THE MANGROVE VEGETATION OF MORETON BAY

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A SET OF 10 MAPS COVERING THE MANGROVE COMMUNITIES OF MORETON BAY ACCOMPANIES THIS REPORT. THESE ARE AVAILABLE ON PERSONAL OR WRITTEN APPLICATION TO DIRECTOR, BOTANY BRANCH, DEPARTMENT OF PRIMARY INDUSTRIES, ME1ERS ROAD, INDOOROOP1LLY, 4068.

Originally it was intended that this report be published as Botany Branch Technical Bulletin No. 7 and this reference has been quoted in several publications. The last. Botany Branch Technical Bulletin was No. 6 published in 1980. A new series Queensland Botany Bulletin was commenced in 1982 and to reduce any further confusion this report is published as part of that series.

Some Queensland Botany Bulletins are saleable publications and others are free; details of this are given inside the back cover.

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(i)

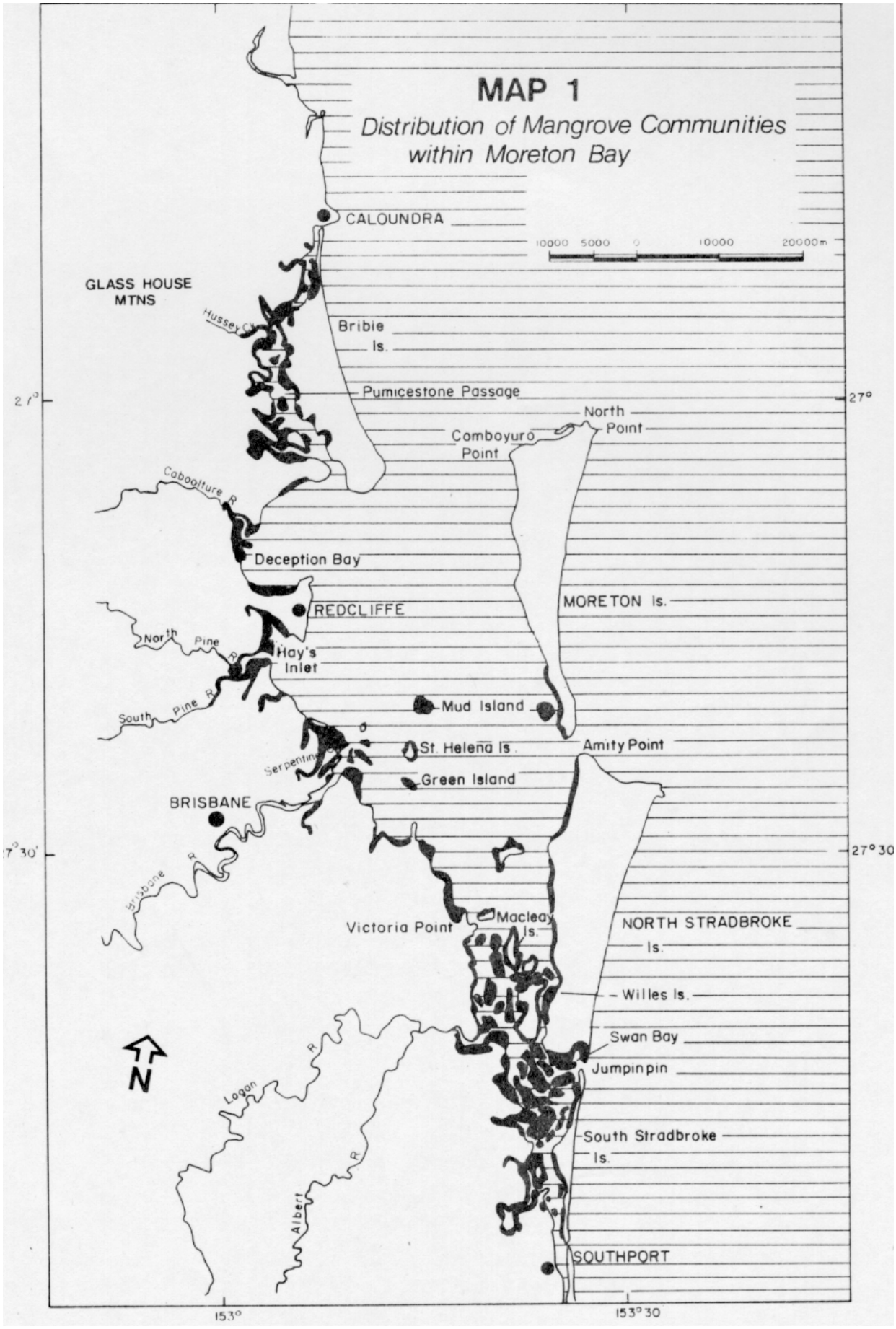
SUMMARY

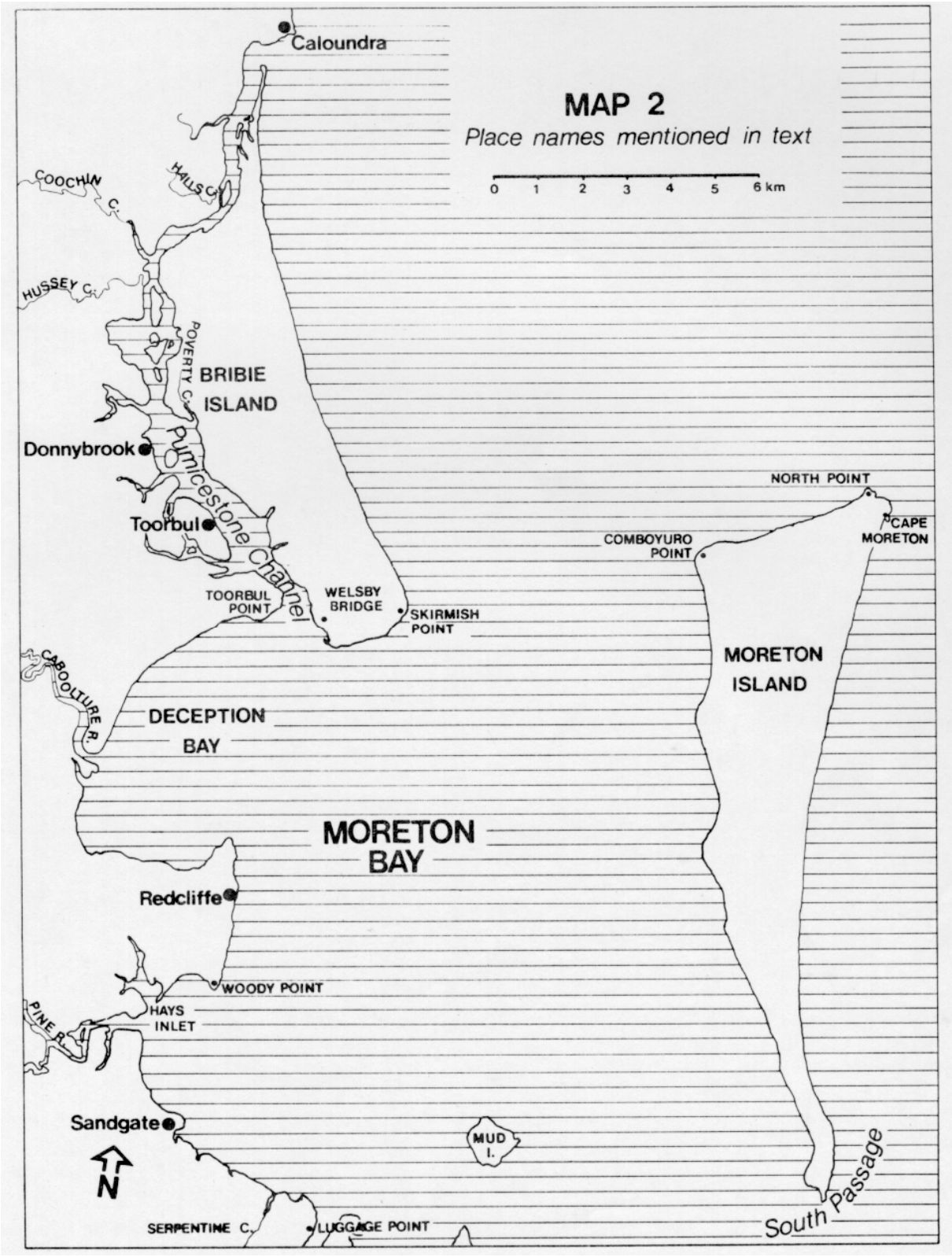
A descriptive account of the mangrove vegetation and a series of 10 maps at a scale of 1:25 000 have been prepared for the area from Caloundra to Southport on the southern Queensland coast.

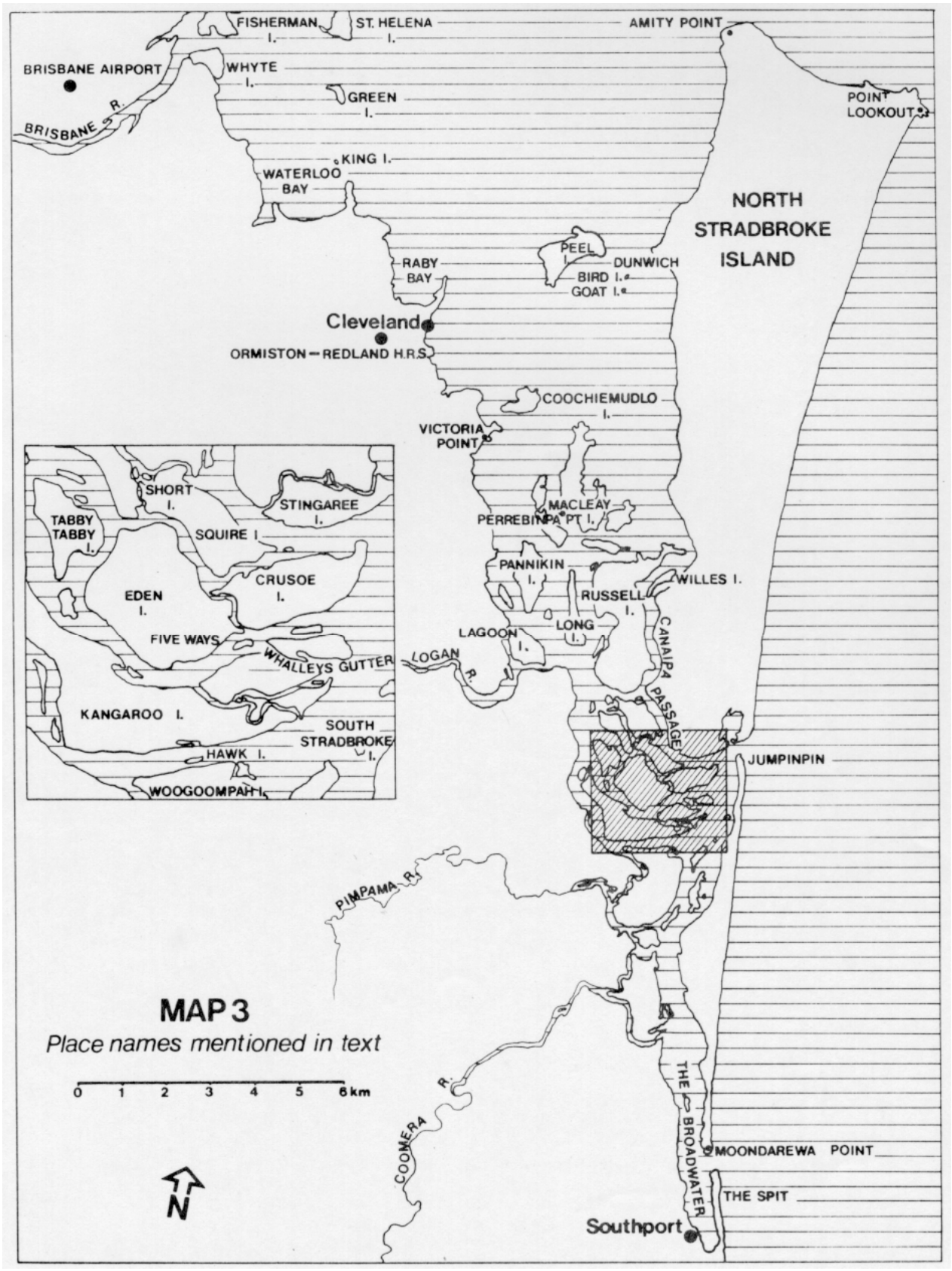
Seven species of mangrove are recorded from the area and a field key to the species is provided. Common species are *Avicennia marina* var. *australasica, Rhizophora stylosa, Aegiceras corniculatum* and *Ceriops tagal* var. *australis.*

Mapping is based on colour aerial photographs taken in April 1973. Twelve mapping units are described based on floristic and structural attributes. Major communities are *Avicennia marina* var. *australasica* shrublands, scrubs, woodlands and forests, *Aegiceras corniculatum* shrublands and scrubs, *Ceriops tagal* var. *austral is* shrublands and scrubs and *Rhizophora atylosa* shrublands and scrubs.

Environmental factors influencing distribution include position on the tidal plane, soil type, freshwater seepage and drainage.


MAP 1
Distribution of Mangrove Communities within Moreton Bay
CALOUNDRA
10000 5000 0 10000 20000m
GLASS HOUSE MTNS
Hussey Ck
Bribie Is.
Pumicestone Passage
North Point
Comboyuro Point
Caboolture R
Deception Bay
REDCLIFFE
MORETON Is.
North Pine R
Hay's Inlet
South Pine R
Mud Island
St. Helena Is.
Amity Point
Serpentine Ck
Green Island
BRISBANE
Brisbane R
Victoria Point
Macleay Is.
NORTH STRADBROKE Is.
Willes Is.
Swan Bay
Jumpinpin
Logan R
Albert R
South Stradbroke Is.
SOUTHPORT
N
27°
27°30'
153°
153°30


MAP 2
Place names mentioned in text
0 1 2 3 4 5 6 km
Caloundra
COOCHIN C.
HALLS C.
HUSSEY C.
POVERTY C.
BRIBIE ISLAND
Donnybrook
Pumicestone Channel
Toorbul
TOORBUL POINT
WELSBY BRIDGE
SKIRMISH POINT
NORTH POINT
CAPE MORETON
COMBOYURO POINT
MORETON ISLAND
CABOOLTURE R.
DECEPTION BAY
MORETON BAY
Redcliffe
WOODY POINT
HAYS INLET
PINE R.
Sandgate
N
MUD I.
SERPENTINE C.
LUGGAGE POINT
South Passage


FISHERMAN I.
ST. HELENA I.
AMITY POINT
BRISBANE AIRPORT
WHYTE I.
GREEN I.
POINT LOOKOUT
BRISBANE R.
KING I.
WATERLOO BAY
NORTH STRADBROKE ISLAND
PEEL I.
DUNWICH
RABY BAY
BIRD I.
GOAT I.
Cleveland
ORMISTON – REDLAND H.R.S.
COOCHIEMUDLO I.
VICTORIA POINT
SHORT I.
STINGAREE I.
TABBY TABBY I.
SQUIRE I
MACLEAY PT I.
PERREBINPA
PANNIKIN I.
WILLES I.
CRUSOE I.
EDEN I.
RUSSELL I.
LONG I.
LAGOON I.
FIVE WAYS
WHALLEYS GUTTER
LOGAN R.
CANAIPA PASSAGE
KANGAROO I.
SOUTH STRADBROKE I.
HAWK I.
JUMPINPIN
WOOGOOMPAH I.
PIMPAMA R.
MAP 3
Place names mentioned in text
0 1 2 3 4 5 6 km
N
COOMERA R.
THE BROADWATER
MOONDAREWA POINT
THE SPIT
Southport

CONTENTS

INTRODUCTION

The study area (Maps 1, 2 and 3), located in the south-east corner of Queensland Australia, is bounded by Caloundra (26°48'S, 153°08'E) in the north, to Southport (27°58'S, 153°,25'E) in the south, Moreton and North and South Stradbroke Islands (153° 28'E) in the east, and a north-south line passing through Brisbane (153°00'E) in the west. It includes Pumicestone Channel, Moreton Bay, The Broadwater and associated waterways. Moreton Bay is divided among eight Local Authorities, these are Landsborough, Caboolture, Pine Rivers, Redlands and Albert Shires and Redcliffe, Brisbane and Gold Coast Cities.

The study was undertaken during 1973-75 at the request of the Queensland Co-Ordinator-General's Department to provide a statement on the type and extent of the mangrove communities occurring within Moreton Bay. The study was initially undertaken as a supplement to the Brisbane Airport Environmental Study. The original aim of the study described in this report, was to assess the effect of clearing the mangroves occurring within the boundary of the proposed new Brisbane International Airport in relation to Moreton Bay as a whole. The original report and associated maps were provided to the Terrestrial Ecology Review Group of the Brisbane Airport Environmental Study Committee in 1974. The technical recommendations made to that Group may be found in Dowling (1979a). This publication is based on the original report to that Group.

Mangroves are the tree, shrub and heath communities occupying the land between the upper and lower tidal limits. They occur along shorelines, on the banks of creeks and streams, in swamps, in areas of silt and mud at creek and river mouths, around islands and in bays and other low-lying areas that are regularly inundated and which contain suitable substrates and are protected *from* strong wave action.

In this report the word mangrove is used in either of two senses. It is used to refer to the association of woody plants that grow between the tidal limits and it is also applied to each and any of the species occurring within those associations. Map 1 shows the general distribution of mangroves within Moreton Bay.

EARLY EXPLORATION AND SETTLEMENT

South-eastern Queensland was one of the earliest explored and settled areas in Queensland and is currently the most densely populated area of the State. The name Morton Bay was given by Captain James Cook when he sailed up the east coast of Australia in May 1770. He applied it to the area of the outer coast from Point Lookout on North Stradbroke Island to Cape Moreton on Moreton Island and included the South Passage. Cook regarded Moreton and Stradbroke Islands as part of the mainland and gave

the name of Glass House Bay to the area of open water behind Cape Moreton. This bay was originally named after the Glasshouse Mountains which Cook saw to the west of Bribie Island and which reminded him of the glass houses or furnaces of his native Yorkshire (Steele 1972).

In 1799 Lieutenant Matthew Flinders explored and charted Glass House Bay, which he renamed Moreton Bay, in H.M. Sloop 'Norfolk'. He also discovered and named many of the islands in the bay including Mud, St. Helena, Green, King, Peel and Coochiemudlo Islands. In addition he named Point Skirmish, Pumicestone River and Red Cliff Point, now South Point, Pumicestone Channel and Woody Point respectively. Flinders also found that Cook's Morton Bay was connected to Cook's Glass House Bay by the South Passage. Flinders named the land mass to the north of this passage Moreton Island. Flinders failed to find the mouth of the Brisbane River, even though he sailed close by, as it was obscured by mangroves. He explored Pumicestone Channel and noted the mangroves there. He also noted that many of the islands in the bay were covered or surrounded by mangroves. (Steele 1972).

In March 1822 John Bingle in H.M. Cutter 'Sally' explored Pumicestone Channel for four days. Bingle described this area as 'the river to be nothing but low mangrove swamp filled with islands and creeks' (Gill 1968).

In June 1822 William Edwardson in H.M. Cutter 'Snapper' explored Pumicestone Channel for almost its entire length as well as the southern part of Moreton Bay as far south as what is now Jumpinpin. In both areas he mentions the abundance of mangroves (Gill 1968, Steele 1972).

In 1823 Lieutenant John Oxley was sent northwards from Sydney to assess certain areas as to their suitability as convict settlements. On 29 November 1823 Oxley entered Moreton Bay and on 2 December with the guidance of the two castaways Pamphlet and Finnegan, who had been living with the local natives, Oxley discovered the mouth of the Brisbane River. While Oxley was exploring the Brisbane River some others of his party were exploring the islands at the southern end of Moreton Bay and they continued as far south as Southport.

In September 1824 Oxley returned to Moreton Bay to establish a penal settlement at Redcliffe. However the settlement was transferred to the site of Brisbane between March and July 1825. By 1827 branch penal settlements had been established at Dunwich on North Stradbroke Island and at Ipswich.

Oxley noted in his journals that mangroves occurred at Redcliffe, Pine River, the mouth and lower reaches of the Brisbane River (Fisherman Islands and Luggage Point) and Coochiemudlo Island (Steele 1972). Other early explorers including Major Edmund Lockyer, Alan Cunningham and Charles Eraser also noted mangroves within the Bay and particularly the mangroves at the mouth of the Brisbane River (Steele 1972). This suggests that they were extensive at that time. Lockyer also provided a

map of the Brisbane River with areas of mangroves marked on it, while Pamphlet, noted the mangroves on North Stradbroke Island and at Cleveland (Steele 1972).

Meston (1885) noted that on St. Helena Island 'the whole of the island is cleared of the original timber, except for a few solitary mangroves.' In 1984 the northern and eastern sides of the island supported extensive stands of mangroves.

Since the mid 1800s, when Queensland was thrown open for free settlement, major settlement and development has taken place on the mainland side of the bay. Only minor settlement of the islands within the bay, mainly for agricultural pursuits, has taken place since that time and most are relatively undisturbed.

The mangrove communities within Moreton Bay have been subject to development pressures such as construction of port and harbour facilities, marina developments and airport construction. It is difficult to ascertain accurately the area of mangroves that has been cleared within Moreton Bay. There are two reasons for this:

(i) No estimate has been previously made of the area of mangroves and

(ii) At the same time as clearing has been taking place the advancement and establishment of mangrove communities has been occurring in other areas

It is unlikely that clearing has exceeded 5% of the total area and it is more likely to be less than this figure. Newly established areas of mangroves are most apparent in Raby Bay, Deception Bay and off the south-western end of Moreton Island.

Examination of early aerial photographs of Moreton Island and Raby Bay reveals substantial increases in area (up to 30%) in the last forty years while a large area of mangroves has obviously developed on St Helena Island since Meston (1895) described the mangroves there.

PREVIOUS STUDIES ON MORETON BAY

Detailed published information on the mangrove communities of Moreton Bay is sparse. However generalised accounts of the mangroves of Moreton Bay and certain areas within the Bay are available.

Jones (1971) and Lear and Turner (1977) gave accounts and descriptions of most of the mangrove species that occur in Queensland. Macnae (1966) gave a generalised account of the mangroves of Queensland, while Chapman (1976) described Australian mangroves in general. A generalised account of the distribution of the mangrove communities of Queensland can be

found in Dowling and McDonald (1982). Dowling (1979b) gave a generalised account and a small scale map of the distribution of mangroves within the study area. Hegerl and Timmins, (1973) and Shine, Ellway and Hegerl (1973) gave generalised accounts of areas lying to the north and south of Moreton Bay respectively. Elsol and Sattler (1978), Dowling and McDonald (1976) and Elsol and Dowling (1978) provided broad descriptions and maps (all 1:100 000 scale) of the mangrove and salt marsh communities in the northern, central and southern parts of the study area respectively. A series of small scale maps showing the various areas of mangrove communities in the area was provided in Co-Ordinator-General's Department, Queensland (1974a).

Davie (1984) discussed the structure and classification of the mangrove communities in the Bay. McDonald and Elsol (1979) and Sattler (1979) provided a map and broad description of the mangroves occurring in Pumicestone Channel. Durrington (1977c) gave a generalised account and a map of the mangroves of Moreton Island. Blake (1940) provided a map and account of the mangroves of Goat and Bird Islands. A detailed account of the vegetation, including mangroves, along Serpentine Creek and adjacent areas was provided in Durrington (1977 a and b) while a detailed account of the mangroves of Fisherman Islands was provided in Durrington (1973). Stevens and Rogers (1979) provided a brief account of the mangroves of the Bay.

Clifford and Specht (1979) provided a map and broad account of the mangroves and associated communities of the northern part of North Stradbroke Island. A description of the land forms of the study area was provided in Thompson (1975) while the soils of North Stradbroke Island including mangrove areas were described in Thompson & Ward (1975). Hekel, Ward, Jones and Searle (1979) described the geological development of the northern part of Moreton Bay. A discussion of the hydrology of Moreton Bay which is useful in understanding water and siltation movements was included in Newell (1971). Bailey and Stevens (1979), provided useful background information on the entire Moreton Bay area.

PHYSICAL ENVIRONMENT

Moreton Bay is a roughly triangular shaped bay approximately 35 km at its widest point in the north, narrowing to about 5 km in the south. It is protected from oceanic swells from the east by Moreton, and North and South Stradbroke Islands. It is shallowest in the western and southern parts, gradually becoming deeper in the eastern central area (Newell 1971). The coastline along the western edge is composed of Quaternary deposits of shale, silt, clay and coral resting on a basement of Triassic-Jurassic sandstones and shales with some Tertiary basalts and Palaeozoic metamorphics (Stevens and Rogers, 1979). The eastern shorelines and the offshore islands of Bribie, Moreton, North and South Stradbroke Islands consist predominantly of siliceous sands of Quaternary origin (Benussi 1975, Coaldrake

1960). Tertiary basalt, Mesozoic sandstone, volcanics and Palaeozoic metamorphics with a lateritic cover form coastal headlands and also the cores of the islands of Moreton Bay (Hekel, Jones and Searle 1976).

Deposits within the Bay are dominated by muddy sediments in the western half of the Bay while muddy sand and sands dominate the eastern half of the Bay (Hekel et al. 1979).

For ease of description the study area is divided into three regions, namely:

Pumicestone Channel: Caloundra to the southern end of Bribie Island. Pumicestone Channel is also known as Pumicestone Strait or Pumicestone Passage.

Northern Moreton Bay: The area from the southern end of Bribie Island to Victoria Point.

Southern Moreton Bay: The area from Victoria Point to Southport.

Pumicestone Channel

Pumicestone Channel is a relatively narrow waterway between Bribie Island and the mainland. It extends from Caloundra in the north (26°48'S) to Toorbul Point in the south (27°05'S), a distance of about 30 km. The Channel is open at its northern end to the Pacific Ocean over a narrow, shallow and often shifting bar while the southern end of the Channel opens into northern Moreton Bay. It is shallow for the greater part of its length with extensive mud flats exposed at low tide in the southern and central parts. The Channel is widest south of Hussey Creek, generally being from 2000 m to 3000 m in width, but extending to 4500 m wide between Long and Goat Islands. Between Hussey Creek and Halls Creek the Channel is narrowest and numerous small islands occur, the edges of which fall sharply away into the adjacent waterways. North of Halls Creek the Channel widens slightly and is generally about 500m wide, though near Caloundra it widens to 1000 m. Several rivers and creeks flow into the Channel from the mainland or western side and it is along the estuaries of these that some of the most extensive areas of mangrove communities are present.

Northern Moreton Bay

This area of Moreton Bay is open, varying in width from about 32 km in the north to about 9 km in the south. Because of the large expanse of open water, the shores are often subject to appreciable wave action. As a consequence of the wave action the mangrove communities are restricted to protected areas such as river and creek estuaries.

The most extensive mangrove communities occur on the western shores along the protected estuaries of the Caboolture River, Pine River, Hays Inlet, Serpentine Creek and mouth of the Brisbane River.

Large areas of mangroves also occur on more exposed areas such as Whyte Island and Fisherman Islands at the mouth of the Brisbane River, and on Mud, St. Helena, Green and Peel Islands. These islands, though occurring in open water, are surrounded by extensive areas of sand, mud flats and shallow water. These shallow areas effectively form protective barriers and help to moderate wave action, allowing the formation of mangrove communities.

Where mangroves form a fringe along the mainland shores, for example Waterloo Bay, Raby Bay, they occur in areas that are protected from strong wave action by extensive mud flats.

Southern Moreton Bay

This section of Moreton Bay contains the most extensive and varied development of mangrove communities in the whole Bay. The region is a complex of channels and tidal islands and extensive mudbanks and is most easily understood if it is considered as the combined river deltas of the three main rivers that flow into the area, namely the Logan, Pimpama and Coomera Rivers. The deltas of these rivers are combined and are also bounded to the east by North and South Stradbroke Islands. This causes the deltas to run in a north-south direction. Also occurring within this part of the bay are low hilly islands (for example Russell, Coochiemudlo, Lamb) of the same geologic formation as the adjacent mainland (Beckmann 1975).

Prior to 1898, North and South Stradbroke Islands were continuous. However, about 13 May, 1898 the sea broke through the narrow spit joining the northern and southern portions of Stradbroke Island, in the vicinity of what is now known as Jumpinpin (Welsby 1907). The breakthrough occurred several hundred metres south of Swan Bay and has migrated slowly northward until it is now just south of Swan Bay. Considerable changes in both size and shape of many of the islands in the vicinity of Jumpinpin have occurred since the breakthrough.

Since the original breakthrough in 1898 erosion has been taking place along Canaipa Passage and in the channels between Stingaree and Short Islands, Stingaree and Crusoe Islands, Tabby Tabby and Eden Islands, Short and Eden Islands, Short and Crusoe Islands, Eden and Kangaroo Islands, Kangaroo and Woogoompah Islands and along Whalleys Gutter and Fiveways. Strong tidal currents have resulted in scouring, undermining and sheet erosion along the edges of many islands in this area, with the result that the sides of many of the islands fall vertically into the adjacent channels. Large slabs of hard consolidated mud often peel off the islands carrying with them the covering vegetation. Some of the smaller islands have been completely eroded in

living memory and all that remains of others is a few square metres of soil.

Due to the deposition of mud new mud banks are forming in the wider, slower flowing parts of the channels and in still backwaters. This build up is most marked between Squire Island and Jumpinpin, between Crusoe and North Stradbroke Islands and between Hawk and South Stradbroke Islands. Many of the banks are constantly shifting and it seems unlikely that these shifting banks will immediately stabilise to form new islands. Erosion is further manifested by many vegetation types normally only found at the higher tidal levels toward the landward edge of the mangroves now occurring on the seaward edge, showing that erosion of the more seaward vegetation types has taken place.

The northern section of this southern region of the Bay, that is Logan River mouth to Victoria Point, is shallow with extensive areas of soft mud which are exposed at low tide. These banks were noted by Flinders in 1799 (Steele 1972). The area between Long Island and Pannikin Island is particularly shallow and it is in this area that the major advancement and formation of new mangrove communities is currently occurring. Colonisation is only taking place on those banks that have built up to a height close to or above mean high water neaps and is mainly occurring between Long, Lagoon and Pannikin Islands.

The southern portion of this region, Southport to Jumpinpin, (known as The Broadwater) contains numerous mud and sand banks. Many of the muddy areas have substrates with a high sand content. The Broadwater is open to the ocean between The Spit and Moondarewa Point which is also the outlet to the ocean for the Nerang River. The most extensive mangrove communities found in this area are confined to the western side of The Broadwater on the islands formed at the mouths of the Pimpama and Coomera Rivers and adjacent areas. Both Woogoompah Island and Coomera Island contain large areas, well above normal high water mark, which support *Eucalyptus* spp. and *Casuarina* spp. open-forests.

Climate

The climate of Australia is controlled by the position of the subtropical high pressure anticyclone belt of the Southern Hemisphere. The axis of this belt oscillates across 15 degrees of latitude (25°S to 40°S) during the year following the apparent migration of the sun away from the equator as solstices approach (Linacre and Hobbs 1977, Co-Ordinator-General's Department, Queensland 1974 b).

The southeast of Queensland, of which Moreton Bay is a part, is therefore predominantly influenced by air movement from (a) the southwest over the continent during the winter months when the high pressure systems move to the more northerly latitudes and (b) from the east, over the Pacific Ocean during the summer months when the belt of anticyclones moves to the south (Co-Ordinator-General's Department Queensland 1974 b).

The passage of these high pressure systems alternates with low pressure systems which move from west to east across Australia. Stable high pressure systems can cause prolonged dry periods while stable low pressure systems may lead to persistent rain (Co-Ordinator-General's Department, Queensland 1972).

The climate of the Moreton Bay area is classified as Cfa using the Koppen-Geiger system (Koeppe and Long 1958, Linacre and Hobbs 1977, Saenger, Specht, M., Specht, R.L. and Chapman 1977). The area is classified as belonging to the humid subtropical climatic region (Gentilli 1971, 1972, Koeppe and Long 1958). This climate is characterised by higher rainfall, atmospheric moisture content and cloud cover during the warmer summer months. The winter and spring have drier conditions, clearer skies and greater temperature ranges. Moreton Bay is situated in an area of acute thunderstorm activity and during the summer months, a substantial portion of the rainfall is derived from high intensity storms. Tropical cyclones periodically pass through or adjacent to the area with the greatest incidence being in February and March. These cyclones generally move from the south-east to south-west and are associated with periods of high rainfall, strong winds and increased tidal heights (Co-Ordinator-General's Department, Queensland 1974 b). Data on cyclones tracks can be found in Lourensz (1981).

Rainfall varies throughout the Moreton Bay area with the stations at the northern and southern ends of the Bay receiving more rainfall than those in the central region. Highest rainfalls occur from December to March.

Evaporation in most months exceeds rainfall except for February, March and June when rainfall marginally exceeds evaporation, while from August to December evaporation greatly exceeds rainfall.

Monthly means of daily sunshine at Brisbane (the only centre in the area for which such data are available) vary by less than 2 hours per day throughout the year. Monthly daily averages range between 6.7 (June) and 8.3 hours (September and October) with a daily average of 7.5 hours. The small range in diurnal sunshine throughout the year is a result of the greater number of clear days in winter compensating for their shorter day length.

Winds at Brisbane exhibit a distinct diurnal cycle. During the night and early mornings south westerlies predominate, particularly in the colder months, while the afternoon winds mostly prevail between north and southeast in the warmer months and from all directions in the colder months. Sea breezes, often from the north-east, are common in the afternoons in the summer months while calms are frequent at night in the summer months.

The climatic data for various recording stations within the area are summarised in Table 1.

Tides

Tidal inundation is probably the most important factor affecting mangrove distribution within Moreton Bay. Mangroves cannot withstand prolonged inundation and they must have regular and in many cases prolonged periods free from inundation to survive. Water-logging rapidly leads to their death. Trials undertaken within the New Brisbane International Airport Area at the mouth of the Brisbane River show that mangroves cannot survive or grow below approximately 1.6 m above tidal datum. Salt marsh communities are formed at tidal heights of 1.9 m or above (Dowling unpublished report).

The tides along the open east coast of Queensland are well known and have been adequately documented (Olsen 1971). They are remarkable for their regularity, predictability and uniformity. The tidal sequence is high high water - low low water - low high water - high low water, with the highest tides occurring during the morning in April, night in July, afternoon in October and day in January. The seasonal variations are small with the maximum spring tides in January and July being some 10% greater than in April and October. Average monthly mean sea levels vary little being 0.1 m above average between March and June and 0.1 m below average between August and November (Co-Ordinator-General's Department 1974 b). Variations between consecutive months may be as much as 0.2 m. Substantial variations from these figures may occur due to storm surges during periods of strong onshore winds or during cyclonic disturbances.

The Brisbane Bar is used as the reference point for Moreton Bay but does not represent ocean conditions. The tides within Moreton Bay have the same general features as those in the ocean except that the heights are larger and occur later than they do in the ocean. The Brisbane Bar is a suitable reference point as the tidal range within Moreton Bay is within 5% of that of the Bar. There is some evidence that the tidal range in the Russell Island - Macleay Island area may be slightly larger than at the Brisbane Bar (Co-Ordinator-General's Department 1974 b).

Table 1 Mean maximum temperature, mean minimum temperature, annual rainfall, raindays, evaporation, relative humidity and sunshine for selected localities within or near the study area.

Maximum temperature (°C)

	Jan.	Feb.	Mar.	Apr.	May	June.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Brisbane	29.4	29.0	28.0	26.1	23.2	20.8	20.4	21.8	24.1	26.1	27.8	29.1	25.5
Caloundra	28.2	27.6	27.1	25.3	22.6	20.3	19.7	20.8	22.6	24.6	26.1	27.6	24.4
Cape Moreton	26.6	26.6	25.9	24.2	21.6	19.7	18.7	19.6	21.2	23.0	24.7	25.8	23.1
Ormiston	28.5	28.3	27.5	25.8	23.0	20.9	20.2	21.3	23.2	24.9	26.9	28.1	24.9
Southport	28.5	28.3	27.7	26.2	23.3	21.3	20.6	21.5	23.2	25.1	26.8	28.0	25.0

Minimum temperature (oC)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Brisbane	20.7	20.6	19.4	16.6	13.4	10.9	9.5	10.3	12.9	15.8	18.2	19.9	15.7
Caloundra	21.5	21.1	20.1	17.2	14.6	11.8	10.6	11.7	13.7	16.4	18.4	20.5	16.5
Cape Moreton	21.7	21.9	21.1	19.3	16.2	14.1	12.9	13.6	15.5	17.6	19.2	20.8	17.8
Ormiston	20.3	20.1	18.7	15.5	12.3	9.8	7.9	8.5	10.9	14.4	17.0	19.1	14.5
Southport	20.3	20.3	19.0	16.5	13.2	10.8	9.0	9.7	11.9	14.8	17.3	19.2	15.2

Mean annual rainfall (mm)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Brisbane	165.0	163.0	144.0	86.0	73.0	69.0	55.0	46.0	47.0	75.0	99.0	130.0	1155.0
Caloundra	191.0	206.0	219.0	164.0	168.0	96.0	83.0	62.0	58.0	80.0	113.0	140.0	1580.0
Cape Moreton	166.0	165.0	196.0	152.0	177.0	139.0	119.0	82.0	71.0	83.0	95.0	129.0	1574.0
Ormiston	186.0	181.0	186.0	83.0	101.0	83.0	78.0	54.0	41.0	98.0	101.0	137.0	1329.0
Sandgate	171.0	180.0	156.0	89.0	74.0	70.0	58.0	42.0	48.0	82.0	101.0	132.0	1203.0
Southport	186.0	195.0	206.0	129.0	124.0	97.0	75.0	54.0	60.0	85.0	103.0	129.0	1443.0

Raindays

	Jan.	Feb.	Har.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Brisbane	13.0	14.0	15.0	11.0	9.0	8.0	7.0	7.0	8.0	9.0	10.0	12.0	123.0
Caloundra	11.0	13.0	14.0	12.0	11.0	9.0	7.0	7.0	6.0	7.0	9.0	9.0	115.0
Cape Moreton	13.0	14.0	16.0	14.0	14.0	12.0	10.0	9.0	9.0	10.0	10.0	11.0	142.0
Ormiston	11.0	14.0	13.0	9.0	9.0	7.0	6.0	6.0	6.0	9.0	10.0	9.0	109.0
Southport	13.0	13.0	15.0	11.0	10.0	8.0	7.0	7.0	7.0	9.0	9.0	11.0	120.0

Table 1 continued

Sunshine (h)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Brisbane	235	198	212	217	210	199	221	246	247	256	248	254	2741

Sunshine (h)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Brisbane	7.6	7	6.8	7.2	6.8	6.7	7	8	8.3	8.3	8.2	8.2	7.5

Evaporation average per month (mm)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Brisbane	177	143	14	115	82	65	71	98	129	155	172	195	1544

Relative humidity (per cent.) 9.00 a.m.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Brisbane	66	69	71	70	71	72	70	66	62	60	60	62	67
Caloundra	75	79	79	76	76	73	69	67	64	66	70	72	72
Cape Moreton	77	79	78	75	75	75	71	70	71	72	75	77	75
Orniston	69	72	71	68	69	70	68	60	60	62	64	66	67
Southport	67	70	71	69	70	70	67	63	59	60	64	64	66

Relative humidity (per cent.) 3.00 p.m.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Brisbane	58	60	59	55	53	52	49	46	49	53	56	57	54
Caloundra	72	75	75	68	66	62	58	58	61	65	70	72	67
Cape Moreton	75	76	75	71	69	67	62	63	66	70	74	75	70
Orniston	66	68	66	61	59	57	54	52	56	60	62	65	61
Southport	67	67	66	61	58	56	51	52	54	60	64	66	60

(SOURCE: Bureau of Meteorology Brisbane 1984 unpublished data)

Table 2 Tidal planes for selected localities (height in metres.)

	H.H.M.S.	M.H.N.N.	H.L.H.N.	H.L.W.S.	M.H.M.	Maximum predicted 1984	Minimum predicted 1984	Maximum predicted 1970-1984	Minimum predicted 1970-1984
Brisbane	2.1	1.7	0.7	0.3	1.9	2.77	-0.04	2.77	-0.1
Caloundra	1.6	1.3	0.5	0.2	-	-	-	-	-
Macleay Island	2	1.6	0.6	0.2	-	-	-	-	-

H.H.M.S. - Mean High Water Springs; M.H.H.N. - Mean High Water Neaps; M.L.M.M. - Mean Low Water Neaps; M.L.M.S. - Mean Low Water Springs; M.H.W. - Mean High Water.

Table 3 Summary of maximum height of high tides 1984

Tidal range	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year
m)	(number of days)												
1.2 - 1.29	-	-	-	-	-	-	-	-	2	4	1	-	7
1.3-.1.39	-	-	-	-	-	-	-	2	3	6	6	-	17
1.4 - 1.49	-	-	-	2	1	-	-	1	3	3	4	1	15
1.5 - 1.59	-	3	4	5	6	3	4	6	3	1	3	7	45
1.6 - 1.69	12	4	3	1	4	15	15	3	3	4	4	12	80
1.7 - 1.79	10	3	2	3	5	6	8	8	5	2	2	8	62
1.8 - 1.89	5	8	2	2	4	4	6	7	5	9	7	6	65
1.9 - 1.99	7	6	4	3	8	4	3	7	13	8	7	3	73
2.0 - 2.09	2	5	10	7	5	3	2	6	4	12	9	3	68
2.1 - 2.19	3	9	11	11	5	4	4	5	8	3	9	5	77
2.2 - 2.29	5	4	6	12	9	5	3	5	4	5	2	6	66
2.3 - 2.39	8	5	9	4	9	9	7	5	2	3	2	5	68
2.4 - 2.49	3	3	4	6	3	5	3	1	3	-	2	4	37
2.5 - 2.59	2	2	2	1	1	-	4	4	-	-	-	-	16
2.6 - 2.69	2	1	2	-	-	-	-	-	-	-	-	-	5
2.7-2.8	1	3	1	1	-	-	-	-	-	-	-	-	6

Source Tables 2 and 3: Department of Harbours and Marine, Queensland 1984.

The hydrology of Moreton Bay is described in Newell (1971), while tidal data can be found in the tide tables published annually by the Department of Harbours and Marine Queensland. Tidal data taken from these tables for selected localities within Moreton Bay are given in Table 2 while a summary of the maximum height of each high tide and frequency of occurrence for that height for the year 1984 are given in Table 3.

METHODS

Vegetation descriptions were drawn from field studies using the structural classification based on Specht (1970). Specht's classification uses as its basis two readily observable and measurable parameters for the definition of communities (Table 4). These are:

(1) projective foliage cover (P.F.C.); and

(2) height of the tallest stratum or layer.

The 1:12 000 colour balanced aerial photographs used in this project were flown in April 1973.

Data were recorded from approximately 90 field sites between November, 1973 and January, 1975. These sites were selected by delineating patterns on the aerial photographs and within each different pattern representative sites were selected. These sites were scattered throughout all parts of the study area and were selected to cover the variation found within the various mangrove communities.

Data collected at each field site included a description of the community in terms of structure and layering, species present, P.F.C., soil type, presence or absence of hydrogen sulphide (smell in the soil was noted), type of litter and its abundance, the number and height of pneumatophores and frequency of tidal inundation estimated.

For each species present, data were collected on height, canopy size, girth at breast height, basal girth, P.F.C., cover, number of stems, height of tallest and shortest individuals of that species in each layer and the number of alive and dead individuals per hectare, together with notes on their distribution. Of this collected data only height, P.F.C., species present and number per hectare, have been tabulated in this report.

Table 4 Structural forms of vegetation in Australia

Life form and height of tallest stratum	Projective foliage cover of tallest stratum *			
	Dense (70-100%)	Mid-dense (30-70%)	Sparse (10-30%)	Very sparse** (<10%)
+Tree > 30 m	Tall closed-forest*	Tall open-forest	(Tall woodland)	(Tall open-woodland)
+Tree 10-30 m	Closed-forest*	Open-forest	Woodland	(Open-woodland)
+Tree 5-10 m	Low closed-forest*	Low open-forest	Low woodland	Low open-woodland
+Shrubs 2-8 m	Closed-scrub	Open-scrub	Tall shrubland	Tall open-shrubland
+Shrubs 0-2 m	Closed-heath	Open-heath	Low shrubland	(Low open-shrubland)
Hummock grasses 0-2 m	-	-	Hummock grassland	(Open hummock grassland)
Herbs (including moss, ferns, hemicryptophytes, geophytes, therophytes, hydrophytes, helophytes)	Closed-herbland^	Herbland ‡	Open-herbland t	-
	1. Closed-tussock grassland	1. Tussock grassland	1. Open-tussock grassland	-
	2. Closed-grassland	2. Grassland	2. Open-grassland	-
	3. Closed-herbfield	3. Herbfield	3. Open-herbfield	-
	4. Closed-sedgeland	4. Sedgeland	4. Open-sedgeland	-
	5. Closed-fernland	5. Fernland	5. (Open-fernland)	-
	6. Closed-mossland	6. Mossland	6. (Open-mossland)	-

+ A tree is defined as a woody plant more than 6 to 8 m tall, usually with a single stem. A shrub is a woody plant less than 6 to 8 m tall, frequently with many stems arising at or near the base (slightly modified from Beadle and Costin (1952).

* Isolated trees (emergents) may project from the canopy of some communities (Richards, Tansley and Matt, 1940). In some closed-forests, emergent Araucaria, Acacia or Eucalyptus species aay be so frequent that the resultant, structural form may be classified better as an open forest.

** Some ecologists prefer to ignore scattered trees and shrubs, equivalent to emergents in a predominately grassland, heath or shrubland fomation.

‡ Appropriate names for the comniunity will depend on the nature of the dominant herb.

( ) These formations are rare in Australia

The heights of individuals up to 2 m were measured, above this height a clinometer was used or the heights were estimated.

Values for P.F.C. were obtained using the method as proposed by Winkworth and Goodall (1962). Some figures for P.F.C. were estimated. These agreed to within 5 to 10% of measured values and were considered to be of sufficient accuracy to be used in this report.

The data for number of plants per hectare were obtained using 20 m square quadrats, except in the case of dense communities where 5 m or 10 m square quadrats were used. Several quadrats were laid out at each site, so that a representative area was sampled.

Where a community was distinctly two layered, the community was classified on the denser layer. In most cases this was the lower layer. The upper layer was then considered as consisting of emergents.

Traverses were made on foot through many areas. These were undertaken to confirm photo interpretation of community types. Data on species composition and P.F.C. of the community types along the traverses were collected.

Mapping was done by transferring the vegetation patterns delineated on the colour photographs onto 1:25 000 base maps. The maps do not take into account areas that have been cleared, filled or otherwise destroyed since the aerial photographs were taken. Some areas shown as mangroves are now dry land due to the build up of silt or the formation of sand ridges. In other areas the mangrove communities have changed structurally and in areal extent since the mapping was completed in 1974. The extent of these changes is limited and they occur in only a few localities.

A mapping unit 'Land subject to tidal inundation comprising saltwater couch and or samphire flats or marine clays' was not shown on the original maps produced in 1974 but has been added to the current maps by the Queensland Fisheries Service. These areas were derived by subtracting the area shown as mangroves on the maps accompanying this publication from areas shown as tidal on standard 1:25 000 Department of Mapping and Surveying topographic maps.

Because of the mapping scale used it is not possible to show all variation within a unit and some mapped areas consist of a mosaic of smaller units. In these cases the area has been mapped as the predominant unit.

The unit names are provided as a guide to the type of community found within that unit. A full description of each unit is given in the text.

The maps were redrawn from the original format into their present format and published by the Queensland Fisheries Service (now Division of Dairying and Fisheries, Department of Primary Industries).

All information on the maps relating to swamp lands other than mangroves was added by the Queensland Fisheries Service.

All specimens collected during the course of field work have been lodged with the Queensland Herbarium (BRI), Meiers Road, Indooroopilly, Brisbane.

SPECIES OF MANGROVES WITHIN MORETON BAY

Seven species of mangrove trees or shrubs occur in Moreton Bay. Table 5 contains a list of the species and a summary of their ecology and distribution within Moreton Bay.

Table 5 Mangroves species list and summary *of* ecology and distribution

Common Name	Botanical name	Family	Other common names	Comments
Black mangrove	Lumnitzera racemosa	Combretaceae	White-flowered black mangrove	Occurs in the most landward fringe, usually on clayey soils. Rare, mostly commonly found in Pumicestone Channel.
Grey mangrove	Avicennia marina var. australasica	Avicenniaceae	White mangrove	Occurs in all parts of the intertidal zone, on a *wide* range of soils varying from soft mud, sandy mud, to clays. It is the most common of all the mangroves.
Milky mangrove	Excoecaria agallocha	Euphorbiaceae	Blind your eye	Occurs in the lost landward fringe, often on s«all ridges or on sandy soils.
Orange mangrove	Bruguiera gymnorhiza	Rhizophoraceae	Large-fruited orange mangrove	Normally occurs as the most landward of the mangroves, but may be found scattered throughout most mangrove communities. Prefers firm, hard, well-drained mud, often with a high organic content, that is inundated by only a few high tides per month. Only two areas of local abundance within the study area. Usually confined to areas of freshwater seepage.
River mangrove	Aegiceras corniculatum	Myrsinaceae		Centre and landward zones of the mangroves, and along creek banks in the upper tidal reaches. Prefers poorly drained soils that are shallowly inundated by lost high tides. Common in most areas of Moreton Bay.
Spotted mangrove	Rhizophora stylosa	Rhizophoraceae	Spotted-leaved red mangrove	Usually occurs around the edges of shallow protected inlets, or other protected areas. Prefers well drained soft unconsolidated muds.
Yellow mangrove	Ceriops tagal var. australis	Rhizophoraceae	Yellow-leaved spurred mangrove	Occurs in the upper tidal limits in areas usually only inundated by a few high tides per month. Prefers well drained clayey soils. Common on the islands around Jumpinpin.

FIELD KEY TO THE MANGROVES OF MORETON BAY

la Leaves opposite

2a Leaves greyish on underside (discolorous) and sometimes slightly woolly *Avicennia marina* var. *australasica*

2b Leaves not grey on underside

3a Trunk with aerial prop roots; leaves with numerous small black or brown spots on the underside *Rhizophora stylosa*

3b Trunk without aerial prop roots; leaves with occasional small black or brown spots on the underside

4a Leaves less than 10 cm, yellow or light green; base of trunk usually distinctly buttressed *Ceriops tagal* var. *austral is*

4b Leaves more than 10 cm, dark glossy green; bark hard and often fissured; trunk usually not buttressed *Bruguiera gymnorhiza*

1b Leaves alternate

5a Sap milky *Excoecaria agallocha*

5b Sap not milky

6a Leaves about twice as long as wide, tips rounded and not notched and salt crystals often present on the leaf surface *Aegiceras corniculatum*

6b Leaves 4-6 times as long as wide, with a distinct notch *Lumnitzera racemosa*

SPECIES DESCRIPTIONS*

Avicennia marina (Forsskal) Vierh. var. *australasica* (Walp.) Mold. Grey Mangrove or White Mangrove.

Description: tree or shrub growing to 10 to 12 m, occasionally to 15 m.

Trunk: fairly smooth with a light grey bark, smooth and somewhat flakey in younger trees, rough and pustulous in older trees.

Leaves: arranged in pairs, 5 to 8 cm long, narrowed to each end and from three to four times as long as broad, glossy and pale green above, grey and sometimes sparsely woolly below.

Flowers: deep yellow or orange, about 6 mm long, 6 mm wide, produced in small dense bunches (panicles) at the end of twigs and in leaf axils; petals four, united into a tube in the lower part; corolla tube surrounded by four sepals and hidden from view; stamens four, small, attached to the inside of the corolla tube.

Fruit: two lobed somewhat flattened pear shaped structure seeds contained in a green velvety covering; viviparous, exposing two large cotyledons and hairy hypocotyl before falling from tree.

Roots: numerous peg like structures (pneumatophores) projecting from main lateral roots for a few centimetres above mud or sand.

Comment: *Avicennia* is the most widespread and common of the mangrove species found in Moreton Bay. It can occur in any part of the intertidal zone, either as pure stands or mixed with other species, usually as an emergent. *Avicennia* is the most variable in form of all the mangrove species within the bay, occurring as large, well developed trees, 10 to 12 m or greater tall or as small (spreading) shrubs only 0.5 m tall when fully developed. Its tallest and most vigorous development occurs where it grows as the most seaward of the mangroves in well drained soils that are inundated by all high tides. The further towards the upper tidal limits that it occurs the smaller and less vigorous *Avicennia* usually becomes. At the upper tidal limits, *Avicennia* usually occurs as a small shrub.

The pattern of inundation by both fresh and saltwater, appears to determine the growth of *Avicennia*. In areas with poor drainage, but fairly frequent tidal inundation, *Avicennia* usually forms a low spindly tree or shrub. Where freshwater seepage occurs, the *Avicennia* plants tend to be stunted and form low bushes with a characteristic round, leafy shape.

*Wherever possible in the text the mangrove species are referred to by their generic names only.

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Waterlogging, ponding of water or siltation, especially where it covers the pneumatophores, results in the death of *Avicennia.* Watson (1928) observed that siltation and waterlogging was responsible for the death of *Avicennia* along the Brisbane River.

Avicennia leaves and fruit are readily eaten by cattle, (Everist 1969, Maiden 1889). The fruit are edible by humans after preparation (Maiden 1889, Cribb and Cribb 1975) while the wood is useful for mallets and boat knees and the ashes may be used for soap manufacture (Maiden 1889). It is sometimes used as a source of honey and pollen (Blake and Roff 1972).

Aegiceras corniculatum (L.) Blanco River Mangrove.

Description: bushy, multistemmed, dark green shrub or occasionally a small slender tree to 6 to 7 m.

Leaves: alternate, leathery and spoon-shaped, 3.5 to 6.5 cm long, 2.0 to 3.5 cm wide, edges usually rolled under (revolute), upper surface often covered by film of salt crystals.

Flowers: white, highly fragrant, smelling somewhat like over-ripe bananas, up to 10 mm long, borne in terminal or axillary bunches (umbels); pedicels 1 mm long; sepals 4 to 5 mm long, contorted, orbicular; corolla white, glabrous, tube 4 to 5 mm long, lobes 4 to 5 mm long, ovate, acute, spreading; stamens up to five, exserted, filaments united in lower half, adnate to base of corolla; ovary superior.

Fruit: small, 2 to 4 cm long, 0.5 cm wide, greenish, curved, pointed, viviparous.

Comment: *Aegiceras* occurs along the edges of tidal rivers and creeks upstream as far as the tidal limit and in the centre and landward zones of the mangroves communities. It is often found in areas of reduced salinity such as the upper reaches of creeks, however the most extensive stands occur in areas under normal tidal influences. It is common as an understorey in many *Avicennia* communities. It also forms pure stands of heath and scrub communities. The scrub communities are often impenetrable.

Aegiceras usually grows on firm muds which often have a shallow (3 to 4 cm) layer of soft mud on top. It grows well on poorly drained soils that are shallowly inundated by most high t ides.

Aegiceras is common along creek banks, occurring as a multistemmed shrub 2 to 3 m tall where it frequently overhangs the stream. In these situations *Aegiceras* is only inundated by the higher tides. Along the banks of the smaller streams it usually occurs as a pure community, while along the edge of larger streams and rivers, *Avicennia* is usually also present as an emergent. *Aegiceras* communities are usually characterised by

the sharp demarcation between them and adjacent mangrove and salt marsh communities.

Aegiceras is used by commercial beekeepers. It is worked freely for nectar and for the large quantities of the greyish coloured pollen it produces (Blake and Roff 1972). In the past, use was made of the stems of *Aegiceras* for oyster stakes by professional oystermen, however this practice has now ceased. The wood is a light colour, close grained and easily worked (Bailey 1888, Maiden 1889), while according to Cribb and Cribb (1975), the salt crystals, which are usually present on the leaf surface, could be used as an emergency salt supply.

Ceriops tagal var. *australis* C.T. White Yellow Mangrove or Yellow-leaved Spurred Mangrove.

Description: shrub or small slender tree to 7 m. Trunk: usually buttressed, yellowish or fawn coloured bark.

Leaves: opposite, obovate, usually erect and grouped at the end of the branches, 4 to 6.5 cm long, 2 to 3.5 cm wide, margins commonly rolled under (revolute), leaves commonly with a yellowish tinge, pale to dark green in deeply shaded areas.

Flowers: white, about 6 mm long, paired in the axils of leaves; petals oblong joined at the base; calyx lobes erect.

Fruit: brown and pear shaped, 10 to 12 mm long, viviparous; hypocotyl smooth, round, somewhat tapering, 10 to 15 cm long.

Comments: *Ceriops* communities are normally found in the upper tidal limits and are consequently inundated by only a few tides each month. *Ceriops* most commonly is found on firm well drained clays, clayey muds or sandy clays.

In areas that are frequently inundated by the tide, are poorly drained or have a high clay content, *Ceriops* forms low open-and low shrublands. The tallest and best developed *Ceriops* communities occur on peaty soils. These usually occur in the upper tidal limits in areas where leaf litter does not readily wash away or in areas to which leaf litter is washed by the tide. The litter builds up a peaty layer of mainly decomposing leaves but also twigs.

The most extensive and tallest stands of *Ceriops* occur on the islands from Victoria Point to Woogoompah Island, in the southern part of Moreton Bay. Extensive stands also occur in the region of Serpentine Creek but they tend to be less than 1.5 m in height.

According to Bailey (1888) the wood is dark brown, close grained hard and tough while Maiden (1889) suggests that it could be used for boat knees.

Rhizophora stylosa Griffith Spotted Mangrove or Spotted-leaved Red Mangrove.

Description: shrub or small tree, 4 to 7 m tall.

Trunk: reddish brown with somewhat rough and sometimes fissured persistent bark; trunk red when cut.

Leaves: opposite, 6 to 11 cm long, 3.5 to 7 cm wide, thick and brittle, usually with a small deciduous point and with numerous small reddish brown spots on the undersurface; stipules slender, 2 to 4 cm long, clasping terminal bud, soon deciduous.

Flowers: white or yellowish white 10 to 15 mm wide, 10 to 15 mm long, in cymes branching in pairs with two bracts below each flower; petals four, alternating with the calyx lobes, both about 10 mm long.

Fruit: brown, pear shaped, with four persistent calyx lobes, viviparous; hypocotyl round, elongate, pointed, up to 40 cm long.

Roots: arching prop or stilt roots produced on trunk, aerial prop roots common on lower branches; roots red when cut.

Comment: *Rhizophora* may form almost pure stands or it may be associated with other mangrove species. It usually occurs as a large single stemmed shrub or small tree, towards the lower tidal limits.

Rhizophora occasionally occurs as a very narrow zone behind a seaward fringe of *Avicennia*. It only occurs as the most seaward fringe around the upper ends of shallow protected inlets or along the edge of small protected creeks where it usually forms pure stands. In these areas the community can be quite extensive.

According to Bailey (1888) and Maiden (1889) the bark can be used for tanning. The timber is reddish to dark brown, close grained, hard and tough. Cribb and Cribb (1975) suggest that the fruit is edible after treatment.

Bruguiera gymnorhiza (L.) Lam. Orange Mangrove or Large-fruited Orange Mangrove.

Description: tree growing to 8 to 10 m, occasionally to 12 m.

Trunk: dark brown, roughly fissured, occasionally slightly buttressed.

Leaves: opposite, 15 to 20 cm long, 6 to 7 cm broad, dark glossy green, elliptic in outline with a shortly acuminate apex.

Flowers: solitary in leaf axils; petals pale yellow to white, 13 to 15 mm long, fringed with silky white hairs, falling soon after flowers open; calyx with 12 to 13 spreading bright red lobes, 3 to 3.5 cm long.

Fruit: small, enclosed within calyx lobes, viviparous; hypocotyl narrow round, cigar-shaped, up to 30 cm long.

Roots: characteristic knee roots at the surface of soil.

Comments: *Bruguiera* usually occurs as scattered plants or in small clumps of 10 to 15 trees on the most landward fringe of the mangroves usually in areas of shade such as in the understorey in *Avicennia* forests. It is generally found on hard consolidated muds or peaty clays and is most common in areas of fresh water seepage.

There are only two areas within Moreton Bay where *Bruguiera* is locally abundant, and forms communities large enough to map. These are:

i) south of Hussey Creek

ii) on the northern tip of Russell Island.

According to Bailey (1888) and Maiden (1889) the bark is suitable for tanning and the wood is light or yellowish, hard, durable and suitable for pick or axe handles. Cribb & Cribb (1975) say that the fruit is edible.

Excoecaria agallocha L. Milky Mangrove or Blind your Eye.

Description: tree growing to 7 to 8 m.

Trunk: bark fawn to grey, covered in numerous brown corky pustules.

Leaves: bright green, alternate, obovate to elliptic, 5 to 11 cm long, 2.5 to 4 cm wide, pair of small glands at the base; leaf margins often finely toothed, leaves and branches exude milky sap when broken.

Flowers: male and female flowers on separate trees, flowers in spikes 2.5 to 3.5 cm long, usually occurring in the axils of the previous years leaves or at the old nodes, flowers 1 to 2 mm long, 1 to 2 mm wide, perianth segments three lobed, fleshy; male flowers crowded, stamens two to three on short stipe; female flowers less crowded on shorter spike.

Fruit: small fleshy three lobed capsule up to 5 mm across.

Comment: *Excoecaria* is normally found on the most landward fringe of the mangroves at or about high water springs. It is often found growing on sandy ridges within the mangroves and is commonly found growing on peaty muds in association with *Bruguiera*.

Excoecaria contains an acrid white milky sap which can cause intense pain and temporary blindness if it gets into the eyes (Everist 1974), while Maiden (1889) notes that it is useful in curing chronic ulcerous diseases (for example leprosy). It may also cause blistering if it makes contact with other tender parts of the body.

The wood is light, white, soft, close grained and easily worked (Bailey 1888).

Lumnitzera racemosa Willd. Black Mangrove or White-flowered Black Mangrove.

Description: small shrub growing to 3 to 4 m.

Leaves: alternate, spirally arranged, succulent, blunt and emarginate at the apex, gradually tapering at the base, 2 to 7 cm long and 1 to 2.5 cm wide.

Flowers: 3 to 4 mm long, white and sessile; calyx lobes broadly ovate, about 1 mm long; petals white, glabrous, up to 4 mm long and about 1 mm wide; stamens 10, about as long as the petals.

Fruit: slightly compressed 1 to 1.5 *cm* long, crowned at the apex by five erect calyx lobes.

Comments: *Lumnitzera* grows on the most landward fringe of the mangroves in sandy, clayey soil, in areas only reached by the highest tides. It is the rarest of all the mangrove species in Moreton Bay. It occurs as isolated plants or small groups of plants.

Lumnitzera is known only to occur at Poverty Creek and Welsby Bridge on Bribie Island, on Willes Island (between Russell and North Stradbroke Island), at Perrebinpa Point Macleay Island, Moreton Island between Comboyura Point and North Point and south of Amity on North Stradbroke Island.

It has a pinkish grey to black wood, with a hard close grain and it is very durable (Bailey 1888, Maiden 1889).

MANGROVE COMMUNITIES, DESCRIPTION AND STRUCTURE

Mapping units and structural formations

The following structural formations are found within the mangrove communities of Moreton Bay.

Structural formation	Mapping unit*
Avicennia marina var. *australasica* communities	
low open-shrubland, low shrubland and open-heath	2
tall open-shrubland and tall shrubland	3
open-scrub and closed-scrub	4
low open-woodland, low woodland and woodland	5
low open-forest and open-forest	7
Aegiceras corniculatum communities	
low open-shrubland, low shrubland and open-heath	9
tall shrubland, open-scrub and closed-scrub	11
Ceriops tagal var. *australis* communities	
low open-shrubland, low shrubland, open-heath and closed-heath	13
tall open-shrubland, tall shrubland, open-scrub and closed-scrub	15
Rhizophora stylosa communities	
open-heath	17
tall shrubland, open-scrub and closed-scrub	18
Bruguiera gymnorhiza communities	
low open-forest and low closed-forest	19

An unnumbered map unit showing 'land subject to tidal inundation comprising saltwater couch and or samphire flats or marine clays' is also depicted on the maps.

*The communities originally numbered 1,6,8,10,12,14 and 16 have been combined with other communities for mapping purposes and are not shown on the maps.

Avicennia marina var. *australasica* communities

Mapping unit 2, low open-shrubland, low shrubland and open-heath.

These communities generally occur towards the upper tidal limits on the landward fringe of the mangroves. They frequently adjoin *Sporobolus virginicus* (saltwater couch) and or samphire communities (see page 37 for description of these communities).

Most commonly *Avicennia* occurs as a pure stand about 0.8 to 1.2 m high and has a characteristic low bushy shrub growth form. In a few areas, mainly where these communities adjoin *Sporobolus virginicus* grasslands, *Avicennia* is grazed by cattle and this helps to maintain a low growth habit. The occasional emergent tree of *Avicennia may* be

present in some communities.

The ground cover is generally one of three types; namely

(1) *Avicennia* pneumatophores.

(2) Pneumatophores and seedlings of *Avicennia*

(3) Samphire species and or *Sporobolus virginicus*

The latter type of ground cover is infrequent and occurs in areas that are inundated by only a few high tides a month. When it does occur it is usually sparse.

Strata	Species	Height(m)	P.F.C.	No./ha
Tree layer	*Avicennia*	5.0-6.0	5	0-500
Shrub layer	*Avicennia*	0.5 -2.0	5-35	1 500-30 000
	Rhizophora	1.0-1.5	5	0-130
Low shrub layer	*Avicennia*	0.4-0.7	5	0-3 000
	Ceriops	0.4-0.6	5	0-1 200
Ground cover	*Avicennia*	0.20-0.3	5	0-40 000
	Rhizophora	0.30-0.4	5	0-100
	Ceriops	0.05-0.12	5	0-300
	Samphire species and or *Sporobolus virginicus*	0.20	5	

Mapping unit 3, tall open-shrub land and tall shrubland.

These communities usually occur as the most landward of the *Avicennia* communities and often from a mosaic with samphire and or *Sporobolus virginicus* communities. They are characterised by well developed leafy shrubs 2 to 5 m in height and they normally occur as a pure stand of *Avicennia.* In some areas a sparse low shrub layer of *Ceriops* may be present.

Ground cover usually consists of *Sporobolus virginicus* and or samphire species. In areas where abundant fresh water seeps onto the mangroves the herbaceous *Fimbristyiis dichotoma, Juncus kraussii* and sometimes *Triglochin striata* may also be found. In drier areas seedlings of *Avicenaia, Rhizophora* and *Ceriops* may also be present.

This unit commonly occurs in poorly drained areas and often a layer of ponded water is found around or adjacent to the *Avicennia* shrubs. It is common to find dead *Avicennia* bushes in waterlogged depressions.

In many areas there are numerous *Avicennia* seedlings and often they are clumped around the mother tree. This is the result of the samphire species and the *Sporobolus virginicus* restricting the tidal movement of the seedlings away from the parent plant.

Strata	Species	Height(m)	P.F.C.	No./ha
Shrub layer	*Avicennia*	2.0-5.0	5-30	250- 2 100
Low shrub layer	*Avicennia*	0.4-1.2	5-10	*50-7 000*
	Ceriops	0.6-1.3	5	0-400
Ground cover	*Avicennia*	0.1-0.4	5-10	0-79 000
	Rhizophora	0.2-0.4	5	0-200
	Ceriops	0.1-0.2	5	0-200
	Samphire species and or *Sporobolus virginicus*	0.3	5-40	

Mapping unit 4, open-scrub and closed-scrub.

These communities often occur as the intermediate zone between *Avicennia* open-forest and *Avicennia* heaths and shrublands. They commonly occur in areas which are not well drained and often have a peaty soil.

They usually consist of a pure stand of spindly, multistemmed *Avicennia* shrubs up to 8 m high. In communities that consist mostly of smaller shrubs, the plants are often branched from near ground level and are usually quite bushy.

There is often a sparse low shrub layer of *Avicennia* and occasionally *Aegiceras* present. In some areas *Aegiceras* may become locally common while isolated plants of *Ceriops* and *Rhizophora* may also be present in the low shrub layer.

Two types of ground cover are found in this community:

(1) The most common is one consisting of seedlings of *Avicennia* and pneumatophores with occasional seedlings of *Aegiceras* and scattered seedlings of *Rhizophora.*

(2) A sparse stand of samphire species and or *Sporobolus virginicus.* The latter type most commonly occurs on consolidated muds or sands and peat is not obvious in the soil.

Strata	Species	Height(m)	P.F.C.	No./ha
Shrub layer	*Avicennia*	2.0-8.0	35-85	350-8 900
	Rhizophora	2.1-3.2	5	0-600
Low shrub layer	*Avicennia*	0.6-1.4	10	450-6 000
	Aegiceras	0.5-1.0	5	0-1 200
	Rhizophora	0.6-1.1	5	0-400
	Ceriops	0.6-1.1	5	0-300
Ground cover				
	Avicennia	0.1-0.5	5	0-148 200
	Aegiceras	0.2-0.5	5	0-3 000
	Rhizophora	0.2-0.4	5	0-700
		0.2	5	
	Samphire species and or *Sporobolus virginicus*			

Mapping unit 5, low open-woodland, low woodland and woodland.

These communities are characterised by spreading *Avicennia* trees which are commonly branched close to their base. Trees of *Bruguiera* and *Rhizophora* may be present but they are never common and are usually not as tall as the *Avicennia* trees.

A shrub layer is usually not present, but where it does occur it consists mainly of shrubs of *Avicennia* and *Aegiceras* though the occasional shrub of *Rhizophora*, *Bruguiera* and *Ceriops* may also be present.

The ground cover consists mainly of *Avicennia* seedlings. A sparse layer of samphire species and or *Sporobolus virginicus* may be present in some communities especially in the open areas or in areas that are infrequently tidally inundated. In some communities large amounts of dead and decomposing *Avicennia* timber is found lying in the mud, often being washed up into heaps.

Strata	Species	Height(m)	P.F.C.	No./ha
Tree layer	*Avicennia*	5.0-11.0	5-30	90-500
	Bruguiera	5.0-8.0	5	0-320
	Rhizophora	5.0-7.0	10	0-340
Shrub layer	*Avicennia*	1.0-3.0	10	600-16 000
	Bruguiera	1.0-5.2	5	0-280
	Aegiceras	1.0-2.5	5	0-3 200
	Rhizophora	1.5-6.5	5	0-260
	Ceriops	0.5-1.0	5	0-100
Ground cover	*Avicennia*	0.2-0.4	5	0-79 000
	Samphire species and or *Sporobolus virginicus*	0.3	20	

Mapping unit 7, low open-forest and open-forest.

These communities are usually found as the most seaward of the mangrove communities and are normally inundated by all high tides. The open-forest is characterised by large, well developed trees of *Avicennia* with trees of *Bruguiera* or *Rhizophora* occasionally present as a low tree layer. A shrub layer is usually absent, however where it does occur it consists of *Avicennia, Rhizophora, Bruguiera* and occasionally *Aegiceras* and *Ceriops*.

When present, the shrub layer occurs towards the landward side of these communities where it is sheltered from strong wave action.

Ground cover of the open-forests consists mainly of *Avicennia* seedlings with occasional seedlings of *Bruguiera,* and *Rhizophora.*

The low open-forest is commonly found on the landward side of the open-forest. It usually occurs in areas that are not as well drained and less frequently inundated than the areas supporting the open-forests. These low open-forests commonly consist of pure stands of spindly *Avicennia* trees.

Aegiceras may be locally abundant where *Avicennia* low open-forest adjoins *Aegiceras* communities. Scattered plants of *Bruguiera, Rhizophora* and *Ceriops* may also be present.

The ground cover of these low open-forests normally consists of seedlings of *Avicennia,* which may become locally abundant, while occasional seedlings of *Bruguiera, Aegiceras* and *Rhizophora* are also present.

Strata	Species	Height(m)	P.F.C.	No./ha
Tree layer	*Avicennia*	5.0-13.0	30-75	120- 2 900
	Bruguiera	4.0- 7.0	5	0- 100
	Rhizophora	4.0- 8.5	10	0- 800
Shrub layer	*Avicennia*	2.0- 5.0	5	0-65 000 (exceptional)
	Bruguiera	3.0- 5.2	5	0-520
	Aegiceras	1.0- 3.5	10	0- 1 700
	Rhizophora	1.2- 5.0	10	0- 800
Low shrub layer	*Avicennia*	0.5- 1.2	10	0-10 000
	Aegiceras	0.5- 1.0	5	0-3 300
	Ceriops	0.6- 1.4	5	0-3 200
Ground cover	*Avicennia*	0.1- 0.4	5	0-79 500
	Bruguiera	0.3- 0.5	5	0-3 200
	Rhizophora	0.3- 0.5	5	0-2 300

Aegiceras corniculatum communities

Mapping unit 9, low open-shrubland, low shrubland and open-heath.

Aegiceras communities are found in localities protected from strong wave action and often occur towards the landward edge of the mangroves in locations that place them in the mid to high tidal range. They are commonly found on clay soils.

The low open-shrubland and low shrubland communities often contain many dead plants while the living plants commonly have many dead stems. The denser, open-heath communities do not usually contain as many dead plants, as the other two communities.

These communities are characterised by low multistemmed shrubs, generally from 0.7 to 2.0 m tall.

The shrub layer is commonly a pure stand of *Aegiceras. Avicennia* shrubs may occur in some communities and *Ceriops* may become locally abundant, especially where *Aegiceras* and *Ceriops* communities adjoin. Emergent trees of *Avicennia* and occasionally *Bruguiera*, may also be present.

Ground cover most commonly consists of *Aegiceras* and

Avicennia seedlings, while *Ceriops* seedlings may be locally abundant in some areas but are usually never common. Stem and branch litter is the main ground cover in communities where there are many dead or dying plants. In these communities it is rare to find *Aegiceras* seedlings.

Strata	Species	Height(m)	P.F.C.	No./ha
Tree layer	*Avicennia*	4.0-6.0	10	0- 200
	Bruguiera	3.0-5.0	10	0- 40
Shrub layer	*Avicennia*	0.5-2.5	10	0- 7 000
	Aegiceras	0.7-2.0	5-60	4 000-60 000
	Ceriops	0.7-1.7	20	500- 4 000
Ground cover	*Avicennia*	0.2-0.5	10	200-75 500
	Aegiceras	0.2-0.4	5	100-25 000
	Rhizophora	0.1-0.5	5	0- 250
	Ceriops	0.1-0.7	10	0-39 500 (exceptional)

Mapping unit 11, tall shrubland, open-scrub and closed-scrub.

Open-and closed-scrubs are the most common of the *Aegiceras* communities. They are characterised by 2 to 5 m tall multistemmed shrubs which often form almost impenetrable stands. Emergent trees of *Avicennia* are usually also present while *Bruguiera* and *Rhizophora* may also be occasionally present. In some communities *Ceriops* may become common, mainly adjacent to *Ceriops* communities.

Ground cover generally consists of *Aegiceras* and *Avicennia* seedlings but may also contain *Bruguiera* seedlings. Often *Aegiceras* scrubs occur as an understorey to *Avicennia* woodlands or the more open of the *Avicennia* low open-forests.

In these cases the *Avicennia* has been considered as an emergent and the community has been included in the *Aegiceras* communities.

A most obvious feature of many *Aegiceras* scrubs is their sharp with demarcation adjacent communities.

Strata	Species	Height(m)	P.F.C.	No./ha
Tree layer	*Avicennia*	4.0-10.0	10	0-1 500
Shrub layer	*Bruguiera*	1.5-4.5	5	0-800
	Aegiceras	2.0-5.0	(25)70-95	100-77 00
	Rhizophora	2.0-5.0	15	0-4 000
	Ceriops	2.0-3.5	15	0-6 500
Ground cover	*Avicennia*	0.1-0.4	5-25	1000-306 000
	Bruguiera	0.3-0.7	5	0-600
	Rhizophora	0.1-0.3	5	1000 -20 000

Ceriops tagal var. *australis* communities

Mapping unit 13, low open-shrubland, low shrubland, open-heath and closed-heath.

Ceriops low open—shrubland and low shrubland are characterised by small low plants which are generally from 0.8 to 1.2 m high. They are single stemmed, but often branch at a height of 0.3 to 0.5 m. Emergent trees of *Avicennia* are characteristically present but they may or may not be common. Low shrubs of *Avicennia, Aegiceras* and occasionally *Rhizophora* may occur in some communities but they are never common.

The sparse ground cover consists of seedlings of *Ceriops* and *Avicennia.*

In some communities the shrub layer may contain up to 30 to 35% dead plants of *Ceriops.* In these areas it appears that death is the result of waterlogging.

Open- and closed-heaths are characterised by shrubs that are taller than those in low open-shrub lands, being 1.3 to 2.0 m tall and usually branched near the top. Scattered emergent trees of *Avicennia* are also commonly present in these communities.

Shrubs of *Rhizophora* occur in some heath communities, but they are generally never common, however *Avicennia* and *Aegiceras* shrubs may be common.

Ground cover consists mainly of seedlings of *Ceriops* and *Avicennia.* In those areas where shrubs of *Aegiceras* and *Rhizophora* occur the ground cover usually contains many seedlings of those two species.

Strata	Species	Height(m)	P.F.C.	No./ha
Tree layer	*Avicennia*	3.0-7.5	10	0-1 400
Shrub layer	*Avicennia*	0.8-2.2	15	0-1 500
	Aegiceras	0.8-1.9	10	0-2 000
	Rhizophora	0.7-3.2	5	0-900
	Ceriops	0.8-2.0	5-85	1000-29 000
Ground cover	*Avicennia*	0.1-0.6	10	0-1 000
	Aegiceras	0.2-0.4	5	0-5 500
	Rhizophora	0.3-0.6	5	0-1 400
	Ceriops	0.1-0.5	5-30	1000-200 000

Mapping unit 15, tall open-shrubland, tall shrubland, open-scrub and closed- scrub

These communities are dominated by tall, straight well developed shrubs. They occur in the upper tidal limits in areas less frequently inundated than *Ceriops* heaths and they often occur adjacent to the heaths. There is often an abrupt change in plant height between the two communities. The soils are generally peaty and there is often a thick layer of decomposing leaves on the soil surface.

Ceriops open-scrub and closed-scrub normally consist of a pure shrub layer of *Ceriops* with emergent trees of *Avicennia.*

In some localities *Bruguiera, Aegiceras* and *Rhizophora* may be present but they are rarely common. *Bruguiera* normally only occurs where these communities grow adjacent to communities in which *Bruguiera* is common. *Ceriops* tall open-shrubland and tall shrubland generally have more trees of *Avicennia, Bruguiera, Aegiceras* and *Rhizophora* than the scrub communities and they may become common in places.

Ground cover consists mainly of scattered seedlings of *Avicennia* and *Ceriops. Sporobolus virginicus* and samphire species may be present, but they usually occur as scattered plants or as scattered clumps of plants and they generally occur on the higher ground.

Strata		Species	Height(m)	P.F.C.	No./ha
Tree layer		*Avicennia*	3.5-6.5	15	0-500
					0-2 400
Shrub layer		*Bruguiera*	2.0-4.0	5	0-4 500
		Aegiceras	1.0-4.0	10	0-3 000
		Rhizophora	2.0-4.0	10	0-3 000
		Ceriops	2.0-5.0	5-90	400-18 000
Lower shrub layer		*Avicennia*	0.4-1.3	5	0-1 800
		Aegiceras	0.7-1.5	5	0-220
		Ceriops	2.0-5.0	10	200-9 000
Ground cover	(a)	*Avicennia*	0.1-0.4	5	0-500
		Ceriops	0.1-0.6	5	100-48 000
	(b)	Samphire species and or *Sporobolus virginicus*	0.3	10	-

Rhizophora stylosa communities

Mapping unit. 17, open-heath.

This unit is restricted to only one small area north of Donnybrook. The community contains *Rhizophora* plants from 1 to 2 m high. *Avicennia* shrubs are common and low trees of *Avicennia* are also present.

The ground cover consists of seedlings of *Rhizophora* and *Avicennia.*

Freshwater from an adjacent *Melaleuca quinquenervia* (paper-barked tea-tree) swamp flows onto the area and this may be the cause for the dwarfing of the *Rhizophora.*

Strata	Species	Height(m)	P.F.C.	No./ha
Tree layer	*Avicennia*	2.2-3.5	5	0-30
Shrub layer	*Avicennia*	0.5-1.9	10	3 000-4 000
	Rhizophora	0.6-2.0	25-40	12 000-14 000
Ground cover	*Avicennia*	0.2-0.4	5	900-1 200
	Rhizophora	0.1-0.6	5	6 000-7 000

Mapping unit 18, tall shrubland, open-scrub and closed-scrub.

These communities contain tall well developed shrubs or low trees of *Rhizophora.* The trunks are usually straight and unbranched while a tangle of stilt and prop roots usually rise for about 1 to 1.5 m from ground level.

Rhizophora tall shrublands often occur as a fringe on the landward side of *Avicennia* open-forests. The canopy is often mixed and contains *Rhizophora, Avicennia* and sometimes *Bruguiera.*

The shrub layer usually consists of *Rhizophora* and *Avicennia. Ceriops* and *Aegiceras* may also be present, usually as a low shrub layer.

Ground cover consists of seedlings of *Rhizophora* and *Avicennia* and occasionally *Aegiceras, Ceriops* and *Bruguiera.*

Rhizophora tall shrublands usually occur on firm muds and are generally lower in height than *Rhizophora* scrubs.

Rhizophora open- and closed-scrubs usually consist of pure stands of *Rhizophora* although scattered emergent trees of *Avicennia* may occasionally be present.

A shrub layer is usually not present, however, where it does occur, it consists of scattered plants of *Rhizophora, Avicennia, Aegiceras* and occasionally *Bruguiera. Ceriops* may be common in those communities that adjoin *Ceriops* communities.

The ground cover is normally sparse and consists mainly of seedlings of *Rhizophora* and *Avicennia* but may also include *Aegiceras* and *Ceriops.*

Strata	Species	Height(m)	P.F.C.	No./ha
Tree layer	*Avicennia*	3.0-10.0	10	0-550
	Bruguiera	3.0-6.0	5	0-100
Shrub layer	*Avicennia*	1.2-6.0	10	0-5 500
	Bruguiera	1.5-5.0	5	0-500
	Aegiceras	1.5-3.0	20	0-4 200
	Rhizophora	2.0-7.0	10-80	800-8 500
Lower shrub layer	*Avicennia*	0.5-1.0	5	0-3 200
	Aegiceras	0.5-1.9	20	0-108 000 (exceptional)
	Rhizophora	0.5-1.3	5	0-3 100
	Ceriops	1.0-2.0	15	0-40 000
Ground cover	*Avicennia*	0.1-0.5	20	0-160 000 (exceptional)
	Bruguiera	0.2-0.5	5	0-850
	Aegiceras	0.2-0.8	20	0-180 000 (exceptional)
	Rhizophora	0.3-0.8	10	200-30 000
	Ceriops	0.1-0.3	5	0-5 000

Bruguiera gymnorhiza communities Mapping unit 19, low open-forest and low closed-forest.

Only two mappable communities of *Bruguiera* occur in Moreton Bay. A low closed-forest occurs south of Hussey Creek in Pumicestone Channel and a low open-forest occurs on the northern tip of Russell Island.

The low closed-forest consists of an almost pure stand of well developed trees of *Bruguiera.* Occasional large trees of *Excoecaria* are also present and in places the *Excoecaria* is common.

The sparse shrub layer consists of *Bruguiera.* Ground cover consists of numerous seedlings of *Bruguiera* and knee roots of *Bruguiera.*

The *Bruguiera* low open-forest on Russell Island consists of an almost pure stand of *Bruguiera* 'trees with large leafy crowns. The community is fairly open because the trunks are commonly unbranched to a height of 2 or 3 m. Scattered trees of *Avicennia* are commonly unbranched to a height of 2 or 3 m. Scattered trees of *Avicennia*

may also be present together with the occasional *Rhizophora.* There is no shrub layer.

Ground cover consists of numerous knee roots and the occasional seedling of *Bruguiera.*

In some areas of Moreton Bay a fringing community of *Bruguiera* low open- or low closed-forest occurs at the landward edge of the mangroves. These communities are usually only 1 to 2 trees in width, or at most 3 to 4 trees, and are unmappable. *Excoecaria* is common in these communities.

Strata	Species	Height(m)	P.F.C.	No./ha
Tree layer	*Avicennia*	3.0-5.0	5	0- 25
	Exoecaria	5.0-6.0	5	0- 30
	Bruguiera	4.0-9.0	25-90	300-2 000
	Rhizophora	5.0-6.0	5	0- 25
Ground cover	*Bruguiera*	0.3-0.8	5	100-7 000
	Rhizophora	0.4-0.7	5	0-25

Land subject to tidal inundation comprising saltwater couch and or samphire flats or marine clays.

The Co-Ordinator-General's Department, Queensland (1974a) estimates the area of claypan and salt marsh to be approximately 7994 ha. These areas are the interface between the marine and terrestrial environments and as such are dynamic in nature. They can vary in their nature and composition from unvegetated claypan to saltmarsh and may at times carry species that are terrestrial or that can grow under brackish conditions. The nature of these areas appears to be related to the variations in annual rainfall. As these areas occur towards the upper tidal limits and have only a slight change in microrelief, small changes in tidal regimes such as caused by storms, cyclones or strong on-shore winds may have a significant influence on species composition.

In general the claypan is devoid of vascular plants but it is often covered by an algal mat. It also occurs lower on the tidal plane than the areas of saltmarsh. From time to time, however, the claypan may be covered by a sparse layer of samphires up to 0.2 m high consisting predominantly of *Suaeda australis* and *S. arbusculoides* but also including *Sarcocornia quinqueflora, Halosarcia pergranulata* and *H. indica* subsp. *leiostachya.*

Within the higher tidal limits a saltmarsh which varies from open-herb land to closed-herb land is often formed. The species that are present include *Sporobolus virginicus* (saltwater couch), which may form extensive almost pure swards, *Suaeda australis, S. arbusculoides, Halosarcia pergranulata* and *Sesuvium portulacastrum.* Also present, mainly at extreme tidal limits or in areas subject to fresh water influence are *Casuarina glauca*

(swamp sheoak), *Melaleuca quinquenervia* (paper-barked tea-tree) and occasionally *Cupaniopsis anacardioides* (cupania tree). In these areas the sedges *Fimbristylis ferruginea, F. polytrichoides, Cyperus polystachyos* (bunchy sedge), the rush *Juncus kraussii* and the grass *Cynodon dactylon* (couch grass) occur. Also quite commonly present is *Baccharis halimifolia* (groundsel bush).

ZONATION OF MANGROVES WITHIN MORETON BAY

Numerous authors (for example Watson 1928b, Macnae 1966, 1967, Davie 1984) have pointed out that within the various mangrove communities in tropical areas, the species are usually distinctly zoned and that these zones are more or less parallel to the sea, river or creek to which they are adjacent. The nature and extent of these zones is attributed to various factors including rising level of the land and the resultant fall off in frequency of tidal inundation, soil salinity, water table depth, waterlogging, soil drainage, soil type and freshwater inflow.

Within Moreton Bay it is not possible to distinguish a distinct zonational pattern except in as much as the distribution of various species appears to be related to tidal planes and soil types as noted in species descriptions and Table 5.

The only generalisations that can be made are that the largest most well developed *Avicennia* communities are found at the most seaward edge of the mangroves and that they become progressively lower higher up the tidal plane and that *Ceriops* communities are found at the higher tidal levels on clay soils.

USE OF MANGROVES AND MANGROVE AREAS

Currently the use made of the mangroves themselves is limited though the mangrove areas are used extensively by commercial and recreational fisherman. At present mangroves in Queensland are protected under the Fisheries Act 1976. At one time *Aegiceras* was used for oyster stakes but this practice has been discontinued. Some use is still made of *Aegiceras* and *Avicennia* by beekeepers (Blake & Roff 1972) though their use in the Moreton Region is not as extensive as in the Wide Bay Region to the north. *Avicennia* was also used extensively for boat construction (Maiden 1889, local fishermen, pers comm.). A list of known uses for all species within the Bay is given in the section on species descriptions.

The current developments at the mouth of the Brisbane River, namely the Port of Brisbane Development (Fisherman Islands) and the redevelopment of the Brisbane International Airport will result in the destruction of approximately *10%* of the existing

mangrove area within Moreton Bay (Dowling 1979a). Proposed developments also call for the clearing of substantial areas of mangroves at Raby Bay, Deception Bay and around the mouth of Sandgate and Nundah Creeks.

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APPENDIX 1

The original maps, supplied to the Terrestrial Ecology Review Group of the Brisbane Airport Environmental Study Committee, were drawn onto twenty 1:25 000 topographic series maps. The approximate areas of the mapping units on each of these maps is shown in the attached table. The mapping units are the same as those shown on page 25 of the text. It should be noted that the areas shown refer to the original 1:25 000 topographic series maps and not the maps which accompany this report.

		Mapping Unit												
1:25 000 topographic map	**Map reference number**	**2**	**3**	**4**	**5**	**7**	**9**	**11**	**13**	**15**	**17**	**18**	**19**	**Total (ha)**
Caloundra (special)	9544-III-NW	21	22	11	21	67	-	9	20	1	-	12	-	184
Hussey Creek (special)	9544-III-SW	94	247	138	52	70	19	128	32	17	1	99	5	902
Toorbul	9543-IV-NW	140	203	161	80	107	13	43	-	2	-	16	-	765
Bongaree	9543-IV-NE	5	12	30	20	16	-	-	2	-	-	38	-	123
Redcliffe	9543-IV-SW	106	166	366	22	99	2	51	8	5	-	-		825
Sandgate	9543-III-NW	100	105	534	24	189	11	76	9	-	-	-		1 048
Bishop Island (special)	9543-III-NE	137	-	334	5	114	-	-	34	-	-	21	-	645
Brisbane	9543-III-SW	18	7	124	-	95	-	24	1	-	-	-		269
Wynnum	9543-III-SE	169	56	507	18	281	-	10	8	35	-	10	-	1 094
Kooringal	9543-II-NE	-	36	34	32	80	-	-	-	-	-	-		182
Amity (special)	9543-II-SE	15	23	5	54	64	-	-	-	-	-	12	-	173
Redland Bay (special)	9542-I-NW	141	66	169	29	146	12	-	13	-	-	12	4 -	700
Dunwich (special)	9542-I-NE	-	6	8	36	73	-	-	-	-	-	11	-	134
Beenleigh	9542-IV-SE	-	-	31	-	-	-	3	-	-	-	-	-	34
Woongoolba	9542-I-SW	137	194	641	34	501	21	172	87	207	-	45	-	2 039
Russell Island	9542-I-SE	12	99	89	208	332	40	67	37	228	-	52	7	1 171
Pimpama	9542-II-NW	45	127	247	1	134	21	196	1	29	-	4	-	805
Couran	9542-II-NE	101	147	350	130	634	122	300	30	248	-	19	0 -	2 252
Nerang	9542-II-SW	3	22	111	-	99	-	11	-	-	-	-		246
Southport (overlay)	9542-11	-	1	12	9	55	-	20	-	-	-	34	-	131
	Total (ha)	1 244	1 539	3 902	775	3 156	261	1 110	282	772	1	385	12	13 722

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