Information Series QI00099

Queensland COASTAL WETLAND RESOURCES

The Northern Territory Border to Flinders River

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2000

QI00099
ISSN 0727-6273

This report may be cited as:
Bruinsma, C and Duncan, S (2000). Queensland Coastal Wetland Resources: The Northern Territory Border to Flinders River. Department of Primary Industries Queensland, Brisbane, 72pp.

General disclaimer

Acknowledgments

Funding provided by Environment Australia supported the research and collation of information presented in this report. The project was undertaken for the Marine Protected Areas Program, Coast and Clean Seas, Natural Heritage Trust.

The views and opinions expressed in this report are those of the authors and do not reflect those of the Commonwealth Government, the Minister for the Environment or the Director of National Parks and Wildlife.

Landsat TM satellite imagery was acquired by the Australian Centre for Remote Sensing (ACRES), a business unit of the Australian Surveying and Land Information Group (AUSLIG), Australia's national mapping agency.
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EXECUTIVE SUMMARY

Project Scope

Protection of coastal wetland environments is an important prerequisite to effective and sustainable fisheries management and conservation of habitats for the use of future generations. Mangroves, saltmarshes and seagrasses directly support local and offshore fisheries through the provision of food, shelter, breeding and nursery grounds. As such, these vegetated wetland environments along with sandbars, mudflats, rocky foreshores and reefs have significant economic value as well as their intrinsic aesthetic and ecological values.

Approximately 85% of the wetland resources of the Queensland coastline have been mapped or are currently being mapped by the Assessment and Monitoring Unit, Queensland Fisheries Service, Department of Primary Industries (DPI) Queensland. This process is being undertaken in order to provide a baseline dataset for future Fish Habitat Area (FHA) declaration, Ramsar site nomination and continued monitoring of these important fish habitats. This report summarises the results of the mapping undertaken in the Gulf of Carpentaria Region from the Queensland/Northern Territory border eastwards to the western bank of the Flinders River (hereafter called the Gulf Study Area). The study was undertaken in order to:

1. document and map coastal wetlands of the Gulf Study Area;
2. document levels of existing disturbance to and protection of these wetlands;
3. examine existing recreational, indigenous and commercial fisheries of the region;
4. evaluate the conservation values of the areas investigated from the viewpoint of fisheries productivity and as habitat for important and/or threatened species for future FHA/Marine Protected Area (MPA) declaration.

Project Rationale

There is a need to identify and map fisheries habitat for the management and conservation of the resource through the declaration of MPAs (FHAs) and Ramsar sites, as well as a requirement for conducting further research into the interactions between fauna and the habitat. Studies combining data on mangrove forest and saltmarsh primary productivity, fish species associated with these habitats and feeding strategies of these fish species will contribute to a better understanding of the value of particular habitats and habitat mosaics to fisheries productivity. Completion of the mapping of the coastal wetland communities of the Queensland coastline will provide quantitative data for incorporation into these studies. Additionally, it provides the base information required for monitoring short and long term changes in coastal wetland habitats and planning appropriate management measures.

Results

The dominant coastal wetland community type, in terms of area, within the Gulf Study Area is Saltpan. A combination of extensive low coastal plains and a seasonally dry climate create a hypersaline environment where very little vegetation is able to survive. Additionally, the low tidal range restricts the diversity of mangrove communities and zones encountered. In general, mangrove communities within the Gulf Study Area are confined to foreshore environments and drainage channels through the extensive Saltpans. Closed *Avicennia,* and to a lesser extent Open *Avicennia,* dominate the foreshore environment, whereas narrow Closed Mixed communities are the dominant mangrove communities further landward.

TABLE I Areas of coastal wetland communities of the Gulf Study Area.

COMMUNITY	AREA (ha)	% OF TOTAL
CLOSED *RHIZOPHORA*	1 388	0.19
CLOSED *AVICENNIA*	11 895	1.60
OPEN *AVICENNIA*	2 462	0.33
CLOSED *CERIOPS*	2 566	0.34
CLOSED MIXED	10 376	1.39
SALINE GRASSLAND	2 141	0.29
SALTPAN	713 991	95.86
TOTAL	744 819	100.00
TOTAL MANGROVE	28 687	3.85

Coastal wetland communities are currently poorly represented in FHAs within the Gulf Study Area. Of the total of 744 819 ha of coastal wetlands present in the area, less than 2% are protected by declared FHAs. The extensive Saltpans and narrow Closed Mixed communities are representative habitats of this region that should be included in FHAs. It is strongly recommended that efforts be made to include these areas within Queensland's system of MPAs due to their recognised role in providing habitats for the important fisheries within the Gulf of Carpentaria (eg. Barramundi, threadfins, mud crab).

Recommendations

1. The coastal wetland communities associated with the Nicholson and Leichhardt River Sub-basin Catchments are suitable habitats to be considered for further protection under Fisheries legislation. In particular, it is strongly recommended that Saltpan and Closed Mixed communities are protected within a FHA. The intertidal flats, seagrass meadows and foreshore mangrove communities should also be included in any enhanced protection of fisheries habitats in this area.

2. A FHA protecting important fisheries habitats on and adjacent to islands within the Wellesley Island Group is recommended. The Wellesley Island Group contains the most diverse range of fisheries habitats within the Gulf Study Area including mangrove and saltmarsh communities, intertidal flats, seagrass meadows, coral reefs and rocky foreshores.

3. Extension of the landward boundaries of the Morning Inlet/Bynoe River and Eight Mile Creek FHAs, to include a greater diversity of intertidal environments, is recommended.

4. Continuation of coastal wetlands mapping to complete the remainder of the Queensland coast is strongly recommended to:
    - provide baseline data for FHA declaration and Ramsar site nomination;
    - provide a basis for future monitoring of spatial and composition changes in tidal coastal wetland communities on a local, bioregional and State-wide basis;
    - as a resource for incorporation into studies of the relationships of specific marine fauna to particular coastal wetland habitats at various spatial scales.

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SECTION 1. INTRODUCTION

1.1 Project Scope

Marine, estuarine and freshwater systems in Queensland are managed under the provisions of the *Queensland Fisheries Act 1994* and Fisheries Regulation 1995. This legislation provides for the *'management, use, development and protection of fisheries resources and fish habitats'*. All marine plants throughout Queensland are specifically protected under this legislation. Key fisheries habitats are further protected through the declaration of Fish Habitat Areas (FHAs). FHAs are part of the on-going management of fisheries resources within Queensland and are specifically declared to ensure continuation of productive recreational, indigenous and commercial fisheries in a region through habitat protection. Declaration publicly proclaims the value of the area from a fisheries viewpoint, and increases the statutory level of protection of the wetlands for community benefits. Appendix 1 displays the current distribution of declared FHAs of both Management A and B status in Queensland. Appendix 2 gives further details on the FHA declaration process and management options.

Further protection of significant wetland areas is achieved through the declaration of Ramsar sites. Formal listing of Ramsar sites was the result of the Convention on Wetlands of International Importance. Coastal wetland resources are an important consideration in the nomination of these Ramsar sites. In order for a site to be eligible for nomination as a Ramsar site the following four clusters of criteria have been developed:

1. Criteria for representative or unique wetlands;
2. General criteria based on plants or animals;
3. Specific criteria based on waterfowl;
4. Specific criteria based on fish.

Further details of these criteria can be found in Appendix 3.

This report provides key resource data for the ongoing assessment of the requirement for additional Marine Protected Areas (FHAs) in regions of high fish habitat value from the Queensland/Northern Territory border to the western bank of the Flinders River (hereafter called the Gulf Study Area). Additionally, the study provides baseline information on the coastal wetlands within the Gulf Study Area for consideration in the Ramsar site nomination process. The project aimed to:

1. document and map the coastal wetland communities of the Gulf Study Area;
2. document levels of existing disturbance to and protection of the wetlands;
3. examine existing recreational, indigenous and commercial fisheries resources in the region;
4. evaluate the conservation values of the areas investigated from the viewpoint of fisheries productivity and as habitat for important and/or threatened species for future FHA/MPA declaration.

1.2 Current Progress of Queensland Coastal Wetlands Resource Mapping

To date, approximately 85% of Queensland's coastal wetland resources have been or are currently being mapped by the Queensland Fisheries Service, Department of Primary Industries (DPI) Queensland, as a baseline resource for FHA declaration and continued monitoring of these environments. The areas that have been completed or are currently being mapped are displayed in Figure 1. A summary of this work and the resulting MPA declarations are included in Appendix 4.

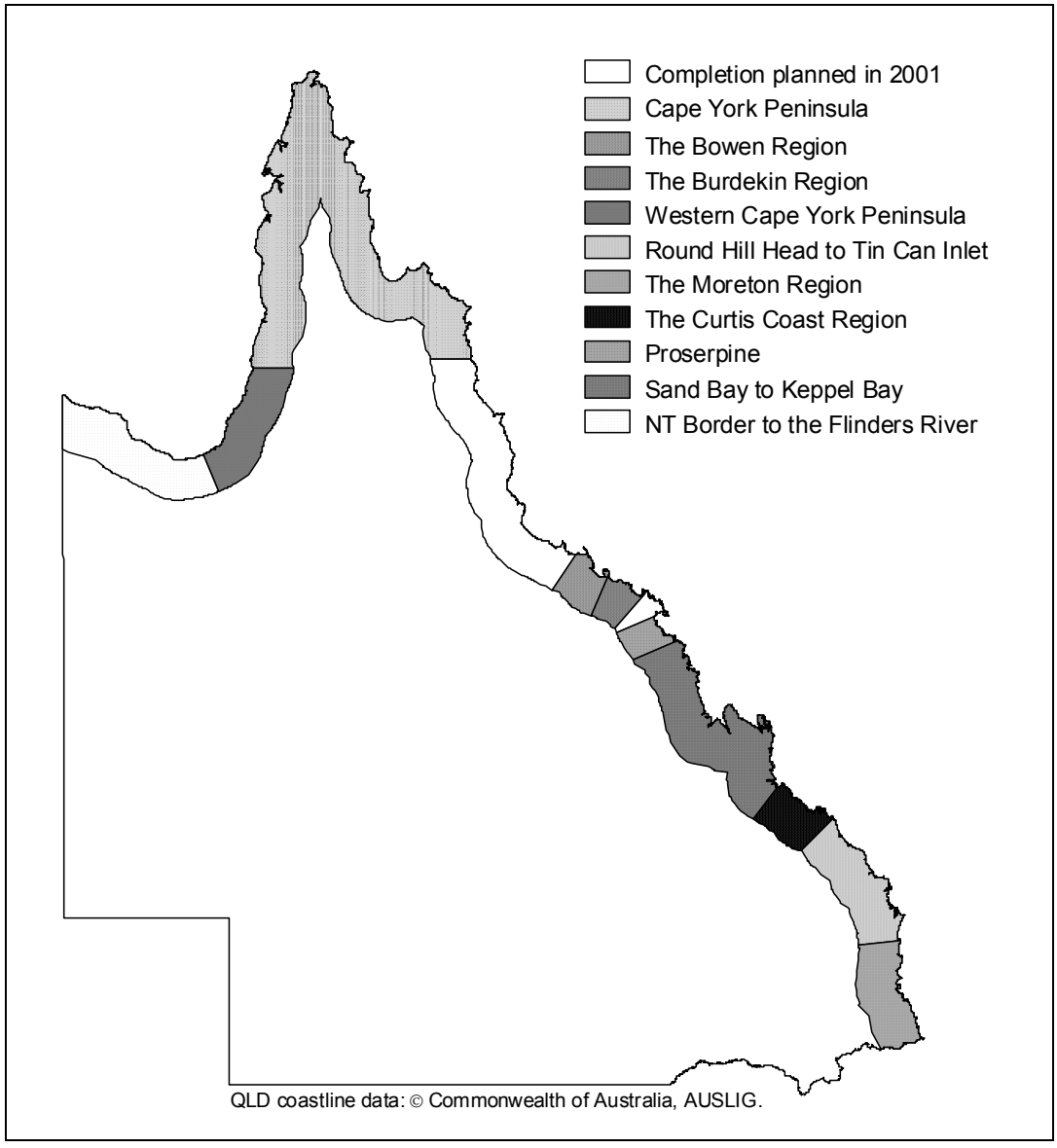

FIGURE 1 Queensland Coastal Wetlands Resource Mapping

SECTION 2. BACKGROUND

2.1 The Study Area

The Gulf Study Area lies within the Gulf of Carpentaria, northern Australia and stretches east from the Queensland/Northern Territory border to the western bank of the Flinders River (Figure 2.1). With approximately 350 km of north facing coastline, this area forms a bay containing the Wellesley Island group, the largest of which is Mornington Island.

Located in the monsoon tropics, the Gulf Study Area experiences heavy rainfall during the summer months and very minimal rainfall during the winter dry season. Burketown is the major population centre for the region (139.55°E, 17.74°S) with an average annual rainfall of 759 mm (Saenger and Hopkins 1975). A large majority of this rainfall is recorded between December and March. During the winter months, lack of rainfall, persistent dry continental winds and radiation exposure create a harsh dry environment. In the shallow inshore belt and the coastal plains, salinities are very high.

The monthly variations in maximum and minimum air temperatures, relative humidity and mean rainfall in Burketown are recorded in Table 2.1. Relative humidities refer to 0900 and 1500 hrs and rainfall refers to the period 1885–1973 (Saenger and Hopkins 1975). The IMCRA Technical Group (1998) reports that this area experiences 5–10 cyclones per decade.

TABLE 2.1 Monthly variations in air temperature, relative humidity and mean rainfall at Burketown.

MONTH	MEAN MIN TEMPERATURE (°C)	MEAN MAX TEMPERATURE (°C)	RELATIVE HUMIDITY	MEAN RAINFALL
JANUARY	25.0	34.9	69–51	215
FEBRUARY	24.5	34.1	74–54	189
MARCH	23.5	33.6	70–50	156
APRIL	21.0	33.4	56–40	23
MAY	16.8	30.9	47–35	6
JUNE	14.2	28.8	48–33	6
JULY	13.2	28.4	40–28	2
AUGUST	14.5	30.2	36–25	1
SEPTEMBER	17.5	32.6	40–30	2
OCTOBER	20.9	34.9	43–33	12
NOVEMBER	23.5	36.5	48–37	36
DECEMBER	24.6	36.5	57–45	111
TOTAL				759

(Source: Saenger and Hopkins 1975)

Tides in the Gulf Study Area vary according to lunar phase. Generally they are diurnal but become semi-diurnal for 1–3 days during the neap tides. The tidal range varies from 0.45 m during neap tides to 3.3 m during the spring tides (Saenger and Hopkins 1975).

During the winter months, wind direction in the Gulf Study Area is predominantly south to south-east, blowing in across the continent. The situation is reversed in the summer with winds predominantly coming from the north to north-east, across the Gulf waters. The nearly unidirectional northerly winds in the summer monsoon season are responsible for

large variations in mean sea level in the Gulf (Rhodes 1982). The variation in mean sea level from winter to summer can be as much as 1 m (Munro 1973; cited in Saenger and Hopkins 1975).

The majority of the Gulf Study Area, from approximately Moonlight Creek to Flinders River consists of a broad chenier plain. Widely separated coastal ridges oriented parallel or sub-parallel to the coast (cheniers) are distributed across a broad plain (Rhodes 1982). These plains are dissected by ephemeral drainage channels lined with narrow mangrove communities.

The coastal wetland communities within the Gulf Study Area are backed by broad grassy plains (Sinclair Knight and Merz 1999). These southern Gulf Plains are primarily utilised as cattle grazing country. During the wet season the plains are transformed into brackish wetlands which are continuous with the inundated Saltpans.

The study area lies within the Wellesley Bioregion as defined in the Interim Marine and Coastal Regionalisation for Australia (IMCRA Technical Group 1998) and is adjacent to the Gulf Plains Bioregion as defined in the Interim Biogeographic Regionalisation of Australia (Thackway and Cresswell 1995).

2.2 Coastal Wetland Environments

Mangrove, saltmarsh and seagrass communities are recognised for their value to fisheries production. These marine plants establish habitats that directly support local inshore and offshore fisheries through the provision of food, shelter, breeding and nursery areas. Previous DPI 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 stage of their life cycle (e.g. mud and blue swimmer crabs, prawns, barramundi, threadfins, whiting, flathead, bream and mullet). Mangrove and seagrass communities form only part of a range of coastal habitats (along with unvegetated to samphire-dominated Saltpans, Saline Grasslands, intertidal flats, rocky foreshores and coral reefs) that all provide a diversity of environments maintaining marine and estuarine ecosystems.

Fisheries Habitats Mapped in this Study

For the purposes of this study, environments located between the highest astronomical tide contour and the low water mark (ie. the intertidal communities) are described collectively as coastal wetlands. The coastal wetlands mapped in this study include mangrove and saltmarsh communities.

The absence of a universally accepted definition of a mangrove community leads to many different interpretations of areal extents of “mangroves”. Here, the term mangrove community refers to any community within the intertidal zone that is dominated by trees and shrubs. Saltmarshes are intertidal plant communities that are dominated by salt tolerant herbs and low shrubs, such as samphires and salt couches (Hopkins et al. 1998). Two subsets of this vegetation type are recognised in this study. Saltpans are those hypersaline areas that range from unvegetated claypans to areas dominated by samphire

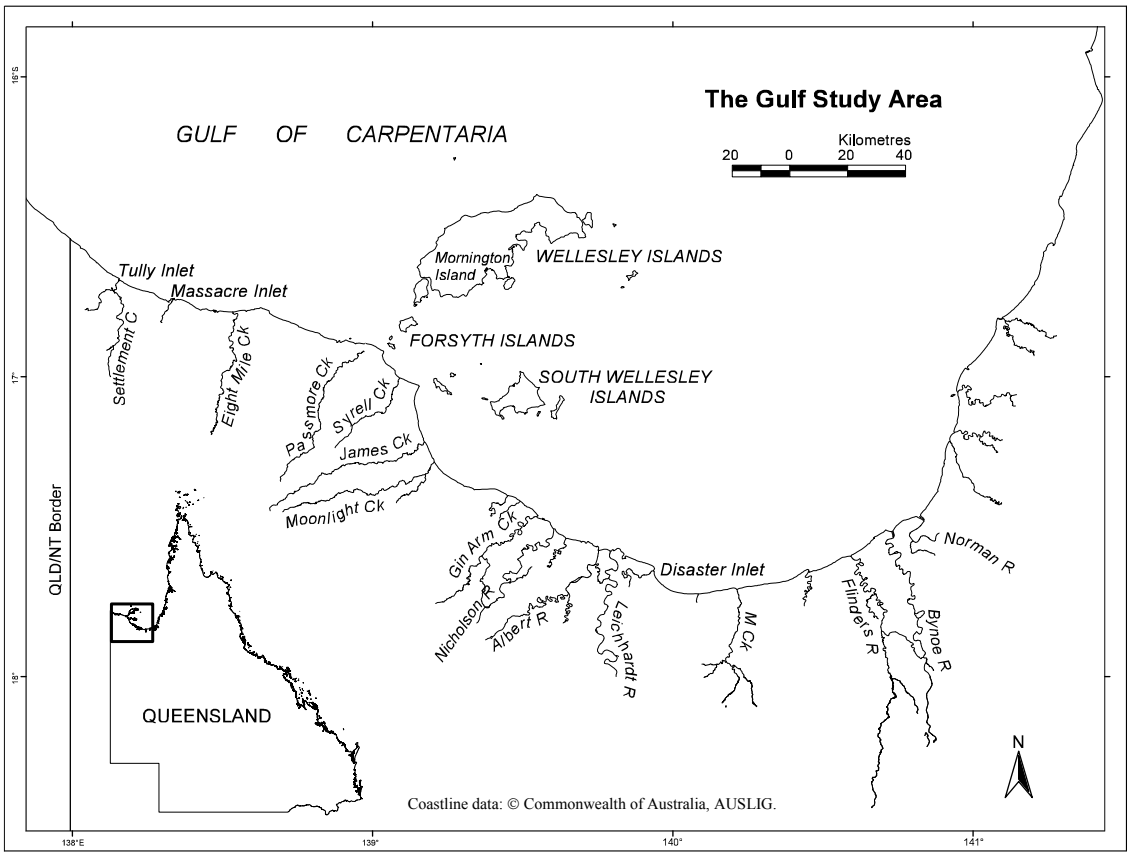

FIGURE 2.1 The Gulf Study Area: stretching from the Queensland/Northern Territory Border to the western bank of the Flinders River.

vegetation. Saline Grasslands are those areas that are dominated by *Sporobolus virginicus* (salt couch).

Mangroves

Mangroves are a diverse group of predominantly tropical shrubs and trees growing in the marine tidal zone (Duke 1992). These marine plants serve a wide variety of functions (Claridge and Burnett 1993; Ewel et al. 1998) including:

- physical protection of the coastal fringe from erosion and flooding;
- sediment trapping;
- primary production, nutrient uptake and transformation;
- provision of food, shelter, breeding and nursery areas for a wide variety of marine and terrestrial animal species.

At a regional scale, the distribution of mangrove species is determined by a number of factors including temperature, rainfall, catchment area and tides. It has been shown that mangrove species are limited in their latitudinal distribution by their physiological tolerance to low temperatures (Duke et al. 1998). The majority of mangrove species are limited to tropical environments where the mean winter temperatures are higher than 20^{o}C. Consequently, mangrove species diversity generally decreases with increasing latitude.

Additionally, areas of high freshwater availability (both as rainfall and runoff from riverine catchments) tend to support more species rich mangrove communities than areas of low freshwater availability. In Queensland this phenomenon can be clearly seen in the north of the state. The relatively dry coastline of the Gulf of Carpentaria supports less than twenty species of mangrove whereas more than thirty species have been recorded for areas of similar latitude on the wetter eastern coastline of Australia.

Mangrove species are also variable in their tolerance to the variety of environmental parameters experienced in the intertidal zone, including salinity, soil type, frequency of inundation (both tidal and fresh) and wave action. Accordingly, mangrove species distribution within an estuary can generally be related to the variation of these factors and typical mangrove zones often result. For example, Closed *Rhizophora* zones (or communities) within Queensland generally occur on the waters edge where they receive inundation with every high tide. In contrast, Open or Closed *Ceriops* communities, which occur towards the landward mangrove edge, are generally only inundated on the spring tides that occur only once or twice per month.

The primary production of mangroves varies between different communities. Factors affecting net primary productivity and forest growth include soil nutrient status and redox potential, salinity, temperature, light intensity, associated fauna and tidal flushing (Clough 1992; Amarasinghe and Balasubramaniam 1992). Economically important detrital marine food webs are supported by primary production from mangrove trees. Unfortunately, there is a lack of quantitative information regarding the direct benefits gained from the various mangrove forest community types.

Wells (1983) reports that thirteen mangrove species can be found in the Gulf Study Area. These are:

- *Acanthus ilicifolius* L. — Holly leaf mangrove
- *Aegialitis annulata* R. Br. — Club mangrove
- *Aegiceras corniculatum* (L.) Blanco — River mangrove
- *Avicennia marina* (Forsk) Vierh. — Grey mangrove
- *Bruguiera exaristata* Ding Hou — Rib-fruited orange mangrove
- *Bruguiera gymnorrhiza* L. Lam — Large-leafed orange mangrove
- *Ceriops tagal* C. T. White — Yellow mangrove
- *Excoecaria agallocha* L. — Milky mangrove
- *Lumnitzera littorea* (Jack) Voigt — Red-flowered black mangrove
- *Lumnitzera racemosa* Willd. — White-flowered black mangrove
- *Osbornia octodonta* F. Muell. — Myrtle mangrove
- *Rhizophora stylosa* Griff. — Red mangrove
- *Xylocarpus australasicus* (moluccensis) Koen — Cedar mangrove

Wells (1983) reports that *A. ilicifolius*, *B. gymnorrhiza* and *L. littorea* are uncommon in the Gulf of Carpentaria. Both *B. gymnorrhiza* and *L. littorea* have been reported from Tarrant Point (Saenger and Hopkins 1975) and *L. littorea* has been collected from Mornington Island (Woolston 1973). Otherwise these species are unknown in the Gulf Study Area.

In addition to these thirteen species, Claridge and Burnett (1993) report that the following four species are present in the Gulf Study Area:

- *Camptostemon schultzii* Masters — Kapok mangrove
- *Hibiscus tileaceus* L. — Native hibiscus
- *Pemphis acidula* Forst — Pemphis
- *Thespesia populnea* (L.) Solander — Portia, Indian Tulip

For the purposes of this study, *H. tileaceus* and *T. populnea* are considered to be "marginal mangrove species" as in some instances they are found growing in the marine tidal zone, whereas in other locations they may be found growing in terrestrial areas.

Saltmarshes

Saltmarshes are intertidal plant communities that are dominated by salt tolerant herbs and low shrubs, such as samphires and salt couches (Hopkins et al. 1998). In contrast to mangrove species, saltmarsh species diversity and community complexity in Queensland increases with increasing latitude (Zeller 1998).

Although saltmarsh environments are generally only inundated with the high tides they can play an important role as fisheries habitat. In these environments, interactions of the soil, water and air provide optimal environmental conditions, which under specific circumstances allow fisheries resources to feed, grow and reproduce to complete their lifestyle (Beumer et al. 1997). Specifically, shallow tidal pools within the saltmarshes provide transitory feeding habitat for larval and juvenile fishes, and may support a variety of invertebrates (Zeller 1998).

Even unvegetated claypans can be important for the life cycles of certain fishes (eg. barramundi). In the Gulf of Carpentaria extensive claypans are flooded during the monsoon season. Major spawning of barramundi occurs just before or early in the wet

season so that the juveniles can take maximum advantage of this temporary wetland habitat. The inundated claypans also allow extensive migrations of juvenile and spawning fish moving along and among stream channels, tidal pools and coastal waters.

Connolly (1999) recently studied the use by fish species of subtropical saltmarsh habitat. In this study it was confirmed that both vegetated and non-vegetated saltmarsh habitats are utilised by a surprisingly high number and diversity of both estuarine-resident and estuarine-marine fish species. More than half of the fish species caught on the saltmarsh habitat was of direct economic importance, and several of these species were common without dominating the catch numerically. The distribution of fish on saltmarshes was found to be most strongly influenced by proximity to intertidal, mangrove-lined feeder creeks, with more species and more individuals near to creeks than further away (Connolly 1999).

Other Fisheries Habitats not Mapped in this Study

Seagrasses

Seagrasses are productive flowering plants, which are able to complete their life cycle completely submerged beneath marine waters (Mateer 1998). In order to establish a healthy community, seagrasses require minimum exposure to air, shelter from high-energy waves, sufficient light penetration for photosynthesis and marine salinities. Consequently, coastal and substrate topography, water depth and turbidity, and freshwater run-off all influence seagrass distribution and abundance patterns.

Seagrass species occurring in the Gulf of Carpentaria (Poiner et al. 1987) include:

- *Cymodocea rotundata* Ehrenb. et Hempr. ex Aschers.
- *Cymodocea serrulata* (R. Br.) Aschers. and Magnus
- *Enhalus acoroides* (l.F.) Royle
- *Halodule uninervis* (broad) (Forsk.) Aschers. in Bolssier
- *Halodule uninervis* (thin); Halodule pinifolia (Miki) den Hartog
- *Halophila ovalis* (small) (R. Br.) Hook F.; *Halophila ovata* Gaud. In Freycin
- *Halophila ovalis* (large); Halophila decipiens Ostenfeld
- *Halophila spinulosa* (R. Br.) Aschers.
- *Syringodium isoetifolium* (Aschers.) Dandy
- *Thalassia hemprichii* (Enrenb.) Aschers.

Poiner et al. (1987) conducted an aerial survey of seagrasses in the Gulf of Carpentaria, identifying an estimated 906.4 km^2 of seagrass meadows along the 671 km of coastline. In the Gulf Study area, 108.4 km^2 of seagrass meadows were mapped around the Wellesley Island Group. An additional 56.4 km^2 of seagrass communities were located along the coastline stretching west from the Wellesley Island Group to the Sir Edward Pellew Group in the Northern Territory.

Coles and Lee Long (1985) report on the distribution of seagrasses around Mornington Island in March and September 1984. Coles et al. (unpublished) also conducted surveys of the distribution of seagrasses from Tarrant Point to Cape York in November 1986. The approximate distribution of seagrass communities in the Gulf of Carpentaria is also illustrated in Elliott (1993).

Natural seasonal and annual variability in the species composition, density and biomass of seagrass communities results from the different responses of seagrasses to environmental parameters such as temperature, water turbidity, sediment stability and nutrient levels (English et al. 1994). For this reason, distribution patterns from previous studies can only be considered as 'snapshots' of seagrass distribution in a window of time. However, as these regions have supported seagrass communities in the past, it is possible that they may do so in the future, providing the environmental conditions for colonisation and maintenance of the meadows remain favourable.

Intertidal Flats, Rocky Foreshores and Coral Reefs

Despite their often unrecognised role in primary production, 'non-vegetated' habitats such as intertidal flats, rocky foreshores and coral reefs are important fisheries habitats. Intertidal flats are defined as the zone exposed at low tide and submerged at high tide (Bird 1968), and may be non-vegetated sand or mud or colonised by seagrass or algal beds. Erftemeijer and Lewis (1999) recognised that intertidal mudflats constitute an important habitat that support a high biodiversity and biomass of benthic invertebrates, sustain productive fisheries and provide important feeding grounds for migratory shorebirds.

Rocky foreshores provide a hard substrate for the attachment of algal flora as well as the long-term attachment of immobile invertebrates (such as barnacles, oysters and tube worms) (Zeller 1998). Both macro and micro algae, particularly benthic microalgae, play a key role in primary production and may in total contribute more than half of the total net production (Alongi 1998).

Coral reefs, both natural and artificial, provide shelter and food for reef and pelagic animals that colonise or are attracted to them (eg. sponges, coral and fish).

Details of the distribution of intertidal flats and sandy and muddy shores within the Gulf of Carpentaria are given by Sinclair Knight Merz (1999). Elliot (1993) also describes the location of various substrates and the benthic fauna they support within the Gulf of Carpentaria.

Rocky shores within the Gulf of Carpentaria are relatively rare. Areas of rocky shores are limited within the Study Area to the eroding shoreline to the west of the Wellesley Islands and rocky headlands on the Wellesely Islands themselves (Sinclair Knight and Merz 1999).

2.3 Project Rationale

There is a need to identify and map fisheries habitat for the management and conservation of fisheries resources through the declaration of MPAs (FHAs) and Ramsar sites, as well as a requirement for conducting further research into the interactions between fauna and the habitat. Studies combining data on habitat primary productivity, fish species associated with these habitats and feeding strategies of fish species will contribute to a better understanding of the relationships of particular habitats to fisheries productivity. Continuation of the mapping of the coastal wetlands of the Queensland coastline will provide quantitative data at various spatial scales for incorporation into these studies. Additionally, it will provide the base information required for monitoring short and long term changes in coastal wetland habitats and planning appropriate management measures.

SECTION 3. METHODS

3.1 Data

Maps of coastal wetland communities were produced from Landsat 5 Thematic Mapper (TM) satellite imagery. Two scenes, Mornington Island (13 August 1995) and Burketown (18 May 1995) were required to map the two regions from the Queensland/Northern Territory Border to Tarrant Point, including the Wellesley Islands, and from Tarrant Point to Flinders River, respectively. The imagery used in this study was obtained with final radiometric correction and geometric rectification using ground control points already complete. The scenes were rectified to the Australian Map Grid (Zone 54) using the Australian National Spheroid and the Australian Geodetic Datum 1984.

The spatial resolution of Landsat TM data is 25 m x 25 m. The spectral characteristics of the data as well as details of the Landsat satellites are outlined in Appendix 6.

Aerial photography was used to aid in the classification of the coastal wetland vegetation. The photography used in this study was 1: 50 000 Crab Island to NT Border Beach Protection Authority photography acquired in December 1988. More recent aerial photography was not available for use in this study. The available aerial photography did not provide a complete coverage of the coastal wetlands in the study area. Areas not included within the aerial photography coverage are illustrated in Figure 3.1.

3.2 Mapping Methods

The satellite imagery was processed using ERDAS Imagine® 8.3.1 on a PC with a Microsoft® Windows NT4 operating system. Six TM bands (excluding Band 6 — the thermal band) were contrast stretched using a linear stretch and breakpoints to highlight the intertidal regions. All water bodies were spectrally masked out using a TM band 4 (near infrared) image. In order to limit the area of the classification to the coastal wetland environments, the terrestrial land features were masked out manually. The upper limit of the intertidal zone was identified using a false colour composite of TM bands 1, 4 and 5 (through blue, green and red colour guns, respectively) in conjunction with colour aerial photography, topographic maps and fieldwork. The use of brightness and wetness bands of a tasselled cap analysis also assisted in defining the tidal boundary.

The remaining imagery, which included the intertidal zone and a small strip of adjacent coastal land, was processed using an unsupervised classification procedure. ERDAS Imagine® uses the Iterative Self-Organising Data Analysis Technique (ISODATA) classification algorithm in order to create clusters of pixels that are spectrally similar. The ISODATA utility repeats the clustering of the image until either a maximum number of iterations has been performed, or a maximum percentage of unchanged pixels (convergence threshold) has been reached between two iterations (ERDAS 1997). A limit of thirty iterations or a convergence threshold of 99% was set in this classification. The resulting classes were labelled according to their dominant cover type with the aid of the aerial photography. Clumps of pixels less than 0.5 ha were eliminated and the image was smoothed using a three by three pixel, moving kernel.

The classification was converted from raster to vector format using ARC/INFO® GIS software. To improve cartographic presentation of the data, the jagged vector boundaries were splined and generalised and polygons with areas under 0.5 ha were excluded. Appendix 7 contains the metadata for the resultant coverage. The coastal wetlands coverage was overlaid on a Band 3 (visible red) Landsat TM image for presentation. Maps were produced using ARCVIEW® GIS Version 3.1 software at a scale of 1: 100 000 (Appendix 8: Sheets 1–22).

3.3 Field Methods

The computer-based coastal wetland community classification was validated with fieldwork conducted during June 2000. The distribution of 99 sites, which were accessed by helicopter or boat, is illustrated in Figure 3.1. At each site, information on mangrove community floristics and structure was documented. The data recorded included the specific composition of mangroves, dominant genus, estimated density (Projective Foliage Cover – PFC) 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.

A Garmin 4S XL Personal Navigator Global Positioning System (GPS) was used to determine the latitude and longitude of each field site. The estimated errors recorded by the GPS were generally between 10 m and 20 m (less than 1 pixel) with a maximum error of 47 m.

The time available, budget requirements and accessibility to the mangroves limited the amount of fieldwork able to be done. The information collected from the fieldwork was used to aid in the classification of the satellite image and the interpretation of the aerial photography. As the field sites were used to derive the final coastal wetland classification they were not used to assess its accuracy. Rather a set of random points was generated in order to assess the accuracy of the classification (Section 3.5).

3.4 Classification Details

Mangroves were classified to the community level on the basis of dominant genus present and relative densities of the whole community. The density of the community was determined by estimating the PFC. A canopy cover of greater than 50% was classified as closed, while less than 50% was identified as open.

The standard Specht (1987) vegetation categories of ‘forest’ and ‘shrub’, which are based on height, were not included in this classification. This is due to the fact that vegetation height cannot be determined from the Landsat TM data.

Only areas subject to tidal inundation were included in this mapping exercise. Excluded classes included permanent pools of water and elevated land containing terrestrial vegetation. Tidally exposed non-vegetated intertidal flats along with seagrass or algal beds were also excluded.

3.5 Accuracy Assessment

A set of 248 random points was generated using ERDAS Imagine® for accuracy assessment. The community present at each of these points was determined from the aerial photography and this was compared to the class assigned on the computer-classified maps. An error matrix using this data was generated and the overall accuracy along with user's accuracy and producer's accuracy was calculated.

The overall classification accuracy is a measure of the number of correct pixels in the error matrix. User's accuracy is the probability that a pixel classified on the map actually represents that category on the ground and producer's accuracy calculates the probability of a reference pixel being correctly classified (how well a certain area can be classified) (Jensen 1996). An overall evaluation of the project is included in Appendix 9.

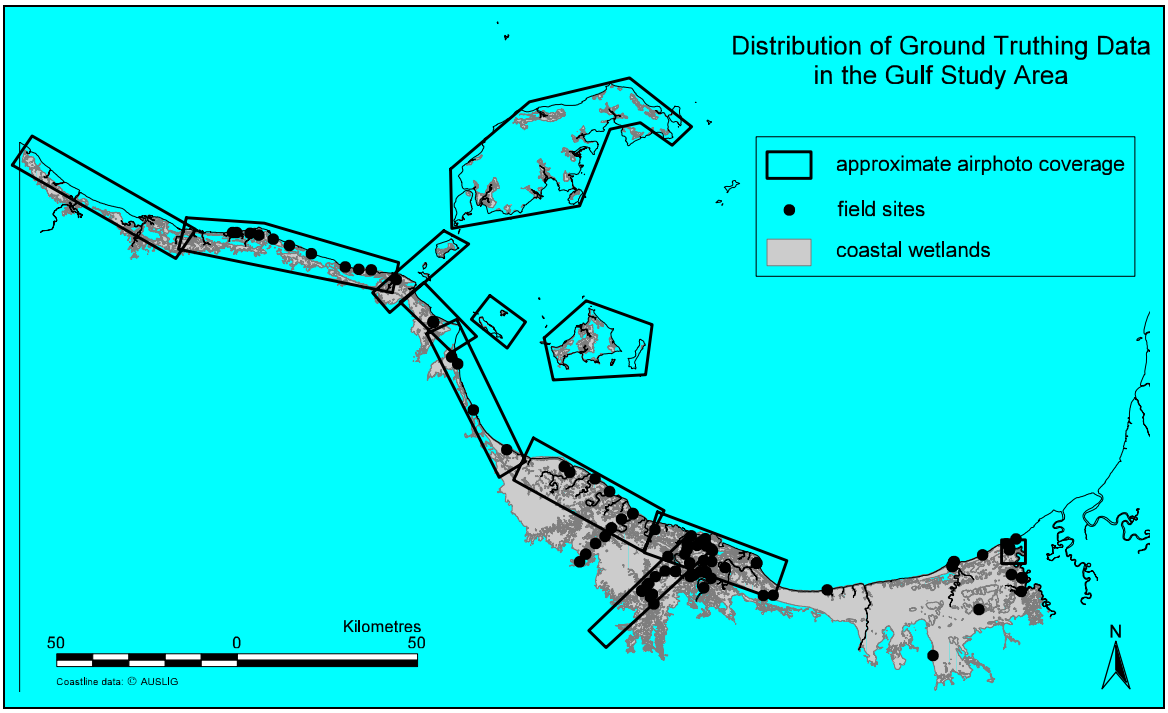

FIGURE 3.1 Distribution of ground truthing data utilised in this study.

3.6 Land Tenure Maps

The coastal wetland community coverage created in this study, along with the foreshore flats theme from the the digital GEODATA TOPO-250K topographic map series (AUSLIG 1994), was overlaid on the Digital Cadastral Database (DCDB Feb 2000) to produce a 1: 250 000 map of tenure within the study region (Appendix 10: Sheets 1–6).

The AUSLIG GEODATA product is primarily sourced from the 1: 250 000 scale National Topographic Map Series, which was completed in 1988. Foreshore flats from the Burketown, Mornington, Cape van Diemen and Westmoreland 1: 250 000 map sheets were extracted for the Gulf Study Area. Foreshore flats are defined as part of the seabed

between mean high water and the line of low water (AUSLIG 1994). Areas of intertidal flats have not been calculated from this data as this coverage is current only to 1988 and intertidal flats can be variable in distribution over time. The coverages are included to provide an overview of intertidal flats in the study area and should not be considered as an accurate present day distribution.

3.7 Assessment of Coastal Wetlands for Fish Habitat Area Nomination

The suitability of various coastal wetland systems for nomination as candidate areas for FHA declaration is currently assessed on the basis of the following criteria:

1. Size
2. Diversity of or specific habitat features
3. Diversity of or specific marine fauna and flora
4. Level of existing and future disturbances
5. Unique features
6. Existing or potential fishing grounds
7. Protected species

The details of the methods of assessment of these criteria are included in Table 3.1. The results of the assessment are summarised in Table 9.1 and are discussed further in Section 5.

TABLE 3.1 Details of the methods of the coastal wetland significance assessment.

CRITERIA	SUBCATEGORIES	DETAILS
Size		Area of mangrove and saltmarsh communities as mapped in this study, calculated in hectares.
Diversity of or specific habitat features	Diversity of Mangrove and Saltmarsh Communities	**High (H)**: 11–14 mangrove and saltmarsh communities present
		Medium (M): 5–11 mangrove and saltmarsh communities present
		Low (L): 1–4 mangrove and saltmarsh communities present
		The number of mangrove and saltmarsh communities was calculated on the basis of the coastal wetland mapping conducted for this investigation. See Section 4.1 for the descriptions of these mapping units.
	Presence of Intertidal Flats	Comments on the extent of intertidal flats along the coastline were based on aerial photograph interpretation and the foreshore flats coverage of the digital GEODATA TOPO-250K topographic map series (AUSLIG 1994).
	Presence of Seagrass Communities	**Area where seagrass communities have been identified within the Gulf Study Area (✔).** The distribution of seagrass communities within the reporting areas was determined from information gathered from literature review (Elliott 1993; Coles and Lee Long 1985; Coles et al. unpublished; Poiner et al. 1987). Seagrasses may inhabit other regions within the Area however these regions have not been surveyed in the literature reviewed.
Diversity of or specific marine fauna and flora		Comprehensive surveys of species diversity for each wetland system were not conducted as part of this investigation. Specific, noteworthy marine flora communities have been described in Section 5 and are recorded as unique features (see below). Information concerning the diversity of fauna was not included in this evaluation.
Level of existing and future disturbances	Significant Dams and Weirs	**Presence (✔)** or **absence (✘)** of significant dams or weirs on the river or creek. The locations of dams and weirs in Queensland collected by the Dept. of Natural Resources.
	Disturbance to Adjacent Terrestrial Vegetation	**Near Pristine (NP)** : natural cover >90%
		Largely Unmodified (LU) : natural cover ~65–90%
		Modified (M) : natural cover ~35–65%
		Severely Impacted (SI) : natural cover <35%
		Adjacent terrestrial vegetation refers to the vegetation within 5km of the upper intertidal limit.
Unique Features		**Presence (✔)** of unique features. The details of these features are included in Section 5.
Existing or potential fishing grounds	Significant/Important Fishing Grounds	**Significant (✔)** fishing grounds. Assessed from local knowledge of each coastal wetland system and/or from literature review.
Protected species	Not included in this evaluation.	All marine plants are protected under fisheries legislation. Other information on protected species was not collected as part of this study.

Note: Symbols presented here (e.g. ✔) refer to symbols used to summarise the results of the coastal wetland assessment in Table 9.1.

SECTION 4. RESULTS

4.1 Description of the Mapping Units

CLOSED *RHIZOPHORA*	FIGURE 4.1
HABITAT	Not common within the study area. Generally occurring in foreshore regions surrounded by communities of Closed *Avicennia*.
CANOPY	Usually dominated by tall, mature *R. stylosa* which forms a dense canopy (approximately 5–10 m) with a Projective Foliage Cover (PFC) greater than 50%. Other species that may occur in this community are *A. marina* and *C. tagal*.
SHRUB LAYER	Poorly developed or completely absent.
GROUND COVER	*R. stylosa* stilt roots with a sparse cover of *R. stylosa* seedlings.

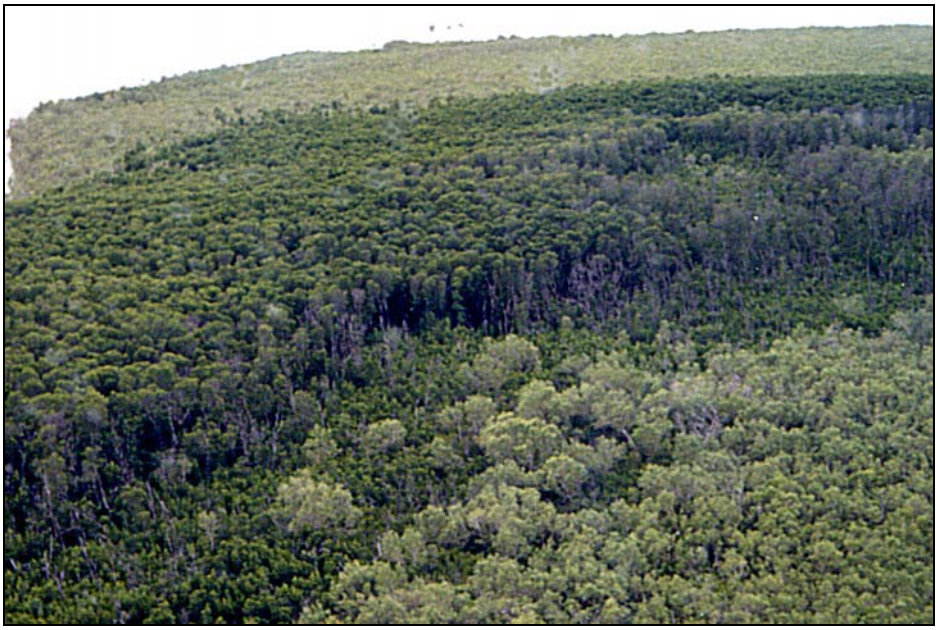

FIGURE 4.1 Closed *Rhizophora* (tall darker canopy) surrounded by Closed *Avicennia* (lighter canopy) at the mouth of an unnamed creek north of Gin Arm Creek.

CLOSED *AVICENNIA*	FIGURE 4.2 AND 4.3
HABITAT	Can be found in a diverse range of intertidal environments from the seaward edge (as a pioneer), to accreting banks (as a fringe), to the landward edge.
CANOPY	*A. marina* forming a dense canopy with a PFC of greater than 50%. Occasional *C. tagal, E. agallocha, L. racemosa* and *A. corniculatum.* Heights often around 2–5 m although lower communities of <1 m are also common.
SHRUB LAYER	Generally absent
GROUND COVER	Often a dense groundcover of samphires and a sparse coverage of *A. marina* pneumatophores and seedlings.

FIGURE 4.2 Closed *Avicennia* at the mouth of an unnamed creek north of Gin Arm Creek.

FIGURE 4.3 Closed *Avicennia* on the border of a Saltpan at Syrell Creek.

OPEN *AVICENNIA*	FIGURE 4.4 AND 5.2
HABITAT	Found on the seaward edge as a pioneer or on boundaries of Saltpan.
CANOPY	*A. marina* plants form a canopy that has a PFC of less than 50%. Height varies, generally <1 m in areas bordering on Saltpans and up to 5 m in pioneering zones.
SHRUB LAYER	Generally absent
GROUND COVER	Often a dense groundcover of samphires and a sparse coverage of *A. marina* pneumatophores and seedlings.

FIGURE 4.4 A typical Open *Avicennia* community in the foreshore environment of much of the Gulf Study Area. Live and dead *A. marina* plants are accompanied by a samphire groundcover.

CLOSED *CERIOPS*	FIGURE 4.5
HABITAT	Generally occurs landward of *R. stylosa* and *A. marina* communities and in upstream locations of creeks and rivers.
CANOPY	Dominated by *C. tagal* with occasional *A. marina*, *E. agallocha* and *L. racemosa*. Height of the canopy across sites varies (from approximately 1–4 m) however at an individual site is generally remarkably uniform. PFC greater than 50%.
SHRUB LAYER	Generally absent
GROUND COVER	Consists of sparse cover of seedlings and roots of the species present.

FIGURE 4.5 Closed *Ceriops* at Leichhardt River.

CLOSED MIXED	**FIGURE 4.6**
HABITAT	Generally found along the abundant small watercourses flowing through the extensive Saltpans and in the upper tidal reaches of creeks and rivers.
CANOPY	A closed mix of species in which a variety of the 17 species present in this region may occur, commonly *A. marina, A. corniculatum*, *E. agallocha, C. tagal,* and *L. racemosa*.
SHRUB LAYER	A shrub layer consisting of juveniles of the various canopy species may be present.
GROUND COVER	Seedlings and roots of the various species, along with samphires and salt couch.

FIGURE 4.6 A typical Closed Mixed community in the Gulf Study Area consisting of a narrow community of mangrove adjacent to Saline Grassland and Saltpan.

SALINE GRASSLAND	FIGURE 4.7
HABITAT	Occurs along the landward edge of the intertidal zone in a hypersaline environment that is only inundated by the highest spring tides. Often interspersed with terrestrial grasses and patches of Saltpan.
CANOPY	Generally absent
SHRUB LAYER	Absent
GROUND COVER	Ranging from sparse to dense coverage of salt couch (*Sporobolus virginicus*) within which a sparse coverage of samphires and sedges may also occur.

FIGURE 4.7 A Saline Grassland community adjacent to a Closed Mixed community located on Leichhardt River.

SALTPAN	FIGURE 4.8
HABITAT	Occupies extensive low coastal plains, a hypersaline environment that experiences tidal inundation on the high spring tides. Commonly inundated by brackish water during the wet season.
CANOPY	Sparse stunted (0.2–0.8 m) plants of *A. marina*, *C. tagal* and *A. annulata* may occur.
SHRUB LAYER	Absent
GROUND COVER	Ranging from no vegetation to closed samphires.

FIGURE 4.8 A typical Saltpan community in the Gulf Study Area ranges from being virtually unvegetated to having a dense coverage of samphire vegetation.

4.2 Accuracy Assessment

The overall accuracy of the coastal wetland coverage was calculated to be 89.92%. User's and producer's accuracy for each community type are included in Table 4.1, below.

TABLE 4.1 Accuracy assessment table for the Gulf Study Area coastal wetland coverage.

CLASS NAME	REFERENCE TOTALS	CLASSIFIED TOTALS	NUMBER CORRECT	PRODUCER'S ACCURACY (%)	USER'S ACCURACY (%)
CLOSED *RHIZOPHORA*	7	7	6	85.71	85.71
CLOSED *AVICENNIA*	15	16	14	93.33	87.50
OPEN *AVICENNIA*	11	7	7	63.64	100.00
CLOSED *CERIOPS*	7	7	6	85.71	85.71
CLOSED MIXED	28	24	22	78.57	91.67
SALINE GRASSLAND	8	11	8	100.00	72.73
SALTPAN	161	167	160	99.38	95.81
TERRESTRIAL	11	9	0		
TOTAL	248	248	223		

4.3 Limitations of the Mapping Technique

Rainfall in this region is highly seasonal with flooding occurring annually in the summer months. The mixing of large amounts of freshwater and saline spring tides create an environment inundated by brackish water during the wet season, which extends inland beyond the tidal limit. Areas which may be inundated with brackish to fresh water in the wet season are then totally dry during the winter months. For this reason, the upper intertidal limit in this region is often difficult to distinguish. Small patches of coastal wetland vegetation extend onto terrestrial environments creating mosaics of Saline

Grassland, Saltpan, and terrestrial communities. Although coastal wetland vegetation does grow within these areas it is isolated from tidal influence during the majority of the year and as such has not been included in this mapping exercise. These areas, which are subject to inundation in the wet season, may be important seasonal habitat from a fisheries perspective for species such as barramundi.

Figure 5.4 illustrates a profile of narrow coastal wetland communities typically found fringing waterways and drainage lines through extensive, virtually unvegetated Saltpans. Although zonation occurs within these communities the individual classes are below the minimum mapping unit used in this study. These areas have been classified as Closed Mixed. Yet it should be noted that this community type can consist of separate communities of monospecific mangrove stands, as well as Saline Grassland and some Saltpan.

Even with the clustering of coastal wetland communities into one Closed Mixed community, narrow seaward fringes and small mangrove communities along drainage lines may still not be identified. The resolution of Landsat TM data and the scale of mapping used in this project prevent the inclusion of these communities. The pixel size of the imagery limits mapping units to 25 m x 25 m, therefore small or linear communities are unable to be recorded.

A small area of coastline extending 2.5 km to the east of the Queensland/Northern Territory border was not included in this mapping exercise. The western boundary of the coverage represents the limit of the Landsat TM imagery used in this study.

SECTION 5. DISTRIBUTION AND SIGNIFICANCE OF THE COASTAL WETLANDS

5.1 General Distribution

The dominant coastal wetland community type within the Gulf Study Area is Saltpan. A combination of low relief and a seasonally dry climate create a hypersaline environment where very little vegetation is able to survive. Additionally, the low tidal range restricts the diversity of mangrove communities and zones encountered. Mangrove communities within the Gulf Study Area are confined to foreshore environments and drainage channels through the extensive Saltpans. Closed *Avicennia,* and to a lesser extent Open *Avicennia,* dominate the foreshore environment, whereas narrow Closed Mixed communities are the dominant mangrove communities further landward.

TABLE 5.1 Areas of coastal wetland communities of the Gulf Study Area.

COMMUNITY	AREA (ha)	% OF TOTAL
Closed *Rhizophora*	1388	0.19
Closed *Avicennia*	11895	1.60
Open *Avicennia*	2462	0.33
Closed *Ceriops*	2566	0.34
Closed Mixed	10376	1.39
Saline Grassland	2141	0.29
Saltpan	713991	95.86
TOTAL	744819	100.00
TOTAL MANGROVE	28687	3.85

Closed and Open *Avicennia* communities form a virtually continuous stretch of coastal wetland vegetation along the foreshore from Moonlight Creek to Albert River and from Disaster Inlet to the mouth of the Flinders River. A typical profile of the coastal wetland communities encountered in this foreshore environment is displayed in Figure 5.1. *A. marina* forms open pioneering communities on the foreshore, succeeded by Closed *Avicennia* further landward. As *A. marina* becomes less dense the open community is dominated by a dense samphire groundcover. Dead *A. marina* trunks are scattered throughout this Open *Avicennia* community (Figure 5.2).

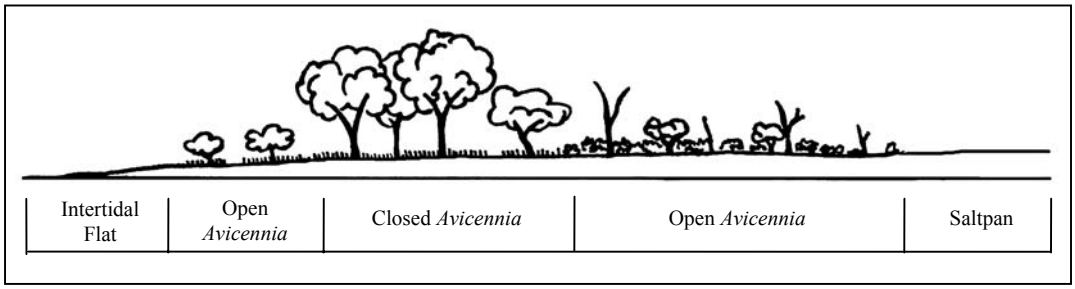

FIGURE 5.1 Profile of coastal wetland communities inhabiting a large proportion of the seaward margin of the Gulf Study Area. Not to scale.

FIGURE 5.2 Open and Closed *Avicennia* communities encountered in the foreshore environment of much of the Gulf Study Area (photo taken facing seaward).

Narrow, fringing Closed Mixed communities form a large proportion of the vegetated coastal wetland communities within the Gulf Study Area (~36%). These communities follow drainage lines through the vast expanses of virtually unvegetated Saltpans (Figure 5.3). Figure 5.4 depicts a typical mangrove profile of the narrow fringing communities in this region. Although zonation is evident in these communities, the area of each zone is below the minimum mapping unit used in this project. Typically, *C. tagal* is found on the erosion banks, whereas *A. marina* and *A. corniculatum* dominate the accretion banks. Further landward the coastal wetland vegetation becomes more mixed in species composition including *A. annulata, A. corniculatum, A. marina, C. tagal, E. agallocha, L. racemosa, X. moluccensis*, and sparse *R. stylosa*. A narrow Saline Grassland community often lies between the Closed Mixed environment and extensive Saltpans behind.

FIGURE 5.3 Closed Mixed communities following drainage lines through the Saltpans.

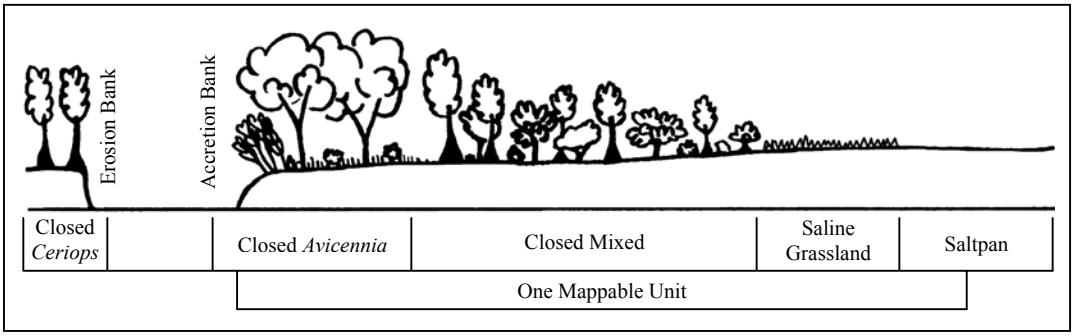

FIGURE 5.4 Profile of typical narrow fringing Closed Mixed community within the Gulf Study Area.

The coastal wetland communities in the Gulf Study Area are virtually continuous in extent from the Queensland/Northern Territory border to Flinders River and beyond. Sub-basin catchments as defined by the Department of Natural Resources were therefore used as reporting units. The sub-basin catchments within the Gulf Study Area are displayed in Figure 5.5. The major creeks and rivers in each of these catchments, along with their hydrology and catchment characteristics, are included in Table 5.2.

Maps of the coastal wetland communities within the Gulf Study Area are included in Appendix 8: Sheets 1–22. The distribution of coastal wetlands in relation to land tenure is displayed in Appendix 10: Sheets 1–6. Intertidal flats are also displayed on these maps.

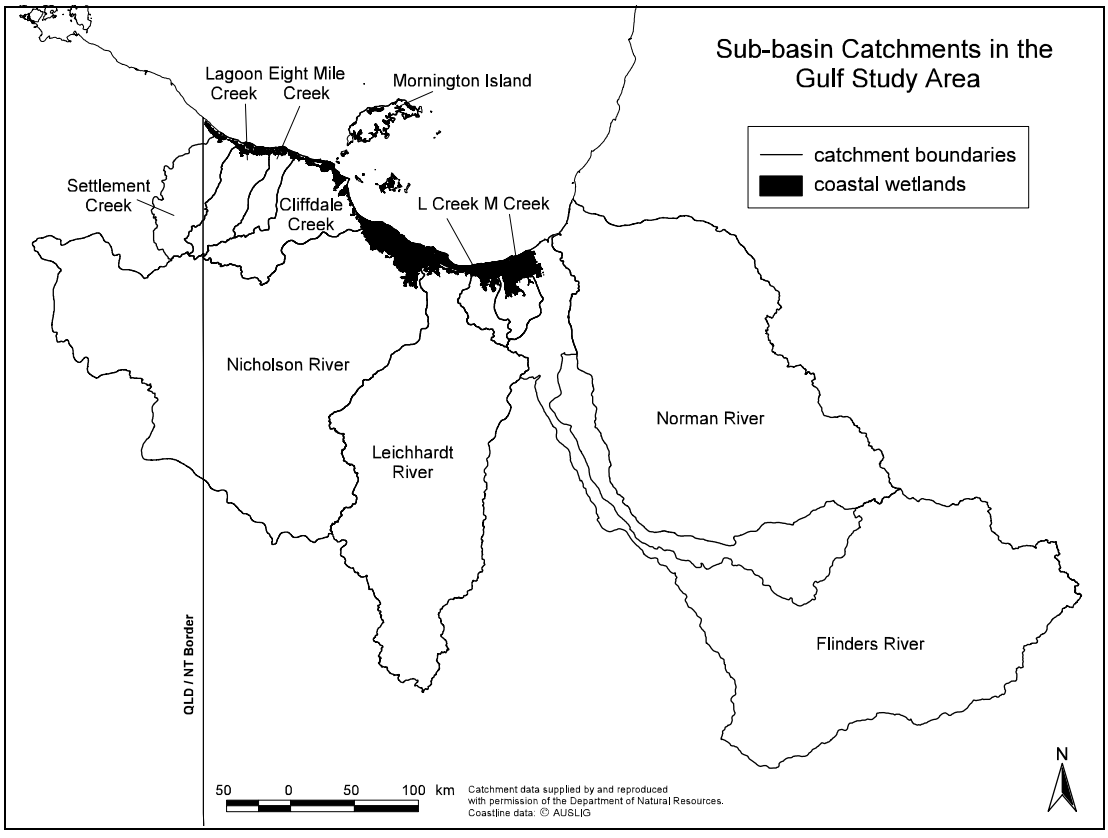

FIGURE 5.5 Sub-basin catchments in the Gulf Study Area.

TABLE 5.2 Hydrology and catchment characteristics of major estuaries within the Gulf Study Area.

ESTUARY NAME	MEAN ANNUAL RAINFALL (mm)	RUNOFF COEFFICIENT	EXTREME TIDAL RANGE (m)	CATCHMENT AREA (km^2)	SUB-BASIN CATCHMENT
Gum Creek	761	0.07	7	357	NT Border
Tully Inlet	761	0.07	7	4362	Settlement River
Massacre Inlet	761	0.07	7	647	Lagoon Creek
Lagoon Creek	761	0.07	7	57	Lagoon Creek
Eight-Mile Creek	761	0.07	7	1334	Eight Mile Creek
Cliffdale Creek	761	0.07	7	2869	Cliffdale Creek
Passmore Creek	761	0.07	7	902	Cliffdale Creek
Syrell Creek	761	0.07	7	344	Cliffdale Creek
Moonlight Creek	761	0.07	7	1066	Cliffdale Creek
Marless Creek	761	0.07	7	412	Cliffdale Creek
John's Creek	761	0.07	5.8	113	Nicholson River
Channon Creek	761	0.07	5.8	50	Nicholson River
Gin Arm Creek	761	0.05	5.8	2340	Nicholson River
Pascoe Inlet	761	0.05	5.8	2795	Nicholson River
Williams Inlet	761	0.05	5.8	284	Nicholson River
Albert River	761	0.05	5.8	2094	Nicholson River
Leichhardt River	761	0.03	5.8	3256	Leichhardt River
Disaster Inlet	761	0.03	5.8	602	Leichhardt River
Morning Inlet	934	0.03	5.8	1617	M Creek
Spring Creek	934	0.03	4.7	1690	L Creek
Flinders/Bynoe	934	0.02	4.7	1094	Flinders River
Beeber Creek	1169	0.14	7	24	Mornington Island
Sandalwood River	1169	0.14	7	102	Mornington Island
Kungunmeah	1169	0.14	7	63	Mornington Island
Toongoowahgun	1169	0.14	7	153	Mornington Island
Boyorunga Inlet	1169	0.14	7	158	Mornington Island
Walbor Creek	1169	0.14	7	57	Mornington Island
Towbulbulan River	1169	0.14	7	29	Mornington Island
Ngulwonmeah	1169	0.14	7	64	Mornington Island
Horse Place Creek	1169	0.14	7	21	Mornington Island
Elizabeth River	1169	0.14	7	62	Mornington Island
Dalmumeah Creek	1169	0.14	7	26	Mornington Island
McKenzie Creek	1169	0.14	6.7	38	Bentinck Island

Source: Digby et al. 1997

5.2 NT Border to Cliffdale Creek Catchment

The coastline between the Queensland/Northern Territory Border and the southern boundary of Cliffdale Creek Catchment stretches for approximately 192 km. In this area, mangrove vegetation is restricted to occasional strips behind sand ridges and at the mouths of creeks where drainage channels provide sufficient freshwater input for survival. In particular, notable coastal wetland communities can be found at Tully Inlet, Massacre Inlet, Passmore Creek and Syrell Creek. Closed *Avicennia* and Closed Mixed communities constitute the majority of these vegetated coastal wetland habitats. However, Saltpans are by far the most dominant community extending almost continuously along this section of the coastline, sub-parallel to the coastline behind the sand dune vegetation.

Within this region there are four small sub-basin catchments of which the largest is Cliffdale Creek. The coastal wetland communities between the northern boundary of Settlement River Catchment and the Queensland/Northern Territory Border have been grouped and reported on as NT Border coastal wetlands.

Intertidal flats are relatively narrow in this section of coastline. The largest intertidal flats stretch between the mouth of Massacre Inlet and the mouth of Eight Mile Creek. This habitat is currently protected in the Eight Mile Creek FHA.

TABLE 5.3 Areas of coastal wetland communities from the NT Border to Lagoon Creek Catchment.

	NT Border		Settlement Creek		Lagoon Creek	
COMMUNITY	**AREA** (ha)	**% OF TOTAL**	**AREA** (ha)	**% OF TOTAL**	**AREA** (ha)	**% OF TOTAL**
Closed *Rhizophora*	0.00	0.00	0.00	0.00	1.43	0.01
Closed *Avicennia*	30.41	0.64	105.51	1.29	358.32	3.04
Open *Avicennia*	2.03	0.04	1.28	0.02	26.05	0.22
Closed *Ceriops*	2.97	0.06	0.00	0.00	0.00	0.00
Closed Mixed	24.25	0.51	76.58	0.94	197.46	1.67
Saline Grassland	9.52	0.20	43.96	0.54	21.73	0.18
Saltpan	4681.90	98.54	7954.16	97.22	11194.61	94.87
TOTAL	4751.08	100.00	8181.49	100.00	11799.60	100.00

TABLE 5.4 Areas of coastal wetland communities of Eight Mile and Cliffdale Creek Catchments.

	Eight Mile Creek		Cliffdale Creek	
COMMUNITY	**AREA** (ha)	**% OF TOTAL**	**AREA** (ha)	**% OF TOTAL**
Closed *Rhizophora*	0.00	0.00	11.70	0.02
Closed *Avicennia*	66.97	0.54	2331.39	3.26
Open *Avicennia*	16.11	0.13	224.91	0.31
Closed *Ceriops*	0.00	0.00	0.00	0.00
Closed Mixed	2.99	0.02	403.08	0.56
Saline Grassland	0.00	0.00	51.38	0.07
Saltpan	12331.54	99.31	68454.71	95.77
TOTAL	12417.61	100.00	71477.18	100.00

5.3 Nicholson and Leichhardt River Complex

The 97 km stretch of coastline of the Nicholson and Leichhardt River Catchments is dominated by muddy shores which are colonised by a continuous band of Closed and Open *Avicennia* reaching up to 1 km wide in some locations. These two large catchments support the largest area of coastal wetlands within the Gulf Study Area.

The Nicholson and Leichhardt River Complex is characterised by an intricate system of drainage channels lined with narrow mangrove communities running through extensive Saltpans. The largest stands of vegetated coastal wetlands are located at the mouths of the major creeks and rivers. In particular, relatively large stands of Closed *Avicennia*, Closed *Rhizophora* and Closed *Ceriops* are found at the mouths of Gin Arm Creek, Nicholson River, Albert River, Leichhardt River and Johnnie Creek (Disaster Inlet).

Larger mangrove stands have also colonised the deep meanders of these creeks and rivers in the upper tidal reaches. The zonation of the coastal wetland vegetation occupying these meanders follows the order of Closed *Avicennia* on the accreting bank, succeeded by Closed *Ceriops* and Closed Mixed behind. Both Closed *Ceriops* and Closed Mixed communities extend in finger-like communities from the outer bank of the meander to the centre of the meander. Saline Grassland communities are often found further landward of these communities.

Intertidal flats are narrower at the western extent and wider at the eastern extent of this region. Large intertidal flats exist at the mouth of the Albert and the Leichhardt Rivers due to sediment deposited from the large catchments. Galloway (1982) suggests that this region of the Gulf of Carpentaria shows signs of seaward progression. The existence of open pioneering *Avicennia* communities on the seaward edge of the foreshore band of Closed *Avicennia*, and the dead *A. marina* on the landward edge, tend to support this theory.

The Kapok mangrove, *Camptostemon schultzii* was identified within the narrow Closed Mixed communities along the Albert River. The significance of this species is discussed further in Section 5.6.

TABLE 5.5 Areas of coastal wetland communities of the Nicholson and Leichhardt River Complex.

	Nicholson River		Leichhardt River	
COMMUNITY	**AREA** (ha)	**% OF TOTAL**	**AREA** (ha)	**% OF TOTAL**
Closed *Rhizophora*	173.08	0.13	174.76	0.12
Closed *Avicennia*	3817.80	2.85	1733.78	1.17
Open *Avicennia*	1246.32	0.93	436.48	0.29
Closed *Ceriops*	1051.00	0.78	732.40	0.49
Closed Mixed	6447.04	4.81	1811.03	1.22
Saltpan	120200.73	89.63	143238.09	96.27
TOTAL	134104.89	100.00	148793.51	100.00

5.4 Morning Inlet to Flinders River

This 50 km section of coastline is similar in physical character to the Nicholson and Leichhardt River Complex with muddy shores extending along the entire length. A continuous band of Open and Closed *Avicennia* has established along the coastline with unvegetated Saltpans extending further landward. The mangrove communities within this region are largely restricted to the banks of the Flinders River and the other smaller creeks.

Intertidal flats up to approximately 1.5 km wide exist along this section of coastline. This habitat type, from the mouth of Morning Inlet to the Bynoe River, is protected within the Morning Inlet – Bynoe River FHA.

TABLE 5.6 Areas of coastal wetland communities from Morning Inlet to Flinders River.

	M Creek		L Creek		Flinders River	
COMMUNITY	**AREA** (ha)	**% OF TOTAL**	**AREA** (ha)	**% OF TOTAL**	**AREA** (ha)	**% OF TOTAL**
Closed *Rhizophora*	0.00	0.00	0.00	0.00	0.00	0.00
Closed *Avicennia*	544.08	0.49	497.87	0.44	384.96	0.34
Open *Avicennia*	182.50	0.16	66.55	0.06	138.96	0.12
Closed *Ceriops*	0.00	0.00	2.82	0.00	16.63	0.01
Closed Mixed	195.36	0.18	165.91	0.15	556.51	0.50
Saline Grassland	7.67	0.01	17.68	0.02	153.03	0.14
Saltpan	110288.11	99.16	111314.01	99.33	110709.29	98.88
TOTAL	111217.74	100.00	112064.84	100.00	111959.38	100.00

5.5 Wellesley Island Group

The estuarine communities of these island groups are among the most diverse in the Gulf Study Area. Mangrove and saltmarsh communities, along with intertidal flats, seagrass meadows, coral reefs and rocky foreshores provide a diverse range of coastal fisheries habitats.

Closed *Avicennia* and Closed *Rhizophora* are the dominant vegetated coastal wetland communities within the Wellesley Island Group. Saltpans still account for a large proportion of the coastal wetland communities. However, mangrove communities cover a greater proportion of the tidal zone on these islands than in other catchments within the Gulf Study Area.

Intertidal flats occur along virtually all of the Bentinck Island foreshore, Sweers Island, Albinia Island and Forsyth Island. On Mornington Island, intertidal flats are limited in distribution to the mouths of the estuaries on the southern foreshore of the island.

Within the Wellesley IMCRA Bioregion (IMCRA Technical Group 1998), the Wellesley Island Group is considered to have high uniqueness and moderate biodiversity and productivity values (Sinclair Knight and Merz 1999). The only significant reef structures within this Bioregion occur in the shallow waters surrounding this Island Group. Consequently, reef-specific taxa found here are not found elsewhere within the Bioregion. Sinclair Knight and Merz (1999) found that the reefs located at Rocky and Man 'o' War Islands (approximately 20 km north of Mornington Island) were more complex than elsewhere within the Gulf of Carpentaria.

A sub-basin catchment for Mornington Island was the only catchment defined within the DNR coverage for the Wellesley Island Group. For the purposes of this study the following groupings of islands were used as reporting units:

- Forsyth Islands - including Forsyth Island, Bayley Island and Pains Island;
- Allen Island - including Allen Island, Horseshoe Island and Little Allen Island;
- South Wellesley Islands - including Bentinck Island, Sweers Island, Fowler Island and Albinia Island.

TABLE 5.7 Areas of coastal wetland communities of Mornington Island and the South Wellesley Islands.

	Mornington Island		South Wellesley Islands	
COMMUNITY	**AREA** (ha)	**% OF TOTAL**	**AREA** (ha)	**% OF TOTAL**
Closed *Rhizophora*	684.18	5.72	274.50	5.32
Closed *Avicennia*	1463.04	12.23	342.84	6.64
Open *Avicennia*	38.37	0.32	78.79	1.53
Closed *Ceriops*	246.54	2.06	500.14	9.69
Closed Mixed	407.45	3.41	76.11	1.48
Saline Grassland	0.00	0.00	0.00	0.00
Saltpan	9123.41	76.26	3887.29	75.34
TOTAL	11963.00	100.00	5159.66	100.00

TABLE 5.8 Areas of coastal wetland communities of Forsyth Islands and Allen Island.

	Forsyth Islands		Allen Island	
COMMUNITY	**AREA** (ha)	**% OF TOTAL**	**AREA** (ha)	**% OF TOTAL**
Closed *Rhizophora*	51.08	6.96	16.80	8.64
Closed *Avicennia*	121.14	16.50	96.54	49.65
Open *Avicennia*	3.89	0.53	0.00	0.00
Closed *Ceriops*	1.31	0.18	12.15	6.25
Closed Mixed	12.52	1.71	0.00	0.00
Saline Grassland	0.00	0.00	0.00	0.00
Saltpan	544.34	74.13	68.97	35.47
TOTAL	734.29	100.00	194.46	100.00

5.6 Regional Significance of the Coastal Wetland Communities

At a regional scale, the distribution of mangrove species is determined by a number of factors including temperature, rainfall, catchment area and tides. It has been shown that mangrove species are limited in their latitudinal distribution by their physiological tolerance to low temperatures (Duke et al. 1998). Additionally, areas of high freshwater availability (both as rainfall and runoff from riverine catchments) tend to support more species rich mangrove communities than areas of low freshwater availability. This is evident in the Gulf Study Area where the relatively dry coastline supports less than twenty species whereas more than thirty species have been recorded for areas of similar latitude on the wetter eastern coastline of Australia.

The total number of mangrove species reported for the Gulf Study Area is seventeen. Field activities in relation to this study confirm that the following twelve species are present in the Gulf Study Area: *A. annulata*, *A. corniculatum*, *A. marina*, *C. tagal*, *C. schultzii, E. agallocha*, *H. tiliaceus*, *L. racemosa*, *O. octodonta*, *R. stylosa*, *T. populnea* and *X. moluccensis*. Appendix 11 contains detailed field survey data including the locations various species were sited.

Thirty-one species of mangrove have been recorded in the entire Gulf of Carpentaria (Dowling and McDonald 1982). However, only seventeen species of mangrove have been identified within the Gulf Study Area. Hutchings and Saenger (1987) recognised three

distinct biogeographical zones in the Gulf of Carpentaria based on the distribution of mangrove species. Zone 1N, from Melville Bay to Blue Mud Bay on the north-west coast of the Gulf of Carpentaria in the Northern Territory, is species rich and structurally complex. The Gulf Study Area lies within zone 2G, an area of relatively low mangrove species diversity and low structural diversity. The majority of the Gulf coastline falls within this category. The third zone (1NE), from Aurukun to Cape York, is characterised by high species diversity and structurally complex mangrove forests.

Camptostemon schultzii was identified in the Gulf Study Area. This species is limited in its distribution in Australia to the northern coastline, from the Kimberley Coast of Western Australian and the Arnhem Land coast of the Northern Territory to Cape York in Queensland (Claridge and Burnett 1993). In Queensland, this species has been recorded as far south as Princess Charlotte Bay (approximately 14.5^{o}S). Wells (1983) reports that *C. schultzii* is unknown from any tidal waterway, other than the Limmen Bight River, entering the southern shoreline of the Gulf of Carpentaria across to Karumba. Here, we report the occurrence of *C. schultzii* in the tidal reaches of the Albert River, where it has not previously been recorded.

C. schultzii is one of the few mangrove species that comes close to being endemic to Australia (Wells 1983). Apart from its wide distribution in Australia, *C. scultzii* has been reported from the Gulf of Papua (Percival and Womersley 1975; Floyd 1977) and Ambon Island in the Moluccas (Chapman 1976).

The coastal wetlands of the Gulf Study Area can be classified as low rainfall Saltpan communities as they are characterised by extensive Saltpan development at the upper tidal limit (Dowling and McDonald 1979). The predominance of Saltpans in the Gulf Study Area is of significance on a regional scale. Along the wetter eastern coast of Australia, Saltpans generally form a relatively small component of the coastal wetland environment. Other areas along the Queensland coastline, which exhibit a comparably high proportion of Saltpans, include Princess Charlotte Bay, the Fitzroy River Delta and the Broadsound Region. The low rainfall Saltpan communities of the Gulf Study Area are the largest continuous stretch of this coastal wetland type on the tropical Queensland coastline.

In their assessment of the significance of the Wellesley Island Group, Sinclair Knight and Merz (1999) found that this island group held a conservation value through to the regional scale. The islands did not meet the traditional conservation criteria of high diversity, productivity, critical habitat or aesthetic impact. However, the Wellesley Island Group still held a conservation value through to the Australia-wide scale due to the uniqueness of the inshore coral reefs in this area.

5.7 Historical Change of the Coastal Wetland Communities

Saenger and Hopkins (1975) described the mangroves of the southeastern Gulf of Carpentaria extending from Tarrant Point to Burketown and including Sweers Island. They describe the distinct zonation of the mangrove communities of the outer shoreline, present in 1973. The progression of communities described is (from outer shoreline to landward zone) a narrow Closed *Avicennia* community, Closed *Rhizophora*, Closed *Bruguiera*, Closed *Ceriops*, Saltmarsh (herbland) and Saltpan.

This historical description of the mangrove foreshore communities of nearly 30 years ago varies markedly from the communities encountered in the region from Tarrant Point to Burketown today. In the present study, Closed *Avicennia* was found to form a continuous band of mangrove along the foreshore. This zone is succeeded directly by a saltmarsh zone and landward of this lies extensive Saltpans. The Closed *Rhizophora*, Closed *Bruguiera* and Closed *Ceriops* communities described by Saenger and Hopkins (1975) were only encountered at the mouths of permanent creeks and rivers (eg. the Albert River) in the Gulf Study Area. *Bruguiera* spp. were uncommon and no large Closed *Bruguiera* communities as described were encountered in the field work.

Changes to the composition of the coastal wetland communities in the Burketown to Karumba area were observed already in the late 1970's (P Saenger, pers. comm. 2000). The dominance of *A. marina*, a pioneering species, in this zone suggests that a large-scale disturbance of the foreshore, such as a cyclone or severe monsoonal season, may have caused widespread destruction of the foreshore mangrove species, after which *A. marina* colonised. The floods associated with the 1974 monsoon season may have contributed to the drastic change in the composition of the foreshore mangrove communities from Tarrant Point to Burketown, and possibly the entire foreshore of the southern Gulf of Carpentaria. The Bureau of Meteorology (2000) reports that some locations in the southern Gulf of Carpentaria received more than twice the average annual rainfall in the month of January 1974 alone. The possibility of the relationship between this flood event and the alteration to the coastal wetland communities requires further investigation.

SECTION 6. DISTURBANCE OF AND THREATS TO COASTAL WETLAND VEGETATION IN THE STUDY AREA

6.1 General Threats to Coastal Wetland Vegetation

Increasing human population poses a continual threat, both directly and indirectly, to coastal wetland environments worldwide. In many regions of the world various development activities have resulted in large losses of valuable coastal wetland environments. For example, development such as waterfront housing estates, marinas and aquaculture ventures often target areas adjacent to coastal wetlands.

Marine plants in Queensland are protected from removal for human developments under Fisheries legislation. Any proposed disturbance of marine plants requires approval under the *Fisheries Act 1994*, with most larger scale developments also being subject to intensive whole of government assessment (via an Environmental Impact Statement or through the Integrated Development Assessment System (IDAS)). These assessment procedures seek to ensure that development impacts are minimised and retained within a localised area.

Although the threat of direct removal of coastal wetland systems is an important management consideration, the indirect effects caused by increased urban and agricultural development within a catchment are potentially more significant. The deterioration of water quality through inappropriate land management and alterations to water flow characteristics are primary concerns. Poor land management practices that facilitate erosion may result in changes to sedimentation and turbidity characteristics of the waterways. Agricultural herbicides, pesticides and fertilisers carried into the waterways, as well as sewage and industrial discharge, create changes in water quality. Alterations to water flow characteristics for the catchment may result from an increase in water usage and the construction of dams to meet water supply needs, as well as an increase in urban runoff.

The damage to aquatic ecosystems, and in particular to fisheries and fish habitats, arising from various human induced changes is largely unquantified and remains poorly understood. However, the potential for these processes to have deleterious effects on coastal wetland systems is recognised. The threshold of tolerance of fisheries and fish habitats to these changes, before major alterations in the physical nature of these systems occur, requires further study.

6.2 Specific Threats to Coastal Wetland Vegetation

In the Gulf Study Area there is little concern over the issues that threaten coastal wetland environments in highly populated areas. Catchment clearing is low in comparison with more highly populated areas of the state (QDNR 1999). Additionally, infrastructure development within the region is slow.

Pondage Systems

There is considerable interest in developing pondage systems in coastal areas of the Gulf of Carpentaria (Hyland and White 1996). Ponded pastures have been developed in Queensland with the intention of improving the grazing potential of lowland areas during the dry season. The creation of ponded pastures in tidal areas has the potential to impact on coastal wetland environments and the fisheries that they support.

The main concerns expressed over the creation of pondage systems in tidal areas, relating to fisheries management, include the loss of fish habitats, interference with fish movement and interference with nutrient and sediment flows. Research to assess the significance of these concerns is currently being undertaken by DPI Queensland (. The Ponded Pastures Steering Committee (1995) provides a more detailed discussion of the issues involved in ponded pasture management.

On 18 July 1991, a moratorium in the construction of impoundments on tidally affected land was declared with the specific intention of halting further development. Policy options to prevent any potentially detrimental effects of pondage systems on fish and fish habitats are being developed (Ponded Pastures Steering Committee 1996).

Feral Animals

Feral animals within the Gulf Study Area have the potential to impact on the coastal wetland environments. Both feral pigs and brumbies are common within the Area and cause limited damage to coastal wetland habitats.

SECTION 7. EXISTING CONSERVATION MEASURES AND CONSERVATION VALUES

7.1 Fish Habitat Areas

FHAs have been declared throughout coastal Queensland to enhance existing and future fishing activities and to protect the habitat upon which fish and other aquatic fauna depend (Beumer et al. 1997). Two FHAs, both of Management A status, are currently declared within the Gulf Study Area (Appendix 5). Table 8.2 summarises the fisheries values and habitat types of the wetlands protected within these FHAs.

7.2 Directory of Important Wetlands in Australia

Several areas in the southern Gulf of Carpentaria have been included in the National Directory of Important Wetlands (ANCA 1996). These include the Forsyth Island Wetlands (wetland reference GUP004QL), Marless Lagoon Aggregation (wetland reference GUP007QL), the Nicholson Delta Aggregation (wetland reference GUP010QL) and the Southern Gulf Aggregation (wetland reference GUP013QL).

The Forsyth Islands are a small group of islands, 10 km off the coastline at Bayley Point. These islands are recognised by the ANCA (1996) for the densely vegetated seagrass beds of Government Bay. These seagrass beds support seven seagrass species, are valuable fisheries habitat and provide a food source for dugong and green turtle.

Marless Lagoon Aggregation, lying within the western region of the study area, is recognised as a complex of discrete seasonal freshwater wetlands within the Gulf Plains bioregion. Waterbirds frequent the area during the summer wet season.

The Nicholson Delta Aggregation, 21 km west of Burketown is recognised as being the best example of a deltaic, alluvial system in this portion of the southern Gulf of Carpentaria. A plethora of permanent, semi-permanent and seasonal wetlands supply breeding, roosting, feeding and moulting habitat for waterbirds as well as drought refuge during the winter months.

The Southern Gulf Aggregation, encompassing coastal extents of the Eastern Gulf, Flinders and Western Gulf catchments, provides important wetland habitat to sixteen species of shorebirds including sandpipers, plovers and curlews, as well as numerous other waterbird species.

7.3 Deed of Grant in Trust (DOGIT) Areas

Several estuaries in this region are areas which are set aside for indigenous Australians (Deed of Grant in Trust Areas) and fishing within these estuaries is restricted to indigenous fishing/hunting methods. These include Passmore Creek on the mainland, Horse Place Creek, Walbor Inlet and Boyorunga Inlet on Mornington Island and all estuaries on Forsyth Island.

7.4 Fisheries Closures/Restrictions

The "Fisheries (Gulf of Carpentaria Inshore Fin Fish) Management Plan 1999", gazetted under the *Fisheries Act 1994,* prohibits the use of nets in certain zones and closes some rivers to commercial fishing. Elizabeth, Towbulbulan, Sandalwood and Flinders River all have various restrictions placed on the extent of fishing allowed within them. A spawning closure has been placed on the capture by any means (recreational or commercial) of barramundi (*Lates calcarifer*) within these rivers during the spawning season, which generally occurs from October to January (however, varies from year to year on the basis of lunar phase). Only a limited number of licences are provided for commercial fishing. These fishers must comply with restrictions on size and type of net, mesh size and net depth. Such limitations as these seek to prevent overfishing and ensure the sustainability of fishing activities and fish communities in this region.

SECTION 8. FISHERIES RESOURCES IN THE STUDY AREA

8.1 Northern Prawn Fishery

The Gulf Study Area lies adjacent to the Northern Prawn Fishery Management Area, which extends from Cape York in Queensland to Cape Londonderry in Western Australia. The Northern Prawn Fishery is the most valuable trawl fishery managed by the Commonwealth (Die et al. 1998). The Queensland component of the Northern Prawn Fishery contributes approximately half of the total product and is worth an estimated $50 million (Lew Williams, Queensland Fisheries Service, pers. comm. 2000). Three species, white banana prawn, brown tiger prawn and grooved tiger prawn, constitute about 80% of the total catch of the Northern Prawn Fishery.

Efforts to catch tiger prawns within the Northern Prawn Fishery are concentrated in waters adjacent to coastal seagrass beds in the southern and western Gulf of Carpentaria and along the Arnhem Land coast. The Gulf Study Area is an important region for this component of the fishery.

8.2 Gulf Set Net Fishery and Joint Authority Fishery

Two other fisheries of importance to the Gulf Study Area are the Gulf Set Net Fishery and the Joint Authority Fishery. The total catch for all product within these two fisheries in 1998 totalled approximately 1 500 tonnes and is displayed in Figure 8.1.

The main product targeted in the Gulf Set Net Fishery is barramundi (*Lates calcarifer*). This species accounts for approximately one third of the estimated 1500 t total catch. The total catch in tonnes of barramundi caught in Queensland in 1998, reported by 30 minute grids, is displayed in Figure 8.2. A significant proportion of the total catch of barramundi caught along the Queensland coastline was landed in the Gulf Study Area.

Other important species for the Gulf Set Net Fishery include king threadfin (approx. 200 t) and blue threadfin (approx. 50 t). Mud crabs also account for about 50–60 t of the total catch of the Gulf Set Net Fishery

The Joint Authority Fishery in offshore waters of the Gulf of Carpentaria targets shark as well as grey and spanish mackerel using nets and lines. Spanish mackerel constitutes the main component of the line fishery.

8.3 Fisheries Resources and their Habitat Requirements

Many of the species targeted in the Gulf fisheries rely on coastal wetland environments for food sources and habitat requirements at some stage of their life cycle (Table 8.1). The coastal wetland environments in this region are particularly important to the life cycle of barramundi. Spawning of barramundi occurs in inshore coastal waters, near the mouths of creeks and rivers. Habitats such as coastal swamps, supralittoral Saltpans, marine plains or low lying coastal flood plains serve as nursery areas for the juveniles (Coates and Unwin 1991). Major spawning of barramundi occurs just before or early in the wet season so that the juveniles can take maximum advantage of the temporary wetland habitat.

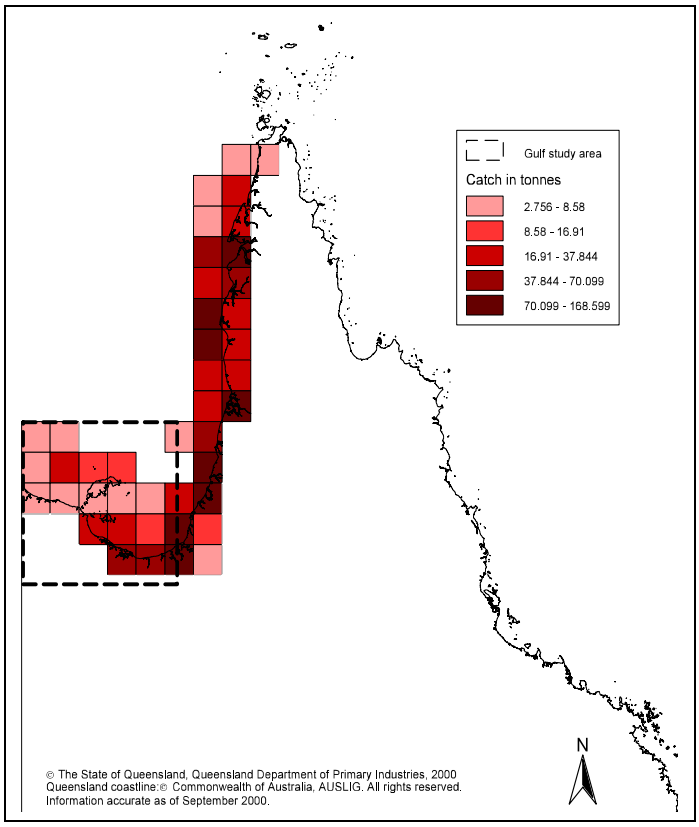

FIGURE 8.1 Total catch in tonnes by 30 minute grid of the combined Gulf Set Net Fishery and Joint Authority Fishery, 1998.

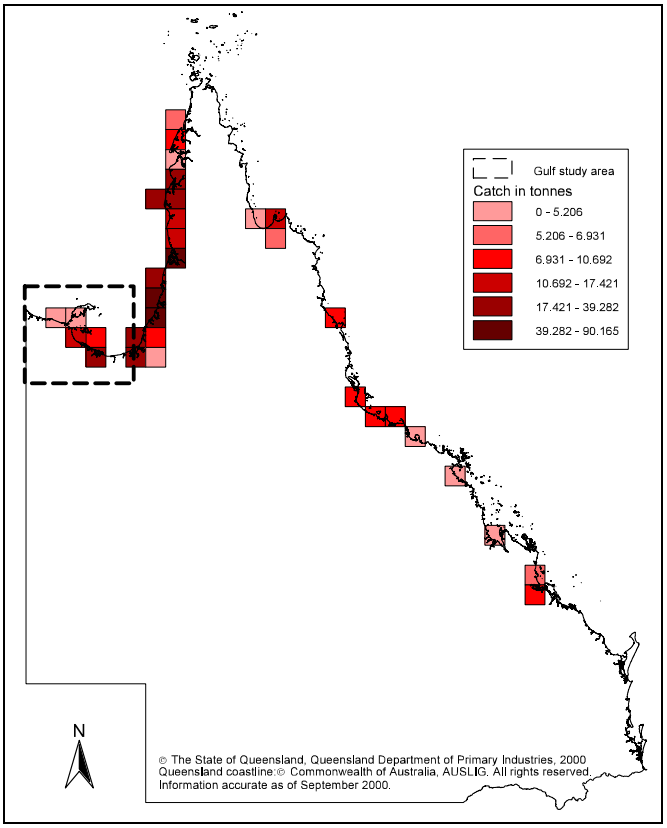

FIGURE 8.2 Total catch in tonnes of barramundi by 30 minute grid, 1998.

TABLE 8.1 Habitat requirements for selected fisheries resources of importance to the Gulf fisheries.

SPECIES	SPAWNING HABITAT	EGG AND LARVAL HABITAT	POST LARVAL AND JUVENILE HABITAT	ADULT HABITAT
BARRAMUNDI	Creek and river mouths	Estuarine and coastal swamps	Coastal swamps, Saltpans, lowlying plains	Freshwater streams and estuaries
BLUE THREADFIN	Inshore waters and estuaries	Coastal waters	Lower estuaries and nearshore waters	Nearshore waters
SPANISH MACKEREL	GBR waters between Townsville and Lizard Is and the NE Torres Strait	Coastal waters	Inshore waters and estuaries	Continental shelf waters
BROWN TIGER PRAWN	Offshore waters	Offshore waters	Lower estuaries and inshore marine waters associated with seagrass beds	Inshore to offshore marine waters
MUD CRAB	Offshore waters	Coastal waters	Intertidal waters in mangrove-lined estuaries	Subtidal waters in estuaries

Source: Zeller 1998

The fisheries values and the major habitat types of the coastal wetland systems that are currently declared as FHAs in this region are summarised in Table 8.2.

TABLE 8.2 Fish Habitat Areas currently declared in the study area.

FHA NAME	FISHERIES VALUE	MAJOR HABITAT TYPES
Eight Mile Creek	Barramundi, blue salmon, grey mackerel, king salmon, queenfish, grunter, mud crabs, catfish	Narrow discontinuous fringe of *A. marina* occurs along the stream banks; extensive unvegetated sand flats occur both within and outside the estuary.
Morning Inlet - Bynoe River	Barramundi, blue salmon, grey mackerel, king salmon, queenfish, grunter, mud crabs, jewfish	Closed Mixed and Open *Avicennia* communities in the riverine areas; Closed and Open *Avicennia* along parts of foreshore; extensive unvegetated salt flats associated with the estuary, and foreshore sand banks.

Source: Beumer et al. 1997

8.4 Indigenous and Recreational Fishing Activities

Extensive indigenous fishing occurs in the Gulf Study Area but total annual catch information is not available.

Recreational fishing in the Gulf Study Area supports a growing tourism industry in the region. Birri Lodge Fishing Resort, on Mornington Island, and Escott Barramundi Lodge, just outside of Burketown, cater particularly for tourists wishing to participate in reef and sport fishing. Barramundi, as well as salmon, grunter and bream, are targeted by reacreational fishers in the Gulf Study Area.

SECTION 9. APPLICATION OF THE DATASET TO FISH HABITAT AREA PLANNING

9.1 FHA Declaration Process

FHAs are part of the on-going management of fisheries resources within Queensland and are declared with the specific intent to ensure the sustainability of productive recreational, indigenous and commercial fisheries in a region. The declaration of a FHA generally follows the process outlined below:

1. Nomination of an area as a candidate for declaration as a FHA.
2. Review of nomination and assessment of its priority for further investigation.
3. Site investigation/field habitat surveys, literature searches and reviews, assessment of fish catch records and preliminary discussions with user groups (e.g. commercial fishers, recreational fishers, indigenous groups, local authority, other community groups, etc.) to determine if the nominated area meets FHA declaration criteria.
4. Preparation of an Area of Interest Plan and draft of known management issues.
5. Initial consultation with interested parties and relevant agencies.
6. Revision of information gathered during the initial consultation phase and preparation of a draft FHA Plan and a draft management strategy with recommendation of an appropriate management level (either 'A' or 'B', and use of a location-specific management plan).
7. Second round of consultation with interested parties and relevant agencies.
8. Revision of information gathered during the second round of consultation.
9. Preparation of a Declaration Plan of FHA Boundaries and submission of a proposal for declaration.
10. Provision of Plan and Submission to the Department of Primary Industries legal section.
11. Provision of Plan and Submission to the Minister for Primary Industries
12. Provision of Plan and Submission to the Governor in Council for declaration under the *Fisheries Regulation*.

The suitability of various coastal wetland systems for nomination as candidate areas for FHA declaration (i.e. step 1) is currently assessed on the basis of the following criteria:

1. Size
2. Diversity of or specific habitat features
3. Diversity of or specific marine fauna and flora
4. Level of existing and future disturbances
5. Unique features
6. Existing or potential fishing grounds
7. Protected species

A summary of the assessment of the coastal wetlands of the Gulf Study Area, on the basis of these criteria, is included in Table 9.1. Details of the assessment methods and the category details are included in Table 3.1, Section 3.7.

Further details of the significance of specific coastal wetland communities are outlined in Section 5. This report concentrates on the identification of suitable areas for fisheries conservation from a coastal wetland community perspective.

Land tenure is also an important consideration in the FHA declaration process. Appendix 10: Sheets 1–6 display the land tenure of the coastal strip as at February 2000 from the Queensland/Northern Territory Border to the Flinders River with the coastal wetland communities overlaid.

A large proportion of the coastal waters adjacent to the Gulf Study Area, including the waters surrounding the Wellesley Island Group, is subject to native title claim. This area is displayed in Figure 9.1.

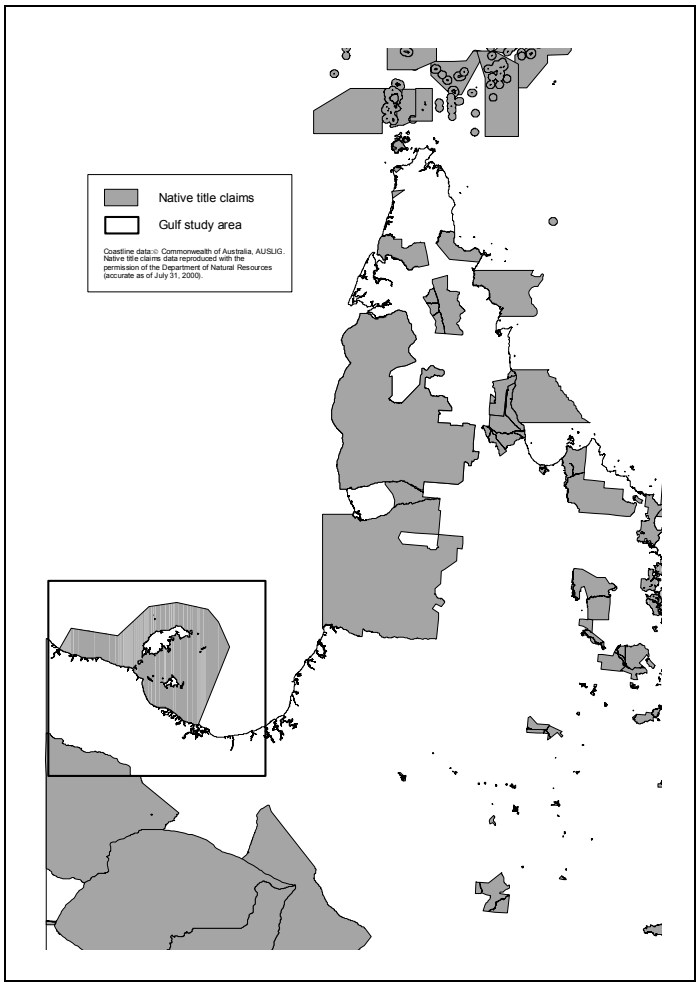

FIGURE 9.1 Native title claims in northern Queensland, July 31 2000.

9.2 Assessment of Coastal Wetland Characteristics for FHA Declaration Purposes

TABLE 9.1 Summary of characteristics of coastal wetlands of the Gulf Study Area, as described in Section 3.7.

WETLAND	AREA OF COASTAL WETLAND COMMUNITIES (ha)	DIVERSITY OF MANGROVE /SALTMARSH COMMUNITIES (#)	INTERTIDAL FLATS (see Appendix 10 for spatial distribution)	SEAGRASS COMMUNITIES	SIGNIFICANT DAMS AND WEIRS	DISTURBANCE TO ADJACENT TERRESTRIAL VEGETATION	RECOGNISED/IMPORTANT FISHING GROUNDS	UNIQUE FEATURES
NT Border to Cliffdale Creek Catchment								
NT Border	4751	M (6)	Narrow intertidal flats	✔	✘	NP		
Settlement River	8182	M (5)	Small area at Tully Inlet	✔	✘	NP		
Lagoon Creek	11800	M (6)	Narrow along coastline, larger area at Massacre Inlet	✔	✘	NP		
Eight Mile Creek	12418	L (4)	Narrow and intermittent	✔	✘	NP		
Cliffdale Creek	71477	M (6)	Narrow and intermittent	✔	✘	NP		
Nicholson and Leichhardt River Complex								
Nicholson River	148794	M (7)	Large area at the mouth of Albert River and wide flats along the foreshore	✔	✘	NP	✔	✔
Leichhardt River	134105	M (7)	Large area at the mouth of Leichhardt River and wide flats along the foreshore	✔	✘	NP	✔	
Morning Inlet to Flinders River								
M Creek	111218	M (5)	Wide and continuous		✘	NP		
L Creek	112065	M (6)	Wide and continuous		✘	NP		
Flinders River	111959	M (6)	Wide and continuous		✘	NP	✔	
Wellesley Island Group								✔*
Mornington Island	11963	M (6)	Mouths of estuaries on the southern side of the island	✔	✘	NP	✔	
South Wellesley Islands	5160	M (6)	Large intertidal flats around Bentinck Island	✔	✘	NP	✔	
Forsyth Islands	734	M (6)	Small area	✔	✘	NP		
Allen Island	195	L (4)	Small area	✔	✘	NP		

* Section 5.6

9.3 Representative Habitats Currently not Included in FHAs

Coastal wetland communities are currently poorly represented in FHAs within the Gulf Study Area. Of the total of 744 819 ha of coastal wetlands present in the area, less than 0.5% are protected by declared FHAs. The areas of communities currently included in each of the FHAs in the Gulf Study Area are listed in Table 9.2.

The extensive Saltpans and narrow Closed Mixed communities are representative habitats of this region that should be included in FHAs. It is strongly recommended that efforts be made to include these areas within the system of MPAs due to their recognised role in providing habitats for the important fisheries within the Gulf of Carpentaria (e.g. barramundi).

TABLE 9.2 Areas of coastal wetland communities contained within FHAs in the Gulf Study Area.

	EIGHT MILE CREEK FHA	MORNING INLET – BYNOE RIVER FHA
TOTAL AREA OF FHA (ha)	5229	12122
AREA OF COASTAL WETLAND COMMUNITY WITHIN FHA (ha)		
Total	725	1480
Closed *Rhizophora*	1	0
Closed *Avicennia*	152	694
Open *Avicennia*	7	255
Closed *Ceriops*	0	2
Closed Mixed	32	87
Saline Grassland	4	9
Saltpan	507	433

9.4 Representative Areas to be Considered as Potential FHAs

Nicholson and Leichhardt River Complex

The coastal wetland communities associated with the Nicholson and Leichhardt River sub-basin catchments are suitable habitats to be considered for further protection under Fisheries legislation.

The diversity of coastal wetland communities in this area is not high. However, the extensive Saltpans and the narrow Closed Mixed communities are representative habitats within the Gulf Study Area that are currently poorly protected.

The Nicholson Delta has been recognised as the best example of a deltaic, alluvial system in this portion of the southern Gulf of Carpentaria. The coastal wetland communities within this River Complex are near pristine and their associated catchments are virtually untouched by human development.

The intertidal flats at the mouth of the Albert and Leichhardt Rivers should be considered as part of the important fisheries habitats within this region and should be included in any further protected areas. Elliott (1993) reports that these flats support seagrass meadows.

Wellesley Island Group

The Wellesley Island Group contains the most diverse range of fisheries habitats within the Gulf Study Area including mangrove and saltmarsh communities, intertidal flats, seagrass meadows, coral reefs and rocky foreshores. Sinclair Knight and Merz (1999) reports that these habitats are unique within the southern Gulf of Carpentaria. Of particular note are the Forsyth Islands, which have been recognised as important wetlands in Australia due to the densely vegetated seagrass beds of Government Bay. This bay contains seven seagrass species that are eaten by dugong and green turtle.

Islands within the Wellesley Island Group should be considered for protection within FHAs. The waters adjacent to the Wellesley Island Group are subject to a native title claim. Additionally, indigenous Australians are the traditional owners of Forsyth Island. Any investigations into the suitability of this area for FHA declaration would need to be conducted in conjunction with the traditional owners of the land.

Extension of Existing FHAs

The intertidal flats currently protected within the Eight Mile Creek and Morning Inlet – Bynoe River FHAs are important habitats within the Gulf Study Area. However, only a very small proportion of other fisheries habitats (such as mangrove and saltmarsh communities) is included within these protected areas. Extension of the landward boundaries of these FHAs, to include a greater diversity and larger area of intertidal environments, is therefore recommended.

SECTION 10. RECOMMENDATIONS

In comparison to the eastern Queensland coastline, the coastal wetlands of the entire Gulf Study Area are under very little pressure from human development and other threats. The region is very important for a number of highly valuable fisheries. The habitats that support these fisheries need to be protected in order to ensure the long-term sustainability of the fisheries of the Gulf of Carpentaria. The following specific recommendations should be implemented in order to achieve this protection of the coastal wetlands of the Gulf Study Area.

1. The coastal wetland communities associated with the Nicholson and Leichhardt River Complex are suitable habitats to be considered for further protection under Fisheries legislation. In particular, it is strongly recommended that Saltpan and Closed Mixed communities are protected within FHAs. The intertidal flats, seagrass meadows and foreshore mangrove communities should also be considered for future protection.

2. Islands within the Wellesley Island Group should be considered for protection within FHAs. The Wellesley Island Group contains the most diverse range of fisheries habitats within the Gulf Study Area including mangrove and saltmarsh communities, intertidal flats, seagrass meadows, coral reefs and rocky foreshores.

3. Extension of the landward boundaries of existing FHAs, to include a greater diversity and larger area of intertidal environments, is recommended.

4. Continuation of coastal wetlands mapping to complete the remainder of the Queensland coast is strongly recommended to:
    - provide baseline data for FHA declaration and Ramsar site nomination;
    - provide a basis for future monitoring of the spatial and composition changes in tidal coastal wetland communities on a local, bioregional and State-wide basis;
    - as a resource for incorporation into studies of the relationships of specific marine fauna to particular coastal wetland habitats.

Other Queensland Coastal Wetland Mapping Projects:

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Bruinsma, C, Danaher, K, Treloar, P and Sheppard, R (1999). Coastal Wetland Resources of the Bowen Region: Cape Upstart to Gloucester Island. Department of Primary Industries Queensland, Brisbane.

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Acknowledgments:

We would like to thank Environment Australia for their financial and administrative support.

Much appreciation is also extended to DPI colleagues, in particular:

- Malcolm Dunning for project management and support, technical advice and editorial comments
- Lew Williams for Queensland net fishery information and assistance with field work
- Karen Danaher and Kurt Derbyshire for editorial comments.

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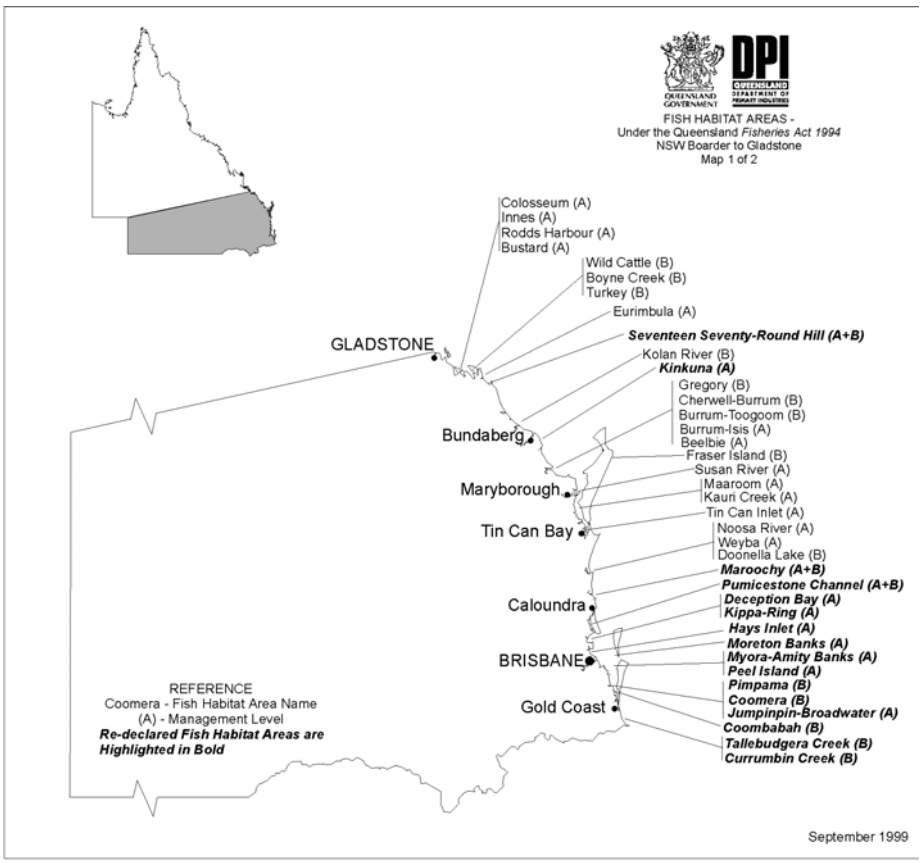
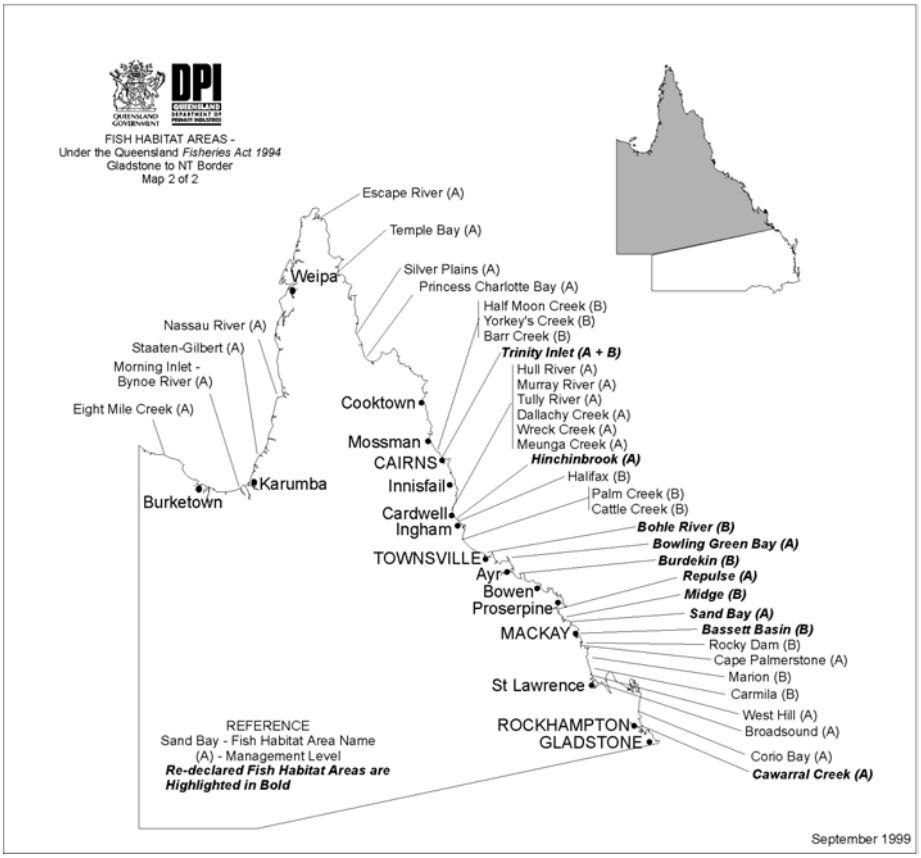
APPENDIX 1: DECLARED FHAS IN QUEENSLAND





Fisheries Information Leaflet

FISH HABITAT AREA

DECLARATION PROCESS AND MANAGEMENT OPTIONS

What is a Fish Habitat Area

Fish Habitat Areas form an important component of the ongoing protection and management of fisheries resources and wetland habitats in Queensland. The Areas are declared with the specific intent of ensuring the continuation of productive recreational, commercial and traditional fisheries in a region.

A Fish Habitat Area may be declared in both marine and freshwater environments to protect important juvenile and adult fish habitats. These habitats include sand bars, shallow water areas, undercut banks, snags, rocky outcrops, pools, riffles, seagrass beds, mangrove stands, yabby banks etc.

Declaration of a Fish Habitat Area complements the existing and more general fisheries habitat management (e.g. protection of all marine plants) by:
providing additional statutory protection to critical freshwater and unvegetated marine habitats,
publicising the fisheries value of the area, and
providing guidelines on fish habitat management to other management groups and members of the community proposing works within or adjacent to the Declared Area.

Fish Habitat Areas are declared and managed under the *Fisheries Act 1994* and the *Fisheries Regulation 1995* by the Department of Primary Industries. Management provides for community use and enjoyment of the area (e.g. commercial, recreational and traditional fishing, boating etc.) whilst restricting activities which may have negative impacts on the fisheries and habitat values of the area (e.g. dredging, reclamation, discharging/drainage etc.).

While an individual Fish Habitat Area (FHA) is nominated and declared on the basis of its specific habitat and fisheries values, each FHA extends the statewide network of Fish Habitat Areas. These Areas combine to help protect the regional viability of Queensland's fish and crustacean stocks by supporting adjacent and offshore fishing grounds (via primary production inputs, protection of nursery areas and feeding grounds, and protection of spawning locations).

Why is it important to protect fish habitat?

Considerable research has been undertaken during the last 20 years to investigate the associations and interrelationships between fish stocks and coastal and freshwater habitats. This research has documented that many species of fish and crustaceans have specific habitat requirements and that these habitat requirements often change as the individual moves through its life cycle. Studies estimate that approximately 75% (by weight) of all seafood landed commercially in Queensland is from species dependent on estuarine habitats during part of their life cycle. Similarly, a high proportion of species targeted by the recreational fishing sector and indigenous fishers is also dependent on estuarine and freshwater habitats during part or all of their life cycles.

Ever increasing pressure for both coastal and inland industrial, residential and agricultural development has and continues to have a major impact on Queensland's freshwater and inshore fisheries habitats. The permanent losses and/or alterations of these fisheries habitats have led to effects on fisheries productivity. For example, CSIRO researchers (Staples D.J., Vance D.J. and Heales D.S. 1984), in relation to commercial prawn fisheries in northern Queensland, concluded that "Any changes

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to the nursery habitat will have a corresponding effect on the offshore catch." The nursery habitats referred to include seagrass flats, algal beds and mud-banks immediately adjacent to the mangrove fringe.

The following examples taken from research data again illustrate the degree of habitat disturbance in recent times:

- during the period 1974 to 1987, 8.4% of the mangrove habitat and 10.5% of the saltmarsh-claypan habitat between Coolangatta and Caloundra have been lost to development (Hyland S.J. and Butler C.T. 1988)
- during the period 1951 to 1992, 60% of the wetlands (including both freshwater and marine wetlands) within the Johnstone River Catchment have been lost (Russell D.J. and Hales P.W. 1993)
- during the period 1941 to 1989, 2.5% (approx. 650ha) of the mangrove forest and 5.5% (approx. 990ha) of coastal saltflats along the Curtis Coast have been lost (QDEH, 1994)

Given the degree of existing development impacts on fisheries habitat and the likely pressures for future impacts on these habitats, it is clear that management and protection of the most significant of these habitats are essential/necessary. Declaring these areas as Fish Habitat Areas, is an important measure in sustaining important and valuable* commercial, recreational and traditional fisheries stocks.

* At a wholesale level the product value of the Queensland commercial fishing industry in 1996 was estimated to be $300 million. The recreational fishing industry value has been estimated to be at least equal to that of the commercial industry.

Who owns a Fish Habitat Area?

In Tidal Areas

Fish Habitat Areas in tidal areas are generally declared over Unallocated State Land (USL). The areas are not declared over tenured land (e.g. freehold or leasehold) unless a specific agreement is reached between the DPI and the holder of the tenure. A Fish Habitat Area is a fisheries habitat management measure for protection of habitat, not a form of tenure.

As the majority of land over which a Fish Habitat Area is usually declared is State Land, **community** use and enjoyment of these areas is a primary consideration in their management. It should be noted however, that if tenured land is included in a Fish Habitat Area, through specific agreement, the **rights of the tenure holder** is a primary management consideration and community use of the tenured portion of the Fish Habitat Area may be severely restricted. Protection of and the use of the habitat by fish in these lands is the key management concern.

In Freshwater Areas

As with tidal areas, freshwater Fish Habitat Areas are not a tenure but a Fisheries management measure. They can be declared over USL and, may be declared over tenured land if a specific agreement is reached between the DPI and the holder of the tenure. Given the nature of landuse and tenure arrangements around freshwater rivers and streams throughout Queensland, it is likely that freshwater Fish Habitat Area proposals may involve more tenured land than those in tidal areas.

It is envisaged that freshwater Fish Habitat Areas will focus on critical areas of fisheries habitat within a catchment and that these areas will complement existing and future whole of catchment management initiatives.

What criteria are used to determine if an area is suitable for declaration as a Fish Habitat Area?

An area may be proposed for declaration as a Fish Habitat Area by a range of interested parties or individuals. A number of recent proposals have been submitted by community groups, recreational and commercial fishing groups, local authorities and by staff from within the Department of Primary Industries.

Selection criteria currently used by DPI to assess the suitability of an area to be declared as a Fish Habitat Area are outlined below:

- size (larger areas being seen as more viable in the long-term)
- existing or potential fishing grounds
- diversity of or specific fish habitat features
- diversity of or specific marine flora and fauna
- level of existing and likely future disturbances
- unique features
- protected species

Management categories

A Fish Habitat Area may be declared under either **Management 'A'** (the highest level of protection) or **Management 'B'**. These two management categories have associated management frameworks.

In general terms, a Fish Habitat Area 'A' is declared over areas that contain fish habitats that are **critical** for fisheries productivity and sustainable fishing in the short and long term and to maintain the ecological character and integrity of undisturbed fisheries habitats. This management level does not impact on the normal day to day uses of the area by the community (e.g. boating and fishing), but does severely restrict development related disturbances.

A Fish Habitat Area 'B' is declared over areas that contain fish habitats that are **important** for productive and sustainable fishing in the short and long term and to minimise the impacts of non-fisheries related disturbance to important fisheries habitat. Declaration of an area as a Fish Habitat Area 'B' is often proposed to act as a buffer between a Fish Habitat Area 'A' and existing or future disturbances (e.g. residential or industrial development). This management level allows for Permits to be granted for construction of certain private and public facilities subject to minimal impacts on the habitats.

(A guide to management policies for activities within Fish Habitat Area 'A' and 'B' is provided on page 4-5 of this document).

Additional management may occur through a location-specific management plan, once the Fish Habitat Area has been declared. This management may be most suitable in freshwater areas, which are likely to have specific management issues (e.g. extractive industry).

A decision regarding the most appropriate management category is usually made following the first round of community consultation, at which time all relevant issues should be available for consideration.

The declaration process

The declaration of a Fish Habitat Area generally follows the process outlined below:

1. Nomination of an area as a candidate for declaration as a Fish Habitat Area.
2. Review of nomination and assessment of its priority for further investigation *[Period of time between Stage 2 and 3 will be determined by the prioritisation process]*
3. Site investigation/field habitat surveys, literature searches and reviews, assessment of fish catch records and preliminary discussions with user groups (e.g. commercial fishers, recreational fishers, indigenous groups, local authority, other community groups etc.) to determine if the nominated area meets Fish Habitat Area declaration criteria.
4. Preparation of an Area of Interest Plan and draft of known management issues.
5. Initial consultation with interested parties and relevant agencies.
6. Revision of information gathered during the initial consultation phase, preparation of a draft Fish Habitat Area Plan and a draft management strategy with recommendation of an appropriate management level (either 'A' or 'B', and use of a location-specific management plan).
7. Second round of consultation with interested parties and relevant agencies.
8. Revision of information gathered during the second round of consultation.
9. Preparation of a Declaration Plan of Fish Habitat Area Boundaries and a submission of proposal for declaration
10. Provision of Plan and submission to the Department of Primary Industries legal section.
11. Provision of Plan and submission to the Minister for Primary Industries.
12. Provision of Plan and submission to the Governor in Council for declaration under *Fisheries Regulation*.

It is expected that the declaration process from Step 4 to the final declaration should take a period of approximately 12 months to complete, however this will depend on the complexity of the issues associated with the individual area.

What are the restrictions to the user groups/adjoining land holders of the declaration of an area as a Fish Habitat Area ?

It should be noted that the management guidelines for Fish Habitat Areas 'A' and 'B' outlined below have been developed from the legislative powers and provisions of the Fisheries Act 1994 and Fisheries Regulation 1995.

Any works within a Fish Habitat Area require approval under the Fisheries Act. Each application is assessed on its individual merits and the manner in which it complies with current fisheries legislation and management policies.

ACTIVITY	FHA 'A'	FHA 'B'
Community access	✓	✓
Boating	✓	✓
Commercial and recreational fishing by lawful line or net	✓	✓
Commercial and recreational crabbing by lawful dilly or pot	✓	✓
Traditional Fishing	✓	✓
Yabby pumping	✓	✓
Worm digging	✗	✗
Collection of molluscs	✗	◆
Public works for fisheries infrastructure benefit (e.g. public jetty, public boat ramp), where there is an existing need	✓✪	✓✪
Minimal impact public works for community infrastructure benefit, with full restoration of habitat (e.g. fully buried water, power or sewerage lines)	✓✪	✓✪
Major impact public works for community infrastructure benefit (e.g. road bridge, rail bridge etc.)	✗	✗
Maintenance of existing structures	✓✪	✓✪
General placement of mooring piles or blocks	✗	✗
Placement of mooring piles or blocks directly adjacent to proponents tenured property	✗	✓✪
Construction of private access facilities for fisheries purposes into FHA from proponents tenured property (e.g. jetty, pontoon, boat ramp)	✗	✓✪
Construction of new private access facilities for other than fisheries purposes (e.g. ferry loading / boarding facilities)	✗	✗
Placement of structures for the restoration of fish habitat or of natural processes (e.g. placement of baffles or booms to revegetated marine plants)	✗	✓✪
Construction of residential canal estates	✗	✗
Mining (including sand mining)	✗	✗
Minimal impact exploratory surveys of potential mineral deposits	✗	✓✪
Extractive industry operations (including gravel dredging)	✗	✗
Dredging tidal lands for a private purpose (including channel dredging)	✗	✗
Disposal of dredge spoil	✗	✗
Revetment works where there is visible proof of bank erosion or slumping	✗	✓✪
Revetment works where there is no visible proof of bank erosion or slumping	✗	✗
Beach replenishment to control erosion for community fisheries purposes	✓✪	✓✪
Beach replenishment to control erosion for other than fisheries purposes	✗	✓✪
Reclamation of any land (e.g. for car parks, vessel trailer parks, restaurants, airport runways etc.)	✗	✗
Construction of tidal gates, weirs and baffles	✗	✗
Drainage or flood mitigation works affecting natural water flows	✗	✗
Reclamation of any land within the FHA for aquaculture purposes (including for pond construction and/or cage culture)	✗	✗
Dredging of a aquaculture water intake or outlet channel	✗	✗
Placement of underground aquaculture inlet and outlet pipes or elephant trunk systems	✗	✓✪
New facilities for discharge of sewage effluent or unfiltered stormwater	✗	✗
Collection of dead wood	✗	✗
Any proposal having only minor benefit in terms of management, public use and enjoyment of any declared Fish Habitat Area for fisheries purposes not justifying the impacts	✗	✗

Key to Symbols

✓ Unrestricted Activity

✓✪ Activity considered compatible with FHA declaration, subject to DPI Permit consideration

✗ Activity considered incompatible with FHA declaration

◆ Under review

How does community infrastructure requirements (e.g. road, rail bridges) relate to the management of a Fish Habitat Area?

Infrastructure for community benefit (e.g. bridge pylons, powerline support structures), permanently alters the natural fisheries habitat values of the localized area, without offering fisheries management benefits to the area. Therefore, these structures are not seen as compatible with the intent of Fish Habitat Area declaration. In addition, any impacts on intertidal habitats as a result of regular maintenance of these structures to ensure community and structural safety may require statutory approvals from the DPI.

For the reasons outlined above DPI management seeks to exclude present and planned community infrastructure from Fish Habitat Areas. This is generally achieved through prior negotiation with the individual government agencies to incorporate strategically located community infrastructure corridors through the Fish Habitat Area. These corridors are not part of the Fish Habitat Area and not subject to its management.

It should be noted that public jetties and public boat ramps providing boat access to fisheries resources are considered compatible with the intent of Fish Habitat Area declaration, therefore these facilities are generally not excluded from the declared Areas.

The Revocation Process

The declaration of a Fish Habitat Area is seen as long-term management of an area of important fisheries habitats. It is recognised when adopting this style of management that with time, community needs may change and additional community infrastructure (e.g. a road / rail bridge duplication) may be required. A whole-of-government and community approach to acceptance of these needs may then require removal of part of a declared Fish Habitat Area for the agreed purpose. Excision of an area of habitat from within a declared Fish Habitat Area requires formal revocation.

Details of the process for revocation are available from the DPI Fisheries Group. The process is structured and open to public scrutiny and includes such elements as a requirement for the submission of a 'Revocation Support Study' and an appropriate amendment of the Fisheries Regulation by Governor-in-Council.

For further information please contact:

Southern Fisheries Centre
PO Box 76 (13 Beach Road)
DECEPTION BAY Q 4508
telephone- (07) 3817 9500

Northern Fisheries Centre
PO Box 5396 (38-40 Tingira Street, Portsmith)
CAIRNS Q 4870
telephone (07) 4035 0126

References

Hyland, S.J. and Butler, C.T. (1988). *The Distribution and Modification of Mangroves and Saltmarsh - Claypans in Southern Queensland*, Queensland Department of Primary Industries Information Series, Brisbane, 74pp.

Queensland Department of Environment and Heritage (1994) *Curtis Coast Study Resource Report*, Queensland Department of Environment and Heritage Resource Report, 180pp.

Russell, D.J. and Hales, P.W. (1993). *Stream Habitat and Fisheries Resources of the Johnstone River Catchment*, Queensland Department of Primary Industries, Cairns, 59pp.

Staples, D.J., Vance, D.J. and Heales, D.S. (1984) *Habitat Requirements of Juvenile Penaeid Prawns and their Relationship to Offshore Fisheries* pp 47-54, In: P.C. Rothlisberg, B.J. Hill and D.J. Staples (Editors), Second Aust. Nat. Prawn Sem., NPS2, Cleveland, Australia

(Source: http://www.fws.gov/r9dia/global/Ramsarfr.html, accessed 1st Sep 1999)

The text of the Ramsar Convention (Article 2.2) states that:

"Wetlands should be selected for the List [of Wetlands of International Importance] on account of their international significance in terms of ecology, botany, zoology, limnology or hydrology" and indicates that *"in the first instance, wetlands of international importance to waterfowl at any season should be included."*

To facilitate the implementation of this provision, the Conference of the Parties has adopted the following four clusters of criteria for the identification of wetlands of international importance:

1. Criteria for representative or unique wetlands
   A wetland should be considered internationally important if:

   (a) it is a particularly good representative example of a natural or near-natural wetland, characteristic of the appropriate biogeographical region; or
   (b) it is a particularly good representative example of a natural or near-natural wetland, common to more than one biogeographical region; or
   (c) it is a particularly good representative example of a wetland which plays a substantial hydrological, biological or ecological role in the natural functioning of a major river basin or coastal system, especially where it is located in a transborder position; or
   (d) it is an example of a specific type of wetland, rare or unusual in the appropriate biogeographical region.

2. General criteria based on plants or animals
   A wetland should be considered internationally important if:

   (a) it supports an appreciable assemblage of rare, vulnerable or endangered species or subspecies of plant or animal, or an appreciable number of individuals of any one or more of these species; or
   (b) it is of special value for maintaining the genetic and ecological diversity of a region because of the quality and peculiarities of its flora and fauna; or
   (c) it is of special value as the habitat of plants or animals at a critical stage of their biological cycle; or
   (d) it is of special value for one or more endemic plant or animal species or communities.

3. Criteria based on waterfowl
   A wetland should be considered internationally important if:

   (a) it regularly supports 20,000 waterfowl; or
   (b) it regularly supports substantial numbers of individuals from particular groups of waterfowl, indicative of wetland values, productivity or diversity; or
   (c) where data on populations are available, it regularly supports 1% of the individuals in a population of one species or subspecies of waterfowl.

4. Criteria based on fish

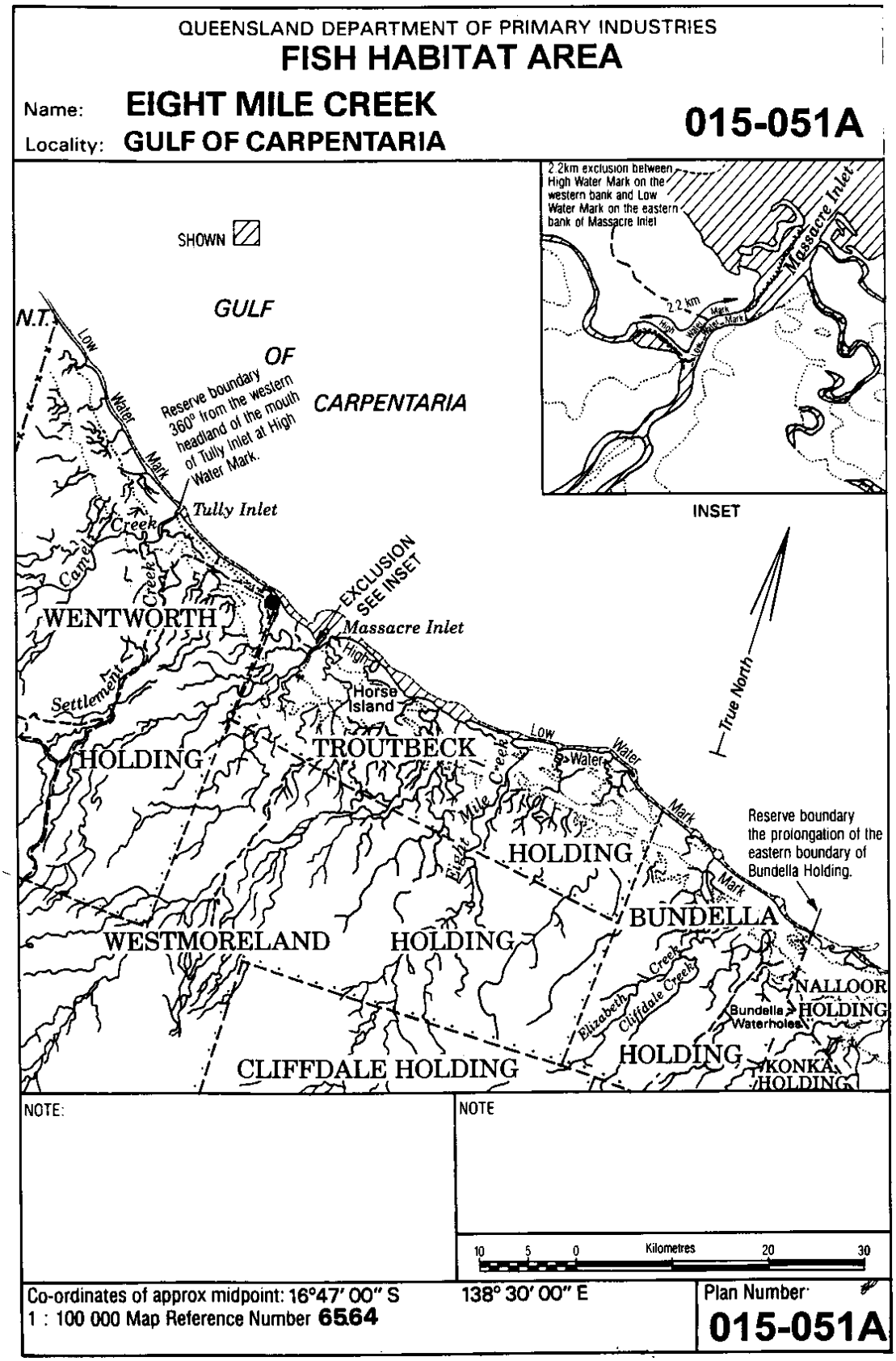
A wetland should be considered internationally important if:

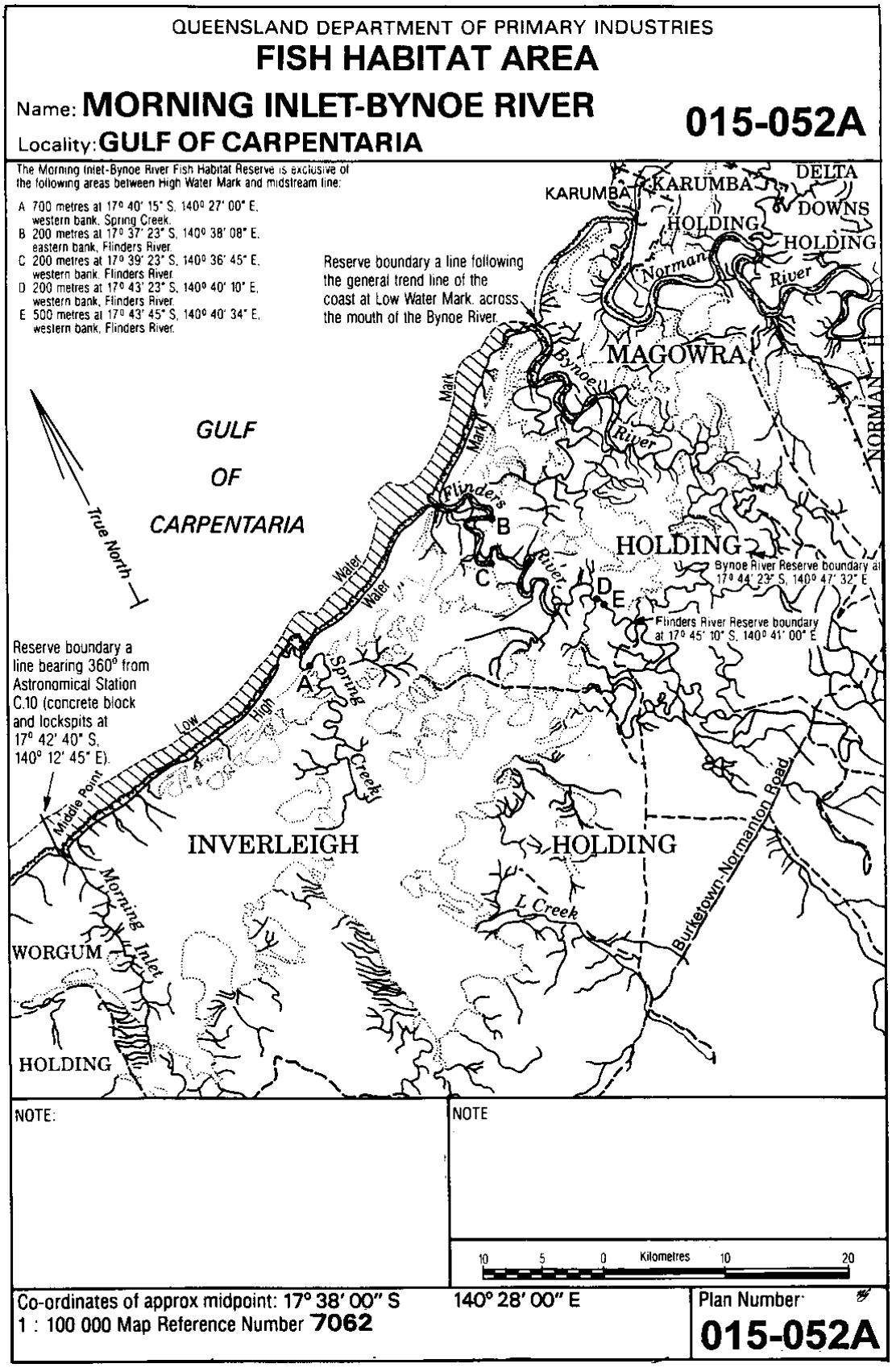
(a) it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity; or
(b) it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetlands or elsewhere, depend.

Each cluster of criteria is supplemented by guidelines for its application. The guidelines can be obtained from the Ramsar Bureau or on the Ramsar Web site.

APPENDIX 4: MPA DECLARATIONS AND NOMINATIONS RESULTING FROM QUEENSLAND COASTAL WETLANDS MAPPING PROJECTS

AREA	FUNDING	STATUS OF MAPPING	STATUS OF REPORT	NEW MPA DECLARATION?
SE GULF OF CARPENTARIA	OR2000 G007/93	Completed 1994	Completed 1995	Recommendations for additional Fish Habitat Areas to regional implementation staff.
CAPE YORK	CYPLUS	Completed 1993	Completed 1994	Annan River – FHA declaration scheduled for late 2000. Kirke River – FHA consultation (NHT funded) complete by late 2000. Starke River – initial FHA consultation (NHT funded) underway, FHA declaration proposal for late 2001. Margaret Bay – FHA consultation scheduled to commence early 2001.
BURDEKIN	OR2000 G006/93	Completed 1994	Completed 1995	Burdekin FHA declared in August, 1999.
EDGECUMBE BAY	MPA G019/96b	Completed 1999	Completed 1999	Edgecumbe Bay – FHA consultation scheduled to commence late 2000.
REPULSE BAY	QDPI Fisheries	Completed 1995	Draft report in preparation.	N/A - confirmation of the fisheries conservation values of existing extensive FHAs only
CURTIS COAST	MPA G019/96a	Completed 1998	Initial report complete, undergoing revision for publication.	Narrows / Fitzroy Delta – under further investigation.
NOOSA TO 1770	MPA 97/98 funding	Completed 1999	Completed 1999	Baffle Creek – FHA declaration scheduled for late 2000. Elliott River – initial FHA consultation underway, FHA declaration proposal for early 2001.
MORETON REGION	QDPI Fisheries	Completed 2000	Completed 2000	N/A - confirmation of the fisheries conservation values of existing extensive FHAs only
CENTRAL QLD	MPA 98/99 funding	Completed 2000	Completed 2000	Recommendations for additional FHAs to regional implementation staff.
GULF OF CARPENTARIA	MPA 98/99 funding	Completed 2000	Completed 2000	Recommendations for additional FHAs to regional implementation staff.
WHITSUNDAYS TO EDGECUMBE BAY	MPA 99/00 funding	Scheduled to commence late 2000.	-	Awaiting mapping and report
CAPE BOWLING GREEN TO COOKTOWN	MPA 99/00 funding	Scheduled to commence late 2000.	-	Awaiting mapping and report


QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES
FISH HABITAT AREA
Name: EIGHT MILE CREEK
Locality: GULF OF CARPENTARIA
015-051A
SHOWN
GULF
OF
CARPENTARIA
N.T.
Low Water Mark
Reserve boundary 360° from the western headland of the mouth of Tully Inlet at High Water Mark.
Tully Inlet
Camel Creek
WENTWORTH
Settlement Creek
EXCLUSION SEE INSET
Massacre Inlet
High Water Mark
Horse Island
HOLDING
TROUTBECK
Low Water Mark
Eight Mile Creek
HOLDING
Reserve boundary the prolongation of the eastern boundary of Bundella Holding.
BUNDELLA
WESTMORELAND
HOLDING
Elizabeth Creek
Cliffdale Creek
NALLOOR
Bundella Waterholes
HOLDING
CLIFFDALE HOLDING
HOLDING
KONKA HOLDING
2.2km exclusion between High Water Mark on the western bank and Low Water Mark on the eastern bank of Massacre Inlet
Massacre Inlet
2.2 km
INSET
True North
NOTE:
NOTE
10 5 0 Kilometres 20 30
Co-ordinates of approx midpoint: 16°47′ 00″ S
138° 30′ 00″ E
1 : 100 000 Map Reference Number 6564
Plan Number
015-051A


QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES
FISH HABITAT AREA
Name: MORNING INLET-BYNOE RIVER
Locality: GULF OF CARPENTARIA
015-052A
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.
GULF OF CARPENTARIA
True North
Reserve boundary a line bearing 360° from Astronomical Station C.10 (concrete block and lockspits at 17° 42' 40" S, 140° 12' 45" E).
Middle Point
Low Water Mark
High Water Mark
Spring Creek
Flinders River
Bynoe River
Norman River
KARUMBA
DELTA DOWNS HOLDING
HOLDING
MAGOWRA
NORMAN H
HOLDING
Bynoe River Reserve boundary at 17° 44' 23" S, 140° 47' 32" E
Flinders River Reserve boundary at 17° 45' 10" S, 140° 41' 00" E
INVERLEIGH
HOLDING
L Creek
Burketown-Normanton Road
Morning Inlet
WORGUM
HOLDING
A
B
C
D
E
NOTE:
NOTE
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
Plan Number
015-052A

The Landsat 5 satellite, launched by the US government, orbits at 705 km above the earth's surface and takes 16 days to sense the whole of the earth's surface. Its instrument, the Thematic Mapper (TM), digitally scans "scenes" which are 185 x 185 km. The scanned scenes are made up of digital values recorded from the amount of light reflected from the Instantaneous Field of View (IFOV) or pixel. TM pixels represent an area of 30 x 30 m on the ground. Thus objects of interest must be at least this size in order to be detected by the sensor. For every pixel, the Landsat TM sensor records light in seven different wavebands. These bands and some general applications for their use are outlined in Table 2.

TABLE 1 Landsat Thematic Mapped Sensor System Characteristics (Jensen 1996).

SENSOR CHARACTERISTIC	DETAILS
IFOV (Instantaneous Field of View) at nadir	25 x 25 m for bands 1 to 5, 7 120 x 120 m for band 6
Data rate	85 MB/s
Quantisation levels	8 bits, 256 levels
Earth coverage	16 days Landsat 4 and 5
Altitude	705 km
Swath width	185 km
Inclination	98.2^{o}

TABLE 2 Characteristics of Landsat Thematic Mapper Bands (Acres 1989)

TM BAND	MICROMETERS	GENERALISED APPLICATION
1 (blue)	0.45–0.52	Coastal water mapping, soil/vegetation differentiation
2 (green)	0.52–0.60	Green reflectance by healthy vegetation
3 (red)	0.63–0.69	Chlorophyll absorption for plant species differentiation
4 (reflective infrared)	0.76–0.90	Biomass surveys, water body delineation
5 (mid-infrared)	1.55–1.75	Vegetation moisture measurement
6 (thermal infrared)	10.40–12.5	Plant heat stress mapping, sea surface temperatures
7 (mid-infrared)	2.08–2.35	Hydrothermal mapping

APPENDIX 7: METADATA

Title: Coastal Wetland Vegetation: NT Border to the Flinders River **DSIN:** 10342

Custodian Queensland Fisheries Service – Assessment and Monitoring Unit

Jurisdiction Australia

Description:

Abstract

Search Words:

Geographic Extent: SE54-01 Mornington, SE54-02 Cape Van Diemen, SE54-05 Westmoreland, SE54-06 Burketown

Bounding **North:** -16.0000

West: 138.0000 **East:** 141.0000

South: -19.0000

Data Currency:

Beginning: 14/08/2000 **Ending:** 14/08/2000

Dataset Status:

Progress: Complete **Maintenance Frequency:** Not Required

Access:

Stored Data Format: DIGITAL - ARC/INFO, NON DIGITAL - Printed maps

Available Format DIGITAL - ARC/INFO, NON DIGITAL - Printed maps

Access QFS data – release outside QFS on completion of a licence agreement

Data Quality:

Lineage: Landsat 5 TM satellite imagery Mornington Island (13 August 1995) and Burketown (18 May 1995) processed using ERDAS Imagine 8.3.1. 6 bands contrast stretched using linear stretch with breakpoints to highlight intertidal regions. Water bodies and terrestrial features masked out. Remaining imagery processed using an unsupervised classification procedure (ISODATA). Classes labelled using aerial photograph interpretation. Photography used = 1: 50 000 Crab Island to NT Border B.P.A. photography acquired in December 1988. Classification converted from raster to vector format using ARC/INFO GIS software. Jagged vector boundaries were splined and polygons with areas under 0.5 hectares were excluded. Dangles removed. Coverage projected from AMG Zone 54 AGD84 ANS to geographics AGD84 ANS.

Positional Accuracy: Landsat scene rectified to AMG with final radiometric correction and GCPs
Datum AGD84 ANS

Attribute Accuracy: Overall accuracy 90%.User's and producer's accuracies for each class included in the report.

Logical Consistency: As no evidence to the contrary has been ascertained, it is considered that this dataset is logically consistent

Completeness: The dataset is complete

Contact Information:

Contact Queensland Fisheries Service – Assessment and Monitoring Unit **OIN:** 102

Contact Position: Fish Data Coordinator

Address: Level 2 80 Ann Street

Locality: Brisbane

State: Qld **Postcode:** 4001 **Country:** Australia

Telephone: 07 3405 6822 **Facsimile:** 07 3224 2805

Email: FishDataCoordinator@dpi.qld.ql **WWW:** dpi.qld.gov.au

Additional Metadata:

Date: 30/08/2000 **Person:** Data Coordinator

Organisation: Queensland Fisheries Service – Assessment and Monitoring Unit

APPENDIX 8: DISTRIBUTION OF COASTAL WETLAND COMMUNITIES IN THE GULF STUDY AREA

Sheet 1: Tully Inlet
Sheet 2: Massacre Inlet
Sheet 3: Eight Mile Creek
Sheet 4: Cliffdale Creek
Sheet 5: Forsyth Island
Sheet 6: Mornington Island (a)
Sheet 7: Mornington Island (b)
Sheet 8: Mornington Island (c)
Sheet 9: Bentinck Island
Sheet 10: Allen Island
Sheet 11: Point Parker
Sheet 12: James Creek
Sheet 13: Tarrant Point
Sheet 14: Gin Arm Creek
Sheet 15: Pasco Inlet
Sheet 16: Burketown
Sheet 17: Leichhardt River
Sheet 18: Gore Point
Sheet 19: M Creek
Sheet 20: Spring Creek (a)
Sheet 21: Spring Creek (b)
Sheet 22: Flinders River

Outcomes

The acquisition and interpretation of digital satellite imagery and aerial photography undertaken as part of this study, has provided a community based classification of the coastal wetland communities of the Gulf Study Area (from the Queensland/Northern Territory border eastwards to the western bank of the Flinders River). This classification forms a component of the baseline assessment of Queensland's coastal wetland resources, to be completed in July 2001. The current project has provided key information and recommendations for the gazettal of two additional managed, protected areas in Queensland (Section 9) and for the ongoing management of existing protected areas (Fish Habitat Areas). Additionally, the information obtained may form a basis for the nomination of Ramsar sites.

Appropriateness

The current study uses the protocol developed by the Department of Primary Industries Queensland, Fisheries Group (Danaher 1995a) which has been recognised (Ward et al. 1998) as an appropriate model for a national approach to coastal wetlands mapping. For the Queensland coast, this coastal wetland resource mapping is an ongoing process, underway since the mid-1990s. To date, approximately 85% of the coastal wetlands have been mapped using this technique (Danaher 1995b; Danaher and Stevens 1995; Danaher personal communication 1999; and Bruinsma et al. 1999; Bruinsma and Duncan, this report).

Effectiveness

The method of investigating and mapping relatively large coastal regions, utilised in this study, has proven to be cost effective with a high degree of accuracy (approximately 90%) for coastal wetland communities at this scale. The Gulf Study Area is a remote area where numerous difficulties can be experienced (e.g. large distances to travel, inaccessibility in the wet season or after rain, crocodiles etc.). The mapping of this area via remote sensing techniques has provided a cost effective and has limited the difficulties experienced.

The information presented in the report has been provided to the DPI Fisheries, Marine Habitat Unit staff responsible for FHA declaration, for the purpose of incorporation into FHA planning processes relevant to the Gulf Study Area.

Transferability

It has been demonstrated, in this and previous studies, that the technique initially developed for coastal wetlands mapping in Moreton Bay is transferable to similar coastal wetland systems throughout Queensland. Landsat TM data is widely available. However, limitations to the technique apply. The minimum mapping unit is a 30 x 30m Landsat TM pixel. Consequently, a community smaller than this size is not mappable using this technique. Additionally, polygons of less than 0.5 ha are eliminated in the mapping process. The mapping technique is generally more accurate in areas where clear zonation in coastal wetland communities occurs.

In the Gulf Study Area difficulties were encountered when applying this technique to the narrow Closed Mixed communities which are common in this area. Many of the communities which fringe drainage channels are below the minimum mapping unit as described above. This difficulty in transferability of the technique was overcome with aerial photograph interpretation and manual editing.

Fulfilment of Project Specifications

This project has been highly successful in meeting the requirements of the project specifications included in the schedule of work. The success of each task has resulted in the production of coastal wetland community maps of the Gulf Study Area with information suitable for use in GIS systems. Additionally, information has been collated regarding the levels of existing disturbance to and protection of the wetlands and existing recreational and commercial fisheries in the region. As a result of this project numerous environments have been identified in the study area, which have a high conservation value from a fisheries perspective. Actions to protect these environments through FHA declaration have been recommended.

Demonstration/Communication Activities Undertaken

The results of the study have been communicated to DPI Queensland Fisheries Service Marine Habitat Unit, Northern Fisheries Centre and other regional DPI Fisheries staff. Copies of the report are available through the QDPI Library and from the libraries at the DPI regional centres in Cairns, Townsville, Mackay, Rockhampton, Bundaberg and Deception Bay. The report is also available as a PDF file on the DPI Fishweb site (http://www.dpi.qld.gov.au/fishweb/habitat)

APPENDIX 10: LAND TENURE AND INTERTIDAL FLATS IN THE GULF STUDY AREA

Sheet 1: Massacre Inlet
Sheet 2: Cliffdale Creek
Sheet 3: Mornington Island
Sheet 4: Bentinck Island
Sheet 5: Leichhardt River
Sheet 6: Flinders River

APPENDIX 11: FIELD DATA

DATE	LOCATION	LAT.	LONG.	GPS ACCURACY (m)*	COMMUNITY CLASSIFICATION	OTHER SPECIES PRESENT
14/06/2000	Leichhardt	-17.60564	139.80026	17.0	Closed *Ceriops*	
14/06/2000	Leichhardt	-17.60337	139.79932	15.0	Closed *Rhizophora*	Exco, Av
14/06/2000	Leichhardt (mouth)	-17.59755	139.79497	21.0	Closed Mixed	Av, Osb, Exco
14/06/2000	Leichhardt	-17.59533	139.79308	16.0	Closed *Ceriops*	Rhiz, Exco, Av
14/06/2000	Leichhardt River	-17.59430	139.79003	47.0	Closed *Avicennia*	Aeg
14/06/2000	Leichhardt River	-17.59641	139.78635	15.0	Closed Mixed	Exco,Cer, Rhiz, Osb, Av, Lum
14/06/2000	Leichhardt River	-17.59616	139.78621	17.0	Saline Grassland	
14/06/2000	Leichhardt River	-17.59514	139.78571	15.0	Closed *Ceriops*	Exco
14/06/2000	Leichhardt	-17.64665	139.81434	11.0	Saline Grassland	Exco, Casuarina
14/06/2000	Leichhardt	-17.64382	139.79316	10.0	Closed Mixed	Rhiz, Exco, Av, Aeg, Cer
14/06/2000	Landsborough Creek	-17.67362	139.78348	24.0	Closed *Avicennia*	Aeg, Exco
14/06/2000	Landsborough Creek	-17.68127	139.76865	16.0	Closed Mixed	Rhiz, Aeg, Av, Exco
14/06/2000	Landsborough Creek	-17.68607	139.75849	19.0	Closed Mixed	Exco, Xylo, Cer
14/06/2000	Landsborough Creek	-17.62695	139.74374	14.0	Closed *Avicennia*	Aeg, Aegl, Exco, Cer
14/06/2000	Albert River	-17.61489	139.74924	11.0	Closed *Ceriops*	Exco, Av
14/06/2000	Albert River	-17.60458	139.75266	11.0	Closed *Rhizophora*	Av, Aeg
14/06/2000	Albert River	-17.59950	139.75033	14.0	Closed *Ceriops*	Exco, Av. Emergents
14/06/2000	Albert River	-17.63347	139.69970	12.0	Closed Mixed	Xylo, Aegl, Rhiz, Aeg, Av, Exco, Cam
14/06/2000	Albert River	-17.67239	139.71893	18.0	Closed Mixed	Rhiz, Aeg, Aegl, Av, Exco
14/06/2000	Albert River	-17.67164	139.69195	24.0	Closed Mixed	Aegl, Cer, Exco, Av, Rhiz
14/06/2000	Albert River	-17.68590	139.66631	16.0	Clsoed Mixed	Av, Aeg, Exco, Rhiz
14/06/2000	Albert River	-17.70398	139.64857	24.0	Clsoed Mixed	Cer, Xylo, Exco, Aeg
14/06/2000	Albert River	-17.70890	139.64496	14.0	Closed *Avicennia*	Aeg, Exco
14/06/2000	Albert River	-17.73983	139.65380	24.0	Closed Mixed	Cer, Xylo, Exco, Aeg, Rhiz
13/06/2000	Flinders River	-17.68925	140.62788	12.0	Saline Grassland	Av
13/06/2000	Flinders River	-17.68865	140.62614		Closed *Avicennia*	Exco, Aegl, Aeg
13/06/2000	Flinders River	-17.61431	140.59495	12.0	Closed Mixed	Av, Exco, Aegl, Aeg
13/06/2000	Flinders River	-17.61600	140.59416	12.0	Closed Mixed	Aeg, Av, Aegl, Exco, Cer
13/06/2000	Flinders River Mouth	-17.60021	140.58661	18.0	Closed *Avicennia*	
13/06/2000	Flinders River Mouth	-17.61053	140.59516	14.0	Closed Mixed	Av, Exco, Cer, Aegl
13/06/2000	Spring Creek	-17.64751	140.44739	15.0	Saltpan	
13/06/2000	Spring Creek	-17.64619	140.44961	16.0	Closed *Avicennia*	
13/06/2000	Spring Creek	-17.65596	140.44382	18.0	Saltpan	
13/06/2000	Spring Creek	-17.65895	140.44485	13.0	Closed *Avicennia*	Cer, Aeg
13/06/2000	Spring Creek	-17.65963	140.44412	17.0	Closed Mixed	Cer, Exco, Av, Aeg
15/06/2000	Massacre Inlet	17.72352	139.63141		Closed *Avicennia*	
15/06/2000	Massacre Inlet	-17.72350	139.63139		Closed Avi/*Ceriops*	
15/06/2000	foreshore	-17.72347	139.63136		Closed *Avicennia*	Aegl
15/06/2000	Point Parker	-17.01830	139.08546	20.0	Closed *Ceriops*	Exco
36692	Point Parker	-17.01905	139.08522	11.0	Closed Mixed	Exco, Cer, Av, Aeg
15/06/2000	Point Parker	-17.01742	139.08501	16.0	Closed Mixed	Cer, Exco, Av, Hib
15/06/2000	1	-17.46301	139.54684	58.0	Closed *Rhizophora*	Av
16/06/2000	2	-17.52107	139.60784	11.0	Closed *Avicennia*	
16/06/2000	3	-17.52139	139.60815	13.0	Saltpan	
16/06/2000	4	-17.57891	139.76060		Closed Mixed	Av, Cer, Exco, Lumn
16/06/2000	5	-17.58669	139.79759	11.0	Closed *Ceriops*	Av
16/06/2000	6	-17.67330	139.79804	13.0	Saline Grassland	
16/06/2000	7	-17.67315	139.79730	14.0	Closed Mixed	Cer, Av, Exco, Lum
16/06/2000	8	-17.67424	139.79984	13.0	Closed Mixed	Cer, Exco, Lum, Emergent Av
16/06/2000	9	-17.67507	139.79824	13.0	Saline Grassland	
16/06/2000	10	-17.65086	139.93133	10.0	Closed *Ceriops*	Av
16/06/2000	11	-17.65035	139.93191	12.0	Closed *Avicennia*	
16/06/2000	12	-17.65059	139.93195	12.0	Saltpan	
15/06/2000	waypoint	-16.7841	138.5587		Saline Grassland	
15/06/2000	waypoint	-16.7837	138.5691		Saltpan	
15/06/2000	waypoint	-16.7862	138.6052		Saltpan	
15/06/2000	waypoint	-16.8013	138.6653		Saltpan	
15/06/2000	waypoint	-16.8742	138.8543		Saltpan	
15/06/2000	waypoint	-16.8803	138.8898		Closed *Avicennia*	Aeg, Cer, Exco
15/06/2000	waypoint	-16.8814	138.9225		Saline Grassland	

DATE	LOCALITY	LAT.	LONG.	GPS ACCURACY (m)*	COMMUNITY CLASSIFICATION	OTHER SPECIES PRESENT
15/06/2000	waypoint	-16.9073	138.9878		Closed Mixed	Exco, Cer, Av, Rhiz
15/06/2000	waypoint	-17.1101	139.1326		Closed *Avicennia*	Cer, Exco
15/06/2000	waypoint	-17.1282	139.1487		Closed *Avicennia*	
15/06/2000	waypoint	-17.2489	139.1896		Closed *Avicennia*	
15/06/2000	waypoint	-17.3533	139.2769		Closed *Avicennia*	
15/06/2000	waypoint	-17.3979	139.4281		Open Mixed	Exco, Av, Cer
15/06/2000	waypoint	-17.4122	139.4425		Closed *Avicennia*	Cer.
15/06/2000	waypoint	-17.4300	139.5084		Closed *Rhizophora*	
16/06/2000	waypoint	-17.6273	139.4844		Saltpan	
16/06/2000	waypoint	-17.5992	139.5096		Saltpan	
16/06/2000	waypoint	-17.5807	139.5346		Closed Mixed	Av, Exco, Cer, Xylo, Hib
16/06/2000	waypoint	-17.5581	139.5513		Closed *Avicennia*	Cer, Exco, Rhiz
16/06/2000	waypoint	-17.7328	139.6596		Closed Mixed	Av, Cer, Xylo, Exco, Rhiz
16/06/2000	waypoint	-17.7575	139.6628		Closed Mixed	
16/06/2000	waypoint	-17.7152	139.7932		Closed Mixed	Av, Exco, Cer, Xylo, Rhiz
16/06/2000	waypoint	-17.6902	139.8126		Closed *Avicennia*	
16/06/2000	waypoint	-17.6624	139.8493		Closed Mixed	Av, Exco, Lum, Cer
16/06/2000	waypoint	-17.7347	139.9751		Saltpan	
16/06/2000	waypoint	-17.7211	140.1167		Closed *Avicennia*	
16/06/2000	waypoint	-17.6292	140.5239		Closed *Avicennia*	
16/06/2000	waypoint	-17.5877	140.6115		Closed *Avicennia*	

* GPS accuarcy readings were not available for coordinates taken from the helicopter GPS unit (waypoints).

Abbreviations:
Aeg – *Aegiceras corniculatum*
Aegl – *Aegialitis annulata*
Av – *Avicennia marina*
Cam – *Camptostemon schultzii*
Cer – *Ceriops tagal*
Exco – *Excoecaria agallocha*
Hib – *Hibiscus tiliaceus*
Lum – *Lumnitzera racemosa*
Osb – *Osbornia octodonta*
Rhiz – *Rhizophora stylosa*
Xylo – *Xylocarpus moluccensis*

No field sites were accessed on the Wellesley Islands due to time and budget constraints. Species previously recorded at Dugong River, Mornington Island ($160^0$41'S $139^0$13'E) by Norm Duke (University of Queensland pers. comm. 2000) include *A. annulata*, *A. corniculatum*, *A. marina*, *B. exaristata*, *C. tagal* var. *australis*, *O. octodonta*, *P. acidula*, *R. stylosa*, *T. populnea*.