INTRODUCTION

Current coastal zone management issues in the Hinchinbrook region include protection of fisheries habitats, dugong habitat areas and increases in aquaculture, agriculture and tourist operations. A regional coastal management plan which is being developed, also requires detailed information on seagrass resources for the coastal zone from Dunk Island in the north, to Cleveland Bay in the south. Decreases in estimates of dugong abundance in the southern half of the Great Barrier Reef region since the 1980's have also prompted the need for detailed baseline and monitoring surveys of seagrasses in this and other regions.

Seagrasses are important nursery habitat for commercial species of penaeid prawns and fish (Coles and Lee Long 1985; Coles *et al.* 1993; Watson *et al.* 1993). Seagrass meadows in Queensland are also essential food for dugong, *Dugong dugon* (Miller), and green sea turtles, *Chelonia mydas* (Linnaeus) (Lanyon *et al.* 1989). Seagrasses in coastal regions act as "nutrient and sediment sinks" (Short 1987) and help maintain sediment stability and water clarity. Coastal seagrass meadows are therefore an important resource economically and ecologically.

Tropical seagrass meadows are subject to temporal changes, varying seasonally and between years (Mellors *et al.* 1993; McKenzie 1994), with likely consequences for faunal populations of fisheries and conservation value. Widespread loss of *Halophila* and *Halodule* in Hervey Bay had large impacts on local dugong populations (Preen and Marsh 1995). Positive correlation between ENSO cycles and reproduction and growth in green sea turtles in the southern Great Barrier Reef (Limpus and Nicholls 1988) implied changes in quantity or quality of the turtles' staple seagrasses as a possible explanation. The potential for widespread seagrass loss has been well documented and the causes of loss can be natural, such as cyclones and floods (Poiner *et al.* 1989), due to human influences such as agricultural runoff (Preen *et al.* 1995), industrial runoff (Shepherd *et al.* 1989), oil spills (Jackson *et al.* 1989), harbour dredging (Onuf 1994), or any combination of these (Pringle 1989). Any of these impacts are possible in the Dunk Island to Cape Cleveland region.

Seagrass meadows in this region (Dunk Island to Cape Cleveland) were first mapped during a broad-scale survey in October/November 1987 (Coles *et al.* 1992) and large areas of dense seagrass were found in sheltered sections of the coast.

The only measure of temporal change in seagrasses of the Hinchinbrook Island Region comes from detailed Spring and Autumn baseline surveys at Oyster Point, Cardwell (Coles *et al.* 1997). Seasonal variations in seagrass abundance included a spring/summer maximum and autumn/winter minimum, as found in monthly sampling of specific northern Queensland locations (Mellors *et al.* 1993). Long-term variation in seagrass distribution and abundance in northern Australia has received very little investigation (McKenzie 1994). It is unclear whether year-to-year changes in seagrass abundance in the Hinchinbrook Region would reflect those at other north-eastern Queensland locations.

This survey was designed with the following objectives:

1. *To map the fine-scale distribution of coastal and island seagrass meadows in the Hinchinbrook to Townsville Region (Dunk Island to Lucinda, Lucinda to Cape Cleveland).*
2. *To estimate seagrass biomass for the major seagrass meadows.*
3. *To present in a GIS, quantitative data on the major coastal seagrass communities in the Hinchinbrook to Townsville Region for use in future monitoring.*
4. *To provide comment on differences in seagrass distribution and abundance data since the original QDPI broad-scale seagrass surveys of 1987, and recommendations on seagrass conservation management for this region.*

This survey provides a spring-time baseline survey of seagrass distribution and abundance in the Hinchinbrook Region. Seagrass habitats between Dunk Island and Lucinda are required in detail on a Geographic Information System (GIS), suitable for developing a long-term monitoring program. Sampling between Lucinda and Cape Cleveland at a lower spatial intensity will enable identification and mapping of major seagrass areas.

METHODS

Description of study locality

The coastal and island waters from Dunk Island (17°55'S) to Cleveland Bay (19°15'S), are at the southern end of the wet tropics region of northern Queensland (Figure 1). Monsoonal summer rains provide the bulk of precipitation for the region and intermittent showers can occur through the remainder of the year. South-easterly trade winds however dominate the drier winter and spring period, June to November. These trade winds create a general northerly, longshore current inshore, while a light southerly flow exists on the mid and outer shelf under the influence of the East Australian Current (Wolanski 1994). The semi-diurnal tides reach a maximum range of 3.5 m during Summer spring tides (Queensland Department of Transport 1996).

Numerous creeks and rivers drain the Great Dividing Range and narrow coastal plain, and the largest catchment in the region is the Herbert River system which drains into the southern end of Hinchinbrook Channel. There are two large and relatively exposed bays (Rockingham and Halifax) and two very large bays (Missionary and Cleveland).

Patch reefs on the mid and outer shelf of the Great Barrier Reef provide shelter from Pacific Ocean swells. Continental islands dominate the inner shelf features and are all within the 20 m bathymetry contour. These islands also provide further shelter from waves. The Hinchinbrook Channel is a dominant feature in the region and has a very low net water exchange over a tidal cycle (Wolanski 1994).

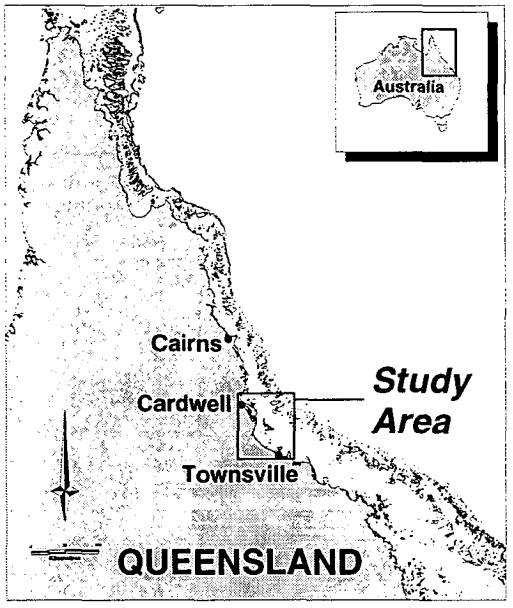

Figure 1. Location of Hinchinbrook Region study area.

Inshore sediments are dominated by terrigenous sands and muds, but carbonate composition of sediments begins close to the coast at about the 20 m contour (Maxwell 1968). Shelf sediments originating from rivers, inshore reefs and the Great Barrier Reef are transported northward and shoreward, with rapid accretion of fine sediments in the lee of headlands (Larcombe *et al.* 1996).

Survey methods

Seagrass communities of the coastal and island waters from Dunk Island to Cleveland Bay were surveyed by divers in spring 1996, between 7th - 16th October. Areas of survey were selected from previous knowledge of seagrass resources (Coles *et al.* 1992), aerial photography, and ground reconnaissance. Results from a detailed fine-scale survey of seagrasses adjacent to Oyster Point, Hinchinbrook Channel, conducted between the 4th - 7th

August 1996 (Coles *et al.* 1997) were included in the present survey with permission from the Queensland Department of Economic Development and Trade.

The field sampling design was implemented to estimate seagrass meadow area and above-ground seagrass biomass. From Dunk Island to Lucinda seagrasses were surveyed at fine scale, with sites and transects approximately 100-500 m apart, using divers and aerial photography (Map 1). Seagrasses from Lucinda to Cape Cleveland were surveyed at a lower intensity, with sites and transects approximately 100-1000 m apart, but sufficient to map and describe the major seagrass habitats. Intertidal and sub-tidal areas were surveyed using boats and divers. Recent (1995) low-tide aerial photography (not digitised due to inadequate control points and poor rectification) was interpreted to help map seagrass distribution patterns where high density habitat was visible but inaccessible during the dive survey.

Halifax Bay coastal and island waters, and windward parts of Magnetic Island were not surveyed because of prohibitive weather conditions. Seagrass habitat in these areas do not appear in aerial photos as clearly distinct from reef or algae habitat. Seagrass maps from initial broad-scale surveys of those areas (Coles *et al.* 1992) will be presented here.

Data Collection

Seagrass habitat characteristics including visual estimates of above-ground biomass (3 replicates of a 0.25 m^2 quadrat), species composition, % algae cover, sediment type, water depth and geographic location were recorded. Aerial photographs (not digitised) were interpreted to aid in mapping some intertidal seagrass meadow boundaries. Survey transects extended from the upper intertidal to depths beyond the outer edge of seagrass meadows. Sites between transects were also dived to check for continuity of habitat types. A differential Global Positioning System (dGPS) was used to accurately determine geographic location of sampling sites (±5 m).

Above-ground biomass was determined by a "visual estimates of biomass" technique modified from Mellors (1991). At each site, divers recorded an estimated rank of seagrass biomass and species composition in three replicate quadrats. On completion of the survey, each diver ranked ten quadrats which were harvested and the above-ground dry biomass (g DW. m^{-2}) measured. The regression curve representing the calibration of each divers' ranks was used to calculate above-ground biomass from all their estimated ranks during the survey.

Seagrass community types were determined by dominant seagrass species found within each meadow. Each community type was assigned a numerical code for further biomass and areal analysis. Seagrass habitat types were determined by species composition and physical attributes (ie intertidal or subtidal, coastal or fringing reef) influencing each seagrass community. Numerical codes were also assigned to each of the distinct habitat types for analysis of biomass and distribution.

Seagrass species were identified where possible according to Kuo and McComb (1989). Voucher specimens were collected if taxonomic verification was required.

Depths of survey sites were recorded with an echo-sounder and converted to depths (m) below mean sea level (MSL), correct to tidal plane datum's (Queensland Department of Transport 1996) for the localities surveyed. Lucinda tidal plane data was used for correcting depth measures at Hinchinbrook sites south of Haycock Island. Cardwell tidal plane data was used for correcting depth measures for sites in the Channel north of Haycock Island.

Field descriptions of sediment type from hand or grab samples were recorded for each site: shell grit, rock gravel, coarse sand, sand, fine sand and mud.

Geographic Information Systems (GIS)

A GIS basemap of the study region including coastline (low and high), reefs and islands was obtained from GBRMPA and AusLig© (digitised at 1:250,000 scale).

A GIS of seagrass community distribution was created in MapInfo® and ArcView® using the above survey information. A CD Rom copy of the GIS with metadata will be archived at the GBRMPA and the original archived with the custodians (QDPI) at Northern Fisheries Centre.

Boundaries of seagrass habitat were interpreted using one or more of the following: seagrass data at each dive site, extent of habitat visible from the vessel, aerial photography (not digitised) and bathymetry. Errors in GIS maps include those associated with digitising and rectifying basemaps and with Global Positioning System (GPS) fixes for survey sites. The point at which divers estimated bottom vegetation may be up to 5 m from the point at which a GPS fix was obtained. Differentially corrected GPS fixes were also only precise to within 5 m. These errors are considered to be within the errors associated with distance between survey sites.

Estimates of mapping reliability were assigned to each meadow, based on the range of mapping techniques used and associated spatial errors. Boundaries of meadows in intertidal depths were usually mapped with greatest reliability (identified from surface observations, from dive sites usually less than 100 m apart, and sometimes interpreted from aerial photos). Boundaries in sub-tidal depths (eg., the outer boundaries of large meadows) were mapped with less reliability because of *a)* very gradual changes in habitat and *b)* poor underwater visibility. Where the depth of outer boundaries were established, bathymetry was used to help outline the meadow boundary between survey sites. Estimates of mapping reliability ranged from 10 m to 500 m and were recorded in the GIS.

Analysis

Standard parametric tests were used for analysis of data (Sokal and Rohlf 1987). All divers had significant linear regressions ($r^2 > 0.85$) when calibrating above-ground biomass estimates against a set of harvested quadrats.

Meadows were classified into seagrass community types according to the dominant species present. Some seagrass community types occurred in a range of habitats, so the dominant seagrass habitat types were also identified. Depth and biomass of seagrasses were also examined by selected localities.