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Queensland COASTAL WETLAND RESOURCES

The Whitsunday Region

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EXECUTIVE SUMMARY

This report provides key resource data for the ongoing assessment of the requirement for additional Marine Protected Areas (e.g. FHAs under the *Queensland Fisheries Act 1994*) in regions of high fish habitat value in the Whitsunday Region from Gloucester Island to Cape Hillsborough (hereafter referred to as the Study Area). The study also provides baseline information on the coastal wetlands within this Study Area for consideration in the Ramsar site nomination process. The project aimed to:

1. document and map the coastal wetland communities of the 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.

The mapping of Queensland's coastal wetland environments by the Department of Primary Industries, Queensland Fisheries Service (QFS) has been an ongoing process, underway since the mid-1990s. This systematic exercise has been undertaken using a standard protocol that was developed by the QFS (Danaher 1995a) and has been recognised (Ward et al. 1998) as an appropriate model for a national approach to coastal wetland mapping.

The QFS Queensland Coastal Wetland Mapping Project has been supported by funding from the Cape York Peninsula Land Use Strategy (CYPLUS), the Great Barrier Reef Marine Park Authority (GRBMPA) through Ocean Rescue 2000 and Environment Australia through the Natural Heritage Trust *Coasts and Clean Seas* Marine Protected Areas Program. The project has been undertaken in a number of phases. The current study forms the last stage of a three-year phase that has been supported by funding from Environment Australia through the Natural Heritage Trust *Coasts and Clean Seas* Marine Protected Areas Program. Table I summarises the details of this project. Figure 1, Section 1 displays the project areas.

This report contributes to a series of reports outlining the status of coastal wetland resources in Queensland. Other reports in the series document the coastal wetland resources of:

- the Northern Territory Border to the Flinders River (Bruinsma and Duncan 2000)
- the south east Gulf of Carpentaria (Danaher and Stevens 1995),
- Cape York Peninsula (Danaher 1995a),
- Cape Tribulation to Bowling Green Bay (Bruinsma 2001),
- the Burdekin (Danaher 1995b),
- the Bowen region (Bruinsma et al. 1999),
- Sand Bay to Keppel Bay (Bruinsma 2000),
- the Curtis Coast (Danaher et al. unpublished report),
- Round Hill Head to Tin Can Inlet (Bruinsma and Danaher 2000),
- the Moreton Region (Duncan et al. unpublished report).

TABLE I Details of the Queensland coastal wetland resources project supported by funding from Environment Australia through the Natural Heritage Trust *Coasts and Clean Seas* Marine Protected Areas Program.

SPECIFIC PROJECT AREA	FUNDING DETAILS	REPORT	MPA DECLARATION?	FUNDING AGENCY CONTRIBUTION	QFS CONTRIBUTION
A) Stage 1 Noosa to Town of Seventeen Seve nty (southern Queensland) (1998-1999)					
Round Hill Head to Tin Can Inlet	MPA 97/98 funding	Bruinsma, C and Danaher, K (2000). Queensland Coastal Wetland Resources: Round Hill Head to Tin Can Inlet. QI99081. Department of Primary Industries, Queensland, Brisbane, 101 pp.	Baffle Creek – FHA declared Sep 2001. Elliott River – initial FHA consultation nearing completion, FHA declaration proposed for early 2002.	$56 985	$79 949
B.1) Stage 2 Fitzroy River to St Helens (Central Queensland) (1999-2000)					
Sand Bay to Keppel Bay, Central Queensland	MPA 98/99 funding	Bruinsma, C (2000). Queensland Coastal Wetland Resources: Sand Bay to Keppel Bay. QI00100. Department of Primary Industries, Queensland, Brisbane, 94 pp.	Narrows / Fitzroy Delta – seeking NHT funding, FHA consultation to commence early 2002.	$64 504 (= total for Stage 2)	$77 908 (= total for Stage 2)
B.2) Stage 2 Flinders River to the Northern Territory Border (Gulf of Carpentaria) (1999-2000)					
The Northern Territory Border to Flinders River	MPA 98/99 funding	Bruinsma, C and Duncan, S (2000). Queensland Coastal Wetland Resources: the NT border to Flinders River. QI00099. Department of Primary Industries, Queensland, Brisbane, 72 pp.	Recommendations for additional FHAs to regional implementation staff.	AS ABOVE	AS ABOVE
C.1) Stage 3 Whitsundays to Edgecumbe Bay (2000-2001)					
Cape Gloucester to Conway Inlet (does not include Edgecumbe Bay)	MPA 99/00 funding	Bruinsma, C and Danaher, K (2001). Queensland Coastal Wetland Resources: The Whitsunday region. QI01065. Department of Primary Industries, Queensland, Brisbane, 60 pp.	Recommendations for additional FHAs to regional implementation staff.	$61 478 (= total for Stage 3)	$59 152 (= total for Stage 3)
C.2) Stage 3 Cape Bowling Green to Cooktown (North Queensland) (2000-2001)					
Cape Tribulation to Bowling Green Bay	MPA 99/00 funding	Bruinsma, C (2001). Queensland Coastal Wetland Resources: Cape Tribulation to Bowling Green Bay. QI01064. Department of Primary Industries, Queensland, Brisbane, 85 pp.	Recommendations for additional FHAs to regional implementation staff.	AS ABOVE	AS ABOVE

Project Effectiveness and Limitations

The method of investigating and mapping coastal wetland communities of relatively large coastal regions, utilised in this study, has proven to be cost effective at this scale with a high degree of accuracy (>80%). The information presented in the report has been provided to the DPI Queensland Fisheries Service, Marine Habitat Unit staff responsible for FHA declaration, for the purpose of incorporation into FHA planning processes relevant to the Study Area.

It has been demonstrated, in this and previous departmental studies, that this technique developed for broad scale coastal wetlands mapping is transferable to similar coastal wetland systems. Landsat TM data is widely available. However, the spatial and spectral resolutions of the Landsat TM sensor result in some limitations. The smallest community that can be detected by the Landsat TM sensor is a community equal to or larger than a

pixel (that is 25 x 25 m). The spectral resolution of the data is too low (seven wide bands of information collected) to be able to distinguish spectrally similar species. 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. The resolution of the satellite imagery and the mapping process used results in a product that should not be interpreted at scales larger than 1: 100 000. An overall evaluation of the project is included in Appendix 8.

Coastal Wetland Communities of the Study Area

The Whitsunday Region Study Area can be divided into two regions based on the terrain of the coastal land. From Gloucester Island to the northern bank of the Proserpine River, the coastal land is generally of high relief and rises sharply from the ocean, leaving only a very narrow intertidal strip. In comparison, the coastal region from the southern bank of the Proserpine River to Cape Hillsborough is of relatively low relief. A wider coastal plain in this region allows the establishment of larger coastal wetland communities. Mountain ranges to the west feed the creeks and rivers that flow into Repulse Bay.

Within the Study Area, Closed *Rhizophora* communities occupy almost half of the total area of coastal wetland communities. In general, Closed *Rhizophora* communities are found on the seaward zone of the intertidal profile. Further landward, narrow communities of Closed *Ceriops* and Saltpan commonly occur. In regions where freshwater input is greater, for example in upstream locations in creeks and rivers, Closed Mixed communities are found. Table II lists the areas of coastal wetland communities within the Study Area.

TABLE II Total area of coastal wetland communities in the Study Area.

COASTAL WETLAND COMMUNITY	AREA (ha)
Closed *Rhizophora*	6 007
Closed *Avicennia*	90
Open *Avicennia*	3
Closed *Ceriops*	2 547
Closed Mixed	3 727
Closed *Bruguiera*	142
Saline Grassland	79
Saltpan	1 327
Total	13 922

Threats to Coastal Wetland Communities

Within the Proserpine and Pioneer/O'Connell catchments a large proportion of the land area is utilised for grazing and agricultural production. Unless carefully managed, these landuses have the potential to impact on the quality of estuarine ecosystems through the input of sediments and nutrients to the waterways. Erosion and expansion of agricultural land are major issues of concern for the catchments of the Study Area.

Increased tourism and the development of tourism infrastructure could have a significant impact on the coastal strip and offshore islands within the Study Area (DPI 1993). Activities associated with land based and marine tourism can potentially impact on reefs, inshore seagrass beds & mangrove habitats.

Protection of Coastal Wetland Communities

Important fish habitats within this Study Area are well represented in existing declared FHAs, Marine Parks and National Parks. A large proportion of coastal wetland vegetation in the Study Area is currently protected within the Repulse Bay and Midge Point FHAs. Recommendations to extend the current protected area network in areas where important habitats are not protected are made below.

Fisheries Resources of the Study Area

In the Study Area, shark, barramundi, mullet, grey mackerel, blue threadfin, mud crab, king threadfin and queenfish are the main species that contribute to the tropical inshore and estuarine fishery. The species in this fishery rely on coastal wetland communities at some stage of their life cycle. Tiger, endeavour, king and banana prawns contribute to the trawl fishery in the Study Area.

Very limited information on recreational and indigenous fishing activities is available for the Study Area. Recreational fishing occurs to varying degrees in most accessible creeks and estuaries in the Study Area and along the beach near population centres.

Recommendations

Within the current Study Area, important fish habitats include the coastal wetlands, intertidal flats and seagrass meadows at Conway Inlet, Midge Point to Dewars Point and Dewars Point to Finlaysons Point. This study supports the inclusion of these habitats within the Repulse Bay and Midge FHAs.

In addition to these important habitats two regions, the Cumberland Islands and the Proserpine/O'Connell Rivers, have been identified as representative habitats that are suitable for nomination as FHAs. It is recommended that:

- The fish habitat values of the Cumberland Islands are recognised.
- The Proserpine/O'Connell Rivers are considered for protection with a FHA.

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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 fish habitats are further protected through the declaration of Fish Habitat Areas (FHAs). The FHA concept focuses on the inclusion, linkage and management of all available habitat types within an area as a single unit, rather than simply protecting individual specific habitat types (McKinnon and Sheppard 2001).

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.

Coastal wetland environments are important habitat for many species of birds, reptiles and marine life, which depend on these habitats for the provision of food, shelter, breeding and nursery areas. Different types of Marine Protected Areas have been established to protect and manage the various ecological, aesthetic, economic, social and cultural values of wetland habitats. FHAs fall within category IV of the World Conservation Union (IUCN) categories for protected areas.

Significant wetland areas are also protected 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. Further details of the criteria for the assessment of wetlands for Ramsar nomination can be found in Appendix 3.

This report provides key resource data for the ongoing assessment of the requirement for additional Marine Protected Areas (e.g. FHAs under the *Queensland Fisheries Act 1994*) in regions of high fish habitat value the Whitsunday Region from Gloucester Island to Cape Hillsborough (hereafter referred to as the Study Area). The study also provides baseline information on the coastal wetlands within this Study Area for consideration in the Ramsar site nomination process. The project aimed to:

1. document and map the coastal wetland communities of the 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 Project Rationale and Status

The mapping of Queensland's coastal wetland environments by the Department of Primary Industries, Queensland Fisheries Service (QFS) has been an ongoing process, underway since mid-1990s. The investigation of the spatial distribution of Queensland's coastal wetland resources uses the protocol developed by the QFS (Danaher 1995a) which has been recognised (Ward et al. 1998) as an appropriate model for a national approach to coastal wetland mapping. The current mapping of the Whitsunday Region (from Gloucester Island to Cape Hillsborough) contributes to the spatial assessment of Queensland's coastal wetland resources. The concurrent mapping of the area from Cape Tribulation to Bowling Green Bay completes the spatial assessment of Queensland's coastal wetland resources. Previous mapping projects that have contributed to the systematic mapping of the coastal wetland resources in Queensland are listed in Table 1. Mapping regions are illustrated in Figure 1.

There is a need to identify and map fish 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.

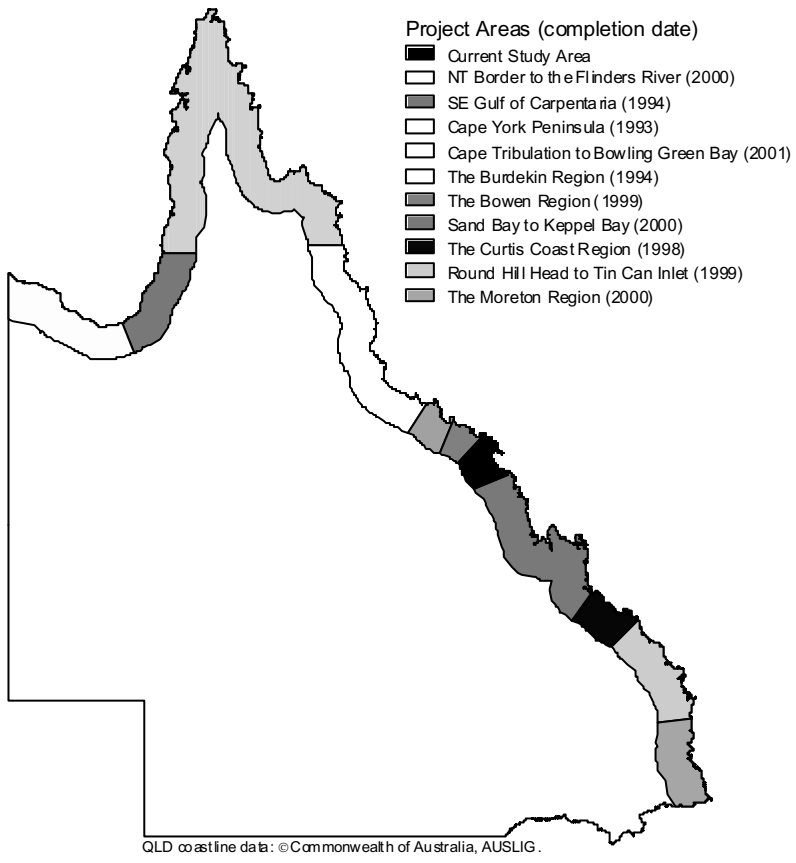

FIGURE 1 Queensland coastal wetlands resource mapping regions.

TABLE 1 Details of the Queensland Fisheries Service Queensland coastal wetland mapping projects.

AREA	PROJECT FUNDING	DATA CURRENCY (=DATE OF IMAGERY USED)	REPORT REFERENCE	NEW MPA DECLARATION?
Marine Protected Areas Program, *Coast and Clean Seas*, Natural Heritage Trust (1998-2001)				
A) ROUND HILL HEAD TO TIN CAN INLET	MPA 97/98	1997	Bruinsma, C and Danaher, K (2000). Queensland Coastal Wetland Resources: Round Hill Head to Tin Can Inlet. QI99081. Department of Primary Industries, Qld, Brisbane, 101 pp.	Baffle Creek – FHA declared Sep 2001. Elliott River – initial FHA consultation nearing completion, FHA declaration proposed for early 2002.
B.1) NT BORDER TO FLINDERS RIVER	MPA 98/99	1995	Bruinsma, C and Duncan, S (2000). Queensland Coastal Wetland Resources: the NT border to Flinders River. QI00099. Department of Primary Industries, Qld, Brisbane, 72 pp.	Recommendations for additional FHAs to regional implementation staff.
B.2) CENTRAL QLD	MPA 98/99	1995 1997	Bruinsma, C (2000). Queensland Coastal Wetland Resources: Sand Bay to Keppel Bay. QI00100. Department of Primary Industries, Qld, Brisbane, 94 pp.	Narrows / Fitzroy Delta – seeking NHT funding, FHA consultation to commence early 2002.
C.1) CAPE TRIBULATION TO BOWLING GREEN BAY	MPA 99/00	1997 1998 1999	Bruinsma, C (2001). Queensland Coastal Wetland Resources: Cape Tribulation to Bowling Green Bay. QI01064. Department of Primary Industries, Qld, Brisbane, 85 pp.	Recommendations for additional FHAs to regional implementation staff.
C.2) THE WHITSUNDAY REGION	MPA 99/00	1997	Bruinsma, C and Danaher, K (2001). Queensland Coastal Wetland Resources: The Whitsunday region. QI01065. Department of Primary Industries, Qld, Brisbane, 60 pp.	Recommendations for additional FHAs to regional implementation staff.
Marine Protected Areas Program (1996/1997) Project Number GO19/96				
THE CURTIS COAST REGION	MPA G019/96a	1997	Danaher, K, Bruinsma, C, Treloar, P and O'Neill, M (unpublished report). Queensland Coastal Wetland Resources of the Curtis Coast Region: Raglan Creek to Round Hill Head. Department of Primary Industries, Qld, Brisbane.	Narrows / Fitzroy Delta – as above.
THE BOWEN REGION	MPA G019/96b	1994 1995	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, Qld, Brisbane, 59 pp.	Edgecumbe Bay – seeking NHT funding, FHA consultation scheduled to commence Jan 2002.
SE GULF OF CARPENTARIA	OR2000 G007/93	1987 1988 1991 1992	Danaher, K and Stevens, T (1995). Resource Assessment of the Tidal Wetland Vegetation of Western Cape York Peninsula, North Queensland, Report to Ocean Rescue 2000. Department of Primary Industries, Qld, Brisbane, 50 pp.	Recommendations for additional FHAs to regional implementation staff.
Other Mapping Projects				
CAPE YORK PENINSULA	CYPLUS	1986 1987 1988 1991	Danaher, K (1995a). Marine Vegetation of Cape York Peninsula. Cape York Peninsula Land Use Strategy, Office of Co-ordinator General of Queensland, Brisbane, Department of the Environment, Sport and Territories, Canberra, and Department of Primary Industries, Qld, Brisbane, 104 pp.	Annan River – consultation complete. FHA declaration scheduled for late 2001. Kirke River – FHA consultation (NHT funded) is ongoing. Starke River – first round of FHA consultation (NHT funded) complete, FHA declaration during 2002. Margaret Bay – preliminary FHA consultation commenced.
THE BURDEKIN REGION	OR2000 G006/93	1991	Danaher, K (1995b). Coastal Wetlands Resources Investigation of the Burdekin Delta for Declaration as Fisheries Reserves: Report to Ocean Rescue 2000. Department of Primary Industries, Qld, Brisbane, 33 pp.	Burdekin FHA declared in August, 1999.
REPULSE BAY	Queensland Fisheries Service	1989	Bruinsma, C and Danaher, K (2001). Queensland Coastal Wetland Resources: The Whitsunday region. QI01065. Department of Primary Industries, Qld, Brisbane, 60 pp.	Recommendations for additional FHAs to regional implementation staff.
MORETON REGION	Queensland Fisheries Service	1995	Duncan, S and Bruinsma, C (unpublished report). Queensland Coastal Wetland Resources: South East Queensland. Department of Primary Industries, Qld, Brisbane.	N/A - confirmation of the fisheries conservation values of existing extensive FHAs only.

SECTION 2 BACKGROUND

2.1 The Study Area

The Whitsunday Region Study Area is located between Gloucester Island, approximately 20 km east of Bowen, and Cape Hillsborough, approximately 30 km north west of Mackay. The stretch of coastline encompasses many small bays and peninsulas and includes numerous continental islands. The Cumberland Islands are located within the Study Area and consist of the Whitsunday Group, the Molle Group, the Lindeman Group and the Sir James Smith Group. Figure 2.1 displays the Study Area and the many islands located in this section of coastline.

The coastal land from Gloucester Island to the northern bank of the Proserpine River, and including the Cumberland Islands, is mostly densely forested terrain of high relief. The steep slopes of the hills rise from the ocean leaving only very narrow sandy beaches and intertidal areas. With the exception of the hills at the southern extent of the Study Area, the region from Proserpine River to Cape Hillsborough is characterised by a coastal plain. This coastal plain is utilised extensively for sugar cane production and grazing.

The coastline from Cape Conway to Cape Hillsborough encloses Repulse Bay. The catchment area of this Bay is bordered in the west by Clarke Range, which reaches heights of over 1000 m. The two main rivers in the Study Area, the Proserpine and O'Connell Rivers, flow from the range across extensive cane fields into the northern end of the Bay. Numerous small creeks feed the southern end of the Bay.

The Whitsunday shire has a population of 18 380, with 6 170 settled in Airlie Beach/Cannonvale (20° 15'S and 148° 43'E) and 3 250 in Proserpine (20° 24'S and 148° 35'E) (ABS 1996). Airlie Beach, as the main access point to the Whitsunday Islands, is a tourist town, while Proserpine services sugar cane production and processing.

The mean annual rainfall for the Study Area varies between 2 330 mm at Conway Station to 1 483 mm within Proserpine River catchment. Cyclone occurrence is around 15 per decade. South-easterly winds prevail, and a long fetch through the Hillsborough Channel allows the wind to build up a considerable chop during the day which dramatically increases water turbidity (Marine Bio Logic 1990). The extreme tidal range at East Repulse Island is 4.9 m with a mean spring tidal range of 3.7 m. Table 2.1 lists the hydrology and catchment characteristics of the main estuaries within the Study Area.

The Whitsunday Region Study Area falls within the Lucinda–Mackay Coast Bioregion as defined in the Interim Marine and Coastal Regionalisation for Australia (IMCRA Technical Group 1998). The Study Area lies adjacent to the Central Mackay Coast Bioregion as defined in the Interim Biogeographic Regionalisation of Australia. This terrestrial bioregion is characterised by humid tropical coastal ranges and plains with rainforests (complex evergreen and semi-deciduous notophyll vine forest), *Eucalyptus* open forests and woodlands and *Melaleuca* spp. wetlands (Thackway and Cresswell 1995).

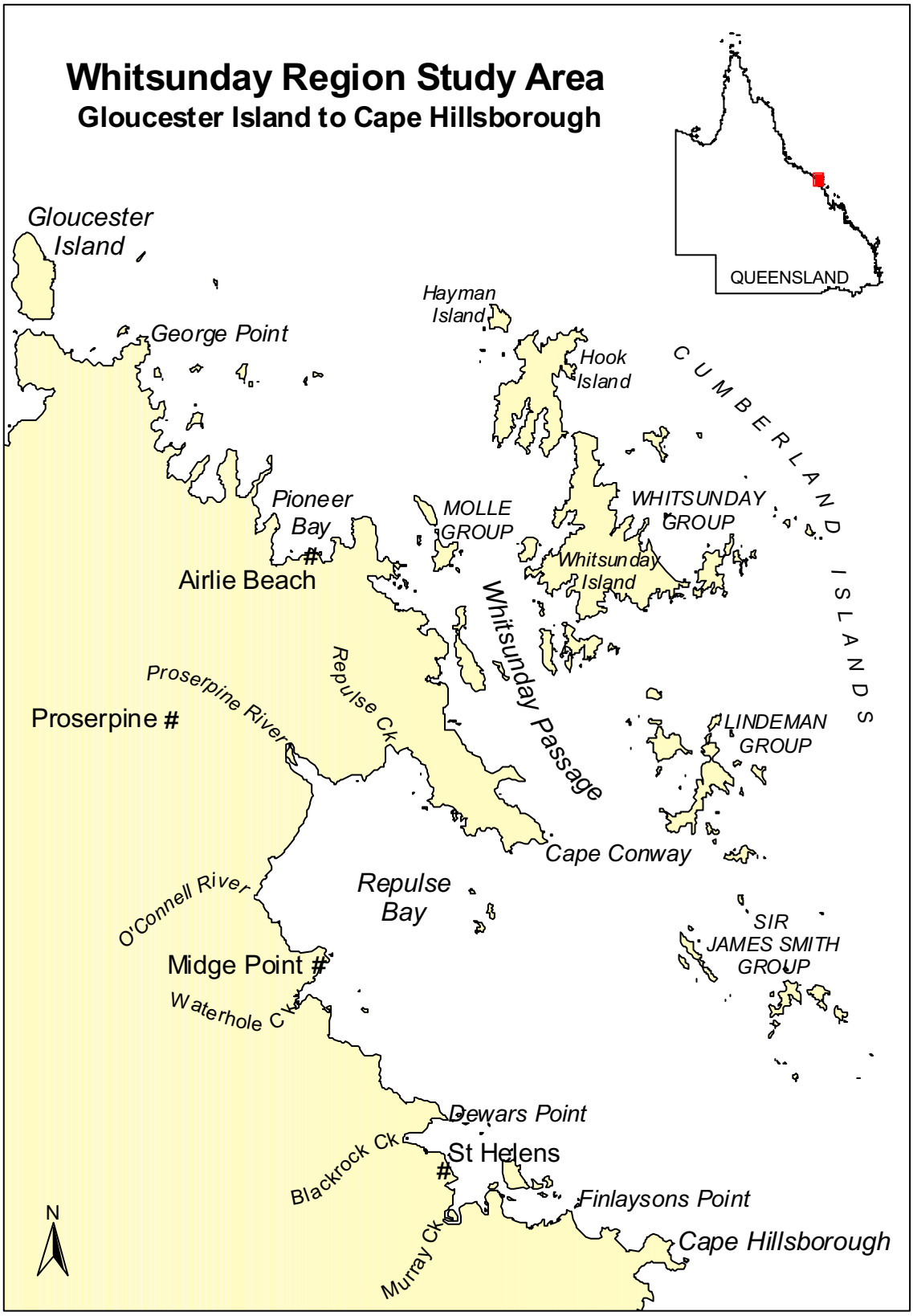

FIGURE 2.1. The Whitsunday region Study Area.

TABLE 2.1 Hydrology and catchment characteristics of major estuaries in the Study Area.

NAME	CATCHMENT AREA (km^2)	MEAN ANNUAL RAINFALL (mm)	RUNOFF COEFFICIENT	EXTREME TIDAL RANGE (m)	FISHERIES VALUE	CONSERVATION THREAT
Repulse Creek	155	2330	0.22	4.9	Moderate	None
Proserpine River	1095	2330	0.25	4.9	Moderate	Perceived
Thompson Creek	86	1626	0.42	4.9	Moderate	None
O'Connell River	859	1626	0.42	4.9	Moderate	Perceived
Dempster Creek	119	1507	0.43	4.9	Moderate	None
Hervey Creek	65	1507	0.43	4.9	Low	None
Blackrock Creek	226	1690	0.38	4.9	Moderate	None
Murray Creek	570	1690	0.38	4.9	Moderate	None
Victor Creek	42	1690	0.38	4.9	Moderate	None
Plantation Creek	49	1785	0.36	4.9	Low	None

Data compiled from the Australian Estuarine Database (Digby et al. 1999).
Only data for main estuaries within the Study Area were included.

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 established that the estuarine habitats provided by mangroves and seagrasses are critical to many commercially and recreationally important fish and crustacean species during some stage of their life cycle. Species that are estuarine dependent include 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.

Fish Habitats Mapped in this Study

For the purposes of this study, environments located between the highest astronomical tide contour and the low water mark (i.e. the intertidal communities) are described collectively as coastal wetlands. The coastal wetlands mapped in this study are 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 mangrove 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 are virtually unvegetated or have a sparse ground cover of samphire vegetation or algae. Saline Grasslands are those areas that are dominated by *Sporobolus virginicus* (salt couch). Coastal wetland communities in this study refer to tidal wetlands only. Freshwater wetlands, such as *Melaleuca* swamp or sedgelands, have not been included.

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 estuarine mangrove communities than areas of low freshwater availability. In Queensland this is clearly demonstrated in the north of the state. The relatively dry coastline of the Gulf of Carpentaria supports less than twenty species of mangrove (Bruinsma and Duncan 2000). In comparison, more than thirty species have been recorded for areas of similar latitude (e.g. from Cairns to Ingham) on the wetter eastern coastline of Australia (Bruinsma 2001).

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 several times 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 community types.

The following twenty species of mangroves have been recorded in the Study Area from field observations and by Saenger (1982):

- *Acanthus ilicifolius* L. holly leaf mangrove
- *Acrostichum speciosum* Willd. mangrove fern
- *Aegialitis annulata* R. Br. club mangrove
- *Aegiceras corniculatum* (L.) Blanco river mangrove
- *Avicennia marina* (Forsk) Vierh. grey mangrove
- *Bruguiera exaristata* Ding Hou orange mangrove
- *Bruguiera gymnorhiza* L. Lam. large leaf orange mangrove
- *Bruguiera parviflora* (Roxb.) Griffith small leaf orange mangrove
- *Ceriops tagal* C. T. White yellow mangrove
- *Cynometra iripa* Kostel. wrinkle pod mangrove
- *Excoecaria agallocha* L. milky mangrove
- *Heritiera littoralis* Aiton looking glass mangrove
- *Hibiscus tiliaceus* L. cotton tree
- *Lumnitzera racemosa* Willd. black mangrove
- *Rhizophora apiculata* Blume tall stilted mangrove
- *Rhizophora lamarckii* Montr. red mangrove
- *Rhizophora stylosa* Griff. red mangrove
- *Sonneratia alba* Sm. white flowering mangrove apple
- *Xylocarpus granatum* Koen cannonball mangrove
- *Xylocarpus moluccensis* Pierre cedar mangrove.

For the purposes of this study, *H. tileaceus* is considered to be a "marginal mangrove species" as in some instances individuals are found growing in the marine tidal zone, whereas in other locations individuals 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 fish 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 regions such as 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 subtropical saltmarsh habitats are utilised by abundant and diverse communities of both estuarine-resident and estuarine-marine fish species. More than half of the fish species caught on the saltmarsh habitat were 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.

Saenger (1982) recorded the following twelve saltmarsh species in the Study Area:

- *Crinum pedunculatum* R. Br.
- *Fimbristylis ferruginea* (L.) Vahl
- *Halosarcia indica* (Willd.) Paul G. Wilson
- *Halosarcia pergranulata* (J.M.Black) Paul G. Wilson
- *Limonium australe* (R.BR.) Kuntze
- *Myoporum acuminatum* R.BR.
- *Salsola kali* L.
- *Sesuvium portulacastrum* (L.) L.
- *Spinefex hirsutus* Labill.
- *Sporobolus virginicus* (L.) Kunth
- *Suaeda maritima* (L.) Dumort
- *Tecticornia australiasica* (Moq.) Paul G. Wilson.

Other Fish 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.

Coles et al. (1987) reports on the distribution of seagrass communities between Bowen and Water Park Point in 1987. The following species were reported from the Study Area:

- *Cymodocea rotundata* Ehrenb. et Hempr. ex Aschers.
- *Cymodocea serrulata* (R. Br.) Aschers. and Magnus
- *Halodule uninervis* (Forsk.) Aschers.
- *Halophila ovalis* (R. Br.) Hook F.
- *Halophila ovata* Gaud.
- *Halophila spinulosa* (R. Br.) Aschers.
- *Halophila tricostata* Greenway
- *Syringodium isoetifolium* (Aschers.) Dandy
- *Thalassia hemprichii* (Enrenb.) Aschers.

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 fish 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).

The Great Barrier Reef Marine Park Authority has mapped the distribution of intertidal flats and coral reefs within the Great Barrier Reef Marine Park. The coral reefs of this region are recognised globally as ecologically significant and are world heritage listed. They provide shelter and food for a high diversity of reef and pelagic animals that colonise or are attracted to these biological structures (eg. sponges, coral and fish).

SECTION 3 METHODS

3.1 Data

Maps of coastal wetland communities were produced from Landsat 5 Thematic Mapper (TM) satellite imagery. Imagery acquired on the 16 July 1997 was used. 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 Map Grid of Australia (Zone 55) using the Australian National Spheroid and the Geodetic Datum of Australia (1994).

The spatial resolution of Landsat TM data is 25 m x 25 m. Spectral characteristics of the data as well as details of the Landsat satellites are outlined in Appendix 4.

Aerial photography was used to aid in the classification of the coastal wetland vegetation. The photography used in this study was 1: 50 000 and 1: 12 000 St Lawrence to Townsville Beach Protection Authority photography acquired in June and August 1993, and 1: 12 000 St Lawrence to Townsville Beach Protection Authority photography acquired in May 1998.

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. Landsat TM bands 1-5 and 7 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 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 of the coastal wetland communities of the Study Area 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 5 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 3.2 software at a scale of 1: 100 000 (Appendix 6).

3.3 Field Methods

Ground truthing of the computer-based classification was conducted during June 1993, November 1993, November 1995 and November 1997. The sites visited and the field data recorded are listed in Appendix 7. At each of 35 sites, 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.

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.

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 Overview Map of Fish Habitats

An overview map of fish habitats was created from various sources using ARCVIEW ® Version 3.2 GIS software. Along with the mangrove and saltmarsh communities mapped as part of this study, spatial datasets of seagrass meadows, intertidal foreshore flats, reefs and coral cays were obtained. A list of the datasets obtained, their source and currency is included in Table 3.1.

The AUSLIG GEODATA product, from which the freshwater swamps theme was taken, is primarily sourced from the 1: 250 000 scale National Topographic Map Series, which was completed in 1988. In this series, swamps are defined as land that is so saturated with water that it is not suitable for agricultural or pastoral use and presents a barrier to free passage. It is often covered with characteristic grass and reed growths, and the degree of wetness may vary with season (AUSLIG 1994).

TABLE 3.1 Details of digital datasets used in the overview map of fish habitats.

TITLE	CUSTODIAN	CURRENCY	DESCRIPTION
Coral reefs	GBRMPA	13-01-1994	Major coral reef structures in the GBR region
Intertidal foreshore flats	GBRMPA	unknown	Intertidal foreshore areas
Seagrass meadows	Department of Primary Industries, Queensland (QDPI)	00-11-1984	Seagrass meadows between Cape York and Hervey Bay
Freshwater swamps	Australian Land, Survey and Information Group (AUSLIG)	~1988	Freshwater swamps theme from the digital GEODATA TOPO-250K topographic map series.

3.6 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:

- Size
- Diversity of or specific habitat features
- Diversity of or specific marine fauna and flora
- Level of existing and future disturbances
- Unique features
- Existing or potential fishing grounds
- Protected species.

The details of the methods of assessment of these criteria are included in Table 9.2. The results of the assessment are summarised in Table 9.1.

SECTION 4 RESULTS

4.1 Description of the Mapping Units

CLOSED *RHIZOPHORA*	FIGURE 4.1
Habitat	Occurs fringing waterways low in intertidal zone with roots submerged during high tides.
Canopy	Usually dominated by *Rhizophora* spp. with occasional *X. moluccensis* and *A. marina*. PFC is more than 50%. Height varies from 4 m to more than 12 m.
Shrub layer	Poorly developed or completely absent.
Ground cover	*Rhizophora* spp. stilt roots with a sparse cover of *Rhizophora* spp. seedlings.

CLOSED *AVICENNIA*	FIGURE 4.2
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,* with occasional *Ceriops* spp., *E. agallocha., Rhizophora* spp., *Bruguiera* spp. and *Sonneratia* spp., forming a dense canopy with a PFC of greater than 50%. Height varies from 2 m to more than 10 m.
Shrub layer	Occasional presence of *A. annulata* and *A. corniculatum* to 2 m in height.
Ground cover	Consists of seedlings of the species present among the pneumatophores of *A. marina.*

CLOSED *CERIOPS*	FIGURES 4.3
Habitat	Generally occur on upstream creek edges and towards the upper intertidal limit landward of *Rhizophora* spp. communities on more elevated land. Only inundated by the spring tides.
Canopy	Dominated by *Ceriops* spp. with occasional *Rhizophora* spp., *Bruguiera* spp., *Sonneratia* spp. and *A. marina*. PFC greater than 50%. Height varies from 1.5 m to more than 10 m.
Shrub layer	Generally absent.
Ground cover	Consists of sparse cover of seedlings and roots of the species present.

OPEN *CERIOPS*	
Habitat	Occurs on the landward edge of the intertidal zone and is inundated by only the high spring tides. This community often surrounds Saltpans and is rarely on the water's edge, except on eroding banks.
Canopy	A community dominated by *Ceriops* spp. with occasional *Rhizophora* spp., *Bruguiera* spp., *Sonneratia* spp. and *A. marina*. The PFC is less than 50%; height varies from 1.5 m in more saline areas to approximately 10 m.
Shrub layer	Generally absent.
Ground cover	Consists of seedlings of the species present along with a sparse to open coverage of samphires and grasses.

CLOSED MIXED	FIGURE 4.4
Habitat	A diverse community which can be found in many intertidal environments from fringing waterways on accretion banks as well as behind Closed *Rhizophora* communities towards the landward edge.
Canopy	A mix which may consist of *Rhizophora* spp., *A. marina*, *Bruguiera* spp., *E. agallocha*, *X. moluccensis*, *Ceriops* spp. and *O. octodonta*. The PFC is more than 50%. Height varies from 5 m to more than 12 m.
Shrub layer	Taller communities may have a shrub layer consisting of juveniles of the canopy species as well as *A. annulata* and *A. corniculatum.*
Ground cover	Seedlings and roots of the various species along with sparse samphires and grasses.

SALTPAN	FIGURE 4.5
Habitat	Occurs along the landward edge of the intertidal zone in a hypersaline environment that is only inundated by the highest spring tides.
Canopy	Sparse stunted (<1 m) individuals of various mangrove species may occur (e.g. *C. tagal*, *A. marina*).
Shrub layer	Some samphire species may be present as very small shrubs.
Ground cover	Sparse samphires (e.g. *Suaeda australis*, *Tecticornia australasica* and *Halosarcia indica*) and salt couch (*Sporobolus virginicus*).

TABLE 4.1 Characteristics of coastal wetland mapping units.

UNIT	POSITION IN INTERTIDAL ZONE	FREQUENCY OF TIDAL INUNDATION
CLOSED *RHIZOPHORA*	Fringes waterways including the seaward edge	every high tide
CLOSED *AVICENNIA*	Diverse, from pioneering the seaward edge and accretion banks, to the landward edge	variable
CLOSED *CERIOPS*	Between Closed *Rhizophora*/Closed Mixed zones and Saltpans	higher tides and spring tides
OPEN *CERIOPS*	Between Closed *Ceriops* zones and Saltpans	higher tides and spring tides
CLOSED MIXED	Landward of the Closed *Rhizophora* zone and also by permanent watercourses	almost every high tide
SALTPAN	Adjacent to the landward edge	higher spring tides

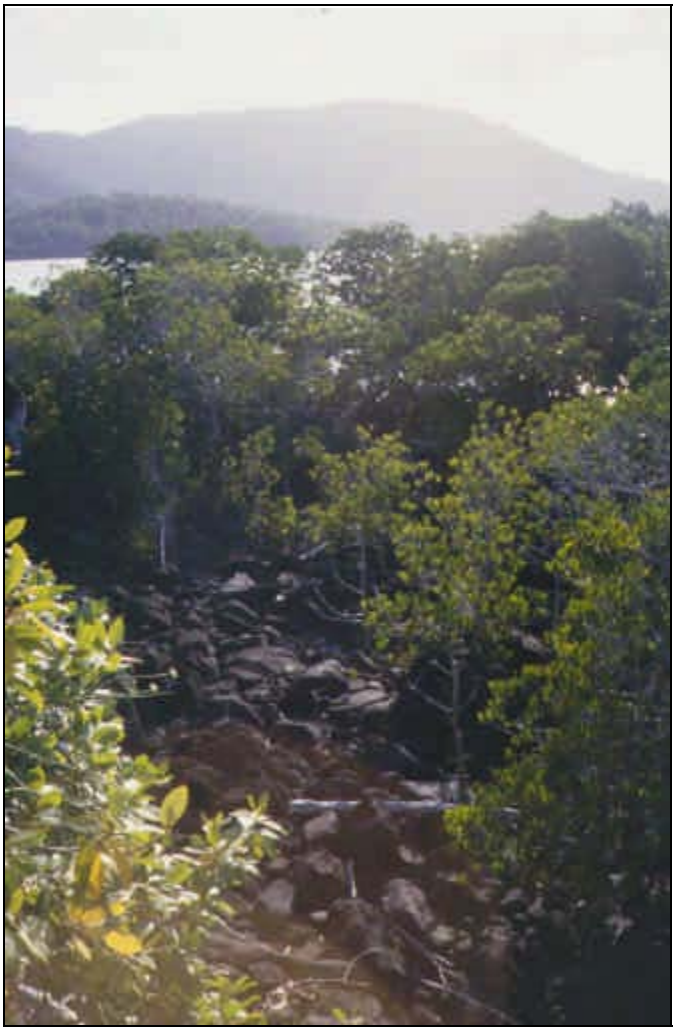

FIGURE 4.1 Closed *Rhizophora* at Double Bay.

FIGURE 4.2 Closed *Avicennia* at Earlando.

FIGURE 4.3 Closed *Ceriops* at Boat Haven.

FIGURE 4.4 Closed Mixed at Shute Harbour.

FIGURE 4.5 Saltpan with Closed *Ceriops* behind at Boat Haven.

4.2 Effectiveness of the Mapping Technique

Scale of the mapping

This mapping technique is limited by the spatial resolution of the Landsat TM satellite imagery, that is, the 25 x 25 m pixel size. The smallest community that can be detected by the Landsat TM sensor is a community equal to or larger than a pixel. For this reason it is not possible to detect some typical mangrove zones, such as narrow seaward fringes, small mangrove communities within a Saltpan or Saline Grassland or narrow fringing Closed Mixed communities in upstream locations. While these communities do occur within the Study Area they are generally linear or small and therefore, are not large enough to be mapping units. These communities included fringing Closed Mixed and fringing Closed *Sonneratia*/*Avicennia*.

Additionally, any communities less than 0.5 hectares are purposefully eliminated in the mapping process. This step enhances the cartographic representation of the data. However, small details of communities present at particular locations are removed.

The resolution of the satellite imagery and the mapping process used results in a product that should not be interpreted at scales larger than 1: 100 000.

Spectral confusion

In comparison to modern hyper-spectral sensors, Landsat TM imagery has a very low spectral resolution with only seven, wide bands of information collected (see Appendix 4). The resolution of the data is too low to be able to distinguish spectrally similar species. For example, *Rhizophora stylosa* and *Bruguiera gymnorrhiza* (family *Rhizophoraceae*) have very similar foliage and are thus difficult to tell apart from both aerial photography and Landsat TM imagery. Ground truthing and knowledge of positions in the intertidal zone that species typically grow is used to aid in distinguishing classes where species have been confused spectrally.

Occasionally towards the landward zone, Closed Mixed mangrove communities were confused with adjacent terrestrial vegetation such as *Melaleuca* communities. The field observations revealed that tidal and freshwater communities sometimes overlap with no clear boundaries.

Data accuracy

Through comparison to aerial photography and field data, the satellite imagery derived maps had an overall accuracy of greater than 80%. An overall evaluation of the project is included in Appendix 8.

SECTION 5 DISTRIBUTION AND SIGNIFICANCE OF THE COASTAL WETLANDS

5.1 General Distribution

The Whitsunday Region Study Area can be divided into two regions based on the terrain of the coastal land. From Gloucester Island to the northern bank of the Proserpine River, the coastal land is generally of high relief and rises sharply from the ocean, leaving only a very narrow intertidal strip. In comparison, the coastal region from the southern bank of the Proserpine River to Cape Hillsborough is of relatively low relief. A wider coastal plain in this region allows the establishment of larger coastal wetland communities. Mountain ranges to the west feed the creeks and rivers that flow into Repulse Bay.

Within the Study Area, Closed *Rhizophora* communities occupy almost half of the total area of coastal wetland communities. In general, Closed *Rhizophora* communities are found on the seaward zone of the intertidal profile (Figure 5.1). Further landward, narrow communities of Closed *Ceriops* and Saltpan commonly occur. In regions where freshwater input is greater, for example in upstream locations in creeks and rivers, Closed Mixed communities are found. Table 5.1 lists the areas of coastal wetland communities within the Study Area.

Closed Mixed communities can often be found fringing creeks, rivers and the foreshore of sheltered bays. However, many of these communities are too narrow to be mappable using this technique.

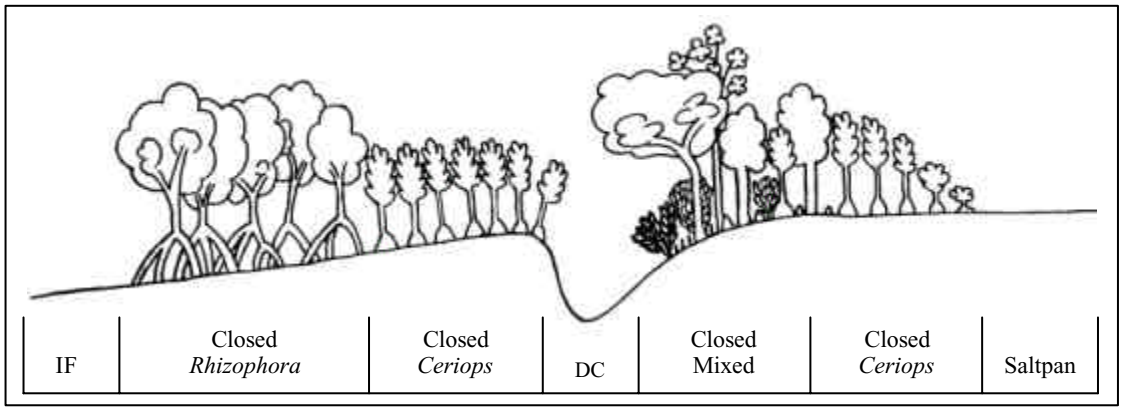

FIGURE 5.1 Transect of a typical coastal wetland system in the Study Area across the tidal profile (seaward-left, landward-right). Not to scale. IF = intertidal flat. DC = drainage channel.

TABLE 5.1 Total area of coastal wetland communities in the Study Area.

COASTAL WETLAND COMMUNITY	AREA (ha)
Closed *Rhizophora*	6 007
Closed *Avicennia*	90
Open *Avicennia*	3
Closed *Ceriops*	2 547
Closed Mixed	3 727
Closed *Bruguiera*	142
Saline Grassland	79
Saltpan	1 327
Total	13 922

An overview of the distribution of some of the coastal and marine environments in the Study Area, which have value as fish habitat is displayed in Figure 5.2. These habitats include the coastal wetland communities as mapped in this study (mangroves and saltmarshes) as well as seagrass communities, intertidal foreshore flats and coral reefs. These datasets have been obtained from various sources and reflect the distribution of the community at a particular date. An explanation of these datasets, including their currency, is given in Section 3.5.

The distribution of the coastal wetland communities to the north of the Study Area (from Cape Upstart to Gloucester Island) and to the south of the Study Area (from Sand Bay to Keppel Bay) are discussed in detail in Bruinsma et al. (1999) and Bruinsma (2000), respectively.

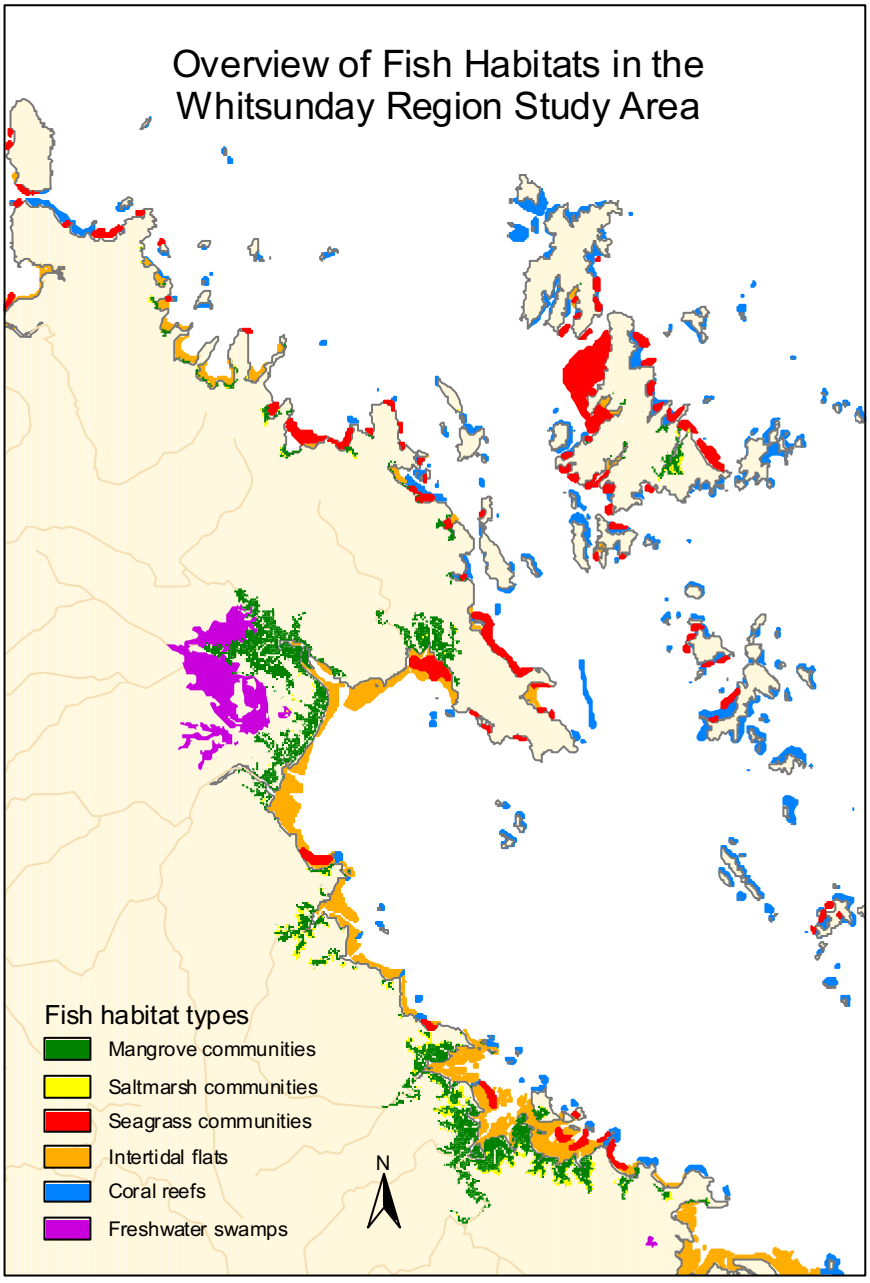

FIGURE 5.2 Overview of fish habitats in the Study Area.

5.2 Gloucester Island to Cape Conway

The stretch of coastline from Gloucester Island to Cape Conway is a diverse coastline of many small bays and peninsulas. Despite the sheltered nature of these bays, the area of coastal wetland communities found in these environments is relatively small in comparison to other similar environments further south (e.g. Dewars Point to Finlaysons Point). The intertidal zone in this region is very narrow, as the mountainous terrain extends virtually to the ocean leaving only a narrow strip of land suitable for the establishment of mangrove communities.

Closed *Rhizophora* is the dominant mangrove community in the region from Gloucester Island to Cape Conway. This community occupies the foreshore, with Closed *Ceriops* and Saltpan communities found further landward. Closed Mixed communities can also be found in more upstream locations of creeks and rivers and along the foreshore. However, these communities are generally only very narrow (approximately 2 trees wide) and do not form a mappable unit using this technique.

Dryander National Park and Conway National Park protect a large proportion of the coastal vegetation in this region. The vegetation adjacent to the coastal wetland communities is therefore near pristine. Airlie beach is the main coastal developments in this region of coastline. Details of development pressures in the region are included in Section 6.

TABLE 5.2 Areas of coastal wetland communities from Gloucester Island to Cape Conway.

COASTAL WETLAND COMMUNITY	AREA (ha)	
	GLOUCESTER ISLAND TO AIRLIE BEACH	AIRLIE BEACH TO CAPE CONWAY
Closed *Rhizophora*	311	215
Closed *Avicennia*	0	0
Open *Avicennia*	0	0
Closed *Ceriops*	80	9
Closed Mixed	4	0
Closed *Bruguiera*	0	0
Saline Grassland	0	0
Saltpan	82	15
Total	477	239

5.3 Cumberland Islands

The many islands in the Study Area are collectively known as the Cumberland Islands, the most famous group being the Whitsunday group. These continental islands are actually drowned mountain ranges that were cut off from the mainland through past geological events (Colfelt 1985). As in the region from Gloucester Island to Cape Conway, the mountainous terrain extends to the ocean leaving only a very narrow intertidal strip. Large sheltered estuaries on the islands (such as Hill Inlet) provide the greatest area suitable for the establishment of mangrove communities.

The dominant coastal wetland community in this island group is Closed *Rhizophora*. This community generally occupies the seaward zone of the intertidal profile. Further landward, Closed *Ceriops* and Saltpan communities occur. As in the region from Gloucester Island to

Cape Conway, Closed Mixed communities are commonly found along the foreshore. However, Closed Mixed communities that occur along the foreshore of the islands are generally smaller than the minimum mappable unit using this technique.

National parks have been declared over the majority of the Cumberland Islands. These parks include: Whitsunday Islands National Park, Molle Islands National Park, Lindeman Islands National Park and the Smith Islands National Park. The terrestrial vegetation on these islands is near pristine and threats to the coastal wetland communities associated with development are low. However, the growing tourism industry in the region may become a threat to the coastal environments if it is not managed well (Section 6).

TABLE 5.3 Areas of coastal wetland communities of the Cumberland Islands.

COASTAL WETLAND COMMUNITY	AREA (ha)
Closed *Rhizophora*	377
Closed *Avicennia*	0
Open *Avicennia*	0
Closed *Ceriops*	23
Closed Mixed	0
Closed *Bruguiera*	0
Saline Grassland	0
Saltpan	81
Total	481

5.4 Conway Inlet

Cape Conway protects Conway Inlet from the prevailing east to south–easterly winds. Consequently, mangrove communities are reasonably stable, with little evidence of pioneering *A. marina*. Closed *Rhizophora* is the dominant mangrove community. However, Closed *Ceriops* and Closed Mixed communities also constitute a relatively large proportion of the intertidal zone. Freshwater drainage from Repulse Creek creates a less saline environment more suitable for the establishment of Closed Mixed communities in upstream locations.

Conway National Park protects the terrestrial vegetation adjacent to the coastal wetlands in this region. The area is relatively inaccessible and is therefore near pristine. The catchment is small constituting mountains covered by closed forest.

The Repulse Bay FHA (management A) protects the coastal wetland vegetation of Conway Inlet along with a large proportion of Repulse Bay.

TABLE 5.4 Areas of coastal wetland communities of Conway Inlet.

COASTAL WETLAND COMMUNITY	AREA (ha)
Closed *Rhizophora*	864
Closed *Avicennia*	0
Open *Avicennia*	0
Closed *Ceriops*	321
Closed Mixed	121
Closed *Bruguiera*	0
Saline Grassland	0
Saltpan	13
Total	1 319

5.5 Proserpine/O'Connell Rivers

The Proserpine River estuary adjoins a coastal plain that is frequently flooded by freshwater. The landward edge of the mangroves and the hydrology of catchment has been modified through the construction of bunds that prevent saltwater intrusion into land utilised for grazing and sugar cane production.

The coastal wetlands associated with the Proserpine River are dominated by Closed Mixed communities. As the wetlands receive a high level of freshwater, *Bruguiera parviflora* dominated communities also occur in upstream and more elevated locations. Closed *Rhizophora* is found towards the mouth of the estuary in more open, seaward locations.

A dune ridge running along the seaward edge of the coastal plain at Lethebrook protects a large area of mangroves along the small tidal creeks. The land adjacent to the coastal wetland communities is utilised for grazing and sugar cane production. As in the Proserpine River estuary, bunds have been constructed abutting the mangrove communities. A mixed assemblage of Closed *Rhizophora*, Closed *Ceriops* and Closed Mixed communities are present in this region.

The estuary of the O'Connell River supports small areas of coastal wetland communities. Closed *Ceriops* and Closed Mixed communities dominate in this estuary. In contrast to Conway Inlet, Closed *Rhizophora* represents only a very small proportion of the communities found on the O'Connell River.

The coastal plain from Proserpine River to O'Connell River has little Saltpan development. Bunding and a high freshwater input to the coastal plain limit the extent of highly saline regions.

There are no existing conservation measures protecting either the coastal wetland vegetation or the adjacent terrestrial vegetation in the Proserpine/O'Connell Rivers region. The land adjacent to the coastal wetland systems has been modified through the construction of bunds and by clearing for agriculture and grazing. A large tourist resort, Laguna Quays, has been constructed to the south of the O'Connell River.

TABLE 5.5 Areas of coastal wetland communities of the Proserpine/O'Connell Rivers.

COASTAL WETLAND COMMUNITY	AREA (ha)
Closed *Rhizophora*	827
Closed *Avicennia*	79
Open *Avicennia*	3
Closed *Ceriops*	560
Closed Mixed	2 829
Closed *Bruguiera*	81
Saline Grassland	79
Saltpan	49
Total	4 507

5.6 Midge Point to Dewars Point

The small peninsula at Midge Point provides shelter to the coastal wetland communities established on the north facing shoreline. Well-zoned Closed *Rhizophora*, Closed *Ceriops* and Saltpan communities are found in this location. Individual *A. marina*, *Rhizophora*

spp. and *S. alba* plants occur on foreshore further northwards toward the Laguna Quays development. However, these plants are not mappable communities using this technique.

The numerous small creeks to the south of Midge Point are clearly zoned, with Closed *Rhizophora* occupying the seaward zone of the intertidal profile. Narrow Saltpan communities are generally located on the landward edge of the Closed *Rhizophora*. In upstream locations Closed Mixed communities dominate. The larger estuaries associated with Dempster Creek and Hervey Creek contain predominantly Closed *Rhizophora* communities on the foreshore, Closed *Ceriops* and Closed Mixed communities behind and narrow Saltpans on the landward edge.

A relatively large amount of Saltpan development indicates that there is a lower level of freshwater input to this region than to those regions to the north.

The section of coastline from Midge Point to Dewars Point has a small catchment consisting of cleared hills, open forest and a coastal plain with little development. The terrestrial land adjacent to the coastal wetland communities is generally used for grazing.

The Midge FHA (management B) protects the majority of the coastal wetland vegetation from Waterhole Creek, just south of Midge Point, to Dewars Point.

TABLE 5.6 Areas of coastal wetland communities from Midge Point to Dewars Point.

COASTAL WETLAND COMMUNITY	AREA (ha)
Closed *Rhizophora*	672
Closed *Avicennia*	0
Open *Avicennia*	0
Closed *Ceriops*	136
Closed Mixed	44
Closed *Bruguiera*	1
Saline Grassland	0
Saltpan	341
Total	1 194

5.7 Dewars Point to Cape Hillsborough

Rabbit Island and Newry Islands provide shelter for the development of extensive foreshore communities of Closed *Rhizophora* in the region from Dewars Point to Finlaysons Point. Narrow communities of Closed *Ceriops* and Saltpan occupy the zone landward of the Closed *Rhizophora*. Closed Mixed and Closed *Avicennia* communities can be found in more upstream locations. In Murray Creek, communities dominated by *Bruguiera parviflora* occur at higher elevations behind the Closed *Rhizophora* zones.

The land adjacent to the coastal wetland communities in this region is utilised extensively for agricultural production, mainly sugar cane. Cultivation for this purpose extends to the intertidal boundaries in many areas. North west of Blackrock Creek, the adjacent terrestrial vegetation has been cleared for grazing.

The catchment area from Finlaysons Point to Cape Hillsborough is a small catchment of open forested hills, with sugar cane farming occurring along the flood plain of the rivers. The estuaries at the mouths of the short creeks within this area are small and are dominated by Closed *Rhizophora* communities. Narrow Closed Mixed communities occur on the landward rim. Saltpans are not common.

The area from Dewars Point to Port Newry is included in the Repulse Bay FHA. This FHA protects a large proportion of the coastal wetland communities from Dewars Point to Cape Hillsborough.

TABLE 5.7 Areas of coastal wetland communities from Dewars Point to Cape Hillsborough.

COASTAL WETLAND COMMUNITY	AREA (ha)	
	DEWARS POINT TO FINLAYSONS POINT	FINLAYSONS POINT TO CAPE HILLSBOROUGH
Closed *Rhizophora*	2 555	186
Closed *Avicennia*	11	0
Open *Avicennia*	0	0
Closed *Ceriops*	1370	48
Closed Mixed	728	1
Closed *Bruguiera*	60	0
Saline Grassland	0	0
Saltpan	709	37
Total	5433	272

5.8 Coastal Wetland Communities in the Lucinda – Mackay Coast IMCRA Region

The coastal wetland vegetation of the Study Area represents only a very small percentage (15%) of the total coastal wetland vegetation of the Lucinda – Mackay Coast IMCRA region. This IMCRA region is dominated in area by Saltpan communities followed by Closed *Rhizophora* communities. The wide, coastal plains such as those at Bowling Green Bay and Bowen allow the development of extensive areas of Saltpan. The very narrow intertidal zone that is found in the northern portion of the Study Area is relatively unique in this IMCRA region.

A comparison of the coastal wetland vegetation in the LMC IMCRA region and the Wet Tropic Coast region to the north, and the Shoalwater Coast region to the south is listed in Table 5.8. Within the Shoalwater Coast (SWC) region, rainfall is between 1 000 mm and 1 400 mm annually. Although rainfall is comparable to the LMC region, temperatures in the SWC region are cooler than in both the WTC and LMC regions. Mangrove species distribution is limited latitudinally by the physiological tolerance of each species to low temperatures (Duke et al 1998). The comparatively lower proportion of diverse Closed Mixed communities in the SWC region reflects this difference in temperature

TABLE 5.8 Coastal wetland communities by IMCRA region.

COASTAL WETLAND COMMUNITIES	IMCRA REGION		
	Wet Tropic Coast	Lucinda Mackay Coast	Shoalwater Coast
APPROX. TOTAL AREA (HA)	35 900	88 600	173 800
PERCENT OF TOTAL IN REGION			
Closed *Rhizophora*	50	20	23
Closed *Avicennia*	0	4	6
Open *Avicennia*	0	1	1
Closed *Ceriops*	18	17	11
Open *Ceriops*	1	0	0
Closed *Aegiceras*	0	0	0
Closed *Rhizophora*/*Ceriops*	1	0	0
Closed *Rhizophora*/*Avicennia*	0	0	0
Closed *Avicennia*/*Ceriops*	0	0	1
Open *Avicennia*/*Ceriops*	0	0	0
Closed Mixed	21	14	8
Closed *Bruguiera*	5	0	0
Saline Grassland	0	2	6
Saltpan	4	42	44

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 or within coastal wetlands.

Marine plants in Queensland are protected from physical disturbance under Fisheries legislation. Any proposed disturbance of marine plants requires approval under the *Queensland 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. Details of known development proposals within the Study Area that have the potential to have minor impacts on coastal wetland vegetation are included in Table 6.1.

TABLE 6.1 Development proposals in the Study Area that may impact upon coastal wetland vegetation.

DEVELOPMENT PROPOSAL	POTENTIAL IMPACT ON COASTAL WETLAND COMMUNITIES
Port of Airlie Development, Airlie Beach	Original proposal by Whitsunday Sailing Club for 600 berth marina plus resort with 110 ha reclamation in Muddy Bay stalled due to large size and potential impacts of project. Proposed reclamation of tidal land, marine plant clearing and dredging of tidal land.
Shute Harbour Marina	Proposed 210 berth marina plus tourist resort. Proposal would involve clearing of marine plant vegetation, tidal land reclamation and dredging of tidal land.
Shute Harbour Terminal Redevelopment	Expansion of existing terminal. Dredge spoil disposed on tidal lands. Potential for ongoing impacts to adjacent seagrass beds and intertidal habitat.
Castaway Bay	Proposed tourist resort. Minimal clearing of marine plant vegetation proposed.

Source: pers comm. K Dodds, Queensland Fisheries Service Mackay.

6.2 Catchment-wide Threats to Coastal Wetland Vegetation

Although the threat of direct removal of coastal wetland systems is an important management consideration, the ongoing 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. Increases in water usage, the construction of dams to meet water supply needs and increases in urban runoff may all cause alterations to water flow characteristics in the catchment.

Within the Proserpine and Pioneer/O'Connell catchments a large proportion of the land area is utilised for grazing and agricultural production. Unless carefully managed, these landuses have the potential to impact on the quality of estuarine ecosystems through the

input of sediments and nutrients to the waterways. The Department of Primary Industries (1993) identified that severe erosion of riverbanks was a major issue for concern in the Pioneer/O'Connell catchment. Erosion of pasture and sugarcane lands was also identified as a problem. The input of large amounts of sediment to the estuarine environment can lead to the destruction of sensitive fish habitats such as seagrass beds and *A. marina* forests. The expansion of agricultural land was also identified as a problem to the hydrology of important wetlands in the Proserpine catchment.

Increased tourism and the development of tourism infrastructure could have a significant impact on the coastal strip and offshore islands within the Study Area (DPI 1993). Activities associated with land based and marine tourism can potentially impact on reefs, inshore seagrass beds & mangrove habitats. A large number of commercial and reef tourist boats and fishing charter vessels operate in the area. Inputs to marine environment (such as human waste; rubbish; oil; fuels, etc.) can potentially impact upon water quality of both inshore & offshore marine habitats.

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.

SECTION 7 EXISTING CONSERVATION MEASURES AND CONSERVATION VALUES

7.1 Fish Habitat Areas

Fish Habitat Areas (FHAs) have been declared throughout coastal Queensland to sustain existing and future fishing activities and to protect the habitat upon which fish and other aquatic fauna depend (Beumer et al. 1997). Details of the management strategies for FHAs (both management A and B) are outlined in Appendix 2.

Two FHAs, Repulse Bay (management A) and Midge (management B), are currently declared over important fish habitats in the Study Area. Table 8.2 summarises the fisheries values and the habitat types of the coastal wetlands systems protected by FHAs within the Study Area.

7.2 Ramsar Sites

No wetlands of international importance (that is, Ramsar sites) are currently declared within the Study Area.

7.3 Marine Parks

The Great Barrier Reef Marine Park and World Heritage Area

The Great Barrier Reef, extending from Cape York Peninsula along the eastern coastline of Queensland to Rockhampton, has been recognised internationally as an area of global ecological significance.

The Great Barrier Reef Marine Park (GBRMP) was declared in 1975 to protect the values of the Reef and to manage activities within the Marine Park area. The Great Barrier Reef Marine Park Authority (a Commonwealth statutory body) in conjunction with the Queensland Environmental Protection Agency manages the GRBMP. The GBRMPA has the legislative obligation of ensuring the protection, wise use, understanding and enjoyment of the Great Barrier Reef in perpetuity through the development and care of the GBRMP (Cook 1995).

Various management Zoning Plans have been gazetted under the *Great Barrier Reef Marine Park Act 1975*, in order to provide for as of right activities, prohibited activities, and activities that can be undertaken with consent (Cook 1995). These zones also reflect the ecological and biological values of particular areas.

In most areas, the boundary of the GBRMP extends only to the low water mark along the eastern coastline of Queensland and as such coastal wetland communities are excluded from the marine park. However, the majority of the marine waters, reefs and coral cays adjacent to the Study Area are managed under Great Barrier Reef Marine Park zoning.

The many values of the Great Barrier Reef have been recognised by its inscription on the UNESCO World Heritage List in 1981. The declared World Heritage Area encompasses the Great Barrier Reef Marine Park (93%), continental islands within the Marine Park boundary (5%) and the adjoining tidal waters outside the Marine Park (2%).

Townsville–Whitsunday Marine Park (State Managed Marine Park)
The Townsville Whitsunday Marine Park covers 600 km of coastline from Clump Point in the north to Midge Point in the south, and covers 200 continental islands. The area has a number of sites of cultural heritage significance including Aboriginal occupation, maritime exploration, and early European use (EPA 1999).

7.4 National Parks

National parks, conservation parks and resources reserves are gazetted under the *Nature Conservation Act 1992*. A number of national parks exist in the coastal region of the Study Area. Some parks directly protect coastal wetland vegetation, whereas other parks protect the terrestrial vegetation adjacent to the coastal wetland communities, providing a buffer between important fish habitats and terrestrial land uses. The National Parks that have been declared adjacent to or over coastal wetland communities within the Study Area and the vegetation that they protect are discussed in Section 5.

7.5 Directory of Important Wetlands in Australia

The Directory of Important Wetlands in Australia is a cooperative project between the Commonwealth, State and Territory Governments of Australia, coordinated by Environment Australia with input from conservation agencies from all jurisdictions, to identify nationally important wetlands (Environment Australia 2001).

Two wetlands of national importance have been recognised within the Study Area: the Proserpine–Goorganga Plain (QLD050) and the St Helens Bay Area (QLD055). The Proserpine–Goorganga Plain wetland is the largest floodplain in the Central Queensland Coast Bioregion. The site has been recognised for the continuity and quality of habitats from marine to freshwater environments and for the diversity of the biota. The St Helens Bay Area is recognised for the extensive mangrove wetlands, intertidal and shallow water habitat and coastal islands with coral reefs that occur in close proximity to each other (Environment Australia 2001).

Further details of the conservation significance of these sites in terms of notable flora and fauna and social and cultural values can be found online (*http://www.environment.gov.au/wetlands/wet.html*).

SECTION 8 FISHERIES RESOURCES IN THE STUDY AREA

8.1 Fisheries Resources and their Habitat Requirements

Many of the species targeted in the fisheries of the Study Area rely on coastal wetland environments for food sources and habitat requirements at some stage of their life cycle. Table 8.1 lists the habitat requirements for selected species of importance to the fisheries of the Study Area. The discussion of fisheries within the Study Area in the following sections focuses on species that are dependent on coastal wetland ecosystems at some stage of their life cycle.

TABLE 8.1 Habitat requirements for selected species of importance to the fisheries of the Study Area.

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
SAND WHITING	Mouths of estuaries and surf bars	Nearshore waters	Estuarine sandflats and ocean beaches	Estuarine sandflats and ocean beaches
SEA MULLET	Offshore coas tal waters between Townsville and NSW border	Coastal waters	Tidal, brackish, and fresh waters	Estuarine and ocean beaches
MUD CRAB	Offshore waters	Coastal waters	Intertidal waters in mangrove-lined estuaries	Subtidal waters in estuaries
BANANA PRAWNS	Inshore waters	Inshore waters	Mudflats in mangrove-lined estuaries	Turbid nearshore waters
BROWN TIGER PRAWN	Offshore waters	Offshore waters	Lower estuaries and inshore marine waters associated with seagrass beds	Inshore to offshore marine waters

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 Fisheries values and habitat types of Fish Habitat Areas (both A and B) within the Study Area**.**

FHA NAME	FISHERIES VALUES	MAJOR HABITAT TYPES
Repulse Bay (A)	Barramundi, blue salmon, estuary cod, flathead, grey mackerel, grunter, mangrove jack, queenfish, school mackerel, whiting, banana prawns.	Mangrove dominated floodplain with *Rhizophora* spp., *A ilicifolius*, *A. speciosum*, *A. marina* and *Ceriops* spp. being common; mangrove-lined creeks; intertidal flats; seagrass beds around the mouth of Repulse Creek.
Midge (B)	Barramundi, blue salmon, bream, estuary cod, flathead, grey mackerel, grunter, mangrove jack, queenfish, school mackerel, sweetlip, various emporer species, banana prawns, blue-legged kink prawns.	Closed *Rhizophora* forests occur along the estuary, fringed by saltmarsh areas; seagrass beds present towards the mouth of Blackrock Creek; inshore reefs.

8.2 Commercial Fishing Activities

Trawl Fishery

The trawl fishery is the largest commercial fishery in Queensland. Target species include a number of species of prawns as well as saucer scallops. Some byproduct from the trawl fishery, including sand crabs and squid, is also kept for sale. A variety of prawn species contributes to the trawl fishery in the Study Area including tiger, endeavour, king and banana prawns. Banana prawns are typically taken in coastal waters adjacent to major estuaries, which act as nursery areas for this species (Williams 1997).

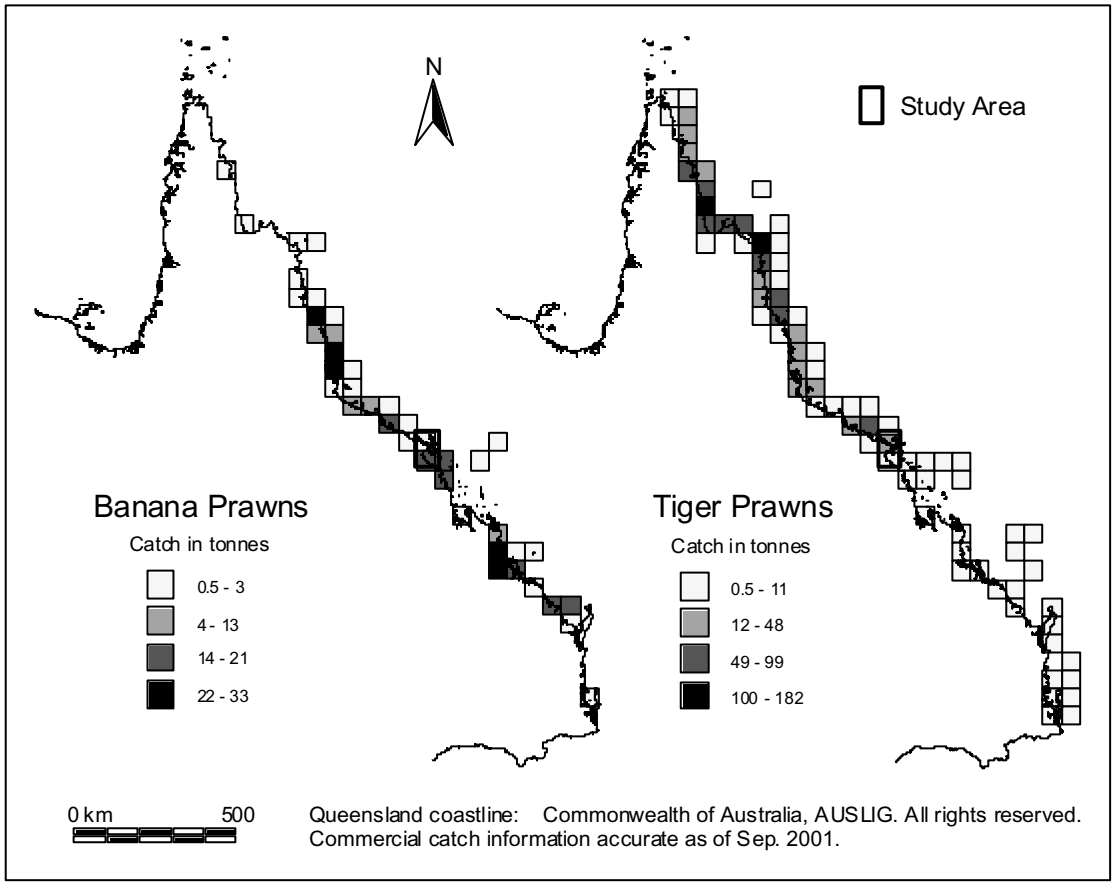

FIGURE 8.1 Commercial catch in tonnes of banana and tiger prawns by 30 minute grid, 2000.

Tropical Inshore and Estuarine Fishery

In tropical Queensland, the main commercial species targeted in the inshore and estuarine fishery are barramundi, king threadfin, blue threadfin, shark, mullet, and grey, school and spotted mackerel. In the Study Area, shark, barramundi, mullet, grey mackerel, blue threadfin, mud crab, king threadfin and queenfish are the main species that contribute to the total catch of this fishery. Table 8.3 lists the total catch of these species within the Study Area over the past decade and the gross value of production (GVP) in the year 2000.

Figure 8.2 illustrates the total catch throughout Queensland of four of these species, which are particularly important to the fisheries of the Study Area. These species utilise estuarine habitats during their life cycle.

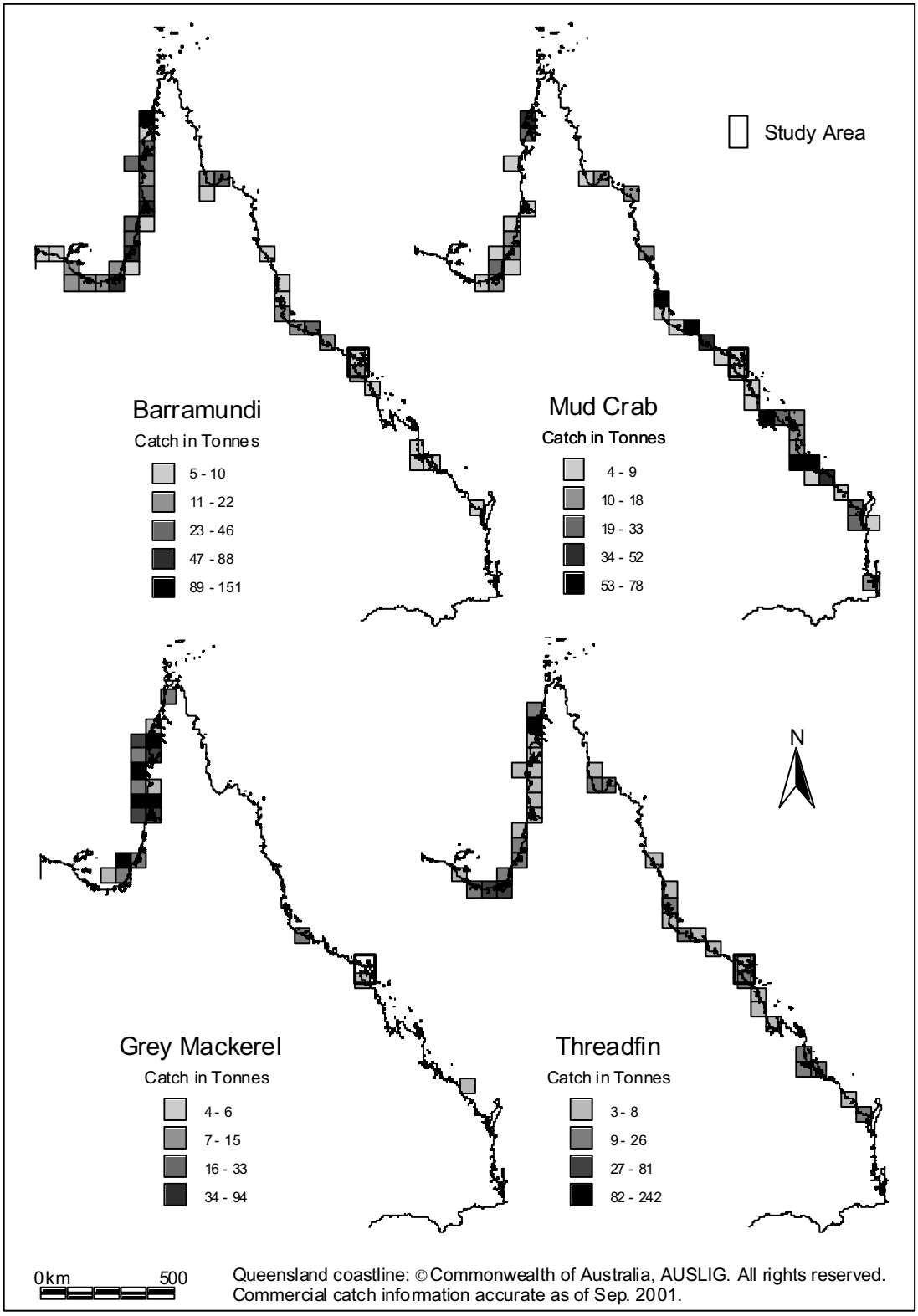

FIGURE 8.2 Commercial catch in tonnes of barramundi, mud crab, grey mackerel and threadfin by 30 minute grid, 2000.

TABLE 8.3 Total catch and Gross Value of Production (2000) of the main species of importance to the tropical inshore and estuarine fishery in the Study Area.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	GVP ($K) 2000
SHARK – ALL	12	30	36	24	36	44	43	31	33	28	167
BARRAMUNDI	15	14	17	13	18	9	15	13	24	19	134
MULLET – ALL	34	14	15	12	12	10	12	7	8	12	36
GREY MACKEREL	4	17	9	2	4	10	24	13	21	8	49
BLUE THREADFIN	19	11	15	9	8	7	10	6	9	9	34
MUD CRAB	5	7	7	6	5	6	11	11	10	12	129
KING THREADFIN	6	4	7	8	9	3	7	5	16	12	47
MACKEREL – NET	1	3	3	6	3	4	3	7	9	4	17
QUEENSFISH	2	5	3	3	2	3	7	5	9	7	22

8.3 Recreational and Indigenous Fishing Activities

Very limited information on recreational and indigenous fishing activities is available for the Study Area. Recreational fishing occurs to varying degrees in most accessible creeks and estuaries in the Study Area and along the beach near population centres.

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:

- Size
- Diversity of or specific habitat features
- Diversity of or specific marine fauna and flora
- Level of existing and future disturbances
- Unique features
- Existing or potential fishing grounds
- Protected species

A summary of the assessment of the coastal wetlands of the 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 9.2.

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.

9.2 Assessment of Coastal Wetland Characteristics for FHA Declaration Purposes

TABLE 9.1 Summary of characteristics of coastal wetlands of the Study Area, as described in Table 9.2.

WETLAND	AREA OF COASTAL WETLAND COMMUNITIES (ha)	DIVERSITY OF MANGROVE /SALTMARSH COMMUNITIES	INTERTIDAL FLATS	SEAGRASS COMMUNITIES	ADJACENT FRESHWATER SWAMPS	SIGNIFICANT DAMS AND WEIRS	DISTURBANCE TO ADJACENT TERRESTRIAL VEGETATION	RECOGNISED/IMPORTANT FISHING GROUNDS	UNIQUE FEATURES	SUITABLE FOR FHA NOMINATION	EXISTING FHA
Gloucester Island to Cape Conway											
Gloucester Island to Airlie Beach	477	Low	Intermittent, in sheltered bays	3		-	**LU**				
Airlie Beach to Cape Conway	239	Low	Intermittent, in sheltered bays	3		-	**NP**				
Cumberland Islands	481	Low	Intermittent, in sheltered bays	3		-	**NP**		3	3	
Conway Inlet	1176	Med	Large flats at the mouth of the inlet and along the foreshore	3		-	**NP**	3		3	3
Proserpine/O'Connell Rivers	4495	Med	Large flats in the sheltered bays and along the foreshore	3	3	-	SI		3	3	
Midge Point to Dewars Point	1192	Med	Large flats in the sheltered bays and along the foreshore	3		-	M	3		3	3
Dewars Point to Cape Hillsborough											
Dewars Point to Finlaysons Point	5288	Med	Extensive flats in the sheltered bays	3		-	SI	3	3	3	3
Finlaysons Point to Cape Hillsborough	323	Low	Intermittent, in sheltered bays	3		-	M				

Low	Low	LU	Largely Unmodified
Med	Medium	M	Modified
NP	Near Pristine	SI	Severely Impacted

TABLE 9.2 Details of the coastal wetland significance assessment.

CRITERIA	SUBCATEGORIES	DETAILS
Size	Area of Coastal Wetland Communities	**Area in hectares of coastal wetland communities** as mapped in this study. Large areas of coastal wetland communities make a significant contribution to the primary productivity of estuarine areas. Areas over 300 ha were considered suitable (1pt), and areas over 500 ha were considered most suitable (2pt) for FHA nomination.
Diversity of or specific habitat features	Diversity of Mangrove and Saltmarsh Communities	**High (H)**: 10–13 mangrove and saltmarsh communities present (1pt)
		Medium (M): 5–9 mangrove and saltmarsh communities present (1pt)
		Low (L): 1–4 mangrove and saltmarsh communities present
		The number of mangrove and saltmarsh communities, calculated based on the coastal wetlands mapping conducted for this study. Protecting a variety of mangrove and saltmarsh habitats will ensure a comprehensive suite of habitats that support fisheries species.
	Presence of Intertidal Flats	**Comments on the presence of intertidal flats** (1pt). Intertidal flats are one of a range of habitats that support fisheries species (see Section 2.2). Comments based on aerial photograph interpretation and the foreshore flats coverage of the digital GOEDATA TOPO-250K topographic map series (AUSLIG 1994).
	Presence of Seagrass Communities	**Areas where seagrass communities have been identified within the Study Area (4)**(1pt). Seagrass meadows are one of a range of habitats that support fisheries species (see Section 2.2). The distribution of seagrass communities in the Study Area was determined from information gathered from literature review (Coles et al. 1987). Seagrasses may inhabitat other regions within the Area, however these regions have not been surveyed in the literature reviewed.
	Adjacent Freshwater Swamps	**Presence of freshwater swamps (4) adjacent to coastal wetland communities.** Freshwater swamps are one of a range of habitats that support fisheries species (see Section 6.1).
Diversity of or specific marine fauna and flora		Comprehensive surveys of species diversity (flora and fauna) for each coastal wetland system were not conducted as part of this study.
Level of existing and future disturbances	Significant Dams and Weirs	**Presence (+) or absence (-) of significant dams or weirs** on the river or creek. Dams and weirs in the Study Area have the potential to impact on fish migrations and available fish habitat, depending on the type of obstruction within the river. The location of major dams and weirs in Queensland was collected be the Dept. of Natural Resources and Mines.
	Disturbance to Adjacent Terrestrial Vegetation	**Near Pristine (NP)** : natural cover >90% (1pt)
		Largely Unmodified (LU) : natural cover ~65–90% (1pt)
		Modified (M) : natural cover ~35–65%
		Severely Impacted (SI) : natural cover <35% (-1pt)
		Some landuses adjacent to coastal wetland systems and stream habitats may have a negative impact on the quality of fish habitat. Adjacent terrestrial vegetation serves to buffer coastal wetlands from the effects of human development in the catchment. Adjacent terrestrial vegetation refers to the vegetation within 5 km of the upper intertidal limit and is described in Section 5.
Unique Features	Unique Features	**Presence (4) of unique features** (2pt). The details of these features are included in Section 5 and Section 7.5.
Existing or potential fishing grounds	Recognised/ Important Fishing Grounds	**Significant (4) fishing grounds** (1pt). Assessed from local knowledge of each coastal wetland system and/or from literature review. Further details are included in Section 8.
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.
Suitable for FHA Nomination		Score of >5 for an estuary based on the points allocated to the criteria above.
Existing FHA		Presence of existing declared FHA of either management A or B status.

Note: Symbols presented here (e.g. 4) refer to symbols used to summarise the results of the coastal wetland assessment in Table 9.1.

9.3 Coastal Wetland Communities Currently Included in FHAs

Of the approximately 14 000 ha of coastal wetland vegetation in the Study Area, a large area (approx. 6 900 ha) is currently protected within declared FHAs. The areas of coastal wetland communities as mapped in this study (i.e. mangroves and saltmarshes) within each of the FHAs in the Lcuinda – Mackay Coast IMCRA region are listed in Table 9.3. Figure 9.1 displays the distribution of these FHAs.

Important fish habitats within this Study Area are well represented in existing declared FHAs. The assessment of the coastal wetland characteristics of these fish habitats supports their inclusion in the MPA network (see Table 9.1). However, some important fish habitats have so far not been the focus of detailed FHA investigation. The current gaps in the protected area network are discussed below.

TABLE 9.3 Area of coastal wetland communities within FHA's in the Study Area.

	AREA OF COASTAL WETLAND COMMUNITIES IN FHA (ha)														
	CLOSED *RHIZOPHORA*	CLOSED *AVICENNIA*	OPEN *AVICENNIA*	CLOSED *CERIOPS*	OPEN *CERIOPS*	CLOSED *RHIZOPHORA*/*AVICENNIA*	CLOSED *AVICENNIA*/*CERIOPS*	OPEN *AVICENNIA*/*CERIOPS*	CLOSED MIXED	CLOSED *BRUGUIERA*	SALINE GRASSLAND	SALTPAN	SAMPHIRE-DOMINATED SALTPAN	TOTAL AREA OF COASTAL WETLAND COMMUNITIES	APPROX. AREA OF FHA
LMC IMCRA region															
Halifax	224	24	0	591	2	0	0	0	704	28	8	0	0	1 58	4 20
Palm Creek	236	71	0	131	0	0	0	0	158	0	58	19	6	67	86
Cattle Creek	204	83	2	477	0	0	0	0	201	0	47	381	59	1 45	1 94
Bohle River	59	27	0	111	0	16	0	0	83	0	22	304	5	62	1 30
Bowling Green Bay	92	36	6	45	0	3	0	0	8	0	0	1	0	19	68 57
Burdekin	3 018	532	140	264	0	0	0	0	3 185	0	0	3 019	0	10 15	91 98
Repulse Bay	3 25	1	(	1 54	(	(	(	(	74	5	(	54	(	6 16	69 49
Midge	51	(	(	10	(	(	(	(	2	1	(	15	(	79	8 20
Sand Bay	946	97	30	1 387	0	0	12	0	132	0	17	340	0	2 96	11 43
Bassett Basin	60	156	0	66	0	7	0	0	74	0	8	0	0	37	67

NB: areas may differ slightly from previously reported figures due to regazettal of and edits made to FHAs.

9.4 Representative Habitats Suitable for FHA nomination

Fish habitats within the Lucinda – Mackay IMCRA region are fairly well represented in FHAs. Previous studies have identified gaps in the FHA network in the LMC region at Cleveland Bay, Bowling Green Bay (Bruinsma 2001) and Edgecumbe Bay (Bruinsma et al. 1999).

Within the current Study Area, important fish habitats include the coastal wetlands, intertidal flats and seagrass meadows at Conway Inlet, Midge Point to Dewars Point and Dewars Point to Finlaysons Point. This study supports the inclusion of these habitats within the Repulse Bay and Midge FHAs. Other areas that have been identified for

nomination as FHAs include the Cumberland Islands and the Proserpine/O'Connell Rivers.

Cumberland Islands

Within the LMC IMCRA region, the Cumberland Islands are relatively unique habitat. This cluster of offshore islands provides a sheltered environment suitable for the establishment of large seagrass beds, which are important habitat for prawn species. The coral reefs, intertidal flats and coastal wetland communities add to the diversity of habitats represented in this region. The Cumberland Islands are currently protected within a number of National Parks. However, the fish habitat values of these Islands should be recognised.

The Proserpine/O'Connell Rivers

The Proserpine and O'Connell Rivers area offers a unique fisheries habitat within the Study Area. The Proserpine River is the largest river in the Study Area, supplying large amounts of freshwater to support extensive, diverse mangrove communities. Along the coastal edge of the flood plain between the Proserpine and O'Connell River is another extensive system of mangroves, protected by the ocean by a series of sand dunes. The mangrove communities present are fairly well zoned, with Closed *Rhizophora*, Closed *Ceriops* and Mixed Communities occurring. This type of dune protection does not occur elsewhere within the Study Area.

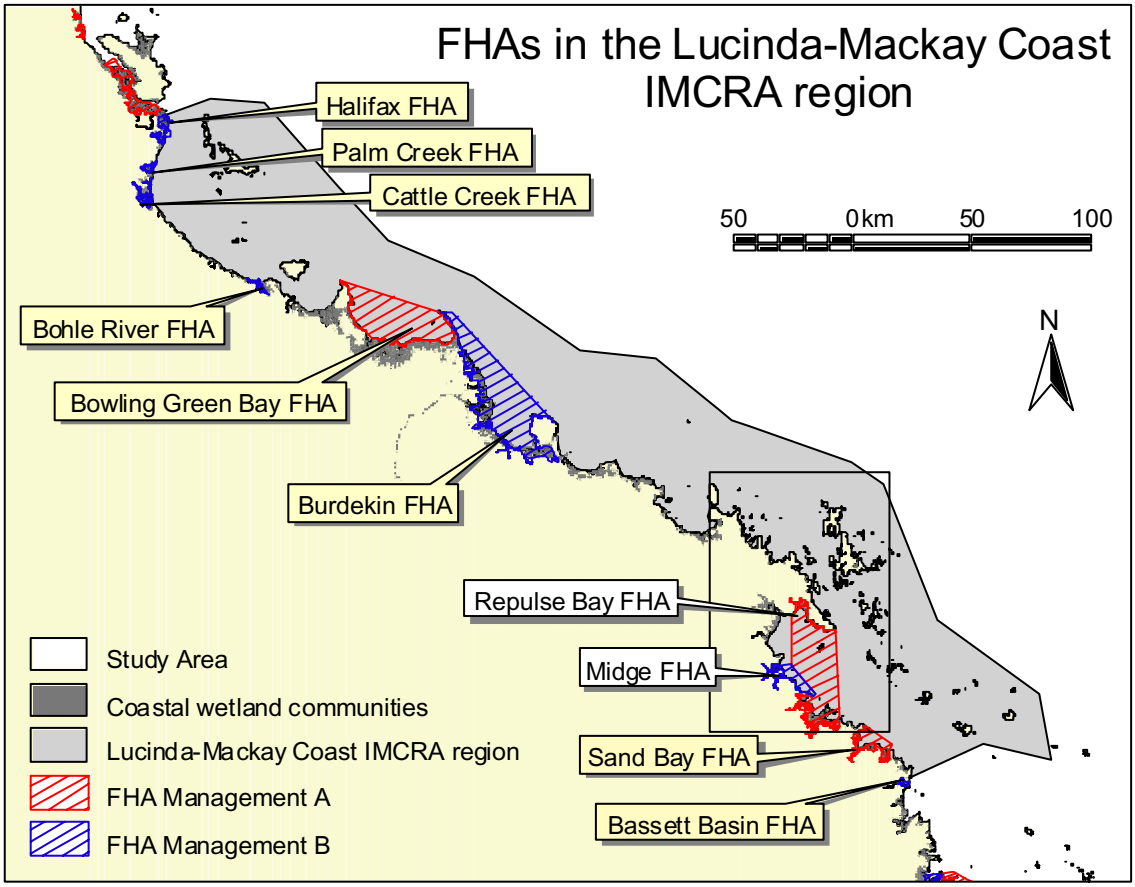

FIGURE 9.1 FHAs in the Lucinda-Mackay Coast IMCRA region.

SECTION 10 RECOMMENDATIONS

Within the current Study Area, important fish habitats include the coastal wetlands, intertidal flats and seagrass meadows at Conway Inlet, Midge Point to Dewars Point and Dewars Point to Finlaysons Point. This study supports the inclusion of these habitats within the Repulse Bay and Midge FHAs.

In addition to these important habitats two regions, the Cumberland Islands and the Proserpine/O'Connell Rivers, have been identified as representative habitats that are suitable for nomination as FHAs. It is recommended that:

- The fish habitat values of the Cumberland Islands are recognised.
- The Proserpine/O'Connell Rivers are considered for protection with a FHA.

Reports in the Queensland Coastal Wetland Resources Series:

This report contributes to a series of reports outlining the status of coastal wetland resources in Queensland. Other reports in the series include:

Bruinsma, C (2001). Queensland Coastal Wetland Resources: Cape Tribulation to Bowling Green Bay. Information Series QI01064. Department of Primary Industries, Queensland, Brisbane, 85 pp.

Bruinsma, C (2000). Queensland Coastal Wetland Resources: Sand Bay to Keppel Bay. Information Series QI00100. Department of Primary Industries, Queensland, Brisbane, 94 pp.

Bruinsma, C and Duncan, S (2000). Queensland Coastal Wetland Resources: the Northern Territory Border to the Flinders River. Information Series QI00099. Department of Primary Industries, Queensland, Brisbane, 72 pp.

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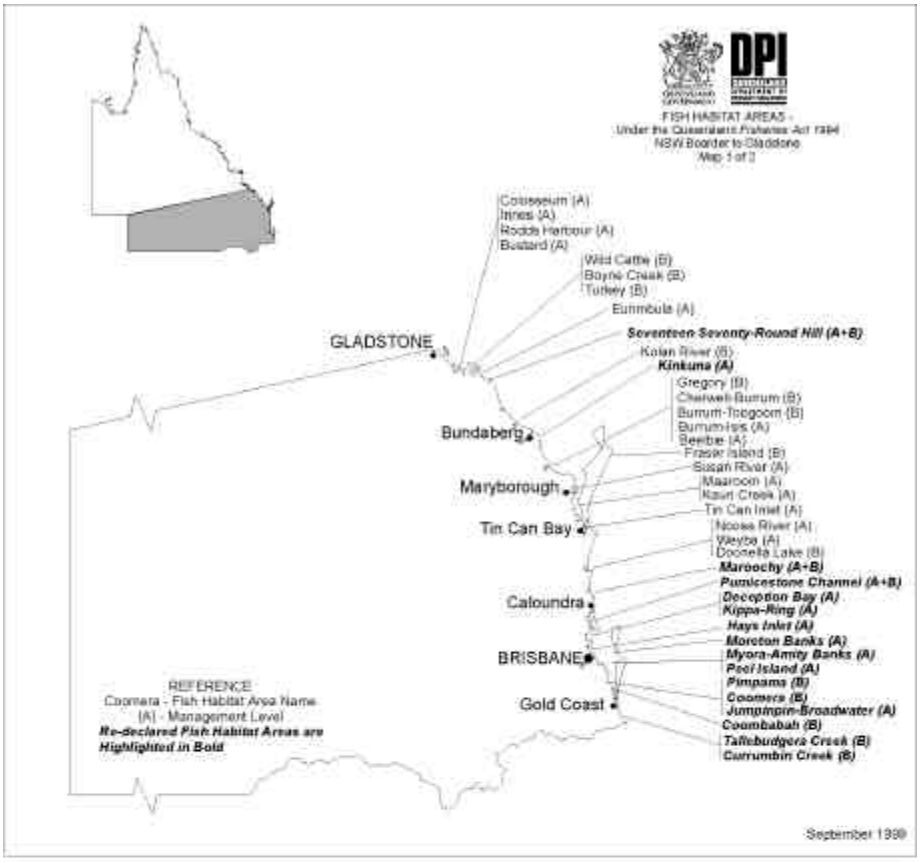
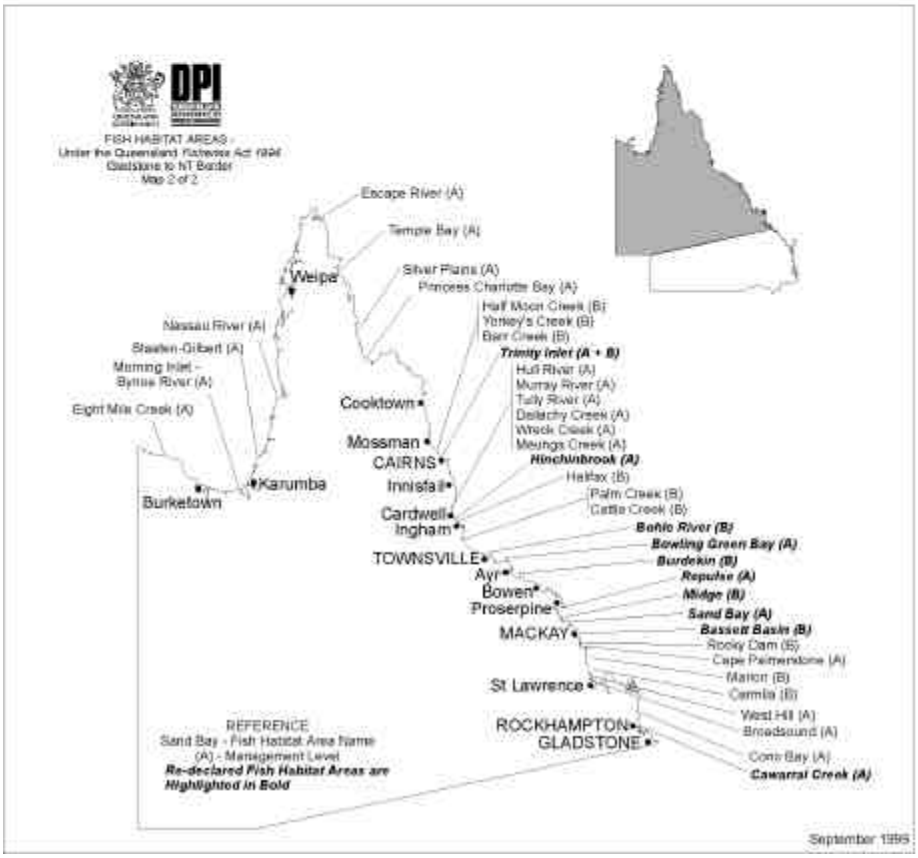
APPENDIX 1: DECLARED FHAS IN QUEENSLAND





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

QUEENSLAND DPI QUEENSLAND EDFISH The Wetlands Education Project

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

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APPENDIX 3: CRITERIA FOR RAMSAR SITE NOMINATION

(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.

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°

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

Dataset

Dataset: DSIN 10403
Title: Coastal Wetland Vegetation: The Whitsunday region.
Legal Owner: Queensland Fisheries Service - Assessment & Monitoring Unit
Custodian: Queensland Fisheries Service - Assessment & Monitoring Unit
Jurisdiction: QLD

Description

Abstract: Coastal wetland vegetation of the Whisunday region from Cape Gloucester to Sand Bay, including mangrove and saltmarsh communities.
Search Word(s) : mangrove, saltmarsh, saltpan
Geographic Extent Name(s): Whitsundays
Beginning date: 1/09/00
Ending date: 1/08/01

Status

Progress: Complete
Maintenance and update frequency: Not Required

Access

Stored Data Format: DIGITAL - ARC/INFO
Available Format Type: DIGITAL - ArcView Shapefile (.shp), DIGITAL - ARC/INFO
Access Constraint: QFS data - release outside QFS on completion of a licence agreement

Data Quality

Lineage: Landsat 5 TM satellite imagery processed using ERDAS Imagine 8.3.1. Landsat imagery used: Gloucester Island to Conway Peninsula - 16 July 1997, Conway Peninsula to Sand Bay - 24 June 1989. Bands 1-5,7 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. The photography used in this study was 1: 50 000 and 1: 12 000 St Lawrence to Townsville Beach Protection Authority photography acquired in August and June 1993, and 1: 12 000 St Lawrence to Townsville Beach Protection Authority photography acquired in May 1998. 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.
Positional Accuracy: Landsat TM imagery rectified to MGA with final radiometric correction and GCP's. DATUM GDA94 ANS
Attribute Accuracy: Overall accuracy >80%
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

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Metadata Creation Date: 28/8/2001

APPENDIX 6: DISTRIBUTION OF COASTAL WETLANDS IN THE STUDY AREA

Maps displaying the distribution of coastal wetland vegetation in the Study Area are included on the CD available with this report. Two files for each map are available in .pdf format, one created with print optimised settings and the other created with screen optimised settings. The map sheets are labelled from north to south as follows:

Sheet 1: Gloucester Island
Sheet 2: Pioneer Bay
Sheet 3: Whitsunday Island
Sheet 4: Whitsunday Passage
Sheet 5: Conway Inlet
Sheet 6: Midge Point
Sheet 7: St Helens
Sheet 8: Cape Hillsborough

APPENDIX 7: FIELD DATA

DATE	LOCATION	LAT.	LONG.	COMMUNITY	COMMENTS/OTHER SPECIES PRESENT
02/06/93	Rocky Point	-20.6325	148.7200	Open Av (2-3)	sparse Av, Aeg, Rhiz <5 m tall
02/06/93	Midge Point	-20.6370	148.7148	Closed Rhiz (<10)	Closed Cer/Brug <10 m tall
02/06/93	Midge Point	-20.6406	148.7172	Saltpan	
02/06/93	Midge Point	-20.6415	148.7153	Closed Cer (<5)	Lum fringe
03/06/93	Proserpine River	-20.4529	148.7008	Closed Rhiz (<10)	seaward - sparse Av landward - closed mixed <10 m tall, <20 m wide (Rhiz, Brug, Exco, Xylom, Acan, Aeg)
10/11/93	Sandfly Creek	-20.5472	148.6673	Closed Rhiz (5-6)	creek edge - Av 7-8 m (on accretion banks), Aeg 2-4 m
10/11/93	Sandfly Creek	-20.6367	148.6994	Closed Mixed (8)	Xylog, Acan, Aeg, Exco, Rhiz, Brug, Spor, Cer, Lum, Her, Osb
28/11/95	Proserpine River	-20.4209	148.6477	Closed Mixed (<10)	Exco, Aeg, Hib, Brug, Her, Lum, Xylog, Acan, Acros
28/11/95	Yard Creek	-20.6596	148.7146	Closed Rhiz (5-8)	Av, Cer 1-5 m (some Exco, Aeg, Av emergents, Spor, samphires)
28/11/95	Yard Creek	-20.6524	148.7111	Saltpan	zones of bare, algal crusted, samphires (Halo, Sesu, Bat, Tect, Sue), dense Spor
28/11/95	Yard Creek	-20.6506	148.7116	Closed Mixed (6)	<10 m wide - Cer, Her, Brugg, Brugp, Lum, Aeg, Exco, Acan, Lum 5-8 m
29/11/95	Peggy's Pocket	-20.8360	148.7790	Closed Mixed (5)	Creek edge - Aeg, Av, Rhiz 5 m landward – Exco
29/11/95	St Helens	-20.8224	148.8298	Closed Rhiz (<5)	Cer <2 m high 10 m wide
29/11/95	Murray Creek	-20.9040	148.8384	Closed Mixed (5)	Exco, Hib, Aeg, Acan, Xylocg, Cer
29/11/95	Murray Creek	-20.9416	148.8303	Closed Mixed (5)	Exco - deciduous, Hib
29/11/95	Rd to Victor Harbour	-20.8871	148.9416	Closed Cer (5)	Exco, Brug
29/11/95	Plantation Creek	-20.0125	148.9626	Closed Rhiz	Cer rim <10 m wide
29/11/95	Ball Bay	-20.9108	149.0000	Closed Cer	
29/11/95	Cape Hillsborough	-20.9256	149.0425	Closed Rhiz	seaward
03/11/97	Shute Harbour	-20.28930	148.7871	Closed Mixed	
03/11/97	Shute Harbour	-20.28982	148.7801	Cer/Osb	
03/11/97	Shute Bay	-20.28709	148.7724	Closed Mixed	
03/11/97	Shute Bay	-20.28489	148.7677	Closed Mixed	
03/11/97	Shute Bay	-20.26257	148.7962	Open Mixed	fringing
03/11/97	Funnel Bay	-20.26568	148.7512	Mixed	
03/11/97		-20.27842	148.7376	Mixed	
03/11/97	Boat Haven	-20.27668	148.7320	Mixed	
03/11/97	Double Bay	-20.21147	148.6340	Mixed	
03/11/97	Double Bay	-20.21146	148.6350	Closed Rhiz	
03/11/97	Charley's Creek	-20.23974	148.6560	Closed Exco	
03/11/97	Morgan's Creek	-20.24757	148.6572	Closed Cer	
03/11/97	Morgan's Creek	-20.24718	148.6583	Closed Rhiz	
03/11/97	Earlando Bay	-20.15245	148.5691	Closed Rhiz	
04/11/97	Earlando	-20.15290	148.5643	Closed Rhiz	
04/11/97	Earlando	-20.14879	148.5615	Saltpan	

Abbreviations for mangrove species:

Acan – *Acanthus ilicifolius*
Acros – *Acrostichum speciosum*
Aeg – *Aegiceras corniculatum*
Av – *Avicennia marina*
Brugg – *Bruguiera gymnorrhiza*
Brugp – *Bruguiera parviflora*
Cer – *Ceriops tagal*
Exco – *Excoecaria agallocha*
Her – *Heritiera littoralis*
Hib – *Hibiscus tiliaceus*
Lum – *Lumnitzera racemosa*
Osb – *Osbornia octodonta*
Rhiz – *Rhizophora* spp
Xylog – *Xylocarpus* granatum
Xylom– Xylocarpus mollucensis

Abbreviations for samphire species:

Bat – *Batis argillicola*
Halo – *Halosarcia* spp
Sesu – *Sesuvium portulacastrum*
Spor – *Sporobolus virginicus*
Sue – *Suaeda* spp
Tect – *Tecticornia australasica*

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 Whitsunday region, from Goulcester Island to Cape Hillsborough. This classification contributes to the final baseline assessment of Queensland's coastal wetland resources. The project has provided key information and recommendations for the declaration of additional managed, Marine Protected Areas in Queensland (Section 9) and for the ongoing management of existing protected areas (Fish Habitat Areas, Marine Parks) and, as appropriate, may form a basis for nomination of Ramsar sites.

Appropriateness

The current study uses the protocol developed by the Department of Primary Industries Queensland, Queensland Fisheries Service (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. The coastal wetlands of the entire Queensland coastline have been mapped using this technique.

Effectiveness

The method of investigating and mapping relatively large coastal regions, utilised in this study, has proven to be cost effective and highly accurate (approximately 80%) for coastal wetland communities at this scale. The information presented in the report has been provided to the DPI Queensland Fisheries Service, Marine Habitat Unit staff responsible for FHA declaration, for the purpose of incorporation into FHA planning processes relevant to the Study Area.

Transferability

It has been demonstrated, in this and previous studies, that the technique developed for coastal wetlands mapping is transferable to similar coastal wetland systems. Landsat TM data is widely available. However, limitations to the technique apply. The minimum mapping unit is a 25 x 25 m Landsat TM pixel. Consequently, a community smaller than this size is not mappable. 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.

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 from Gloucester Island to Cape Hillsborough 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, indigenous and commercial fisheries in the region. As a result of this project, numerous environments have been identified in the Study Area that have a high conservation value. 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 and Southern Fisheries Centres and other regional DPI Fisheries staff. Copies of the report will be available through the QDPI Library and the Coastal Habitat Resource Information System website (*http://chrisweb.dpi.qld.gov.au/chris/*).