4. THE CAPE TRIBULATION AREA

Location (Figure 2)

Situated in the wet tropics of far north Queensland, the area under study comprises an 18 km stretch of coastline (15°56'30" - 16°06'10") extending from Myall Creek to 3 km south of the Bloomfield River. The close proximity of the coastal ranges, the dense cover of tropical rainforest, and the nearshore fringing reefs, combine to make this a beautiful and unique section of the Australian coastline.

Climate and Hydrology

The climate of the area is dominated by two large scale features of the atmospheric circulation, the intertropical convergence zone (ITCZ) and the south Pacific convergence zone (SPCZ). During most of the year, the region is dominated by south-east trades. During summer the ITCZ shifts into the Southern Hemisphere causing the movement of the north-west monsoon into the region (Downey, 1983). This monsoon causes the trades to take a more easterly component, with north-west winds prevailing from January to March and associated increased rainfall (Pickard, 1983). Local coastal and sea breeze effects cause local variations in these wind patterns (Downey, 1983).

Tropical cyclones occur in the Western Coral Sea from November to May with 75% of occurrences in January or February. Generally two cyclones make landfall on the Australian coast per year. Statistics show the maximum frequency of landfall to be in the Cairns region (Downey, 1983). These cyclones may cause extensive (sometimes complete) vertical mixing of water over the shelf region (Holloway, 1983). The Cape Tribulation area has a total average annual rainfall in excess of 3750 mm/yr, one of the highest annual rainfall totals in Australia. A large proportion of this falls from January to March.

Experimental work by Gilmour and Bonell (1979) in a drainage basin near Babinda with similar annual rainfall has shown that in this situation overland flow or storm quickflow is very important because the intensity of the rainfall exceeds the infiltration capacity of the soil. Also

> *"The effect of more frequent heavier downpours is that the kinetic energy of the rain falling at intensities greater than 25 mm/hr ... is about 16 times greater than that of temperate rainfall"* (Gilmour and Bonell, 1979, p 2)

This, together with an increase in drop size means that tropical storms have greater erosion potential. A close agreement between the overland flow graph and the stream hydrograph for Babinda is evidence that in steep catchments with high annual rainfall most overland flow reaches the streams. In the Daintree catchment (910 km^2) just to the south where rainfall totals are between 1250 mm and 2500 mm, mean annual runoff is as high as 1352 mm (Pringle, 1986). It may be expected that runoff for Cape Tribulation will be even higher.

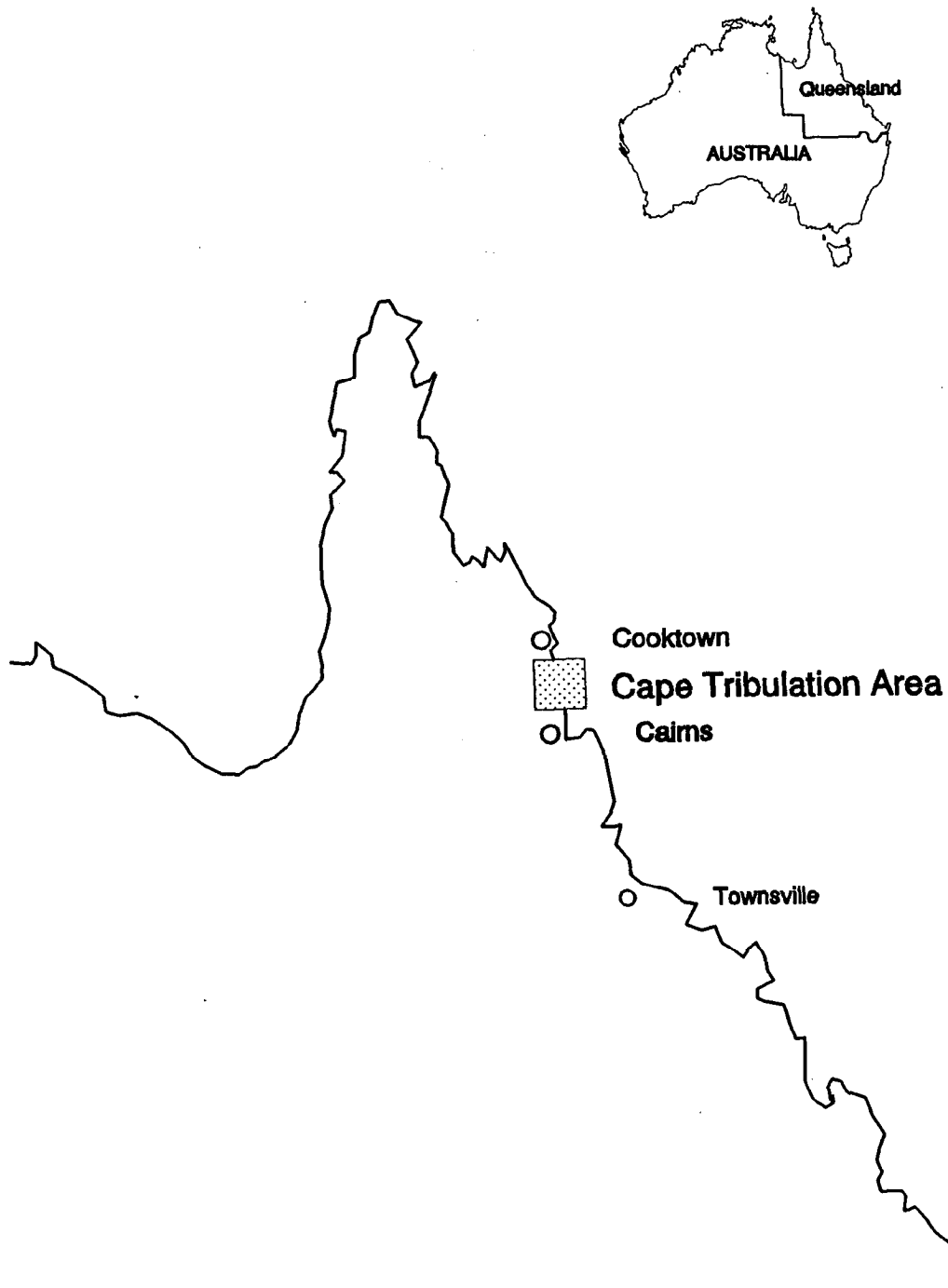

FIGURE 2. Location of the study area

Rainforest

The area is covered with many rainforest types and contains some of the last vestiges of humid tropical lowland rainforest in Australia. The most diverse is complex mesophyll vine forest considered to be the optimum development of rainforest in Australia (Monteith, 1985; Tracey, 1982). The preservation of this lowland rainforest is particularly imporant since *"few areas have escaped sugar cane cultivation and grazing, and practically all the remaining areas have been logged"* (Tracey, 1982, p 4). The forest on the coastal ranges is altitudinally zoned allowing the development of many different forest types in a relatively small area.

Geology and Geomorphology of the Terrestrial Environment

The coastal ranges in the study area are composed of a Permian muscovite biotite adamellite, of the Thornton Batholith. These rocks have intruded deformed Devonian sediments, the Hodgkinson formation, made up of greywacke, siltstones, shales, greywacke conglomerates and rare limestones. A thermal metamorphic aureole surrounds the intrusives (Henderson and Stephenson, 1981). Spillitic lavas of submarine origin occur to the south and south-east of the batholith. The granites are generally composed of quartz and perthite with minor oligoclase, andesine and biotite. The greywackes contain quartz plagioclase and muscovite (Ewart, 1985).

The dominant soil types in the area are red podzolic soils typical of high rainfall areas. They are strongly leached and highly acidic pH 4.5-5.5 (Date and Ross, 1985). The metamorphics are generally covered with fine sandy clay loams, *"structured earths with bleached A2 horizon and red moderately structured subsoils"* (Date and Ross, 1985, p 6). Over the granite, soils are dominated by moderately textured yellow earths, they have a gradational texture profile, yellowish sandy loam with a massive earthy fabric. X-ray diffraction analysis of soils in the study area shows them to be rich in amorphous oxides and oxyhydroxides of iron and aluminia (approx 20%) with clays being kaolinite (approx 30%), illite/mica (approx 10%) and smectite/hydromica (approx 10%). This predominance of kaolinite is expected in a strongly leached soil. Soils in the area are particularly susceptible to erosion and this is accentuated by the steep terrain and high rainfall.

The ranges adjacent to the study area rise in places to 600 m within 3 km of the coast. These steep ranges lead to compact drainage systems with the largest catchments only 15 km^2 in area, and headwaters only 3-4 km from the mouth. This combined with the high rainfall and dominance of overland flow produces rapid current velocities. Streams become raging torrents within minutes of rain falling in their catchments. An interesting feature of a number of the larger streams is the discovery of discrete freshwater layers above the saltwater up to 1 km offshore. This phenomenon may be explained by high current velocities at the mouths of streams. These high velocities also cause the deposition of rocky bars at the mouths of some streams, and almost all streams have a deposit of cobbles at their mouth, often colonised by mangrove communities. Because of the compact nature of the streams mangroves only extend a few hundred metres along them and the environments are often high in energy and flushed of any finer sediments.

Fringing Reefs: Surface Morphology (Figure 3)

Fringing reefs on average 80 m in width, extend intermittently along the entire length of the study area. They occur in two types of location:

- As very narrow fringing reefs attached to exposed rocky headlands
- As broader cuspate shaped reefs occurring along the beaches and steeper coastline between the main headlands.

Frequently, these cuspate reefs are found in front of embayments associated with stream estuaries and are immediately backed by beach ridges formed predominantly of fine grained quartz sands. Partain and Hopley (1989) have identified five intertidal and subtidal zones on these reefs consisting of:

i) *Terrigenous cobble facies.* Cobble sized clasts consisting of well-sorted 20-40 cm diameter igneous and metamorphic cobbles are most commonly found the in the vicinity of stream mouths. They form irregular deposits and grade laterally into other longshore beach features. Individual cobble deposits adjacent to and in front of stream mouths are sometimes fan shaped.

ii) *Beach and tidal flat facies.* The beaches and tidal flats are composed predominantly of fine grained, well sorted, quartz and calcium carbonate sand. Biogenic components include sponge spicules, foraminifera, coral fragments and shell fragments. The calcium carbonate component of the beach sediment increased with proximity to the reef.

iii) *Back reef facies.* The back reef facies is found behind all the larger fringing reefs in the Cape Tribulation area. Surface elevations range from 0.15 m below to 0.5 m above Cairns Port Datum. Live corals are sparse or non-existent in this back reef area. However, the most common characteristic is a zone of dead microatolls very similar to present living microatolls. Their surface is often covered by crustose coralline algae, and towards the beach the older microatolls are buried in moderately well-sorted tidal flat sands. Deeper back reef pools contain loose coral rubble and brown algae such as *Sargassum* sp proliferate. The more landward side of the back reef facies is frequently covered by terrigenous sand and the more seaward side by calcareous rubble.

iv) *Reef crest facies.* The outer reef crest forms a ridge elevated approximately 0.5 m above the adjacent back reef and ranges from 0.7 to 1.4 m above Cairns Port Datum. On the extreme seaward margin, algae such as *Laurencia* sp and *Gelidiella acerosa* are found. Encrusting algae such as *Porolithon* are also present. In many places, the front of the reef crest is dissected by a rudimentary spur and groove system. Within the grooves, typically 1-10 m in width, and 2-20 m in length, small colonies of living corals are often found.

v) *Reef front living coral facies.* A steep drop-off in front of each reef extends to a depth of 2 m below Cairns Port Datum. Below this deep drop-off a more gentle seaward slope begins. Living coral communities flourish in a 30-100 m wide strip parallel to the reef just below the fore reef drop off. Large *Porites* species and *Faviid* colonies exceeding 4 m in diameter as well as *Acroporid* communities are found here.

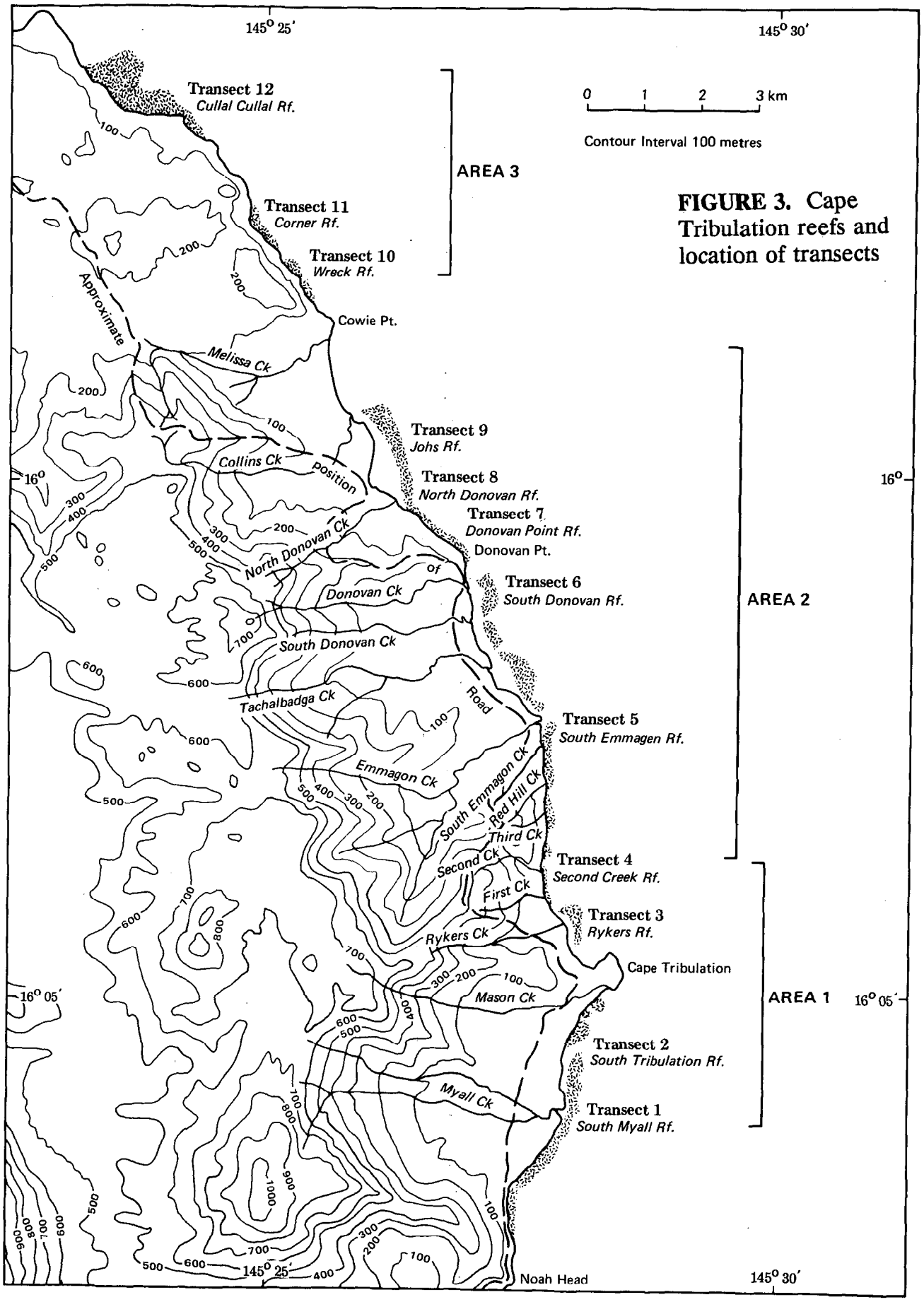

FIGURE 3. Cape Tribulation reefs and location of transects

Fringing Reefs: Evolution

Partain and Hopley (1989) report on the drilling and dating of three of the Cape Tribulation reefs:

- Rykers Reef
- South Myall Reef
- Emmagen Reef.

They conclude that the Cape Tribulation reefs are Holocene in age and began developing approximately 7800 yrs BP. Coral growth on the reef crest and most of the back reef ceased approximately 5400 yrs BP, probably in response to increasing turbidity and water quality deterioration as fine sediments accumulated offshore and became resuspended during strong winds. Significant coral growth is now restricted to the subtidal fore reef, but reef progradation has been minimal over the last 5000 years.

The height of the reef crests relative to present day sea level, and the absence of low magnesium calcite cements in the fringing reefs, suggest that they have not been subjected to extensive subaerial exposure, with a maximum Holocene relative sea level of only 0.6-1.0 m above its present position being responsible for the height of the present algal covered reef crest. Partain and Hopley (1989) suggest that the reefs appear to be in a delicate state of balance having grown under environmental conditions more favourable than present. Further deterioration of the environment produced by anthropogenic factors such as increased sediment yield from the Cape Tribulation road they suggest have the potential to push water quality conditions beyond the point where reef growth can be maintained.

Fringing Reef Communities

The fringing reefs of the Cape Tribulation area contain some of the most diverse coral communities on the Great Barrier Reef. Veron counted 147 different species of coral from 55 genera, out of the 72 genera found on the Great Barrier Reef. He considers these reefs to be the most diverse, extensive fringing reefs of Eastern Australia (Veron, 1985). This conclusion may be misleading, since although the number of species in the area is great, the dominant coral community is restricted to a small number of species of foliose morphology. The foliose habit gives colonies a large surface area and is most useful in low light conditions. It may be related to high turbidity in this area but it is a hindrance in sediment rejection. Some corals were observed to contain small amounts of coarse sediment but remain vigorous. This may imply that light is controlling coral growth rather than sedimentation. If sedimentation were the controlling factor, branching and hemispherical forms would be expected. Ayling and Ayling (1987) report 70% coral cover below 5 m depth compared to 30-50% on offshore reefs. However, the biotic zone is markedly compacted at Cape Tribulation with all communities being restricted to <10 m LWD. The corals which grow in the area are considered to be silt tolerant as they must normally cope with a high silt content and severely reduced light penetration for long periods when south-easterlies are blowing. Most of the corals are dark brown in colour (Ayling and Ayling, 1987). Light absoprtion may be maximised by an increase in the actively photosynthesising endo-symbiotic zooxanthellae *Gymnodinium microadriaticum*. An increase in these unicellular algae will maintain sufficient metabolism in low light conditions. Many of the species listed for the area are found in diverse communities on the bommies. These bommies rise almost vertically for many metres, and may be up to 3 m across; they are normally about 2 m below the surface on a high tide.

Nearshore Environment

Apart from a short stretch of coastline off Cape Tribulation, the inner shelf adjacent to the study area is shallow. The 10 m isobath is always less than 1000 m offshore from the seaward edge of the outer exposed reef flat. Vibracores collected by the James Cook University Geology Department in a transect immediately north of Donovan Point reveal that approximately 1 km offshore mud values in the surface sediment are as high as 60% (Johnson and Carter, 1987). Consequently, an abundant supply of fine sediment is available for resuspension above the fairweather wave base. Tides at Cape Tribulation are semi-diurnal with a maximum range of 3.02 m. Tidal levels are MHWS 2.2 m, MLWS 0.5 m, MHWN 1.6 m and MLWS 0.5 m (Department of Harbours and Marine Qld, 1985). The currents in the Great Barrier Reef have a mean net flow to the north or north-west at 0.5-1.0 knot driven by the south-easterly tradewinds. In the central zone (where the study area is situated) there is a reversal to a net southward flow from October to December (Pickard, 1983). Seas are generally smooth under the monsoonal influence from January to March with light winds. However for most of the year the seas are moderate due to the consistent 10-20 knot south-easterly trades.

In the nearshore area, Parnell (see appendix) has suggested that wind and wave generated circulation dominates but is modified by local morphology. As offshore surficial sediments contain a high proportion of muds, resuspension of these sediments occurs under modal wind and wave conditions. River derived sediments may add to offshore suspended sediment concentrations during extreme weather events, but are only significant in the near vicinity of the stream mouths, with sedimentation likely only in zones of very low velocity. Parnell considered that Cape Tribulation reefs are likely to have developed in conditions of high turbidity and high suspended sediment concentrations.

Settlement and Land Use

A number of aboriginal tribes originally populated the area, their main camps being on the Bloomfield and Daintree Rivers. However, their nomadic lifestyle probably had little effect on erosion rates in the area. Erosion rates may not have increased until cedar cutters arrived in 1880. The area was then left relatively uninhabited until 1928 when clearing began on the banks of Myall Creek and in the valley between Cape Tribulation and Noah Head. This cleared land has been used to grow vegetables and raise beef cattle after timber was cut from it. From 1955 to 1963 a road was constructed from the Daintree River to Cape Tribulation. Tourists first began to visit the area about 1975 and their numbers have increased significantly since then. During the 1970s there was much public pressure for a National Park in the area. This combined with the impetus of the World Wilderness Conference in Cairns in 1981 persuaded the government to act. The Cape Tribulation National Park was gazetted in October 1981. In 1968 a track was bulldozed from Cape Tribulation to the Bloomfield River. This track soon became overgrown but sufficed as a walking track and gave good access to the wilderness area. In 1983 bulldozing began again on this track to form the road from Cape Tribulation to Bloomfield.