input from the public toilet block on the esplanade. The system, constructed by the Queensland Department of Works in 1972, consists of a main sewer line leading to a detention and chlorination tank with an outfall pipe crossing the reef flat in a south-westerly direction from the cay [Fig.1.2]. According to the Green Island Management Committee (1980), the discharge from the outfall pipe is below maximum low water level at the south-west reef edge. Through discussions with long-term residents of Green Island, Kuchler (1978) found that over the years the sewerage outlet may have had several positions around the reef, including one to the north of the cay. However, Kuchler was unable to gain confirmation of this from any government department.

The toilets associated with the theatrette, marineland, observatory residence and Queensland Department of Primary Industries research facility have conventional septic tanks with soakage trenches (Green Island Management Committee, 1980).

Water inlet and outlet pipes for the Marineland Melanesia aquarium system lie on the reef flat to the north of the cay [Fig.1.2]. These are identifiable in some aerial photographs and are marked on lease maps held in the Great Barrier Reef Marine Park Authority library.

WASTE DISPOSAL

In 1979, Hayles employees were collecting and disposing of wastes from the hotel lease, National Park, esplanade, beaches and jetty. Wet wastes (edible food wastes) were tipped off the jetty each morning and consumed by birds and fish. Combustible waste was incinerated and the residue, along with non-combustible waste, was transported to the mainland and dumped. Wastes from the other leases were either buried, dumped at sea or returned to the mainland for disposal (Green Island Management Committee, 1980).

Mr T. Steven of the Queensland National Parks and Wildlife Service at Cairns conducted a survey of fish feeding and garbage dumping activities around Green Island in late 1987 (Hunnam, pers. comm.). He estimated that almost 30 tonnes per year of wet waste were dumped from the jetty by Hayles employees and the crew of the Coral Seatel vessel. In addition, an estimated 18 tonnes per year of bread were being deposited into the water through fish feeding. About 40% was scattered on the water surface in an area known as 'Patches' [area B5: Fig.3.1] by the crew of glass-bottom boats associated with the Hayles ferries and the Coral Seatel. Sub-surface release by the underwater observatory operators accounted for a further 30%, while around 20% was released by snorkellers on the northern and north-western reef flat. The remaining 10% was released from the jetty by the Hayles Activities Officer or at the northern reef edge by the dive tender operated by Peter Tibb's Dive Shop.

Following the survey, fish feeding activities noticeably declined (Hunnam, pers. comm.). Current practice is for all rubbish to be returned to the mainland (Queensland National Parks and Wildlife Service, 1990), although feeding of fish from the jetty was continued until at least November 1989 (comment by reviewer of draft Green Island Information Review).