RESOURCE ASSESSMENT OF

TIDAL WETLAND VEGETATION

OF WESTERN CAPE YORK PENINSULA,

NORTH QUEENSLAND

REPORT TO OCEAN RESCUE 2000

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SUMMARY

A project to allow the resource assessment of tidal wetland vegetation of western Cape York Peninsula, in north Queensland, was undertaken as part of the longterm assessment of the coastal fisheries resources of Queensland. The project incorporated a littoral invertebrate fauna component. Funding was provided by the Ocean Rescue 2000 Program, the Fisheries Division of the Queensland Department of Primary Industries and Marine Parks Division of the Queensland Department of Environment and Heritage. Extending from May 1993 to December 1994, fieldwork was undertaken in May 1993, November 1993 and April 1994.

Importance of the tidal wetland vegetation and littoral invertebrate fauna of Western Cape York Peninsula

Mangroves and seagrasses are of ecological importance, directly supporting local and offshore fisheries through the provision of food, shelter, breeding and nursery areas. Previous departmental research (Quinn 1992) has estimated that the estuarine habitats provided by mangroves and seagrasses are critical to more than 75% of commercially and recreationally important fish and crustacean species during some phase of their life cycle (e.g. prawns, mud and sand crabs, barramundi, whiting, flathead, bream and mullet).

Cape York Peninsula has one of the highest mangrove species diversities in the world with 36 species compared to nine in south-east Queensland and one in Victoria (Duke 1992). There are 13 species of seagrass found in the inshore waters of the Gulf of Carpentaria including Torres Strait, (Poiner *et al*. 1989) compared to 5 species found in south-east Queensland (Coles *et al*. 1989).

Danaher (1995) has recently produced detailed maps of the distribution of mangrove and seagrass communities for Cape York Peninsula, to 16°South. The littoral invertebrate faunae of the Gulf of Carpentaria generally, and of the south-eastern Gulf in particular, are very poorly known. Systematic collections have not been made.

The aims of this project were to:

- obtain baseline information on the distribution of marine plants of western Cape York Peninsula;
- commence a preliminary assessment of the littoral invertebrate fauna and their habitat requirements with a view to extending knowledge of their biogeographic affinities;
- perform biogeographic classification of the tidal wetlands at a meso and local scale for marine conservation planning;
- evaluate the conservation values of the areas investigated from the viewpoint of fisheries productivity and as habitat for important/threatened species.

Methods

The distribution of mangrove communities were mapped on a computer using digital imagery from the Landsat Thematic Mapper satellite. These maps were validated with colour aerial photography and from field work using a helicopter for access. The seagrass distribution maps

were produced from dive and boat surveys conducted by the Department of Primary Industries Northern Fisheries Centre, from 1984 to 1989, supplemented also by colour aerial photography. The mangrove and seagrass maps have been combined and now reside digitally on a geographic information system (GIS). Colour hardcopy products have also been produced at 1:100 000 scale.

Manual collections of littoral invertebrate fauna were made from within mangrove stands and exposed shorelines in the Norman River and adjacent coast near Karumba in November 1993, and between the Nassau River and Pormpuraaw during April 1994. Additional collections of wave deposited shells were also made from these areas. Occurrence of sampled fauna was noted at 8 locations in the Norman River from the mouth to the limit of tidal influence at Normanton to investigate changes in species composition with increasing distance from the sea.

Results

Mangroves	**Area (hectares)**
Rhizophora (closed)	21 570
Ceriops (closed)	6 770
Ceriops (open)	2 340
Avicennia (closed)	18 120
Avicennia (open)	11 590
Rhizophora/Ceriops (closed)	1 770
Avicennia/Ceriops (closed)	260
Avicennia/Ceriops (open)	910
Landward Rim (open)	400
Mixed (closed)	13 970
Saltpan	242 860
Total	**320 560**
Seagrass	**Area (hectares)**
Sparse	6 370
Medium	3 410
Dense	8 180
Total	**17 960**

Table 1: Marine vegetation community areas from Torres Strait to Flinders River (1993-1994)

The hilly Torres Strait islands were generally fringed with *Rhizophora* communities with *Avicennia* and *Ceriops* communities landward and narrow saltpans. This study did not map the seagrass beds in the Torres Strait north of 10°40'S as these have been mapped by CSIRO. The seagrass beds were distributed around the coasts of the islands, on reef flats and in the lagoons of atolls and reefs, as well as in the shallow open waters of the north-western Torres Strait (Williams 1994).

At the northern end of the western side of Cape York Peninsula the general pattern for mangroves zonation was closed *Rhizophora* communities fringing the waterways and protected foreshores, closed *Ceriops* communities immediately landward, open *Ceriops* and *Avicennia/ Ceriops* communities behind, and a narrow saltpan between the mangroves and the terrestrial vegetation. *Avicennia* plants were present in almost all communities. In the north, mangroves rarely occurred on the foreshore of the Gulf of Carpentaria but in rivers and estuaries that run almost parallel to the coast. Extensive mangrove communities occurred in Port Musgrave, Albatross Bay (Weipa) and Archer Bay (Aurukun). These bays also supported seagrass beds. The number of vertical strata in the mangrove communities was usually only one, the main canopy. Understoreys did occur, but mainly in areas with abundant year-round rainfall and freshwater runoff , such as in the mixed communities on the Wenlock River.

South of Aurukun (Cape Keer-weer) the terrain became very level. Within intertidal areas the flatter terrain caused less variation in tidal inundation so distinct zones or communities often did not establish with the communities tending to be more mixed. Saltpans mixed with grasslands and extended for kilometres inland. Due to less fresh water input (from rain and runoff) the mangrove communities to the south were generally not as tall, with lower basal areas but higher stem density than those further north. The communities were either *Avicennia* dominated or mixed. *Rhizophora* communities diminished in depth, and as far south as the Nassau River were restricted to fringing the waterways in bands only several plants deep, thus not mappable units in this study. On the Norman River individual *Rhizophora* plants occurred infrequently. The Mitchell, Nassau, and Staaten Rivers contained large areas of *Avicennia* and mixed communities. The Norman, Bynoe and Flinders Rivers were dominated by *Avicennia* communities with small areas of mixed communities. The more sheltered conditions of the southern Gulf of Carpentaria allowed *Avicennia* communities to line the foreshore. These started just to the north of the Mitchell River (15°S). The only seagrass beds identified were medium and dense beds at the mouth of the Norman River at Karumba.

The general seagrass zonation for western Cape York Peninsula consisted of shallow intertidal communities on open coastlines dominated by *Halophila ovalis* and *Halodule uninervis*, and *Enhalus acoroides* common in sheltered embayments or estuaries (Poiner *et al.* 1987).

A list of species of littoral macro invertebrates collected is given in Table 2. There was a progressive loss of species within the Norman River with increasing distance from the sea, with crustaceans disappearing entirely by Half-Moon Island (60 km inland from the river mouth). Within the mangrove systems, species richness and abundance was highest on banks of moderate slope, stabilised by mangrove roots, within a few metres of the water's edge. The only species found towards the shoreward margins of the mangrove zone was the mud whelk *Telescopium telescopium* in occasional depressions retaining water. No invertebrates were found on the saltpans, although empty shells of *T. telescopium* were located in drainage channels at the margins of the saltpans. The hermit crab *Coenabita spinosus* var. *variabilis* was found supra tidally on the sandy beach at Karumba Point at night in large numbers.

Taxon	Norman River & Karumba coast	Nassau River & adjacent creeks
Molluscs		
Telescopium telescopium	Y	Y
Murex coppingeri	Y	Y
Ostrea sp.	Y	Y
Polinices didyma	Y	N
Turritella terebra	Y	N
Anadara sp.	Y	N
Architectonica sp.	Y	N
Mactra alta	Y	N
Tellina inflata	Y	N
Dosinia mira	Y	N
Diplodonta sp. (?)	Y	N
unidentified species 1	N	Y
unidentified species 2	N	Y
unidentified species 3	N	Y
unidentified species 4	N	Y
Crustaceans		
Metapograpsus latifrons	Y	Y
Metapograpsus frontalis	N	Y
Perisesarma longicristamum (?)	Y	Y
Uca coarctata	Y	Y
Uca sp.	N	Y
Sesarma erythrodactyla	Y	Y
unidentified porcellanid	Y	Y
Coenabita spinosus var. *variabilis*	Y	Y

Table 2 List of species of littoral macro invertebrates collected (1993-1994)

There was a less marked stratification in invertebrate distribution within the Nassau River / Pormpuraaw area. *Metapograpsus latifrons* and *Sesarma erythrodactyla* were located in most parts of the mangrove zone, although more commonly near the water's edge. Abundance of mangrove crustaceans, especially the *Uca* spp. and *S. erythrodactyla* was markedly higher than that found in the Norman River / Karumba coast, although there is no marked difference between the species richness at the two areas.

Most of the molluscs listed from the Norman River / Karumba area were identified from shells gathered from extensive storm-deposited shell and coral debris some 2 or 3 metres above high water at Karumba Point. The species represented are most likely to dwell in mudflats to seaward of the narrow coastal mangrove fringe.

Biogeographic Classification of the marine vegetation and littoral invertebrate fauna of Western Cape York Peninsula

On the basis of tidal wetland vegetation communities, the western side of Cape York Peninsula can be divided northwards and southwards into two biogeographic regions divided at approximately 14°S at Cape Keer-weer. This appears to be the centre of the transition zone where *Rhizophora* dominance switches to *Avicennia*/saltpan dominance. A draft marine biophysical classification by Stevens (1994*a*), using physical and biological parameters such as rainfall, tidal range, mangrove community structure and decapod biogeography, supports this boundary. The two regions from this work are the Inshore Gulf, which extends from the Queensland/Northern Territory border to Cape Keer-weer, and West Cape York, from Cape Keer-weer to the tip of Cape York, including the major inner island groups of Torres Strait. These marine based biogeographic regions interface well with terrestrial based biogeographic regions modified from Stanton and Morgan (1977) (Blackman, Queensland Department of Environment and Heritage pers. comm. 1995).

The south-east Gulf sites appear to be representative of the relatively depauperate littoral invertebrate fauna characteristic of the Inshore Gulf biophysical region. The Nassau River / Pormpuraaw area is transitional in terms of abundance, lying closer to the boundary between the Inshore Gulf and West Cape York marine biophysical regions proposed by Stevens (1994*a*) at Cape Keer-Weer. Representation of these characteristic faunae within a representative marine reserve system is desirable to provide reference points for further assessment of their affinities with other Gulf sites and other regions in Northern Australia.

Conservation planning

Important areas for conservation (as Fish Habitat Areas) were identified from the data set. The purpose of declaring Fish Habitat Areas is to ensure that representative marine vegetation communities (hence representative fish habitats) receive long-term protection to ensure sustainability of dependent fisheries. A preliminary assessment was made of the marine vegetation communities within current Fish Habitat Areas, as well as identifying those communities which are not currently represented.

ACKNOWLEDGMENTS

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Karen Danaher
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1.0 INTRODUCTION

1.1 Western Cape York Peninsula

Western Cape York Peninsula lies between Latitudes 10° and 18°S. Cape York Peninsula is generally of low relief and flat to undulating landscape with a range of low mountains and hills in the eastern and southern areas to 800 metres in elevation. It is subject to a range in environmental conditions. The several large river systems that flow westward are subject to extensive seasonal and annual flow variations, can carry large volumes of water and are dominant landscape features. Eucalypt woodland/open forest dominates the Cape with areas of paperbark woodland. Vine forests occur in the south-eastern, eastern and northern areas.

To the north, the Torres Strait contains many islands, islets, coral reefs and cays. Islands and coral reefs are absent along the eastern coast of the Gulf of Carpentaria. For most of the region the tides are semidiurnal but towards the south-eastern Gulf of Carpentaria they become diurnal.

The climate is distinctively tropical, with the wet season concentrated in a five month period over summer, followed by an almost rainless seven month dry season. Temperatures grade from warm to hot throughout the year with high humidity during the wet season. Winds persist throughout the year.

Cape York Peninsula is sparsely settled but supports several indigenous communities. The major land use of the area is cattle grazing, with mining activities and commercial and recreational fishing also occurring. The large distances from major population centres, poor infrastructure, low population and climate have limited its economic development (Connell Wagner 1989).

Cape York Peninsula is biologically one of the most diverse areas in Australia (Stanton 1976) and thus has a high conservation value. In its relatively pristine condition the Peninsula attracts considerable scientific interest, with recent discoveries of new terrestrial flora and fauna species made by scientific expeditions (Royal Geographic Society of Queensland 1993).

1.2 Marine vegetation

Mangroves and seagrasses are of ecological importance, directly supporting local and offshore fisheries through the provision of food, shelter, breeding and nursery areas. Previous departmental research (Quinn 1992) has estimated that the estuarine habitats provided by mangroves and seagrasses are critical to more than 75% of commercially and recreationally important fish and crustacean species during some phase of their life cycle (e.g. prawns, mud and sand crabs, barramundi, whiting, flathead, bream and mullet).

Mangroves are a diverse group of predominantly tropical shrubs and trees growing in the marine intertidal zone (Duke 1992). Mangroves also provide physical protection of the coastal fringe from erosion and provide a habitat for wildlife such as birds and crocodiles (Claridge and Burnett 1993). Seagrasses are flowering marine plants which grow in subtidal and intertidal areas. Seagrasses stabilise the substrate, provide shelter and a nursery habitat for many marine species (e.g. fish and prawns) and are the main food source for other marine fauna (e.g. protected species such as dugong and turtles).

Intertidal areas are subjected to an extreme range of environmental parameters including salinity, soil type, frequency of inundation (both tidal and fresh) and wave action etc. As mangrove species are variable in their tolerance of these factors a pattern of species distribution known as zonation occurs for these plants (Lovelock 1993). Mangrove zones vary from almost bare saltpans to dense forests more than 30 metres tall. By studying mangrove zonation at a particular location, indirect information can be derived on the amount of tidal inundation, and hence the direct utilisation by marine fauna. For example *Rhizophora* zones (or communities) which occur on the water's edge generally receive inundation with every high tide (twice a day for most of western Cape York Peninsula), while *Ceriops* communities, more towards the landward mangrove edge, are generally inundated only on the spring tides which occur several times per month. Indirect information can also be derived on the amount of food production for marine fauna through leaf litter. Production varies between communities.

Mangroves proliferate in areas protected from high energy waves. Thus in western Cape York Peninsula these plants tend to be abundant in sheltered bays, in coastal inlets and creeks, on the sheltered side of continental islands and can also occur on inner reef platforms. Cape York Peninsula has one of the highest mangrove species diversities in the world with 36 species compared to nine in south-east Queensland and one in Victoria (Duke 1992). Adjacent Papua New Guinean estuaries to the north contain several more species than Cape York Peninsula. This suggests that species richness is due to a latitudinal effect, since most species are found in more equatorial latitudes with a progressive reduction in species diversity to the south (Duke 1992).

Seagrasses tolerate minimal exposure to air, require shelter from high energy waves, light penetration sufficient for photosynthesis and marine salinities. Coastal and surface topography, water depth and turbidity and freshwater runoff therefore affect seagrass distribution and abundance patterns. In western Cape York, seagrasses can occur in sheltered bays, behind continental islands, on platforms of fringing and barrier reefs, and in some of the coastal inlets and creeks. There are 13 species of seagrass found in the inshore waters of the Gulf of Carpentaria including Torres Strait, (Poiner *et al*. 1989) compared to 5 species found in south-east Queensland (Coles *et al*. 1989).

No detailed mapping of communities is available for the marine vegetation of western Cape York Peninsula and until recently for much of the coast of Queensland. Broad scale assessments of the total areas of intertidal vegetation have been made by Galloway (1982) and Bucher and Saenger (1989). Fisheries habitat mapping by the Queensland Department of Primary Industries is ongoing with detailed mapping of seagrass vegetation completed for most of the coast (Lee Long *et al*. 1993, Hyland *et al*. 1989), and mapping of intertidal vegetation completed for Cape York Peninsula (Danaher 1994), south-east Queensland (Hyland and Butler 1988, Lennon and Luck 1990, Danaher and Luck 1991), Trinity Inlet (Olsen 1983), and other areas of central Queensland (Olsen *et al*. 1980).

1.3 Littoral macro invertebrate fauna

The littoral invertebrate faunae of the Gulf of Carpentaria generally, and of the south-eastern Gulf in particular, are very poorly known. Systematic quantitative collections have not been made. Literature reviews and summaries of the Gulf faunae have not generally made mention of intertidal invertebrate faunae, except where they may be of commercial relevance (e.g. Living Planet Analysis 1993). Hanley (1995) pointed out that knowledge of intertidal systems generally along the whole northern Australian coastline was very poor, with the exception of occasional, site specific environmental impact studies. The information available for comparative purposes includes that of Wells, F. E. (1982) from the north-west coast, Poiner *et al.* (1992) from the Pellew Group in western Gulf, Davie (1982, 1994 and pers. comm.) regarding the biogeography on littoral decapod crustaceans in northern Australia, and Reid (1986) for littorinid snails of mangrove forests.

1.4 Western Cape York fisheries

The western Cape York Peninsula region, including Torres Strait and the Gulf of Carpentaria, yields large amounts of seafood for both local consumption and for domestic markets throughout Australia and for export markets. Seafoods are an important part of the diet of the indigenous inhabitants of the Cape York region. The traditional hunting of dugong and sea turtle still takes place.

The commercial fisheries of the region include prawns, barramundi, king and blue salmon, spanish and grey mackerel, shark, mud crab, rock lobster, trochus, beche-de-mer, and pearls. Annually these are worth in excess of $40 million at prices to the fisherman (source: Queensland Fish Management Authority 1994). Many of the local people are involved in the fishing industry. The products are for sale throughout Australia and overseas.

Western Cape York Peninsula is recognised as an important area for recreational fishing. Increasing numbers of tourists are visiting the region each year and are enjoying fishing as a holiday activity.

1.5 The project aims

The aims of this project were to:

- obtain baseline information on the distribution of marine plants of western Cape York Peninsula;
- commence a preliminary assessment of the littoral invertebrate fauna and their habitat requirements with a view to extending knowledge of their biogeographic affinities;
- perform biogeographic classification of the tidal wetlands at a meso and local scale for marine conservation planning; and
- evaluate the conservation values of the areas investigated from the viewpoint of fisheries productivity and as habitat for important/threatened species.

2.0 METHODS

2.1 Mangroves

Digital imagery from the Landsat satellite's Thematic Mapper (TM) sensor was processed and interpreted to map the mangroves. Each Landsat scene covered an area 185 kilometres by 185 kilometres and the pixel resolution was 30 metres by 30 metres. The seven Landsat TM scenes covering the western coast of Cape York Peninsula were captured between 1988 and 1992 and were not all captured in the same climatic season or at the same tidal phase (see Figure 5.1 for the coverage of the 7 scenes). The TM data received was already rectified to the Australian Map Grid with pixels resampled to 30 metres by 30 metres by the Australian Geological Survey Organisation. There was a small gap (15 kilometres by 15 kilometres) in the TM imagery so this area was supplemented by a small portion from a Landsat Multi-Spectral Scanner (MSS) image. The resolution of the data from MSS was less than TM both spatially (80 metre pixels compared to 30 metre pixels), and spectrally (4 bands compared to 7).

Path/Row	Date	Season	Tide Phase
99/67	16 June 1988	early dry	mid
99/68	16 June 1988	early dry	mid
99/69	16 June 1988	early dry	mid
99/70	21 March 1991	late wet	high
99/72	1 October 1992	late dry	mid
98/70	6 April 1988	late wet	high
98/71	21 May 1987	early dry	mid
98/71(MSS)	7 October 1991	late dry	mid

Table 2.1 The Landsat TM scenes used

All 7 scenes were processed separately using MIPS^{TM} (Map and Image Processing System) on a personal computer and a Sun SPARC2 workstation. Thematic Mapper band 6 (the thermal band) was discarded and a linear function stretch highlighting the intertidal zone was applied to all other bands. All water bodies were spectrally masked out using TM band 4 (near infrared). The upper limit of the intertidal zone cannot be spectrally separated readily so a mask was made by manually interpreting the boundary from a false colour composite of TM bands 1, 4, and 5 (blue, green and red respectively) in conjunction with colour 1:50 000 aerial photography and unpublished vegetation maps at 1:250 000 from the Cape York Peninsula Land Use Strategy (CYPLUS) Vegetation Mapping Team (Neldner, Queensland Department of Environment and Heritage, pers. comm. 1993). This false colour composite is the best combination for identifying the intertidal zone and uses the most decorrelated bands (Sheffield 1985). A one kilometre buffer above the intertidal zone was retained for processing, as this boundary with above-tidal lands can be very difficult to interpret, even from colour 1:50 000 aerial photography.

The colour aerial photography at 1:50 000 from the Beach Protection Authority used were - Cooktown to Crab Island - Runs 1 to 26 captured during 1991 and 1992, and Crab Island to NT Border - Runs 26 to 41 captured during 1989.

The remaining imagery, which included the intertidal zone, was processed with unsupervised rather than supervised classification (Danaher and Luck 1991). That is, no training sites were selected by the operator, but the software groups spectrally similar pixels into classes. The classification used the Isoclass algorithm (Skrdla 1992) which uses iterative processes to determine the final classes. Aided by the aerial photography, individual classes were labelled according to their dominant cover type.

The computer-based community classification was validated on field trips by helicopter flights along the coastline or by boat. Landings were made at selected sites to document information on the mangrove community floristics and structure. Sites were selected that represented each of the computer derived classes. At each site data recorded included the specific composition of mangroves, dominant genus, height and density (foliage projective cover) of each vegetation layer, composition and hardness of substrate, and presence/absence of seedlings, samphires, grasses, algae, leaf litter, roots, ferns, epiphytes, sedges and ponds. In addition random trees were selected and the genus, height, girth at breast height and distance was measured for the nearest neighbour in every quarter (point quarter method). The field trips were:

Torres Strait to Aurukun (helicopter survey)	May 1993
Norman River (boat survey)	November 1993
Pormpuraaw to Nassau River (helicopter survey)	April 1994

Scheduled ground truthing of the whole area could not be undertaken because of the refusal of traditional owners to grant access in some locations.

The classification of mangroves was community based using the dominate genus present and relative densities. Generic level was selected as species within some genera could only be identified during the flowering and fruiting seasons. The communities identified are listed in Table 2.2. The densities were determined by the Foliage Projective Cover (FPC) of the canopy layer - more than 50% is closed, less than 50% is open.

The height of communities cannot be easily derived from satellite imagery so the Specht (1978) categories such as "forest" and "scrub" have not been included in the description. However, from field experience Closed *Rhizophora*, Closed *Rhizophora/Ceriops*, Closed Mixed and Closed *Avicennia* are generally more than 10 metres tall, thus "forest" *sensu* Specht; while the remaining classes (except saltpans) generally are less than 10 metres thus Specht's "scrub".

The classes included were those which receive tidal inundation, hence appropriate habitat of mangroves. Excluded classes were permanent pools of water, elevated land containing terrestrial vegetation such as trees, shrubs and grass, and tidally exposed bare mud and sand banks. As these classes were derived spectrally from the Landsat imagery, including permanent water pools would mean including the ocean. Addition of terrestrial vegetation islands would mean including all terrestrial vegetation, which would result in more than the intertidal zone being shown. Tidally exposed bare mud and sand banks were excluded as these can have the same spectral signature as saltpans.

Marine Vegetation Unit	Density
Mangrove Units	
Rhizophora	closed
Ceriops	closed
Ceriops	open
Avicennia	closed
Avicennia	open
Rhizophora/Ceriops	closed
Avicennia/Ceriops	closed
Avicennia/Ceriops	open
Landward Rim	open
Mixed	closed
Saltpan	open
Seagrass Units	
Sparse	0-10%
Medium	10-50%
Dense	50-100%

Table 2.2 The marine vegetation units

2.2 Seagrasses

The Department of Primary Industries mapped inshore seagrass beds in conjunction with sampling juvenile prawn populations and dependent habitat along the western coastline of Cape York Peninsula in July 1985 (Lee Long *et al*. unpublished data).

Visual assessment of the seabed was made by diving along transects out from the coastline at intervals of about four kilometres. Extra dive checks were made between transects for continuity, particularly where coastal topography was varied, such as bays. Where seagrass was present, four $0.25m^2$ samples of the bottom vegetation were collected for laboratory analysis. The height of each species of seagrass and a percentage cover of the bottom were also estimated. Maps were produced showing community densities. In addition this OR2000 project used colour 1:50 000 aerial photography captured between 1988 and 1992 to modify some boundaries. No additional ground truthing was undertaken in the OR2000 project.

Seagrasses have been successfully mapped using Landsat imagery where the water was very clear above submerged beds or where the scene was captured at a low tide sufficiently exposing the intertidal beds (Lennon and Luck 1990). Due to cost, the Landsat imagery used was a pre-existing data set selected for cloudlessness rather than particular tide height or water clarity. As a result the available images are a mix of tide heights and water clarity. The inshore waters on the western side of Cape York Peninsula are fairly turbid. The high incidence of cloud cover over Cape York Peninsula makes the capture of a low tide, clear water image improbable.

The seagrass communities were classified according to density of vegetation cover with 3 classes (see Table 2.2) - sparse (0 to 10%), medium (10 to 50%) and dense (50 to 100%).

2.3 Littoral invertebrate Fauna

Manual collections of littoral invertebrate fauna were made from mangrove stands and exposed shorelines in the Norman River and adjacent coast near Karumba in November 1993, and between the Nassau River and Pormpuraaw during April 1994. Additional collections of wave deposited shells were also made from these areas. Location, habitat notes and tide state were recorded for each site visited. Specimens were identified to species where possible by Queensland Museum staff. Additional identifications were performed by research staff from the University of Queensland. Some further identification of four gastropod species (see Table 5.1) remain to be carried out.

Occurrence of sampled fauna was noted at 8 locations in the Norman River from the mouth to the limit of tidal influence at Normanton to investigate changes in species composition with increasing distance from the sea.

2.4 Conversion for input into GIS

The combined mangrove and seagrass maps were converted from raster format to vector polygons. This was done using ARC/INFO GIS software. To improve cartographic presentation of the data the jagged raster boundaries were smoothed and generalised and polygons with areas under 10 000 square metres were eliminated. The coverages were reprojected to geographical coordinates. Label and node errors were corrected.

2.5 Data accuracy

The overall accuracy for the data was greater than 80%. The accuracy was derived by comparing the computer based community classification to the aerial photography and field data. Using other data sources such as the aerial photography and field data helped to overcome the heterogeneity in the satellite imagery but some inconsistencies in interpretation of vegetation communities may occur. Problems were also created by cloud on the satellite imagery and aerial photography. Gaps in the aerial photography coverage and poor quality pictures also limited interpretation. Only representative estuaries were field checked and selection of these was based on accessibility by helicopter.

There are some typical mangrove zones (or communities) which have been identified by many authors, e.g. Macnae (1967), Davie (1985) and Bunt (1978), which do not fall within the classification used in this study. Some examples of these are the seaward *Sonneratia* fringe, *Bruguiera* communities and *Nypa* stands. While these communities do occur within Western Cape York Peninsula they are generally linear and not large enough to be mappable units (30 metres wide) using the remote sensing techniques as applied in this study. Narrow fringes of *Rhizophora* spp. particularly on the south-western Cape, are not given separate status for this reason. Due to similar foliage, *Bruguiera* communities cannot be easily separated from *Rhizophora* communities, from satellite imagery, aerial photography or even from helicopter.

The grass communities (containing species such as the salt couch, *Sporobolus virginicus*) that receive some tidal inundation on the spring tides could not be separated from terrestrial grass communities and so have been excluded from the tidal vegetation classification for this study. Occasionally towards the landward zone, *Avicennia* communities were confused with adjacent terrestrial vegetation. The field observations revealed that tidal and freshwater communities sometimes overlap with no clear boundary. However if mangrove plants dominated the overlapping community it was included as tidal vegetation.

The seagrass surveys used in this project did not always precisely define the seaward limit, but it is unlikely that dense seagrass beds would be found at depths greater than 30 metres (Lee Long *et al.* 1993). Studies have found large seasonal (Mellors *et al.* 1993) and year-to-year (Poiner *et al.* 1989) changes in seagrass distribution and abundance in the northern Australia region.

Figure 2.1 is a data reliability diagram for the intertidal vegetation (mangroves and saltpan) of the study area. The highest reliability class covers areas which were visited by helicopter for the mangrove survey. The next highest reliability (class 2) is for areas which were not visited but are covered by 1:50 000 colour aerial photography. Of less reliability (class 3) are areas which are covered by satellite imagery but are not covered by the aerial photography, or the available aerial photography is of poor quality. The final class covers areas that were not covered by satellite imagery or where cloud affected the satellite imagery and digital classification.

The horizontal accuracy of the Marine Vegetation product is between 10 and 100 metres. Despite different data sources the satellite imagery based coverages overlay well with the coastline coverage derived from the 1:100 000 topographic maps.

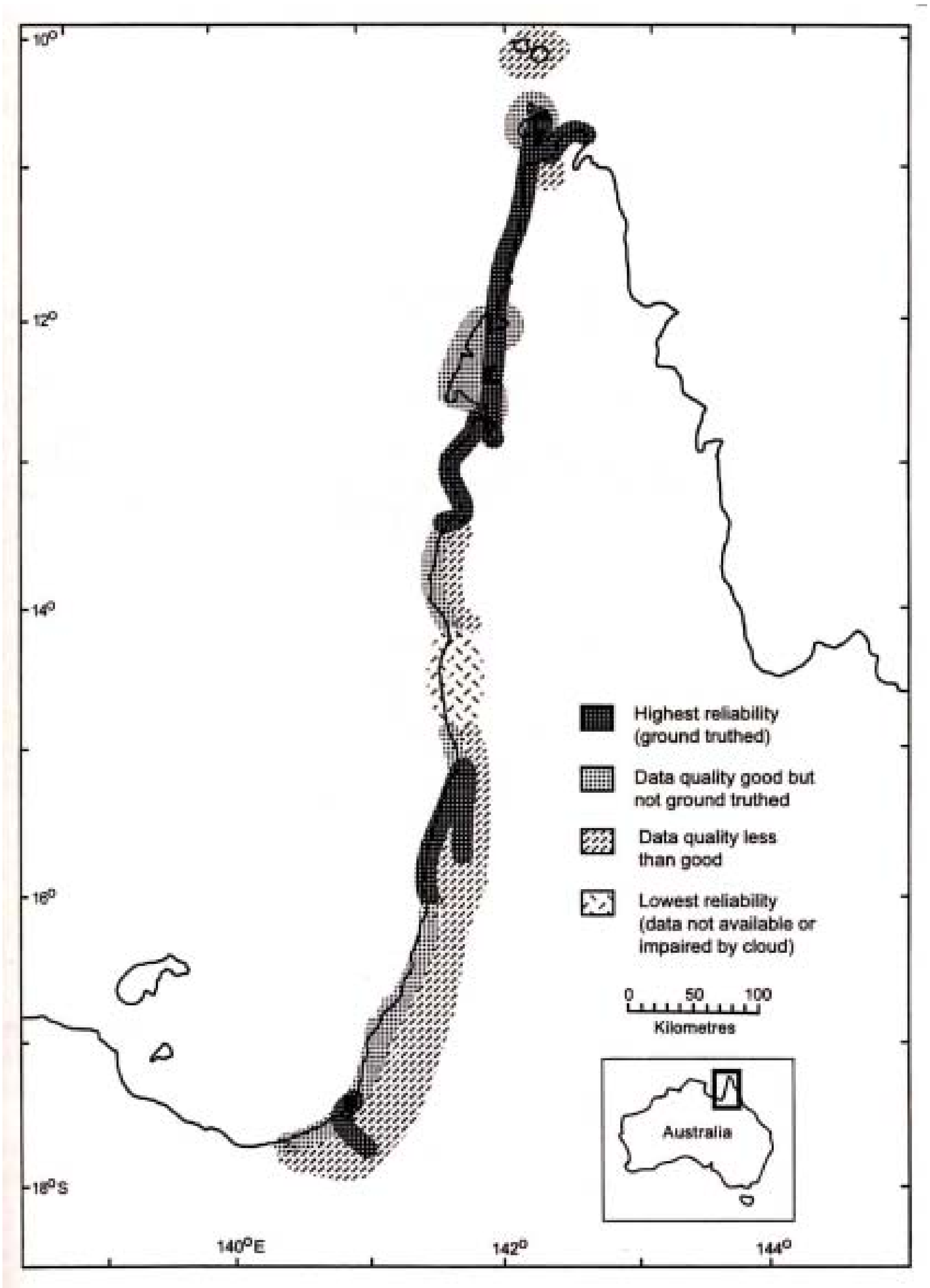

Figure 2.1 Data reliability diagram for the intertidal vegetation

3.0 DESCRIPTION OF THE MARINE VEGETATION UNITS

3.1 The Mangroves

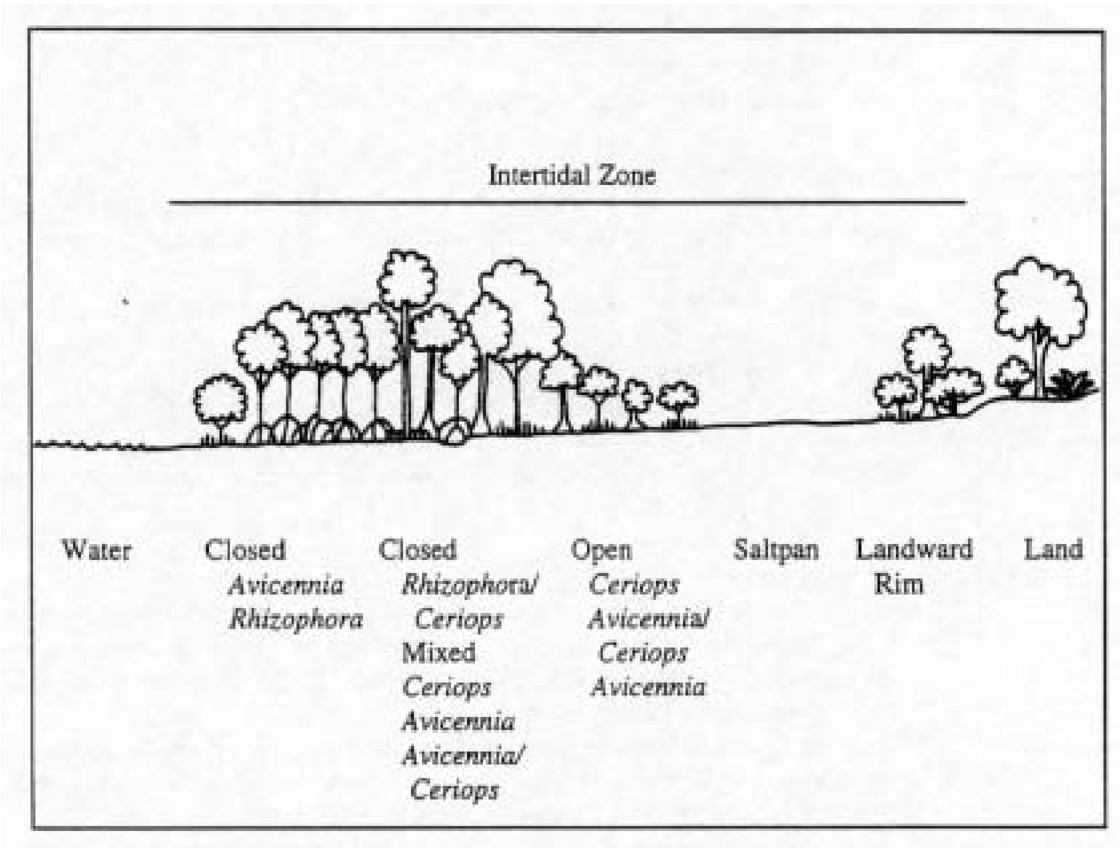

Figure 3.1 The position of the mangrove communities across the tide profile

<u>*Rhizophora* (closed)</u> (Figure 3.2)

Habitat	occurs fringing waterways low in intertidal zone with roots submerged during high tides. Some *Rhizophora* species pioneer in the front of the mangroves such as *R. stylosa* while other species such as *R. apiculata* and *R. lamarckii* prefer perennial freshwater input provided by permanent watercourses.
Canopy	usually dominated by *Rhizophora* spp. with occasional *Bruguiera* spp. and *Avicennia marina*. Foliage projective cover is more than 50%. Height varies from 4 metres to more than 30 metres.
Shrub layer	generally absent.
Ground cover	*Rhizophora* stilt roots with a sparse cover of *Rhizophora* seedlings.

<u>*Ceriops* (closed)</u> (Figure 3.3)

Habitat: generally occurs between *Rhizophora* communities and open *Ceriops* communities on land more elevated than *Rhizophora* communities and not inundated by every tide.

Canopy: *Ceriops* spp. and occasionally *Rhizophora* spp., *Bruguiera* spp. and *Avicennia marina*. Foliage projective is cover more than 50%. Height varies from 1.5 metres to more than 17 metres.

Shrub layer: generally absent.

Ground cover: consists of sparse seedlings of genera present.

<u>*Ceriops* (open)</u> (Figure 3.4)

Habitat: occurs towards the landward edge of the intertidal zone, inundated by only the high spring tides. This community often surrounds saltpans and is rarely on waters edge, except on eroding banks.

Canopy: *Ceriops* spp., and occasionally with emergents of *Avicennia marina*. The foliage projective cover is less than 50%. Height varies from less than 0.5 metre in very saline environments to 5 metres.

Shrub layer: occasional presence of *Aegialitis annulata* to 2 metres in height.

Ground cover: consists of seedlings of species present with occasional presence of samphire species such as *Suaeda arbusculoides*, *Tecticornia australasica* and *Sarcocornia quinqueflora*.

<u>*Avicennia* (closed)</u> (Figure 3.5)

Habitat: a very diverse community which can be found in all intertidal environments from pioneering the seaward edge of mangroves and fringing waterways on accretion banks being inundated on every tide, to the landward edge only being inundated on the highest spring tides.

Canopy: *Avicennia marina* with the occasional presence of *Ceriops* spp., *Excoecaria agallocha* and *Sonneratia* spp. The foliage projective cover is more than 50%. Height varies from 2 metres to more than 10 metres.

Shrub layer: occasional presence of *Aegialitis annulata* and *Aegiceras corniculatum* to 2 metres in height.

Ground cover: consists of seedlings of species present among the pneumatophores (peg roots) of *Avicennia marina*.

<u>*Avicennia* (open)</u> (Figure 3.6)

Habitat: a very diverse community which can be found in all intertidal environments from pioneering the seaward edge of mangroves and fringing waterways on accretion banks being inundated on every tide, to the landward edge only being inundated on the highest spring tides.

Canopy: *Avicennia marina* with the occasional presence of *Ceriops* spp., *Excoecaria agallocha* and *Lumnitzera* spp. The foliage projective cover is less than 50%. Height varies from 0.5 metres in hyper saline areas to more than 10 metres.

Shrub layer: occasional presence of *Aegialitis annulata* and *Aegiceras corniculatum* to 2 metres in height.

Ground cover: may consist of seedlings of species present among the pneumatophores (peg roots) of *Avicennia marina* as well as sparse samphires (e.g. *Suaeda* and *Sarcocornia*) and grasses such as salt couch (*Sporobolus virginicus*).

<u>*Rhizophora/Ceriops* (closed)</u> (Figure 3.7)

Habitat	generally occurs between closed *Rhizophora* communities and closed *Ceriops* communities receiving inundation by most high tides.
Canopy	*Ceriops* spp. with emergent *Rhizophora* spp. and occasional *Bruguiera* spp. Foliage projective is cover more than 50%. Height varies from 2 metres to more than 15 metres.
Shrub layer	generally absent.
Ground cover	consists of sparse seedlings of genera present between *Rhizophora* stilt roots and occasional *Ceriops* knee roots.

Avicennia/Ceriops (closed) (Figure 3.8)

Habitat	generally occurs towards the landward edge or in the centre of islands on substrate only inundated during spring tides.
Canopy	*Ceriops* spp. with emergents of *Avicennia marina*. Foliage projective is cover more than 50%. Height varies from 2 metres to more than 10 metres.
Shrub layer	generally absent.
Ground cover	consists of sparse seedlings of genera present.

Avicennia/Ceriops (open) (Figure 3.9)

Habitat	generally occurs towards the landward edge near hypersaline claypans or in the centre of islands on substrate only inundated during the spring tides.
Canopy	*Ceriops* spp. with emergents of *Avicennia marina*. The foliage projective cover is less than 50%. Height varies from less than 0.5 metre in very saline environments to 10 metres.
Shrub layer	occasional presence of *Aegialitis annulata* and *Aegiceras corniculatum* to 2 metres in height.
Ground cover	consists of seedlings of species present with occasional presence of samphire species such as *Suaeda arbusculoides*, *Tecticornia australasica* and *Sarcocornia quinqueflora*.

Landward Rim (open) (Figure 3.10)

Habitat	generally occurs on substrates only inundated on the highest spring tides - next to the landward edge or on dune systems dissected by tidal waterways.
Canopy	usually a mix consisting of *Avicennia marina*, *Ceriops* spp., *Excoecaria agallocha*, *Lumnitzera* spp. Terrestrial plants from *Melaleuca* and *Acacia* genera may also occur. The foliage projective cover is less than 50%. Height varies from 2 metres to 10 metres.
Shrub layer	may exist of smaller canopy species as well as the occasional presence of *Aegialitis annulata* and *Aegiceras corniculatum* to 2 metres in height.
Ground cover	may consist of seedlings of species present as well as sparse samphires (e.g. *Suaeda arbusculoides*, *Tecticornia australasica* and *Sarcocornia quinqueflora*) and grasses such as salt couch (*Sporobolus virginicus*).

Mixed (closed) (Figure 3.11)

Habitat — may occur behind closed *Rhizophora* communities, in areas where zonation is less defined, as well as by permanent watercourses. Tidal inundation varies from almost every high tide to only the spring tides where there is more fresh water input.

Canopy — a mix which may consist of *Rhizophora* spp., *Avicennia marina*, *Bruguiera* spp., *Excoecaria agallocha*, *Xylocarpus mekongensis*, and *Ceriops* spp. *Melaleuca* spp. may be present. The foliage projective cover is more than 50%. Height may vary from 5 metres to more than 30 metres depending on the amount of fresh water available.

Shrub layer — in the lower communities may be absent. In the taller communities the shrub layer may consist of juvenile canopy species with *Aegialitis annulata* and *Aegiceras corniculatum* to 4 metres in height. *Acanthus ilicifolius* and, in far northern areas, the palm *Nypa fruticans* may occur.

Ground cover — may consist of seedlings of species present as well as the fern *Acrostichum speciosum*.

Saltpan (Figure 3.12)

Habitat — occurs toward the landward edge of the intertidal zone, and are hypersaline being only inundated during the highest spring tides.

Canopy — sparse, stunted plants of *Avicennia marina*, *Ceriops* spp. and *Aegialitis annulata* may occur.

Shrub layer — absent.

Ground cover — sparse samphires (e.g. *Suaeda arbusculoides*, *Tecticornia australasica* and *Sarcocornia quinqueflora*) and grasses such as salt couch (*Sporobolus virginicus*).

3.2 The seagrasses

The seagrass species known from the region are *Cymodocea serrulata, Syringodium isoetifolium, Halodule uninervis, Thallassia hemprichii, Halophila spinulosa, Halophila ovalis, Halophila decipiens* and *Enhalus acoroides*.

Sparse Seagrass (Figure 3.13)
The percentage of vegetation cover on substrate is less than 10%.

Medium Seagrass (Figure 3.14)
The percentage of vegetation cover on substrate is between 10% and 50%.

Dense Seagrass (Figure 3.15)
The percentage of vegetation cover on substrate is between 50% and 100%.

Figure 3.2 A closed *Rhizophora* community near the Normanby River mouth, Princess Charlotte Bay

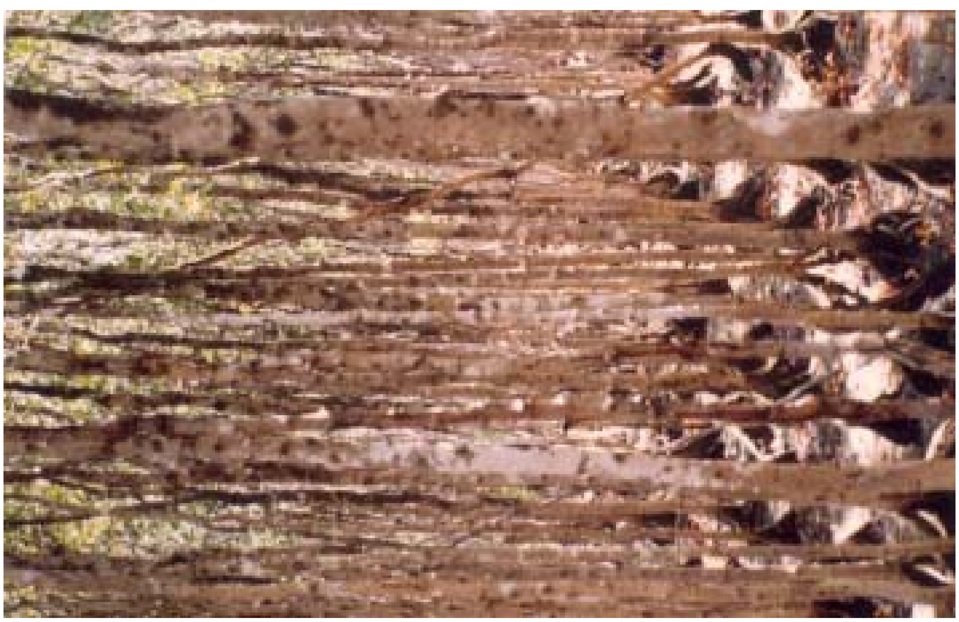

Figure 3.3 A closed *Ceriops* community near the Normanby River mouth, Princess Charlotte Bay

Figure 3.4 An open *Ceriops* community at Temple Bay

Figure 3.5 A closed *Avicennia* community near the South Mitchell River mouth

Figure 3.6 An open Avicennia community near the Claudie River

Figure 3.7 A closed *Rhizophora/Ceriops* community near the Starke River

Figure 3.8 A closed *Avicennia/Ceriops* community in the Lockhart River delta

Figure 3.9 An open *Avicennia/Ceriops* community near the Escape River

Figure 3.10 An open landward rim community near the Jardine River

Figure 3.11 A closed mixed community on the Nassau River

Figure 3.12 A saltpan community on the Nassau River

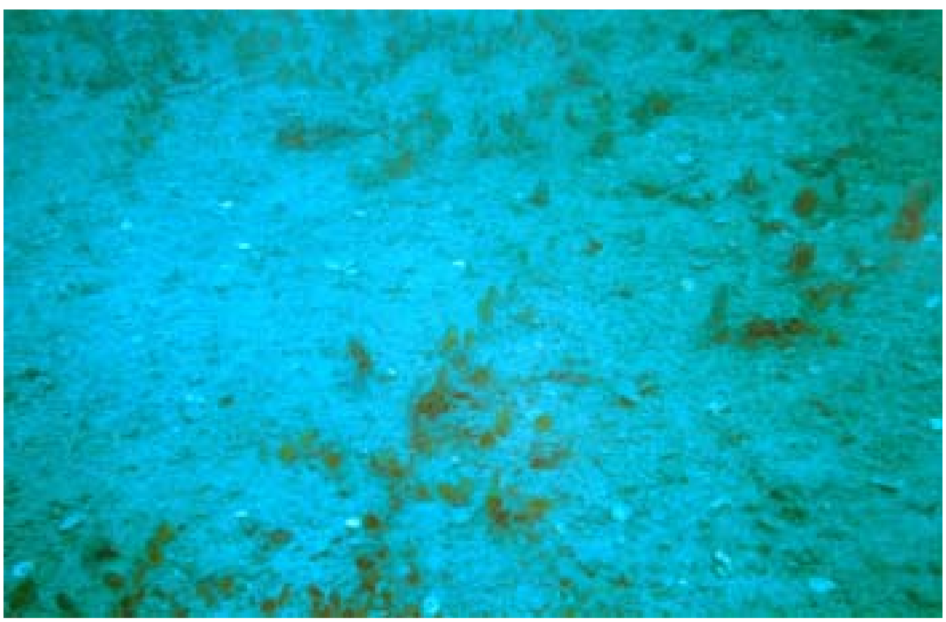

Figure 3.13 A sparse seagrass community near Lizard Island

Figure 3.14 A medium seagrass community in Orford Bay

Figure 3.15 A dense seagrass community near Green Island

4.0 DISTRIBUTION OF THE MARINE VEGETATION

4.1 General distribution for Western Cape York Peninsula

The mangroves and seagrasses of Cape York Peninsula occur in sheltered areas such as bays, estuaries and associated with coral reefs. Table 4.1 displays the area for each marine vegetation community from Torres Strait to Flinders River.

Mangroves	**Area (hectares)**
Rhizophora (closed)	21 570
Ceriops (closed)	6 770
Ceriops (open)	2 340
Avicennia (closed)	18 120
Avicennia (open)	11 590
Rhizophora/Ceriops (closed)	1 770
Avicennia/Ceriops (closed)	260
Avicennia/Ceriops (open)	910
Landward Rim (open)	400
Mixed (closed)	13 970
Saltpan	242 860
Total	**320 560**
Seagrass	**Area (hectares)**
Sparse	6 370
Medium	3 410
Dense	8 180
Total	**17 960**

Table 4.1: Marine vegetation community areas from Torres Strait to Flinders River

The hilly Torres Strait islands were generally fringed with *Rhizophora* communities with *Avicennia* and *Ceriops* communities landward and narrow saltpans. This study did not map the seagrass beds in the Torres Strait north of 10°40'S as these have been mapped by CSIRO. The seagrass beds were distributed around the coasts of the islands, on reef flats and in the lagoons of atolls and reefs, as well as in the shallow open waters of the north-western Torres Strait (Williams 1994).

At the northern end of the western side of Cape York Peninsula the general pattern for mangroves zonation was closed *Rhizophora* communities fringing the waterways and protected foreshores, closed *Ceriops* communities immediately landward, open *Ceriops* and *Avicennia/ Ceriops* communities behind, and a narrow saltpan between the mangroves and the terrestrial vegetation. *Avicennia* plants were present in almost all communities. In the north, mangroves rarely occurred on the foreshore of the Gulf of Carpentaria but in rivers and estuaries that run almost parallel to the coast. Extensive mangrove communities occurred in Port Musgrave, Albatross Bay (Weipa) and Archer Bay (Aurukun). These bays also supported seagrass beds. The number of vertical strata in the mangrove communities was usually only one, the main canopy. Understoreys did occur, but mainly in areas with abundant year-round rainfall and freshwater runoff , such as in the mixed communities on the Wenlock River.

South of Aurukun (Cape Keer-Weer) the terrain became very level. Within intertidal areas the flatter terrain caused less variation in tidal inundation so distinct zones or communities often did not establish with the communities tending to be more mixed. Saltpans mixed with grasslands and extended for kilometres inland. Due to less fresh water input (by rain and runoff) the mangrove communities to the south were generally not as tall, with lower basal areas but higher stem density than those further north. The communities were either *Avicennia* dominated or mixed. *Rhizophora* communities diminished in depth, and as far south as the Nassau River were restricted to fringing the waterways in bands only several plants deep, thus not mappable units in this study. On the Norman River individual *Rhizophora* plants occurred infrequently. The Mitchell, Nassau, and Staaten Rivers contained large areas of *Avicennia* and mixed communities. The Norman, Bynoe and Flinders Rivers were dominated by *Avicennia* communities with small areas of mixed communities. The more sheltered conditions of the southern Gulf of Carpentaria allowed *Avicennia* communities to line the foreshore. These started just to the north of the Mitchell River (15°S). The only seagrass beds identified were medium and dense beds at the mouth of the Norman River at Karumba.

The general seagrass zonation for western Cape York Peninsula consisted of shallow intertidal communities on open coastlines dominated by *Halophila ovalis* and *Halodule uninervis*, and *Enhalus acoroides* common in sheltered embayments or estuaries (Poiner *et al.* 1987).

Figure 4.1 displays the study area divided into the mapping regions.

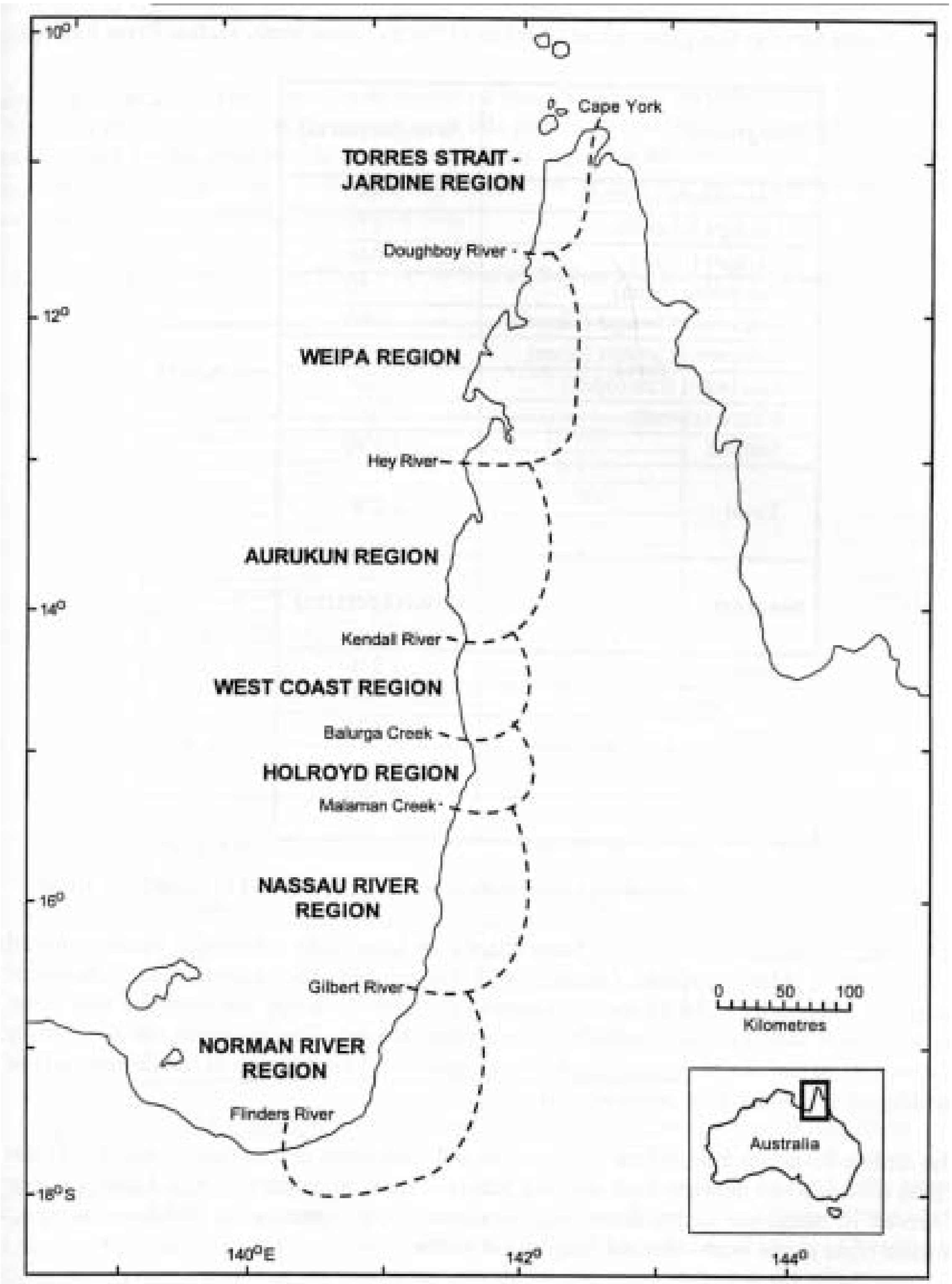

Figure 4.1 The mapping regions of the study

4.2 Distribution of the marine vegetation by mapping regions

4.2.1 Torres Strait to Doughboy River - 10°S to 11°30'S (Torres Strait, Jardine River Region)

Mangroves	**Area (hectares)**
Rhizophora (closed)	5 680
Ceriops (closed)	270
Ceriops (open)	2 040
Avicennia (open)	30
Avicennia/Ceriops (closed)	260
Avicennia/Ceriops (open)	60
Landward Rim (open)	220
Mixed (closed)	530
Saltpan	1 180
Total	**10 270**
Seagrass	**Area (hectares)**
Sparse	2 810
Medium	900
Dense	1 670
Total	**5 380**

Table 4.2 Marine vegetation community areas for Torres Strait to Doughboy River

Community comments. The Torres Strait Islands are large, hilly continental islands covered with woodland. Many headlands combined with fringing reefs encourage the establishment of mangrove communities. *Rhizophora* dominated communities occupy the foreshore and fringe the waterways with *Ceriops* dominated communities behind. The landward rim community (*Avicennia marina, Excoecaria agallocha, Lumnitzera* spp.) often occurs at the *Ceriops* side of the saltpans as well as at the landward side.

The Jardine River has a large area of mangrove and freshwater swamp near its mouth. In this region the boundary between tidal and non tidal is difficult to determine, with *Melaleuca* spp. observed in mangrove communities and *Rhizophora* spp. observed in *Melaleuca* forests. Isolated *Nypa* palms were observed fringing the Jardine River.

On the west facing coastline with no reefs for protection, mangrove communities do not occur on the foreshore, but in a series of inlets with little fresh water input, which run almost parallel to the coastline. The usual zones are very strong, but *Avicennia marina* plants start to mix in with the *Ceriops* communities.

Seagrass beds occur on the mainland side of the Endeavour Strait, south of Crab Island and at the mouth of the Cotterell River. No seagrass data was collected for Torres Strait during this study.

Mapping comments. The Landsat data processed was scene 99/67 captured on 16 June 1988. This was early dry season and the approximate tide phase was mid tide. No aerial photography was obtained for the outer islands of the Torres Strait (e.g. Moa and Badu Islands). The aerial photography over the Jardine River was very washed out. There was an overlap between tidal and freshwater communities in the Jardine area.

4.2.2 Doughboy River to Hey River - 11°30'S to 13°S (Port Musgrave, Weipa Region)

Mangroves	**Area (hectares)**
Rhizophora (closed)	13 700
Ceriops (closed)	6 170
Ceriops (open)	300
Avicennia (closed)	10 380
Avicennia (open)	1 740
Rhizophora/Ceriops (closed)	860
Avicennia/Ceriops (open)	730
Mixed (closed)	4 330
Saltpan	9 530
Total	**47 740**
Seagrass	**Area (hectares)**
Sparse	3 090
Medium	250
Dense	3 720
Total	**7 060**

Table 4.3 Marine vegetation community areas for Doughboy River to Hey River

Community comments. This coastline is bordered by fairly level land covered with open *Eucalyptus* forest. Two large bays, Port Musgrave fed by the Wenlock and Ducie Rivers, and Albatross Bay fed by the Mission and Embley Rivers host large intertidal areas. *Rhizophora* dominated communities hug the foreshore and the major waterways, but the abundance of *Avicennia marina* increases, invading both the *Rhizophora* and *Ceriops* communities, and forming large communities of its own. With significant fresh water input from these river systems very complex mixed mangrove forests have established. At one field site on the Wenlock River *Rhizophora* emergents grew to 35 metres, above a mixed canopy up to 25 metres of *Avicennia marina, Bruguiera* spp., *Ceriops* spp., *Excoecaria agallocha* and *Xylocarpus mekongensis*. The understorey included *Acanthus ilicifolius, Aegiceras corniculatum, Nypa fruticans* and mixed seedlings.

Seagrass beds occur in these sheltered bays along with some coastal inlets such as the Skardon River and Pennefather River.

Mapping comments. The Landsat data processed was scene 99/68 captured on 16 June 1988. This was early dry season and the approximate tide phase was mid tide. The aerial photography did not cover the full tidal areas of the Ducie and Wenlock Rivers. In some places the boundary between tidal and terrestrial was hard to determine, as the field visit revealed open communities of *Avicennia marina* mixed with *Melaleuca* and *Acacia* species.

4.2.3 Hey River to Kendall River - 13°S to 14°15'S (Aurukun Region)

Mangroves	**Area (hectares)**
Rhizophora (closed)	2 190
Ceriops (closed)	330
Avicennia (closed)	1380
Avicennia (open)	620
Rhizophora/Ceriops (closed)	470
Mixed (closed)	1680
Saltpan	9020
Total	**15 690**
Seagrass	**Area (hectares)**
Sparse	470
Medium	890
Dense	2 650
Total	**4 010**

Table 4.4 Marine vegetation community areas for Hey River to Kendall River

Community comments. The coastline from Albatross Bay to Archer Bay is similar to the region further north - fairly level land covered with open *Eucalyptus* forest. Archer Bay, fed by the Archer and Watson Rivers, supports a large tidal area. While *Rhizophora stylosa* still fringes the foreshore and the waterways, the depth of this zone has become much narrower, with *Ceriops* communities mixing in. Landward of this are *Avicennia* communities, then saltpans. *Avicennia marina* plants often mix in with both the *Rhizophora* and *Ceriops* communities. In riverine conditions, mixed communities occur of *Avicennia marina* and *Excoecaria agollocha* with *Melaleuca* spp. These give way to pure *Melaleuca* communities. In the wide sandy channels of the Archer River, mangrove communities are dominated by *Avicennia marina*.

South of Archer Bay the coastal plain becomes very flat supporting large areas of grass, but with wooded dunes on the foreshore. The Love and Kirke Rivers form large saline lakes with extensive saltpans around. The Love River supports communities of *Rhizophora* and *Avicennia*, but the saline Kirke River only supports small communities of *Avicennia*. The Kendall River has mixed communities of *Avicennia, Rhizophora* and *Ceriops*.

Major seagrass beds occur in the sheltered inlets of Archer Bay, Love River and Kirke River.

<u>Mapping comments.</u> The Landsat data processed was scene 99/69 captured on 16 June 1988. This was early dry season and the approximate tide phase was mid tide. The aerial photography did not cover the full tidal areas of the Watson and Archer Rivers. Terrestrial vegetation mixed with mangroves on many river islands. No field data was collected for this region south of the Love River.

4.2.4 Kendall River to Balurga Creek - 14°15'S to 14°45'S

<u>Community comments.</u> The coastal plain is very level supporting grassland and low open *Melaleuca* woodland. There are no major rivers in the area, only a few small creeks with small catchment areas, hence little regular fresh water input during the dry season. The coastal plain would receive freshwater flooding during the wet season. The small creeks are lined narrowly with *Avicennia marina* dominated communities.

No seagrass beds were observed during the dive and boat survey or were visible on the aerial photography.

Mangroves	**Area (hectares)**
Saltpan	1 580
Total	**1 580**

Table 4.5 Marine vegetation community areas for Kendall River to Balurga Creek

<u>Mapping comments.</u> The Landsat data processed was scene 99/70 captured on 21 March 1991. This was late wet season and the approximate tide phase was high tide. This was only a small area which covered a gap between adjacent Landsat scenes. There was substantial fresh water flooding on the coastal plains which contain some saltpans probably inundated during the highest spring tides. The luxurious growth of freshwater grass and reeds in the intertidal areas meant that these areas could not be spectrally separated from terrestrial grass. They have not been mapped as saltpans, the area measurement above being an understatement. There were mangrove fringes on the small creeks (*Avicennia marina* dominated), but most of these have proved not to be "mappable units" and have hence disappeared in the cartographic process. Due to mechanical problems with the helicopter no field data was gathered in this region.

4.2.5 Balurga Creek to Malaman Creek - 14°45'S to 15°S

Mangroves	Area (hectares)
Avicennia (closed)	630
Avicennia (open)	60
Saltpan	6 990
Total	**7 680**

Table 4.6 Marine vegetation community areas for Balurga Creek to Malaman Creek

Community comments. This flat terrain is covered by grassland and low open *Melaleuca* woodland. Along the coast run dune systems which support woodland. These dune systems are dissected with drains that receive fresh water inundation during seasonal flooding and tidal inundation during highest tides. In some places shifting sands may cut off pools from tidal flooding, and in the short term, the landward type mangrove plants such as *Avicennia marina, Excoecaria agallocha* and *Lumnitzera* spp. remain.

Zonation still occurs in the mangrove communities, but on a much smaller scale. *Rhizophora* communities may fringe the waterways but can be only 2 to 3 plants wide. In riverine areas the communities are mixed but tend to be *Avicennia marina* dominated. In this region pure *Avicennia* communities start to line the foreshore but are not continuous.

No seagrass beds were observed during the dive and boat survey or were visible on the aerial photography.

Mapping comments. The Landsat data processed was scene 98/70 captured on 6 April 1988. This was late wet season and the approximate tide phase was high tide. The late wet season Landsat image showed freshwater flooding in tidal areas. The image also had scattered cloud that covered some intertidal areas. The aerial photography did not cover the limits of the intertidal areas. No field data was collected north of Pormpuraaw due to mechanical problems with the helicopter.

4.2.6 Malaman Creek to Gilbert River - 15°S to 16° 35' S (Mitchell, Nassau , Staaten Rivers)

Community comments. This region is dominated by grass covered coastal plains. The terrain is so level that tidal saltpans mix with the grasslands and extend for kilometres inland. Zonation occurred to some extent in the mangrove communities but at a much smaller scale. *Rhizophora* communities generally fringe the creeks but are only 1-5 plants wide. In riverine areas very mixed communities occur containing *Rhizophora, Bruguiera, Ceriops, Xylocarpus mekongensis*, *Avicennia, Aegialitis*, and *Aegiceras* and are generally less than 10 metres tall. The club mangrove *Aegialitis* which is usually only 0.5 to 2 metres in height was observed on several occasions to be growing more than 5 metres tall. Directly landward of these communities, bands of grass (*Sporobolus virginicus*) occur and then saltpans. Pure closed *Avicennia* communities line parts of the foreshore.

The terrestrial land adjacent to the intertidal zone is very infested with the exotic, noxious weed, rubbervine (*Cryptostegia grandiflora*). Isolated rubbervine plants, obviously with considerable salt tolerance, are occurring in the landward rim communities.

No seagrass beds were observed during the dive and boat survey or were visible on the aerial photography.

Mangroves	**Area (hectares)**
Avicennia (closed)	2 560
Avicennia (open)	1 350
Rhizophora/Ceriops (closed)	440
Avicennia/Ceriops (open)	120
Landward Rim (open)	180
Mixed (closed)	3 390
Saltpan	55 390
Total	63 430

Table 4.7 Marine vegetation community areas for Malaman Creek to Gilbert River

Mapping comments. The Landsat data processed was scene 98/71 captured on 21 May 1987. This was early dry season and the approximate tide phase was mid tide. A small gap appeared between this satellite scene and the scene to the south (gulf) over the Gilbert River. This area (15 kilometres by 15 kilometres) was supplemented by a segment from a Landsat Multispectral Scanner (MSS) image captured on 7 October 1991 (late dry season, mid tide). The resolution of the data from MSS was coarser than TM both spatially (80 metre pixels compared to 30 metre pixels), and spectrally (4 bands compared to 7). The available aerial photography did not cover the upper tidal limits. No access was allowed to land occupied by the Kowanyama community which included the whole Mitchell River Delta. Extensive dieback in *Avicennia* communities was observed by helicopter on the Mitchell River Delta which has occurred since the Landsat scene and aerial photography were collected.

4.2.7 Gilbert River to Flinders River - 16° 35' S to 18°S (Norman, Bynoe Rivers)

Community comments. This region is also dominated by grass covered coastal plains. The terrain is so level that tidal saltpans mix with the grasslands and extend for kilometres inland. Mangrove zonation is limited. Avicennia communities dominate the relatively protected foreshore and fringe the rivers. These may contain an understorey of *Aegialitis* and *Aegiceras* plants. The communities become more open towards the landward edge and while still *Avicennia* dominated, may contain occasional stands of *Ceriops*, with a ground cover of samphires (*Halosarcia* spp.) and salt couch (*Sporobolus virginicus*). Directly landward of these communities, bands of grass (*Sporobolus virginicus*) occur and then saltpans. The tidal creeks support mixed communities containing *Avicennia, Aegialitis*, *Aegiceras*, *Xylocarpus mekongensis* and *Lumnitzera racemosa*, and are generally less than 10 metres tall.

Observations made on the Norman River in November 1993 were that *Rhizophora* only occurred infrequently as individual plants. *Ceriops* too was much diminished compared to areas further north. No *Bruguiera* were observed at all. The terrestrial land adjacent to the intertidal zone was very infested with the noxious weed, rubbervine (*Cryptostegia grandiflora*). The exotic rubbervine plants, obviously with considerable salt tolerance, occurred with salt couch (*Sporobolus virginicus)*.

Medium and dense seagrass beds occur on the shallow banks at the mouth of the Norman River.

Mangroves	**Area (hectares)**
Avicennia (closed)	3 170
Avicennia (open)	7 790
Mixed (closed)	4 040
Saltpan	159 170
Total	**174 170**
Seagrass	**Area (hectares)**
Medium	1 370
Dense	140
Total	**1 510**

Table 4.8 Marine vegetation community areas for Gilbert River to Flinders River

Mapping comments. The Landsat data processed was scene 99/72 captured on 1 October 1992. This was late dry season and the approximate tide phase was mid tide. The available aerial photography did not cover the upper tidal limits.

5.0 PRELIMINARY ASSESSMENT OF THE LITTORAL MACRO INVERTEBRATE FAUNA

A list of species of littoral macro invertebrates collected is given in Table 5.1.

Taxon	Norman River & Karumba coast	Nassau River & adjacent creeks
Molluscs		
Telescopium telescopium	Y	Y
Murex coppingeri	Y	Y
Ostrea sp.	Y	Y
Polinices didyma	Y	N
Turritella terebra	Y	N
Anadara sp.	Y	N
Architectonica sp.	Y	N
Mactra alta	Y	N
Tellina inflata	Y	N
Dosinia mira	Y	N
Diplodonta sp. (?)	Y	N
unidentified species 1	N	Y
unidentified species 2	N	Y
unidentified species 3	N	Y
unidentified species 4	N	Y
Crustaceans		
Metapograpsus latifrons	Y	Y
Metapograpsus frontalis	N	Y
Perisesarma longicristamum (?)	Y	Y
Uca coarctata	Y	Y
Uca sp.	N	Y
Sesarma erythrodactyla	Y	Y
unidentified porcellanid	Y	Y
Coenabita spinosus var. *variabilis*	Y	Y

Table 5.1 List of species of littoral macro invertebrates collected

There was a progressive loss of species within the Norman River with increasing distance from the sea, with crustaceans disappearing entirely by Half-Moon Island (60 km upstream from the coast). Within the mangrove systems, species richness and abundance was highest on banks of moderate slope, stabilised by mangrove roots, within a few metres of the water's edge. The only species found towards the shoreward margins of the mangrove zone was the mud whelk *Telescopium telescopium* in occasional depressions retaining water. No invertebrates were found on the saltpans, although empty shells of *T. telescopium* were located in drainage channels at the margins of the saltpans. The hermit crab *Coenabita spinosus* var. *variabilis* was found supra tidally on the sandy beach at Karumba Point at night in large numbers.

There was a less marked stratification in invertebrate distribution within the Nassau River / Pormpuraaw area. *Metapograpsus latifrons* and *Sesarma erythrodactyla* were located in most parts of the mangrove zone, although more commonly near the water's edge. Abundance of mangrove crustaceans, especially the *Uca* spp. and *S. erythrodactyla* was markedly higher than that found in the Norman River / Karumba coast, although there is no marked difference between the species richness at the two areas.

Most of the molluscs listed from the Norman River / Karumba area were identified from shells gathered from extensive storm-deposited shell and coral debris some 2 or 3 metres above high water at Karumba Point. The species represented are most likely to dwell in mudflats to seaward of the narrow coastal mangrove fringe. Wells, F. E. (1982) in examining patterns of distribution of crustaceans and molluscs with a mangrove system in north-western Australia, found the greatest diversity in the mudflats, largely comprised of filter-feeding molluscs. Within the mangrove habitats, deposit and surface feeders, incorporating a large proportion of crustaceans, dominated. This pattern appears broadly similar to that noted in both the areas sampled.

6.0 DISCUSSION AND BIOGEOGRAPHIC CLASSIFICATIONS

6.1 Comparison of marine vegetation of Western Cape York Peninsula

As western Cape York Peninsula is such a huge area supporting a range in environmental conditions it is no surprise that it supports a variety of coastal vegetation habitat types. Major intertidal vegetation composition by latitude along the western coast is shown in Figure 6.1.

One obvious difference between the northern and southern extremes of the western side of the Peninsula is the dominance of *Rhizophora* communities in the north, and its absence as a community type in the south with *Avicennia* and saltpans dominating. *Ceriops* communities are also less common. The south-western Peninsula is subject to quite different environmental conditions from the north-western Peninsula. Average rainfall is lower, especially in the dry season, and tidal patterns are influenced by the diurnal tide of the southern Gulf of Carpentaria. Wells (1983), however, believes that the main reason for the variation in mangrove communities is that the prevailing south-east trade winds blow across hot dry land towards the south-western side of the Peninsula during the dry season. These drying winds cause seasonal aridity and thus limit the establishment of the mangrove species with more humid climatic requirements.

Another difference observed between the northern and southern extremes of western Cape York Peninsula is the predominance of *Avicennia* on the foreshore at the southern end. The northern end is exposed to higher energy conditions from the Gulf of Carpentaria thereby limiting mangrove communities to sheltered bays and estuaries.

The zonation patterns of seagrass habitat are mostly related to depth (Lee Long *et al.* 1993, Poiner *et al*. 1987). Depth zonation patterns were influenced by the tidal range and levels of exposure, turbidity (hence ambient light) and salinity (Coles *et al.* 1987).

On the basis of tidal wetland vegetation communities, the western side of Cape York Peninsula can be divided northwards and southwards into two biogeographic regions divided at approximately 14°S at Cape Keer-Weer. This appears to be the centre of the transition zone where *Rhizophora* dominance switches to *Avicennia*/saltpan dominance. A draft marine biophysical classification by Stevens (1994*a*), using physical and biological parameters such as rainfall, tidal range, mangrove community structure and decapod biogeography, supports this boundary. The two regions from this work are the Inshore Gulf, which extends from the Queensland/Northern Territory border to Cape Keer-Weer, and West Cape York, from Cape Keer-Weer to the tip of Cape York, including the major inner island groups of Torres Strait. These marine based biogeographic regions interface well with terrestrial based biogeographic regions modified from Stanton and Morgan (1977) (Blackman, Queensland Department of Environment and Heritage, pers. comm. 1995).

6.2 Comparison of marine vegetation to other areas

Table 6.1 compares the number of marine vegetation species for selected regions within Australia.

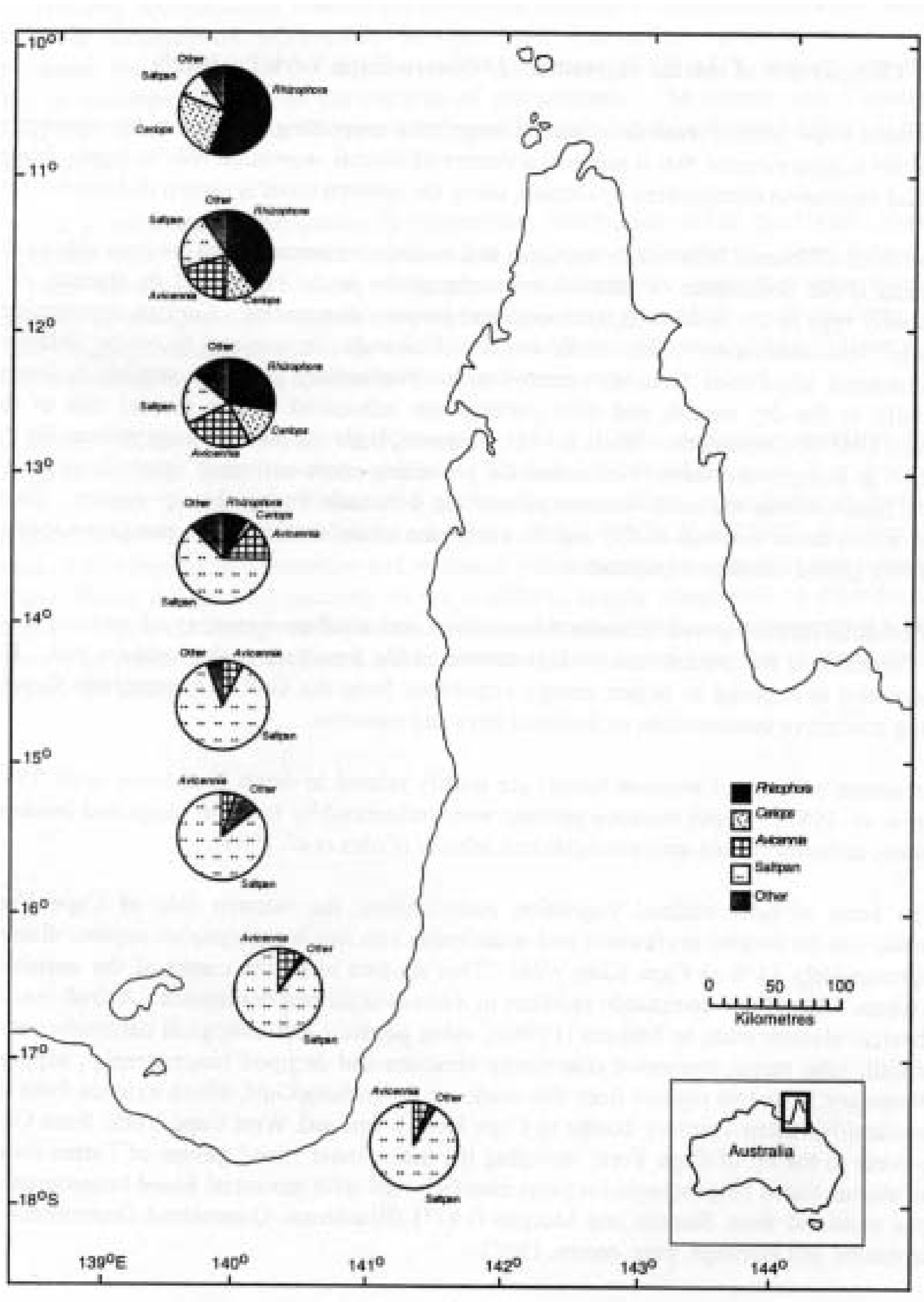

Figure 6.1 The intertidal vegetation communities, by latitude, of western Cape York Peninsula

Region	Number of mangrove species (from Duke 1992)	Number of seagrass species (from Mukai 1993)
Northern Cape York Peninsula and Torres Strait	36	13
Western Cape York Peninsula	20	
Southern Gulf of Carpentaria	12	11
Darwin	28	
Northern Western Australia	17	
South-east Queensland	9	5
Victoria	1	

Table 6.1 Comparison of mangrove and seagrass species numbers

The northern end of the West Cape York biogeographic region (together with the north-eastern side of Cape York Peninsula) contains one of the highest mangrove diversities in the world (Duke 1992). Duke (1992) explains this high diversity by surmising that temperature and rainfall are the two major environmental factors governing the distribution of mangroves. Southern Australia does not receive high enough temperatures for high mangrove diversity while the other tropical regions such as northern Australia and northern Western Australia do not receive as much rainfall as north-eastern Australia.

The seagrass communities on the eastern and western coasts of Cape York Peninsula are different in terms of their species composition. Lee Long *et al.* (1993) found that seagrass beds dominated by *Enhalus acoroides*, which were common in shallow, sheltered sites in the Gulf of Carpentaria (Poiner *et al.* 1987) and in the Torres Strait (Bridges *et al.* 1982), were not common on the eastern coast of north Queensland. Open-coastline communities typical of the western Gulf of Carpentaria, where *Halophila ovalis* and *Halodule uninervis* dominate intertidally and *Cymodocea serrulata* and *Syringodium isoetifolium* dominate subtidally (Poiner *et al.* 1987), did occur in parts of the eastern coast of north Queensland where there was less freshwater runoff from coastal rivers.

6.3 Comparison of littoral macro invertebrate fauna to other areas

The environment for intertidal fauna within the Norman River / Karumba area is a comparatively harsh one. The area is subject to very high temperatures and small river flows for much of the year, broken during the wet season by very large fresh-water inputs and occasional flooding. The tidal regime is also harsh, with only one tide per day and a range of in excess of 4 metres. The intertidal environment of the Nassau River / Pormpuraaw is not so extreme, with a somewhat smaller tidal range and two tides per day, although they are of very different amplitudes. It is therefore not surprising that the mangrove invertebrate fauna within the areas sampled was relatively poor compared to other northern Australian sites (Wells, F. E. 1982, Hanley 1995). It should, however, be emphasised that the knowledge of the Gulf of Carpentaria intertidal faunae is very poor, and a structured quantitative sampling program at range of sites is required to enable meaningful assessment of the patterns of intertidal invertebrate communities within the Gulf and their affinities with other regions in northern Australia.

The south-east Gulf sites appear to be representative of the relatively depauperate littoral invertebrate fauna characteristic of the Inshore Gulf biophysical region. The Nassau River / Pormpuraaw area is transitional in terms of abundance, lying closer to the boundary between the Inshore Gulf and West Cape York marine biophysical regions proposed by Stevens (1994*a*) at Cape Keer-Weer. Representation of these characteristic faunae within a representative marine reserve system is desirable to provide reference points for further assessment of their affinities with other Gulf sites and other regions in Northern Australia.

7.0 IDENTIFICATION OF CONSERVATION AREAS

7.1 Habitats for important/threatened species

The habitat provided by marine plants plays a major role in the survival of many important/threatened species. Robertson and Blaber (1992) have summarised the utilisation of mangrove communities by fish. Mangrove communities provide shelter from predators for juvenile fish and prawns through the structural complexity provided by prop roots, pneumatophores and fallen logs and branches. The increased turbidity in the adjacent waters also provides protection from predators. Mangrove communities are also important feeding sites for fish and increase the supply of food available to juvenile fish. The food provided may not be directly from the mangroves but through plankton or epibenthos. Mangrove habitat are critical to the life cycle of some commercial fish species such as barramundi (Russell and Garrett 1985). Seagrass habitat provides nursery grounds for juvenile fish and crustaceans, with several commercial species of penaeid prawns dependent on this habitat for their survival (Coles *et al*. 1993). Such habitats provide the primary food of dugongs and some turtle species.

Marine plants, including mangroves, saltcouch and seagrasses, are specifically protected under the *Fisheries Act* 1994 in all Queensland waters. Disturbance of these plants may only be undertaken with specific approval. To provide additional habitat protection for fisheries purposes, Fish Habitat Areas are declared under Section 120 of the *Fisheries Act*. Fish Habitat Areas were known as Fish Habitat Reserves and Wetland Reserves in previous fisheries legislation. The *Fisheries Act* 1994 now allows for Fish Habitat Areas to be declared over freshwater as well as estuarine/marine wetlands. These Areas are part of the ongoing management of fisheries habitat resources within Queensland and are declared with the specific intent to ensure continuation of productive recreational and commercial fisheries in a region. Declaration proclaims the value of the area from a fisheries viewpoint, and increases the level of protection and management of the wetlands and/or fishing grounds for community benefits. Appendix 1 provides more information on each type of Reserve under the Fisheries Act 1976-89. A system of Fish Habitat Areas (Reserves) has been in place on western Cape York Peninsula but the boundaries of current Fish Habitat Areas (Reserves) and the need for additional Fish Habitat Areas in places of high habitat value are the subject of ongoing review of which this study forms a major part.

7.2 Criteria for Fish Habitat Areas

The purpose of Fish Habitat Areas is to ensure that representative marine vegetation communities (fish habitats) receive long-term protection to ensure sustainability of dependent fisheries. The following criteria are currently used for the selection of these Areas:

1. size
2. diversity of or specific habitat features
3. diversity of or specific marine fauna and flora
4. existing or potential fishing grounds
5. level of existing and future disturbances
6. unique features
7. protected species

The diversity of or specific habitat features can be categorised according to the classification by Bunt (1978) as:

1. Island sites: e.g. Torres Strait islands
2. Open coastal fronts: e.g. Karumba
3. Coastal flats with complex but not extensive creek drainage: e.g. Doughboy River
4. Small to large meandering rivers without extensive estuaries: e.g. Edward River
5. Relatively directly flowing rivers within confined valleys, character of freshwater discharge variable: e.g. Jardine River
6. Rivers discharging to the sea via extensive estuaries, fresh water influence variable within the estuary and with season: e.g. Archer River

7.3 Existing Fish Habitat Areas (Reserves)

Nassau River Fish Habitat Area. This protected area contains closed mixed and *Rhizophora/Ceriops* communities in riverine areas. Closed and open *Avicennia* communities occur on parts of the foreshore. To date no seagrass beds have been recorded in or near the Reserve. Bunt (1978) habitat environment classification 2 - open coastal fronts, and 4 - small to large meandering rivers without extensive estuaries.

Staaten-Gilbert Fish Habitat Area. Closed and open *Avicennia* communities occur on parts of the foreshore of this Fish Habitat Area. Closed mixed and *Avicennia* communities occur in riverine areas. To date no seagrass beds have been recorded in or near the Area. Bunt (1978) habitat environment classification 2 - open coastal fronts, and 4 - small to large meandering rivers without extensive estuaries.

Morning Inlet-Bynoe River Fish Habitat Area. This Fish Habitat Area contains closed mixed and open *Avicennia* communities in riverine areas. Closed and open *Avicennia* communities occur on parts of the foreshore. To date no seagrass beds have been recorded in the Reserve but to the north medium and dense seagrass beds occur at the mouth of the Norman River. Bunt (1978) habitat environment classification 2 - open coastal fronts, and 4 - small to large meandering rivers without extensive estuaries.

See Appendix 2 for plans of the Fish Habitat Areas (Reserves).

7.4 Representative habitats not currently incorporated in Fish Habitat Areas

The habitat environment classification provided by Bunt (1978) highlights the lack of representation of some mangrove community types: 1 - island sites, 3 - coastal flats with complex but not extensive creek drainage, 5 - relatively directly flowing rivers, and 6 - rivers discharging to the sea via extensive estuaries in current Fish Habitat Areas (Reserves) on the western side of Cape York Peninsula.

Most of the mangrove communities found on the western side are not currently represented in Fish Habitat Areas (Reserves), e.g. *Rhizophora*, *Ceriops*, *Avicennia/Ceriops*. The north-western Cape is very species rich and includes less common mangroves such as the palm *Nypa fruticans.* As the upper boundary of the Fish Habitat Reserves was High Water Mark (the mean of high water springs) most of the tidal saltpans adjacent to the current Fish Habitat Areas (previously declared as Fisheries Reserves) are not protected and may be threatened by adjacent land use such as cattle grazing.

The western side also supports a distinct gradation of species dominance within mangrove communities (i.e. *Rhizophora* in the north and *Avicennia* in the south) so it is important that the different biogeographic regions are represented in Fish Habitat Areas.

Seagrass beds are not extensive in inshore areas along the western coast but do occur in sheltered such as Albatross Bay, Archer Bay and the Norman River mouth. None of the seagrass habitats are currently protected in Fish Habitat Areas.

7.5 Typical areas to be considered for potential Fish Habitat Areas

Reserves for Fisheries Purposes (known as Fish Habitat Areas in the *Fisheries Act 1994*) may be declared over tidal and freshwater wetlands habitat of importance to fisheries. A number of tidal wetland areas considered suitable for declaration are listed below. This list is derived using the baseline information compiled by this project and at this stage is suggestive not conclusive. Boundaries for the potential Fish Habitat Areas will not be determined as part of this project.

<u>Prince of Wales Island.</u> Between the sea and the hills at the southern edge of the island are well developed zones of *Rhizophora*, open *Ceriops*, saltpan and landward rim communities. The land tenure is Licence to Occupy. Bunt (1978) habitat environment classification 1 - island sites.

<u>Jardine River.</u> The persistent flow of water from this river prevents the penetration of tidal water, thus limiting the mangroves to the mouth of the river. However the 'Jardine Swamps' to the south of the river must receive some tidal inundation as mixed mangrove communities occur interspersed with terrestrial *Melaleuca* spp. The land tenure is Crown Reserve for Camp and Recreational Purposes. Bunt (1978) habitat environment classification 5 - relatively directly flowing rivers within confined valleys, character of freshwater discharge variable.

<u>Crab Island.</u> Excluding the Torres Strait Islands, this is the only offshore island on the western side of the Cape. It supports a *Rhizophora* community and is partially surrounded by both dense and sparse seagrass beds. The land tenure is Aboriginal Reserve. Bunt (1978) habitat environment classification 1 - island sites.

<u>Doughboy River / MacDonald River / Jackson River.</u> These rivers are well developed estuaries behind coastal dunes protecting them from the open waters of Gulf of Carpentaria. The mangrove communities present are dominated by *Rhizophora, Ceriops* and *Avicennia* spp. It is in this region that *Avicennia marina* starts to increase it presence. Stands of the uncommon mangrove palm *Nypa fruticans* are also present. The land tenure is Aboriginal Reserve. Bunt (1978) habitat environment classification 3 - coastal flats with complex but not extensive creek drainage.

<u>Wenlock River.</u> This river supports the most impressive mixed communities that were observed during the (limited) field work in Cape York Peninsula. At one site *Rhizophora* emergents grew to 35 metres, above a mixed canopy at 25 metres of *Avicennia marina, Bruguiera* spp., *Ceriops* spp., *Excoecaria agallocha* and *Xylocarpus mekongensis*. The

understorey included *Acanthus ilicifolius, Aegiceras corniculatum,* and *Nypa fruticans.* The land is under mining tenures. Bunt (1978) habitat environment classification 6 - rivers discharging to the sea via extensive estuaries, fresh water influence variable within the estuary and with season.

Kirke River. This area is located in a position of importance but unfortunately was not field checked. According to the mangrove community mapping of this study and supported by Stevens (1994*a*), the western side of Cape York Peninsula is divided into two biogeographic regions at Cape Keer-Weer/Kirke River (roughly 14° South). This is where *Avicennia marina* increases its dominance over *Rhizophora* and *Ceriops* spp. The Kirke River includes a large tidal lake several kilometres inland which supports seagrass communities. The land tenure is Aboriginal Reserve. Bunt (1978) habitat environment classification 3 - coastal flats with complex but not extensive creek drainage.

Holroyd/Kendall Rivers. The Holroyd and Kendall Rivers (Holroyd meets the Kendall near its mouth) support a large area of intertidal land in part of the coast where water courses are not common. The area was not field checked. The land tenure is Aboriginal Reserve. Bunt (1978) habitat environment classification 6 - rivers discharging to the sea via extensive estuaries, fresh water influence variable within the estuary and with season.

Edward River. The Edward River is representative of the small rivers and creeks which dissect an almost continuous coastal saltpan in this region. The land tenure is Aboriginal Reserve. Bunt (1978) habitat environment classification 3 - coastal flats with complex but not extensive creek drainage.

Melaman Plain. This is the only open coastal front (Bunt 1978) of the CYPLUS area on the western side, and the only open coastal front to support *Avicennia* communities.

Nassau River. The boundary of the current Fish Habitat Reserve could be extended from High Water Mark to Highest Astronomical Tide and thus include the extensive saltpans landward of the mangrove communities.

Staaten-Gilbert Rivers. The boundary of the current Fish Habitat Reserve could be extended from High Water Mark to Highest Astronomical Tide and thus include the extensive saltpans landward of the mangrove communities.

Morning Inlet-Bynoe River. The boundary of the current Fish Habitat Reserve could be extended from High Water Mark to Highest Astronomical Tide and thus include the extensive saltpans landward of the mangrove communities.

Norman River mouth. The seagrass beds outside the Norman River mouth are the only ones in the study area to occur south of the Kirke River (approximately 400 kilometres to the north).

Table 7.1 shows the criteria mentioned in Section 7.1 met for these suggested Fish Habitat Areas.

Potential Fish Habitat Area	1	2	3	4	5	6	7
Prince of Wales Island		x	x	x	x	x	
Jardine River		x	x	x	x	x	
Crab Island		x	x			x	
Doughboy, MacDonald and Jackson Rivers	x	x	x	x	x	x	
Wenlock River	x	x	x	x	x	x	
Kirke River	x	x	x	x	x	x	x
Holroyd/Kendall Rivers	x	x	x	x	x	x	
Edward River		x	x	x	x		
Melaman Plain		x	x			x	
Nassau River	x	x	x	x	x		
Staaten-Gilbert Rivers	x	x	x	x	x		
Morning Inlet/Bynoe River	x	x	x	x	x		

Table 7.1 Application of criteria to potential Fish Habitat Areas

7.6 Fish Habitat Area selection and declaration process

Areas of fisheries habitat considered of value to fisheries are investigated in detail before "Area of Interest" plans are drafted. These plans are then circulated to all relevant management agencies, fishing industry sectors, specific interest groups, local authorities, individuals and communities for consideration and provision of comments on draft boundaries. This step includes direct consultation to outline the implications of Reserve status and management.

On receipt of comments, draft boundaries are reviewed and final boundaries are advised to all parties prior to submission for Ministerial and Cabinet consideration. The selection, investigation and declaration process normally extends over a two year or longer period.

The process outlined above will be used to investigate estuarine/marine wetlands that this study has identified.

8.0 CONCLUSIONS

8.1 Importance of the tidal wetland vegetation and littoral invertebrate fauna of western Cape York Peninsula

The tidal wetland vegetation of the West Cape York and Inshore Gulf biogeographic regions are unique and highly diverse. The West Cape York region is one of the most diverse in the world for both mangroves (Duke 1992) and seagrasses (Lee Long *et al*. 1993). The Inshore Gulf region supports one of the largest areas of intertidal land in Australia (Galloway 1982). Due to limited coastal development, the majority of communities are still pristine.

It must be re-emphasised , however, that the knowledge of the Gulf of Carpentaria intertidal faunas is poor, and a structured quantitative sampling program at range of sites is required to enable meaningful assessment of the patterns of intertidal invertebrate communities within the Gulf and their affinities with other regions in northern Australia.

8.2 Reserves for Fisheries Purposes

While some Fish Habitat Reserves do exist on western Cape York Peninsula it is clear that they do not represent all fish habitat types. The boundaries of existing reserves need to be reassessed to take into account the protection of submerged seagrass habitat, saltpan habitat, freshwater habitat, and adjacent terrestrial land.

8.3 Satellite remote sensing and GIS technology

The use of GIS technology and satellite remote sensing has revolutionised natural resources mapping. This project mapped all of the mangrove communities in western Cape York Peninsula to detail greater than 1:100 000 in less than 12 months. The accuracy was greater than 80 percent. Using traditional cartographic methods, production of the twenty-five 1:100 000 maps sheets would have taken approximately 2 years to complete. The methodologies employed here saved approximately 12 months salary for one person. Digital data allows efficient storage and low cost distribution. It is also easier to update than conventional mapping and allows numerical natural resource modelling.

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APPENDIX 1 Fisheries Reserves (Fish Habitat Areas) information

Fisheries Information Leaflet

QL92008

Reserves For Fisheries Purposes

Fish Habitat Reserve, Wetland Reserve, Fish Sanctuary

Fish Habitat Reserves, Wetland Reserves and Fish Sanctuaries are declared under Section 51 of the *Fisheries Act* for fisheries purposes.

These Reserves and Sanctuaries are part of the ongoing management of fisheries resources within Queensland. They are declared with the specific intent to ensure continuation of productive recreational and commercial fisheries in a region. Declaration proclaims the value of the area from a fisheries viewpoint, and increases the level of protection and management of the wetlands and/or of fishing grounds for a community benefit.

Fish Habitat Reserves and Wetland Reserves and, on occasion, Fish Sanctuaries, may also be declared jointly within an area to provide integrated resource management.

Reserve and Sanctuary Lands

The Reserves and Sanctuaries include only tidal wetlands and do not include private property without the specific permission of the owner.

Whilst not limited to, these Reserves are normally declared over, bay and estuarine wetlands identified as critical to the fish and/or fisheries of a region. Within Queensland more than 80% of important fish and crustacean species depend upon and use these wetlands entirely or at some stage during their life cycle for food and habitat requirements (e.g. prawns, mud and sand crab, barramundi, whiting, flathead, bream, bass, mullet).

Reserves

Reserves, in general, are tidal crown wetlands which are important nursery and feeding grounds for the fish stocks of a region and usually also contain important recreational and commercial fishing grounds.

Sanctuaries

Sanctuaries are declared over strategic areas of extreme importance to the maintenance of fish stocks and include nursery grounds or areas from which fish stocks will migrate to replace those fished from neighbouring areas. Not normally declared over popular fishing grounds, sanctuaries may be declared near certain tourist attractions such as underwater observatories to provide protection to fish populations.

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EDFISH A Wetlands Education Project

DPI DEPARTMENT OF PRIMARY INDUSTRIES

Management

-	Fish Habitat Reserve	Wetland Reserve	Fish Sanctuary
Protect	Tidal wetlands and fish and marine products	Tidal wetlands	Fish and marine products
Allow	Access, boating, fishing by lawful line or net, crabbing by lawful dilly or pot, yabby pumping, certain public works under Permit, certain maintenance of existing facilities under Permit	Access, boating, all forms of legal fishing and bait gathering , certain public reserve purpose works under Permit, certain private or other purpose works under Permit	Access, boating
Prohibit	Alteration of tidal lands, placement or removal of material, harmful discharges, spearfishing, wormdigging, collecting activities, private benefit works, public reserve purpose and maintenance works without Permit	Alteration of tidal lands, placement or removal of material, harmful discharges,works without Permit	Fishing, crabbing, bait gathering,collecting activities
Fishing	Legal forms allowed but no spearfishing and wormdigging	Legal forms allowed	No fishing or bait gathering allowed

Fish Habitat Reserves

These Reserves offer the highest level of protection for wetlands under the *Fisheries Act* and are declared over tidal wetlands or fishing grounds considered to be core conservation areas.

Designed and managed to generally not impact upon the normal day-to-day uses of the wetlands by the community, the Reserves do not restrict boating or access, or commercial and recreational fishing, except for worm digging and spear fishing. Wetland habitat disturbances are however, severely restricted.

Dredging, filling, alteration of the habitat features and construction of facilities are prohibited except for specific Reserve purposes or certain public purposes performed under Permit. Construction of public facilities (jetties, boat ramps, etc.) and maintenance of existing facilities (public or private) may be permitted subject to conditions. Disturbances associated with the provision of such as private piled jetties or boat ramps and marinas etc. may not be permitted.

Regulations M1 of the *Fisheries Act* details the activities which may not be undertaken in a Fish Habitat Reserve without Permit (Authorisation). Section 52 of the *Fisheries Act* allows for Authorisation of only those works which are for the preservation, proper management or public enjoyment of a Reserve. (Proper management might include maintenance of existing facilities).

Wetland Reserves

These Reserves are similar to Fish Habitat Reserves, but provide a secondary level of management and protection. They are declared over wetlands or fishing grounds still of importance but not meeting the higher criteria for declaration as a Fish Habitat Reserve. Declaration may also be as a buffer zone between a core conservation Fish Habitat Reserve and existing or future disturbances.

All forms of fishing, boating, access and existing day to day uses are not restricted.

Wetland habitat disturbances, if for specific Reserve purposes or certain public purposes (public boat ramp and jetties, etc.) or maintenance of existing facilities (public or private) might be permitted subject to conditions.

It is also the intention of a Wetland Reserve declaration to allow, on circumstances, with Permit, under proper management of the Reserve works of a non-reserve or private purpose with minimal impact upon the Reserve. These works include private boat ramp or jetties from adjoining tenures where dredging or reclamation are not involved.

Regulation M3 of the *Fisheries Act* details the activities which may not be undertaken in a Wetland Reserve without Permit (Authorisation). Section 52 of the *Fisheries Act* allows for Authorisation of only those works which are for the preservation, proper management or public enjoyment of a Reserve.

Fish Sanctuaries

These Sanctuaries are not common within Queensland but are designed to completely protect all fish and marine products within the boundary of the Sanctuary. Boating and access are not restricted. All forms of fishing, bait gathering or collecting of marine organisms may not be undertaken without specific Permit. It is normal that this type of protection is achieved through the more common, possibly less specific, Fishery Closures.Fish Sanctuaries or Fishing Closures may be declared in association with other types of Fisheries Reserves on occasions.

Regulation M2 of the *Fisheries Act* details the activities which may not be undertaken in Fish Sanctuary without Permit (Authorisation). Section 52 of the *Fisheries Act* allows for Authorisation of only those works which are for the preservation, proper management or public enjoyment of the Sanctuary.

This is a summary only and should not be taken as a substitute for the Queensland *Fisheries Act*

For further information contact :

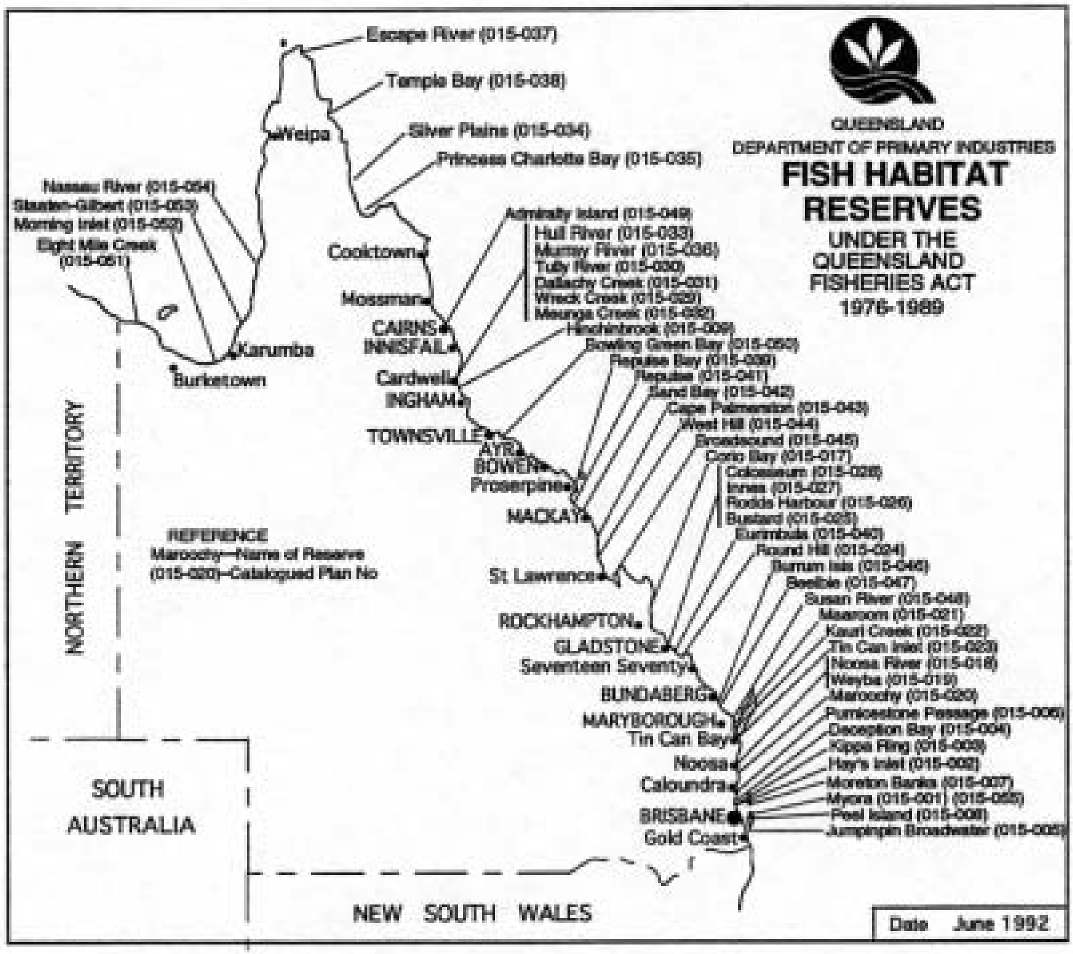
The Land Use and Fisheries Group, or
The Queensland Boating and Fisheries Patrol
at the nearest regional office of the
Queensland Department of Primary Industries.

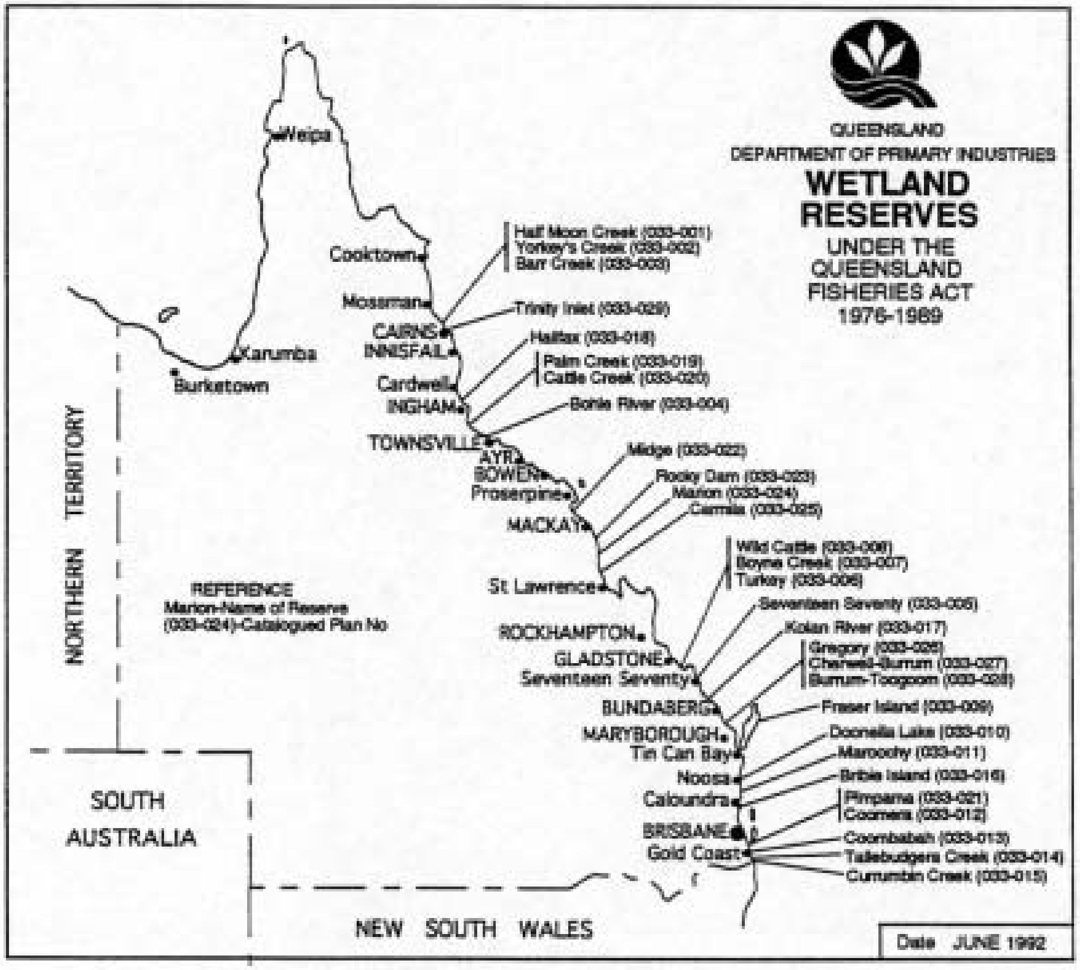
Queensland Department of Primary Industries
Fisheries Division,
G.P.O. Box 46,
Brisbane, QLD, 4001.

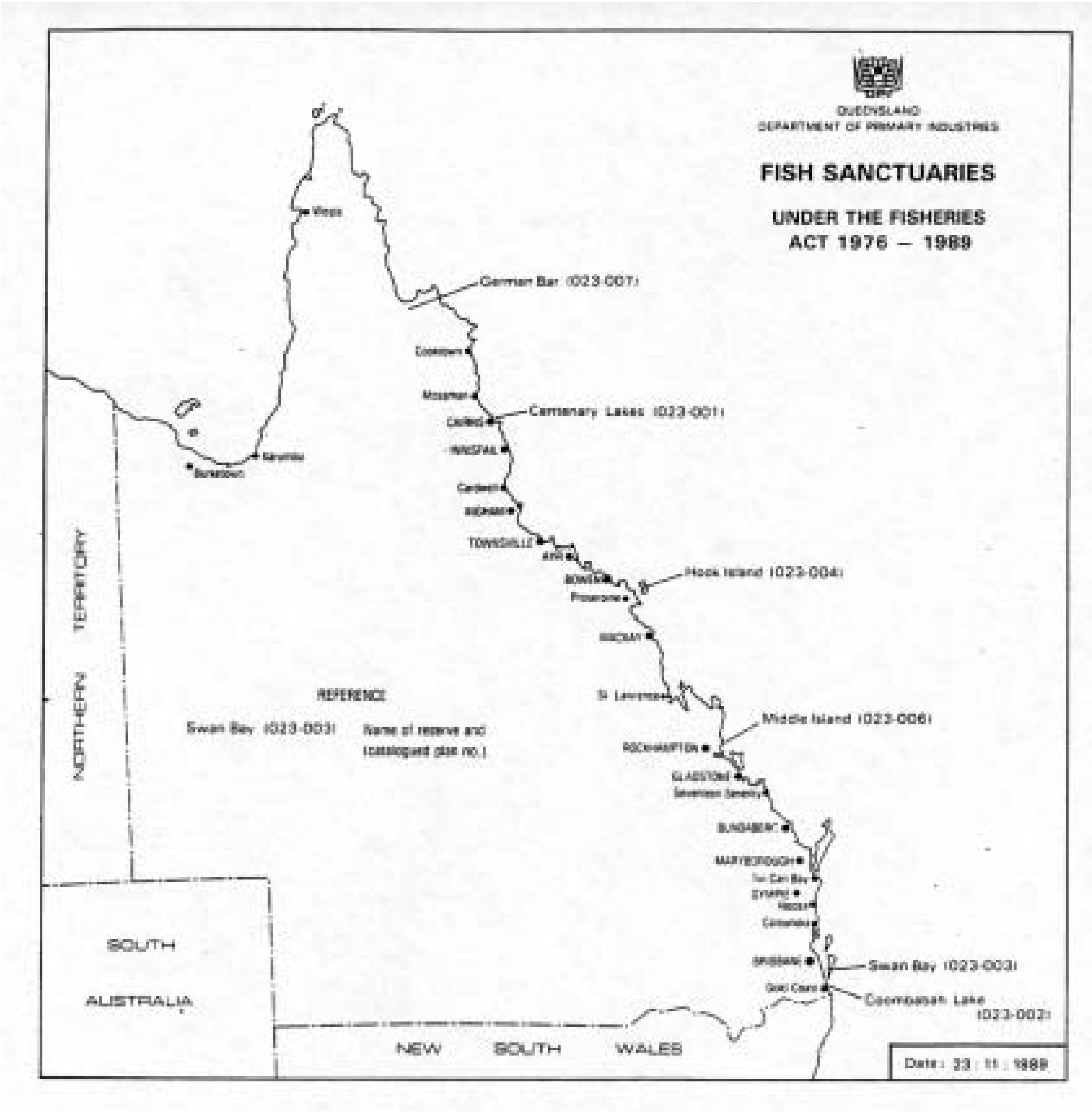
Queensland Department of Primary Industries
Queensland Boating and Fisheries Patrol
G.P.O. Box 46,
Brisbane, QLD, 4001.

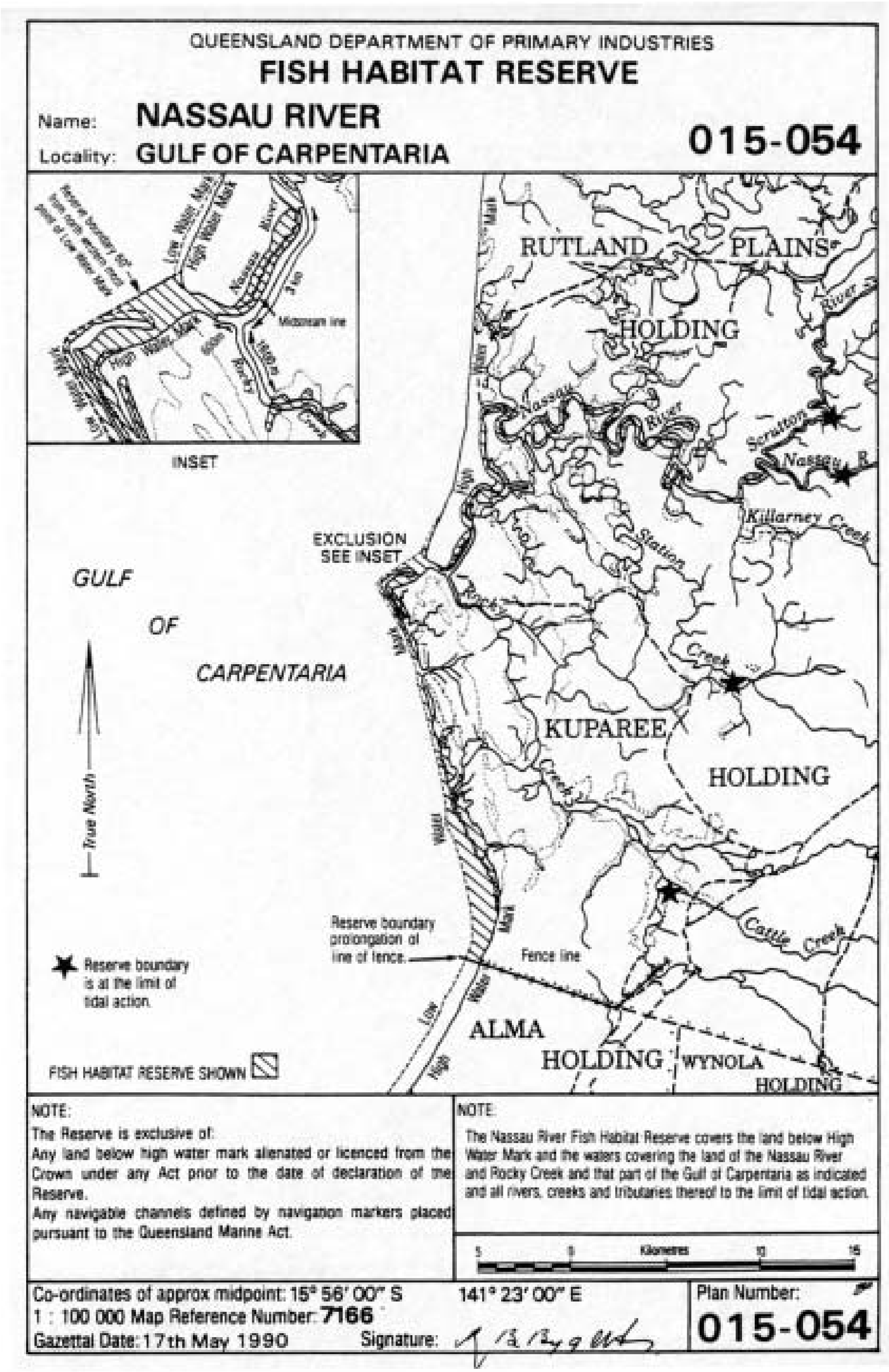
July 1992

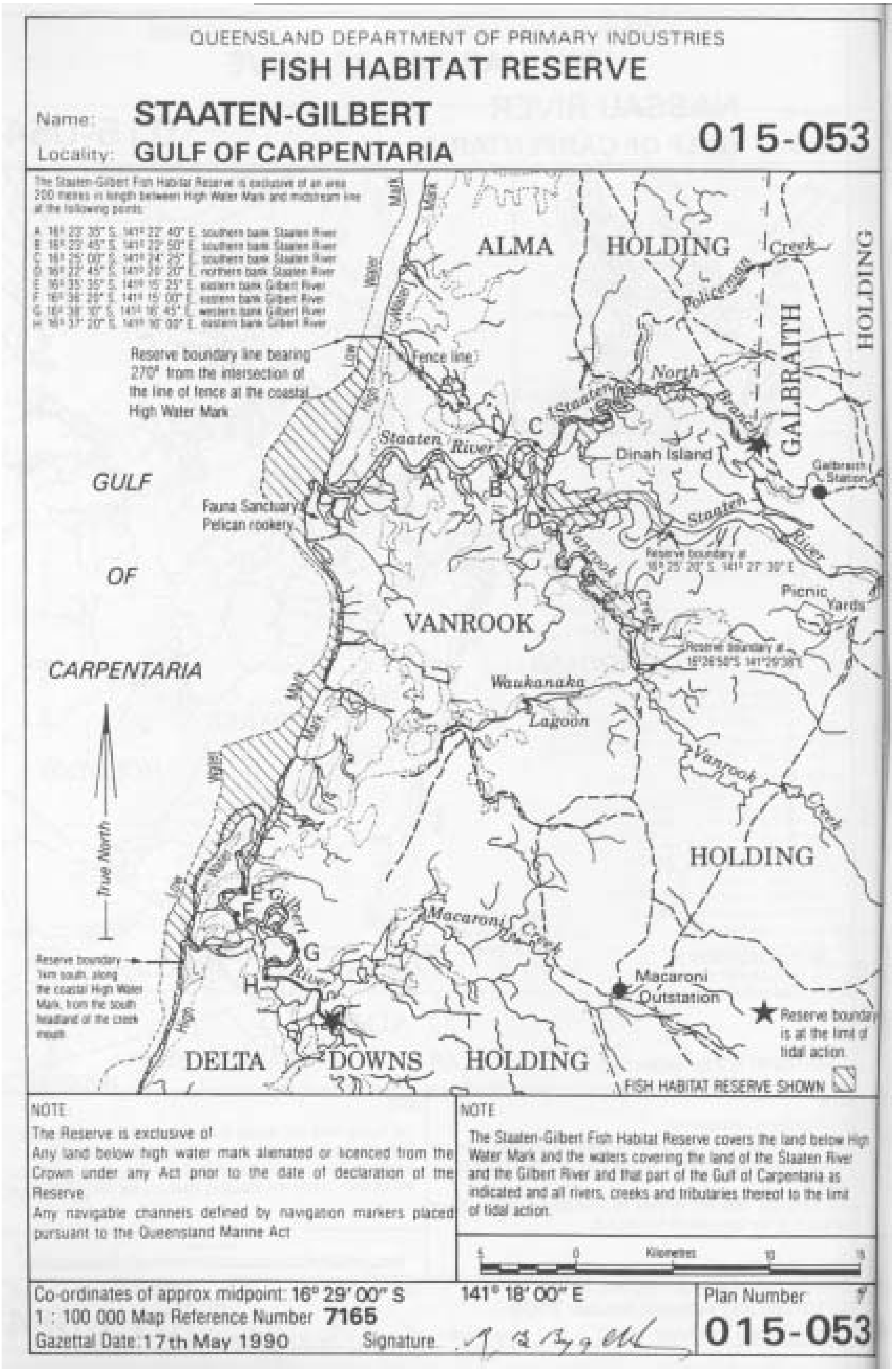
APPENDIX 2 Current Fish Habitat Areas (Fisheries Reserves) plans

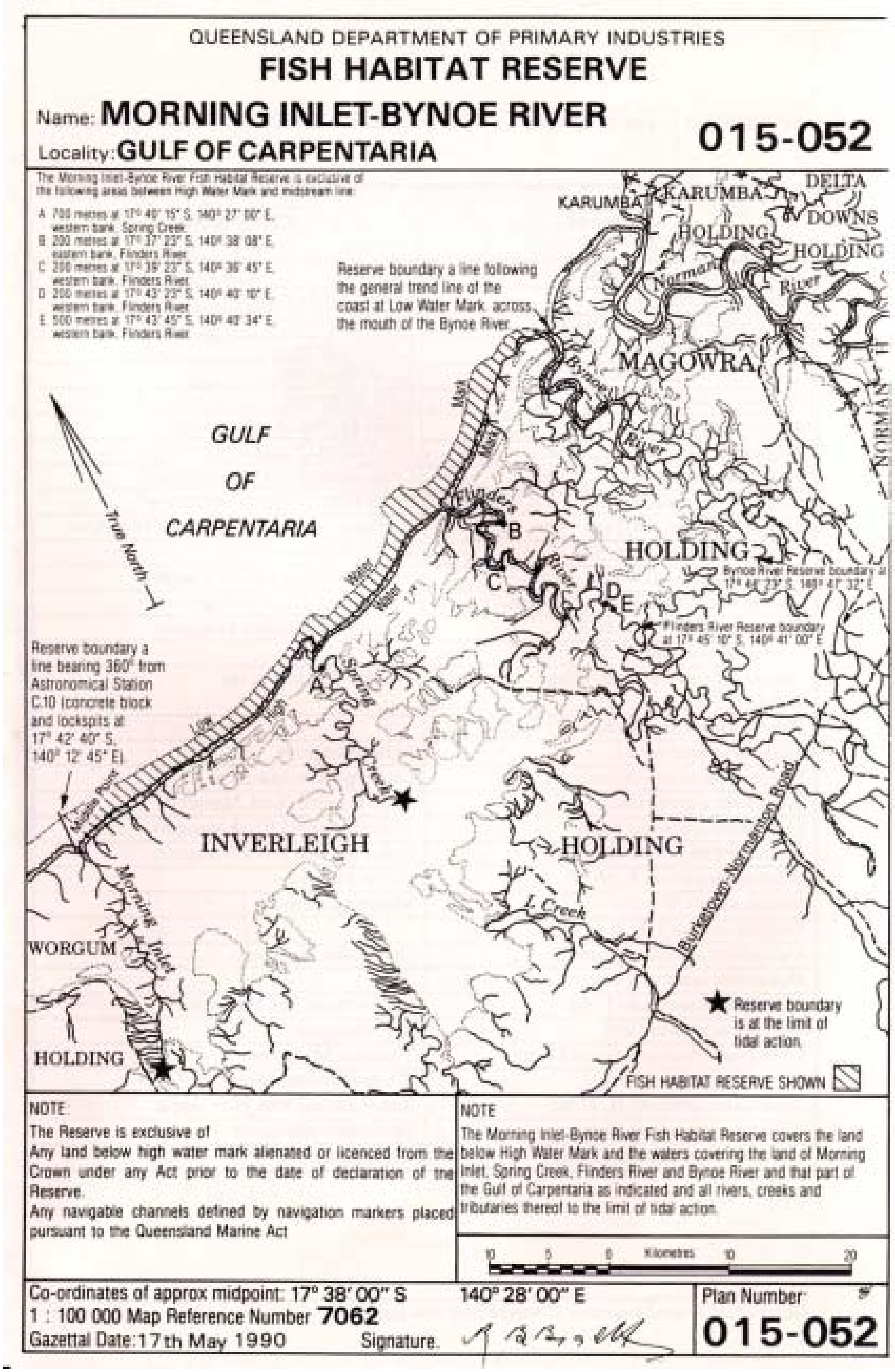



QUEENSLAND
DEPARTMENT OF PRIMARY INDUSTRIES
WETLAND
RESERVES
UNDER THE
QUEENSLAND
FISHERIES ACT
1976-1989
Weipa
Cooktown
Mossman
CAIRNS
INNISFAIL
Cardwell
INGHAM
TOWNSVILLE
AYR
BOWEN
Proserpine
MACKAY
St Lawrence
ROCKHAMPTON
GLADSTONE
Seventeen Seventy
BUNDABERG
MARYBOROUGH
Tin Can Bay
Noosa
Caloundra
BRISBANE
Gold Coast
Karumba
Burketown
Half Moon Creek (033-001)
Yorkey's Creek (033-002)
Barr Creek (033-003)
Trinity Inlet (033-029)
Halifax (033-018)
Palm Creek (033-019)
Cattle Creek (033-020)
Bohle River (033-004)
Midge (033-022)
Rocky Dam (033-023)
Marion (033-024)
Carmila (033-025)
Wild Cattle (033-008)
Boyne Creek (033-007)
Turkey (033-006)
Seventeen Seventy (033-005)
Kolan River (033-017)
Gregory (033-026)
Cherwell-Burrum (033-027)
Burrum-Toogoom (033-028)
Fraser Island (033-009)
Doonella Lake (033-010)
Maroochy (033-011)
Bribie Island (033-016)
Pimpama (033-021)
Coomera (033-012)
Coombabah (033-013)
Tallebudgera Creek (033-014)
Currumbin Creek (033-015)
REFERENCE
Marion-Name of Reserve
(033-024)-Catalogued Plan No
NORTHERN TERRITORY
SOUTH AUSTRALIA
NEW SOUTH WALES
Date JUNE 1992


QUEENSLAND
DEPARTMENT OF PRIMARY INDUSTRIES
FISH SANCTUARIES
UNDER THE FISHERIES
ACT 1976 – 1989
German Bar (023-007)
Cooktown
Mossman
Cemenary Lakes (023-001)
Cardwell
TOWNSVILLE
AYR
BOWEN
Hook Island (023-004)
Proserpine
MACKAY
Middle Island (023-006)
ROCKHAMPTON
GLADSTONE
Seventeen Seventy
BUNDABERG
MARYBOROUGH
Tin Can Bay
GYMPIE
Noosa
BRISBANE
Swan Bay (023-003)
Gold Coast
Coombabah Lake
(023-002)
REFERENCE
Swan Bay (023-003) Name of reserve and
(catalogued plan no.)
NORTHERN TERRITORY
SOUTH AUSTRALIA
NEW SOUTH WALES
Date: 23 : 11 : 1989


QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES
FISH HABITAT RESERVE
Name: NASSAU RIVER
Locality: GULF OF CARPENTARIA
015-054
INSET
EXCLUSION SEE INSET
GULF OF CARPENTARIA
True North
RUTLAND PLAINS HOLDING
KUPAREE HOLDING
ALMA HOLDING
WYNOLA HOLDING
Nassau River
Scrutton River
Killarney Creek
Station Creek
Rocky Creek
Cattle Creek
Midstream line
Reserve boundary prolongation of line of fence.
Fence line
Reserve boundary is at the limit of tidal action.
FISH HABITAT RESERVE SHOWN
NOTE:
The Reserve is exclusive of:
Any land below high water mark alienated or licenced from the Crown under any Act prior to the date of declaration of the Reserve.
Any navigable channels defined by navigation markers placed pursuant to the Queensland Marine Act.
NOTE:
The Nassau River Fish Habitat Reserve covers the land below High Water Mark and the waters covering the land of the Nassau River and Rocky Creek and that part of the Gulf of Carpentaria as indicated and all rivers, creeks and tributaries thereof to the limit of tidal action.
Kilometres
Co-ordinates of approx midpoint: 15° 56′ 00″ S 141° 23′ 00″ E
1 : 100 000 Map Reference Number: 7166
Gazettal Date: 17th May 1990
Signature:
Plan Number:
015-054


QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES
FISH HABITAT RESERVE
Name: STAATEN-GILBERT
Locality: GULF OF CARPENTARIA
015-053
Reserve boundary line bearing 270° from the intersection of the line of fence at the coastal High Water Mark
Fence line
GULF
OF
CARPENTARIA
True North
ALMA
HOLDING
VANROOK
DELTA
DOWNS
HOLDING
HOLDING
GALBRAITH
HOLDING
Staaten River
North Branch
Dinah Island
Galbraith Station
Fauna Sanctuary Pelican rookery
Vanrook Creek
Picnic Yards
Waukanaka Lagoon
Macaroni Creek
Macaroni Outstation
Gilbert River
Reserve boundary is at the limit of tidal action
FISH HABITAT RESERVE SHOWN
NOTE
The Reserve is exclusive of
Any land below high water mark alienated or licenced from the Crown under any Act prior to the date of declaration of the Reserve
Any navigable channels defined by navigation markers placed pursuant to the Queensland Marine Act
NOTE
The Staaten-Gilbert Fish Habitat Reserve covers the land below High Water Mark and the waters covering the land of the Staaten River and the Gilbert River and that part of the Gulf of Carpentaria as indicated and all rivers, creeks and tributaries thereof to the limit of tidal action.
Kilometres
Co-ordinates of approx midpoint: 16° 29′ 00″ S 141° 18′ 00″ E
1 : 100 000 Map Reference Number 7165
Gazettal Date: 17th May 1990
Signature
Plan Number
015-053


QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES
FISH HABITAT RESERVE
Name: MORNING INLET-BYNOE RIVER
Locality: GULF OF CARPENTARIA
015-052
The Morning Inlet-Bynoe River Fish Habitat Reserve is exclusive of the following areas between High Water Mark and midstream line:
A 700 metres at 17° 40' 15" S, 140° 27' 00" E, western bank, Spring Creek
B 200 metres at 17° 37' 23" S, 140° 38' 08" E, eastern bank, Flinders River
C 200 metres at 17° 39' 23" S, 140° 36' 45" E, western bank, Flinders River
D 200 metres at 17° 43' 23" S, 140° 40' 10" E, western bank, Flinders River
E 500 metres at 17° 43' 45" S, 140° 40' 34" E, western bank, Flinders River
Reserve boundary a line following the general trend line of the coast at Low Water Mark, across the mouth of the Bynoe River
KARUMBA
KARUMBA
DELTA
DOWNS
HOLDING
HOLDING
Norman
River
MAGOWRA
NORMAN
GULF
OF
CARPENTARIA
True North
Flinders
River
B
C
D
E
A
HOLDING
Reserve boundary a line bearing 360° from Astronomical Station C.10 (concrete block and lockspits at 17° 42' 40" S, 140° 12' 45" E)
Spring
Creek
INVERLEIGH
HOLDING
L Creek
Burketown-Normanton Road
WORGUM
Morning Inlet
HOLDING
Reserve boundary is at the limit of tidal action.
FISH HABITAT RESERVE SHOWN
NOTE:
The Reserve is exclusive of
Any land below high water mark alienated or licenced from the Crown under any Act prior to the date of declaration of the Reserve.
Any navigable channels defined by navigation markers placed pursuant to the Queensland Marine Act
NOTE
The Morning Inlet-Bynoe River Fish Habitat Reserve covers the land below High Water Mark and the waters covering the land of Morning Inlet, Spring Creek, Flinders River and Bynoe River and that part of the Gulf of Carpentaria as indicated and all rivers, creeks and tributaries thereof to the limit of tidal action.
10 5 0 Kilometres 10 20
Co-ordinates of approx midpoint: 17° 38' 00" S 140° 28' 00" E
1 : 100 000 Map Reference Number 7062
Gazettal Date: 17th May 1990
Signature.
Plan Number
015-052

APPENDIX 3 List of mangrove and seagrass species of western Cape York Peninsula

Mangroves	Common Name
Acanthus ebracteatus Vahl.	
Acanthus ilicifolius L.	Holly Leaf Mangrove
Acrostichum speciosum Willd.	Mangrove Fern
Aegialitis annulata R. Br.	Club Mangrove
Aegiceras corniculatum (L.) Blanco	River Mangrove
Avicennia marina (Forsk.) Vierh.	Grey Mangrove
Bruguiera cylindrica (L.) Bl.	Small-Fruited Orange Mangrove
Bruguiera exaristata Ding Hou.	Rib-Fruited Orange Mangrove
Bruguiera gymnorhiza (L.) Lamk.	Large-Leaved Orange Mangrove
Bruguiera parviflora (Roxb.) W&A ex Griff.	Small-Leaved Orange Mangrove
Bruguiera sexangula (Lour.) Poir.	Northern Large-Leaved Orange Mangrove
Camptostemon schultzii Mas.	Kapok Mangrove
Ceriops australis C.White	Smooth-Fruited Yellow Mangrove
Ceriops decandra (Griff.) Ding Hou.	Rib-Fruited Yellow Mangrove
Ceriops tagal (Perr.) C.B. Rob	Long-Fruited Yellow Mangrove
Cynometra ramiflora L.	
Cynometra ramiflora var. *Bijuga* (Spanoghe) Benth.	Wrinkle-Pod Mangrove
Dolichandrone spathacea (L.f.) K. Sch.	
Excoecaria agallocha L.	Milky Mangrove
Heritiera littoralis (Dryand) Ait.	Looking-Glass Mangrove
Lumnitzera littorea (Jack.) Voigt.	Red-Flowered Black Mangrove
Lumnitzera racemosa Willd.	White-Flowered Black Mangrove
Lumnitzera rosea (Gaud.) Presl.	Pink-Flowered Black Mangrove
Osbornia octodonta F. Muell.	Myrtle Mangrove
Nypa fruticans Wurmb.	Mangrove Palm
Pemphis acidula J. R. & G. Forst	
Rhizophora apiculata Blume	Tall-Stilted Mangrove
Rhizophora lamarckii Montr.	
Rhizophora mucronata Lamk.	Long-Fruited Red Mangrove
Rhizophora stylosa Griff.	Red Mangrove
Scyphiphora hydrophyllacea Gaertn. f.	Yamstick Mangrove
Sonneratia alba J.E. Sm.	White-Flowered Mangrove Apple
Sonneratia caseolaris (L.) Engl.	Red-Flowered Mangrove Apple
Xylocarpus granatum Koen.	Cannonball Mangrove
Xylocarpus mekongensis Pierre	Cedar Mangrove

Seagrasses
Cymodocea rotundata Ehrenb. Et Hempr. ex Aschers.
Cymodocea serrulata (R. Br.) Aschers. and Magnus
Enhalus acoroides (L. f.) Royle
Halodule pinifolia (Miki) den Hartog
Halodule uninervis (Forsk.) Aschers.
Halophila decipiens Ostenfeld
Halophila ovalis (R. Br.) Hook f.
Halophila ovata Gaud. in Freycin
Halophila spinulosa (R. Br.) Aschers.
Halophila tricostata Greenway
Syringodium isoetifolium (Aschers.) Dandy
Thalassia hemprichii (Ehrenb.) Aschers.

APPENDIX 4 DESCRIPTION OF THE GIS DATA

A4.1 Digital data

A4.1.1 Data storage

The directory OR2000 contains all the information in ARC/INFO format. The subdirectory MARVEG contains the mangrove and seagrass community polygons in 24 separate coverages. Due to the problem in the raster to vector conversion in ARC/INFO Rev 6 of reaching more than 10 000 arcs per polygon, several coverages had to be split. These split coverages bear the same name but their parts are numbered.

All coverages are projected in the Australian Map Grid (_amg). Twenty-five megabytes of disk space are required for these coverages. Table A4.1 shows which marine vegetation coverages represent the mapping areas described in 5.2 - distribution of the marine vegetation by mapping regions.

Mapping Region	**Coverage (A.M.G.)**	**Size** (megabytes)
Cape York to Doughboy River (Torres Strait, Jardine River)	torres_amg jardine_amg	0.5 1.0
Doughboy River to Hey River (Port Musgrave, Weipa)	weipa1_amg weipa2_amg weipa3a_amg weipa3b_amg weipa4a_amg weipa4b_amg	1.5 1.5 1.0 1.5 2.5 2.0
Hey River to Kendall River (Aurukun)	aurukun1_amg aurukun2_amg	1.5 1.0
Kendall River to Balurga Creek	west_amg	0.5
Balurga Creek to Malaman Creek	holroyd_amg	0.5
Malaman Creek to Gilbert River (Mitchell, Nassau, Staaten Rivers)	nassau1_amg nassau2_amg staaten_amg	2.0 1.5 1.0
Gilbert River to Flinders River (Norman, Bynoe Rivers)	gulf_amg	5.0

Table A4.1 The marine vegetation coverages related to the mapping regions

For displaying the marine vegetation classes in detail Landsat Thematic Mapper band 3 (visible red) has been provided as a background. The subdirectory TMBAND3 contains segments of Landsat Thematic Mapper band 3 (visible red) imagery in GRID format which have been projected to AMG. Eighty-two megabytes of disk space are required for these coverages. Table A4.2 displays which marine vegetation coverages overlay on the TM Band 3 imagery.

TM Band 3 Grid Coverage	Marine Vegetation Coverage
torresgr_a (7mb)	torres_amg
jardinegr_a (4mb)	jardine_amg
weipagr_a (17mb)	weipa1_amg weipa2_amg weipa3a_amg weipa3b_amg weipa4a_amg weipa4b_amg
aurukungr_a (15mb)	aurukun1_amg aurukun2_amg
westgr_a (1mb)	west_amg
holroydgr_a (4mb)	holroyd_amg
nassaugr_a (16mb)	nassau1_amg nassau2_amg
staaten_a (6mb)	staaten_amg
gulf_a (12mb)	gulf_amg

Table A4.2 The marine vegetation coverages related to the TM band 3 grid coverages with size in megabytes (mb).

The subdirectory COAST_GEO is the AUSLIG coastline data projected to geographicals.

A4.1.2 Data display

Full display of western Cape York Peninsula:

Edit fulldisp.aml for appropriate shadeset
Arc: arcplot
Arcplot: &run fulldisp.aml

Marine vegetation polygons on TM band 3:
For large scale (or detailed) display overlay the marine vegetation polygons over the Landsat TM band 3 grid. This can only be done in the AMG projection.

Example for Jardine:

Edit marveg/marveg.lut for appropriate shadeset.
Arc: w or2000/marveg (change workspace to marveg)
Arc: arcplot
Arcplot: shadeset (allocate appropriate shadeset)
Arcplot: mapextent ../jardinegr_a (set map extent for the TM band 3 grid)
Arcplot: gridpaint ../jardinegr_a # # # gray (displays TM band 3 grid in grayscale)
Arcplot: polygonshades jardine_amg marine-veg marveg.lut (uses the lookup table to paint the marine vegetation classes)

Warning: the TM band 3 coverages contain overlaps but the marine vegetation polygons do not. Marine vegetation areas towards the boundaries of the grid may be shown on the next coverage and not that coverage.

Marine Vegetation Polygons on AUSLIG Coastline:
This is better for small scale display.

Example for Jardine:

Edit marveg/marveg.lut for appropriate shadeset.
Arc: w or2000/marveg (change workspace to marveg)
Arc: arcplot
Arcplot: shadeset (allocate appropriate shadeset)
Arcplot: mapextent jardine_geo (set map extent for the marine vegetation polygons)
Arcplot: polygonshades ../coast_geo 18 (shades coast polygon in grey)
Arcplot: polygonshades jardine_geo marine-veg marveg.lut (uses the lookup table to paint the marine vegetation classes)

A4.2 Hard copy products

Maps of the coloured marine vegetation polygons overlayed on a black and white background of Landsat TM band 3 imagery are available (at cost) produced at 1:100 000 scale from the author. These are plotted on A3 sheets for easy reproduction by colour laser copying.

APPENDIX 5 REMOTE SENSING

Many natural resource mapping programs now use data collected remotely by sensors - thus the term "remote sensing". Aerial photography and satellite imagery are perhaps the best known examples. This project used imagery collected by a Landsat satellite, which was launched by the government of the USA. Landsat orbits at 705 kilometres above the earth's surface and takes 16 days to cover the whole surface of the earth. Its two instruments on board, the Thematic Mapper (TM) and Multi-Spectral Scanner (MSS) digitally scans "scenes" 185 kilometres by 185 kilometres. The scanned scenes are made up of digital values recorded from the amount of reflected light from "pixels". The TM pixels are areas representing 30 metres by 30 metres on the ground. This 30 metre by 30 metre pixel resolution means that an object must be at least this size to be detected by Landsat TM. The MSS pixels are coarser at 80 metres by 80 metres. While it is over Australia, Landsat beams this information to a receiving station in Alice Springs. For every pixel Landsat TM measures light in seven different wavelengths or “bands”. Landsat MSS has four bands. Table A5.1 describes the bands of Landsat Thematic Mapper instrument and Table A5.2 describes the bands of the Landsat Multi-Spectral Scanner instrument.

Band	Light Region	Generalised Applications
1	visible blue	coastal water mapping, soil/vegetation differentiation
2	visible green	green reflectance by healthy vegetation
3	visible red	chlorophyll absorption for plant species differentiation
4	near infrared	biomass surveys, water body delineation
5	middle infrared	vegetation moisture measurement
6	thermal infrared	plant heat stress mapping, sea surface temperatures
7	middle infrared	hydrothermal mapping

Table A5.1 Characteristics of the Landsat Thematic Mapper bands (from ACRES 1989)

Band	Light Region	Generalised Applications
4	visible green	green reflectance by healthy vegetation
5	visible red	chlorophyll absorption for plant species differentiation
6	near infrared	biomass surveys, water body delineation
7	near infrared	biomass surveys, water body delineation

Table A5.2 Characteristics of the Landsat Multi-Spectral Scanner bands (from ACRES 1989)

The advantages of Landsat imagery are that it records infrared light as well as visible light; it is digital; it can be processed by computers; and a new scene can be collected for an area every 16 days. Unfortunately it cannot penetrate through cloud which is an important constraint for wet tropical areas like Cape York Peninsula.

The Fisheries Division of the Department of Primary Industries has already effectively used Landsat imagery to map mangrove communities in Cape York Peninsula (Danaher 1994), Moreton Bay (Danaher and Luck 1991) and to map seagrass communities in Great Sandy Strait (Lennon and Luck 1990).

The collection of aerial photography is very flexible, usually project driven, and thus can be at any resolution (e.g. from 1:5 000 to 1:100 000) depending on the height at which it is flown. It can also be captured in black and white, colour or on colour infrared film. Its ease of interpretation, detail of information and handy size for taking into the field have made aerial photography part of most natural resource mapping programs. However it takes a lot of aerial photography to cover the same area as Landsat imagery and thus is more expensive per square kilometre. Aerial photography may not always exist for some locations and if it does it may be out dated.