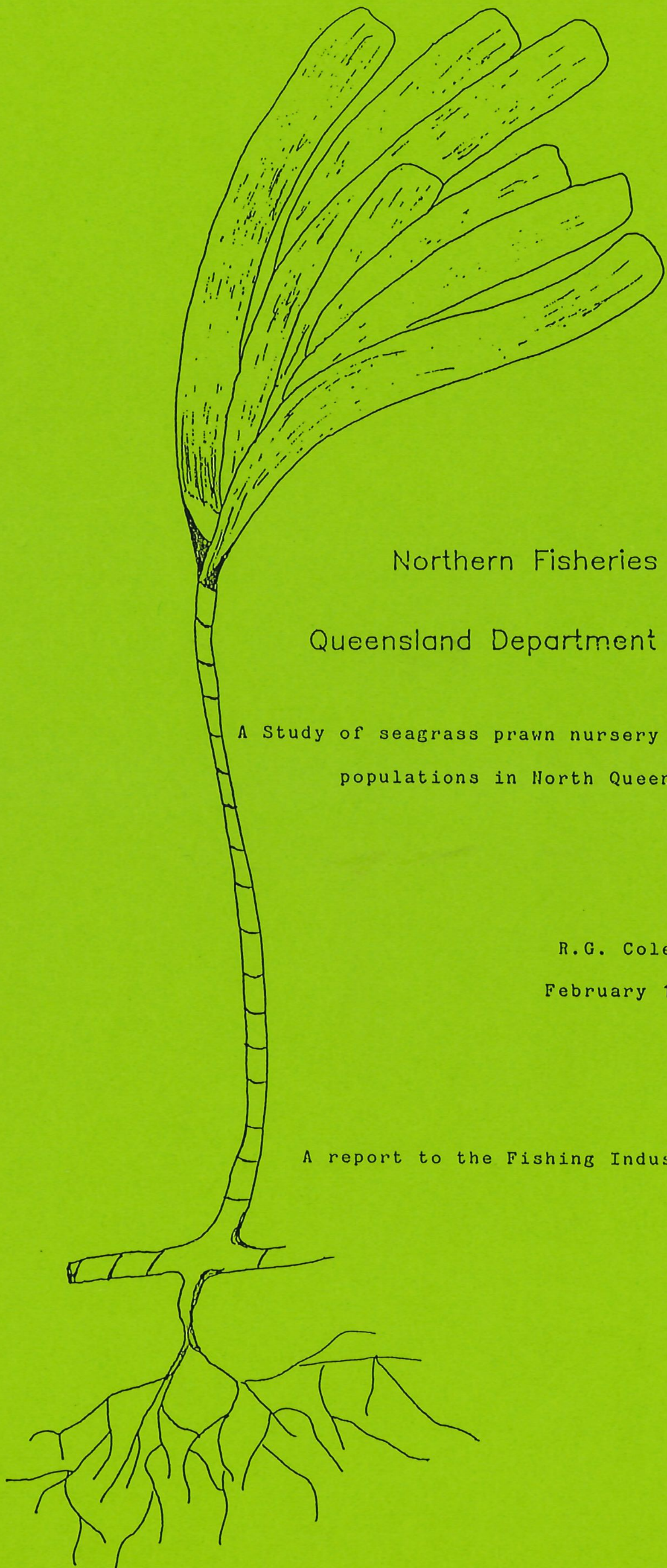

Northern Fisheries Research Centre

Queensland Department of Primary Industries

A Study of seagrass prawn nursery grounds and juvenile prawn populations in North Queensland (FIRTA 84/22)

R.G. Coles

February 1987

A report to the Fishing Industry Research Committee

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A STUDY OF SEAGRASS PRAWN NURSERY GROUNDS AND JUVENILE PRAWN POPULATIONS IN NORTH QUEENSLAND (FIRTA 84/22)

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CONTENTS

INTRODUCTION

Seagrasses are of immense ecological importance in marine ecosystems. Primary production rates for seagrass beds are amongst the highest recorded for marine and terrestrial systems (McRoy 1974; Zieman 1975). They have a well documented role as animal habitat, nursery grounds, and as substrate stabilizers (McRoy and Hefferich 1977).

The proximity of population centres to many of the seagrass-colonized estuaries and embayments of the Australian coast has catalyzed research of the effects of pollution and errosion on these marine angiosperms (Shapiro 1975; Larkum 1976). Although the importance of seagrass habitat and the potential for its loss has been recognized in these studies, ecological research remains surprisingly sparse. This is particularly so in the northern regions of Australia.

In northern Queensland, seagrass-vegetated areas are important, as habitats for the juveniles of commercial penaeid prawn species (Young and Kirkman 1975; Staples 1984; Coles and Lee Long 1985). The tiger prawns, *Penaeus esculentus* Haswell and *P. semisulcatus* de Haan, and the endeavour prawn, *Metapenaeus endeavouri* (Schmitt), form the major component of an otter trawl fishery for prawns in this region worth around $60 million annually.

Post-larvae and juveniles of tiger and endeavour prawns are found almost exclusively in seagrass beds and these habitats are necessary for their survival and growth (Staples 1984; Coles and

Lee Long 1985). A reduction in the extent of seagrass beds could reduce prawn production (Kirkman 1978; Staples 1984). Preserving this aquatic habitat is an important aspect of the management of north Queensland's commercial prawn trawl fisheries.

This report and its associated publications, identify those inshore areas of seagrass and bottom vegetation that provide suitable habitat for juvenile prawns between Cape York and Cairns and provide basic information on the seagrass and their juvenile prawn populations.

MATERIALS AND METHODS

Sampling of seagrass and prawn communities was conducted between June 1984 and July 1986. The area studied included coastal waters between Cape York and Cairns. Two major field trips were conducted; the first in November 1984 and the second in July 1985. In addition to planned samples, seagrass and prawns were collected from reef tops of three reefs; Thrush Reef, Cockburn Reef and Wizard Reef.

Sampling procedure

Seagrasses

Seagrass samples were collected in the field from transects (typically 4-5 km in length and 5-10 km apart) running perpendicular to the coast from shallow water to depths at which seagrasses could no longer be found. On each transect, a diver swam over a 15 m section of bottom every 250 m and recorded the presence or absence of seagrass. Between transects, in estuaries, or in areas of the coastline where, because of depth or bottom type, seagrasses were considered unlikely to be found, single dives were made to check for the continuity of the bottom type and for the possible presence of seagrass.

The position of the transects and distance from the shore were fixed using RADAR with a variable range marker. Depths were recorded in the field on a recording depth sounder. These were later corrected to mean sea level using time of day and tidal plane data for the north-eastern Queensland coast (Queensland Department of Harbours and Marine Official Tide Tables).

Where seagrasses were found, four partially randomized samples (Kershaw 1980) were collected, two by each of two divers. If the seagrass cover along a transect appeared uniform, then one set of samples was collected and subsequent samples at each 250 m interval recorded as similar in composition. Each sample collected consisted of all seagrass plant material in a square quadrat enclosing 0.25 m^2 including roots and rhizomes to a depth of 5-10 cm in the substratum. After the quadrat was placed on the bottom, a knife was used to cut around its inside edge. This ensured previously attached plant material from outside the quadrat was not included when the sample was excavated.

In the laboratory, each quadrat sample was washed and sorted into component species (Lanyon 1986). Samples were not acid treated as there was little epiphyte and sediment contamination. Total wet weight, shoot length and leaf areas were recorded for each species. A subsample of 50 shoots of each species was then taken from the four quadrats at each site. These shoots were divided into above ground (stems and leaves) and below ground (roots and rhizomes) portions. Plant material was dried at 80 C for 48 hours and re-weighed to obtain dry weights.

Juvenile prawn samples

Samples of prawns were collected with two 1.5 m wide, 0.5 m high beam trawls fitted with 2.0 mm mesh and towed at a speed of 0.5 m sec^{-1}(Coles and Lee Long 1985). Sites suitable for night-time prawn trawling were selected during daytime seagrass sampling. Trawls of 2.5-15 min duration were conducted later that night at these sites.

Carapace length measurements (CL) were taken of all prawns caught. Only those with CL >3 mm were identified to species (Dall 1957) and used in subsequent analyses.

RESULTS AND ANALYSES

Seagrasses

A total of 928 quadrat samples of seagrass were used in analyses. These were collected from 254 sites. In addition, at 585 locations, spot checks of the bottom were made to confirm the presence or absence of bottom vegetation. Initially, data collected was used to prepare maps of the percentage cover of vegetated areas in coastal waters (Coles et al 1985). For detailed analysis, sites where seagrasses were found were grouped into 29 geographic areas (Fig. 1). These included estuarine and coastal regions, coastal islands, and coral reef platforms.

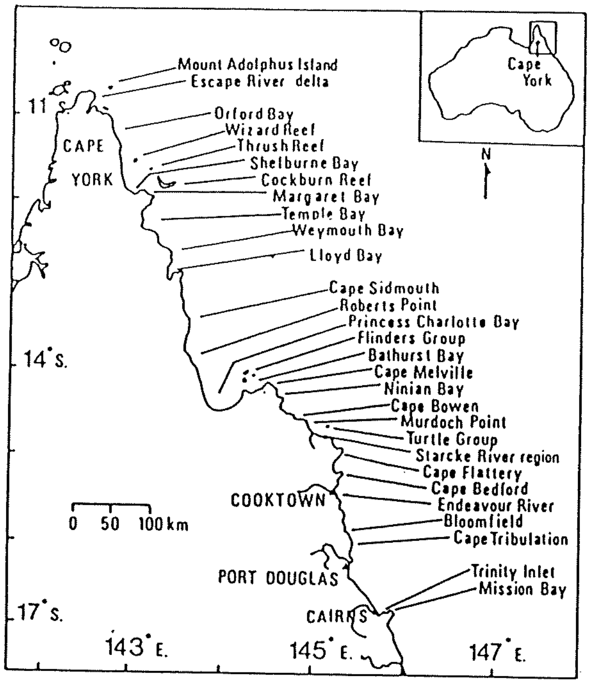

Fig. 1. Sampling areas between Cape York and Cairns, northern Queensland.

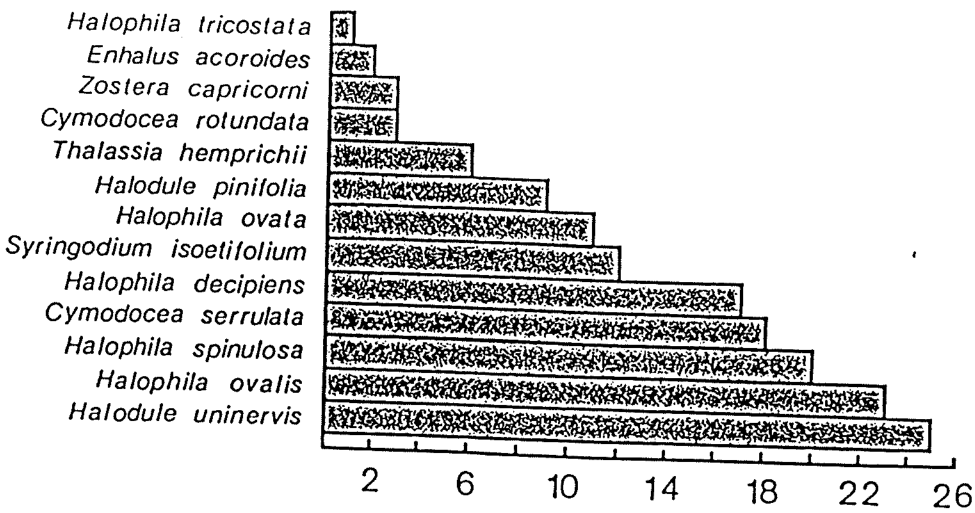

Fig. 2. The number of sites that each of the seagrass species was found, on the north-eastern coast of Queensland, in areas described by Coles et. al. (1987)

Distribution of seagrass species

Thirteen seagrass species were identified. Twelve species were present in coastal seagrass samples, nine species in samples from coastal islands, and two species occurred in reef platform samples.

The most commonly found seagrass species was Halodule uninervis (Fig. 2). Three other species, Halophila ovalis (R. Br.) Hook f., Halophila spinulosa (R. Br.) Aschers., and Cymodocea serrulata (R. Br.) Aschers. and Magnus, were found in 18 or more of the 29 geographic areas sampled. Halophila tricostata and Enhalus acoroides (L.f.) Royle were the least common, found in only one and two areas, respectively (Fig.2).

Nine seagrass species were found around the Flinders Group of Islands, the largest number from a single sampling area. The adjacent coastal areas of Bathurst Bay and Princess Charlotte Bay were also rich in seagrass species.

Distribution of seagrass with depth

Seagrasses were found to a maximum depth of 14 m (Fig. 3). Seagrasses were absent from intertidal zones except in Cairns harbour, Cape Bedford Bay to the north of Cooktown and on reef platforms. However, all 13 species occured at sites <2m deep. Only four species, C. serrulata, Halodule uninervis (wide leafed), Syringodium isoetifolium (Aschers.) Dandy, and Halophila decipiens, were found deeper than 10 m. Some species may have extended into coastal waters deeper than 14 m at densities too low to be observed by divers.

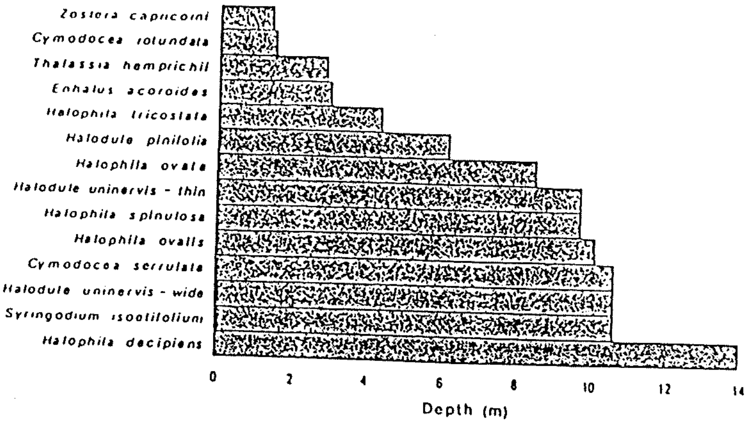

Fig. 3. The maximum depth at which each seagrass was found.

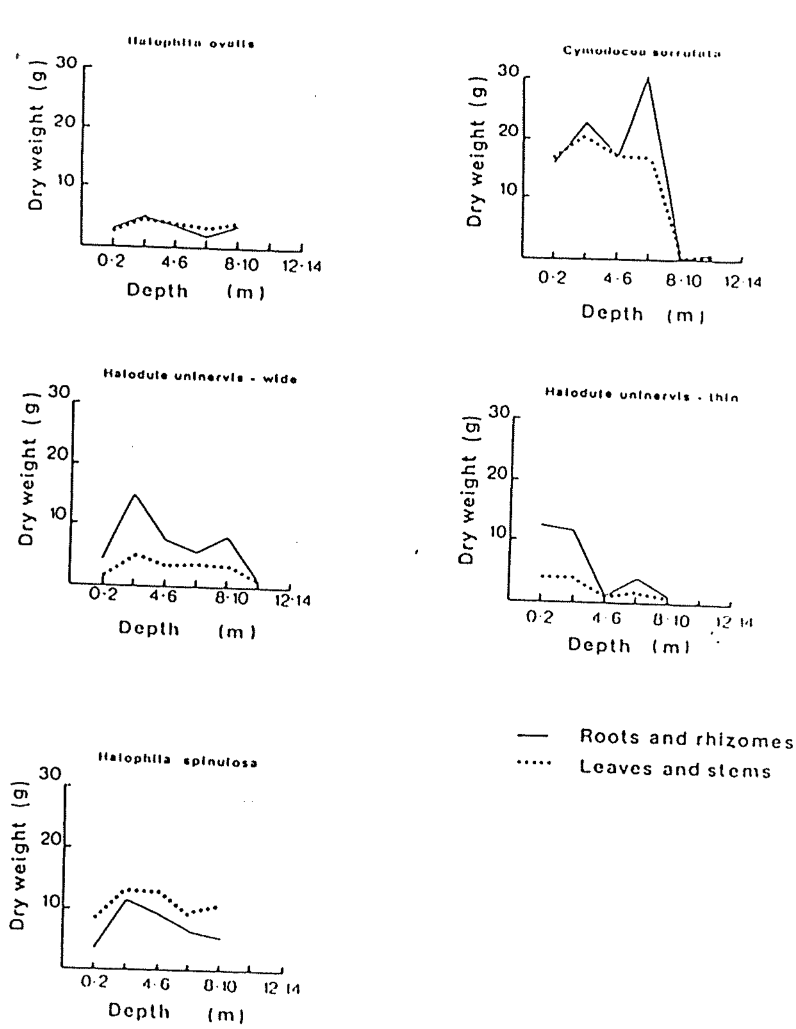

Fig. 4. The average biomass at 2 m depth intervals for the 4 most common seagrass species. Halodule uninervis was seperated into two morphological types, thin and wide leafed.

Three general depth zones of species composition were recognizable. A shallow zone(<6 m deep) had a high diversity of species including all the relatively uncommon species. An intermediate depth zone, 6-11 m, had a lower species diversity and contained species that occurred consistently along the coast. Below 11 m depth, there was a zone with a light and patchy cover of Halophila decipiens.

Plant biomass for the four commonest species was greatest in 2 to 6m of water (Fig. 4). Except for C. serrulata, above ground (leaves and stems) and below ground (roots and rhizomes) biomass followed a similar trend with depth. Cymodocea serrulata has its densest root and rhizome system toward the deeper end of its range.

For these species there was a trend for both above and below ground biomass to be greater in spring (pre-wet season) (1984 samples) than in the winter (post-wet season) (1985 samples). This difference was most apparent for the Halophila species (sig. P = 0.05) with less change apparent in the broad leafed, grass like species (Fig. 5).

Penaeid prawns

A total of 126 samples of penaeid prawns were collected. Juveniles of six commercially important prawn species were captured in these trawls across seagrass beds (Fig. 6). Metapenaeus endeavouri was the most numerous prawn in the samples and was found in all areas trawled. Penaeus esculentus was caught at all but one of the coastal areas and at all island

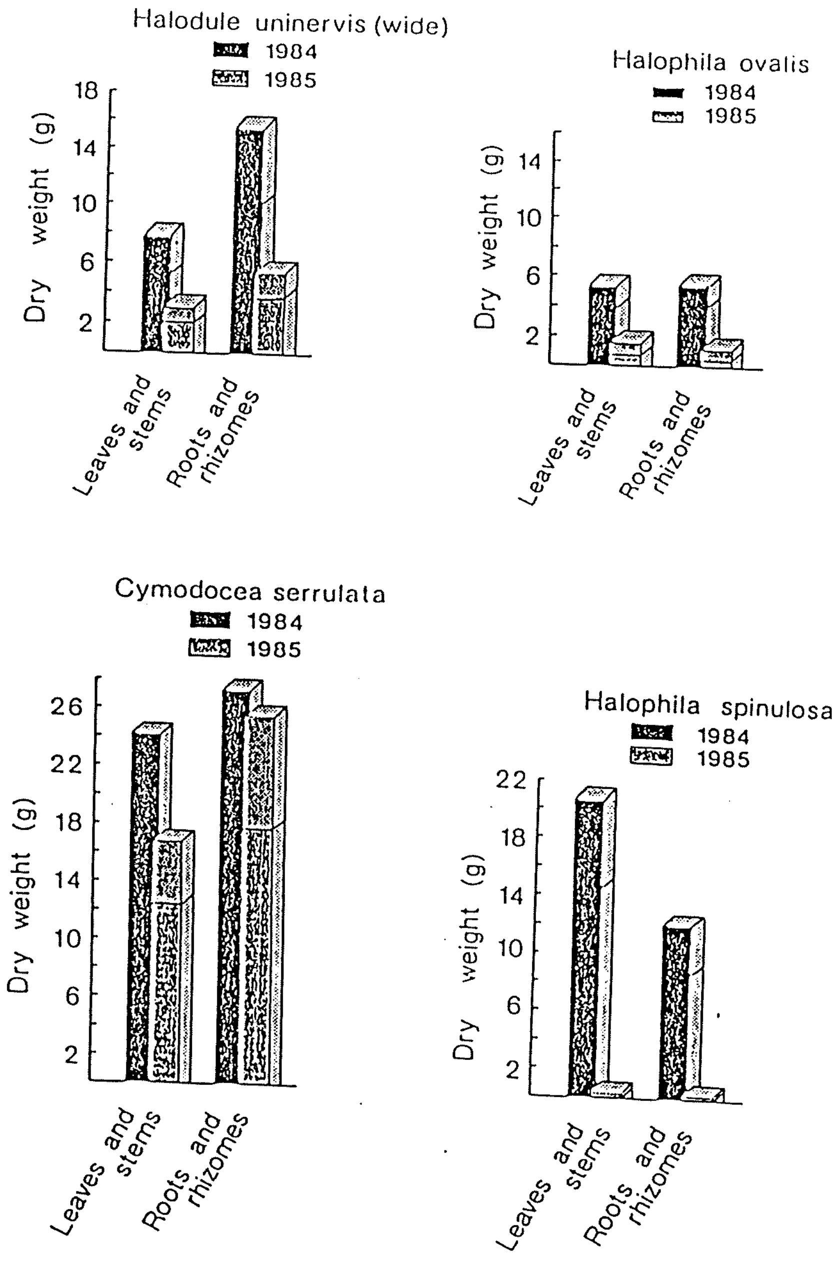

Fig. 5. Seasonal variation of above ground biomass, below ground biomass and shoot number for the 4 most common north-eastern Queensland coastal seagrass species.

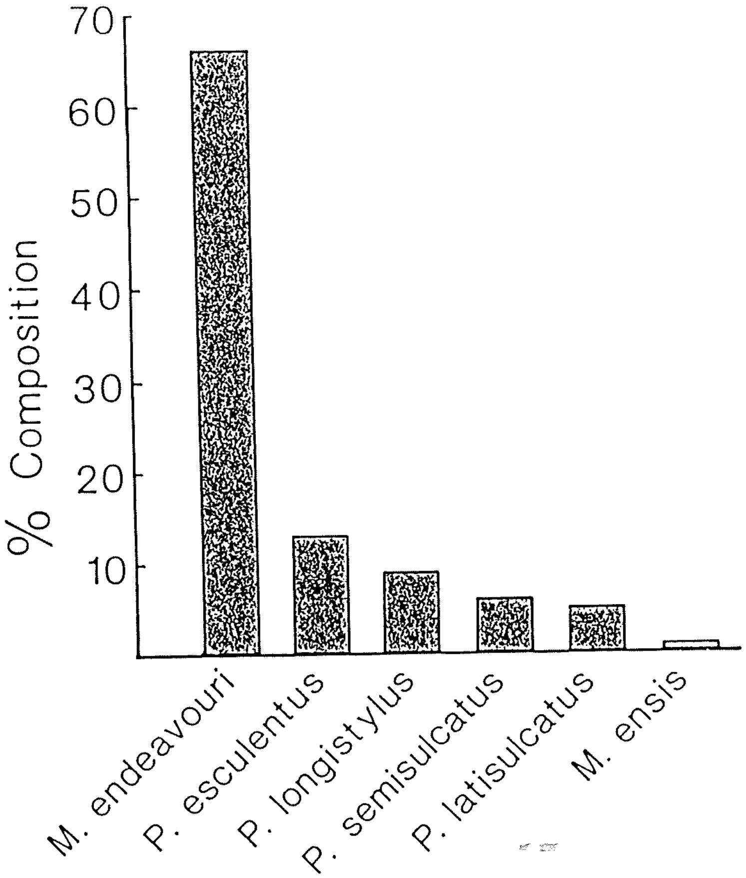

Fig. 6. The proportion of each of six species of juvenile penaeid prawn caught on seagrass beds.

areas. It was also found in small numbers on reefs. In contrast, the grooved tiger prawn, P. semisulcatus, and western king prawn, P. latisulcatus Kishinouye, were patchily distributed along the coast and absent from nearshore islands. Both were present on reefs. Red spot king prawns, P. longistylus Kubo, were found only at four sites, two on the coast and two on coral reef platforms.

The false endeavour prawn, M. ensis (de Haan), was found only in three coastal areas and was absent from island and reef sampling sites.

Although island waters had dense stands of seagrasses similar in species composition to nearby coastal sites, juveniles of only two commercially important prawn species were found there. In comparison, five commercial species were found on coral reef platforms and up to six commercial species in samples from coastal areas. Two penaeid prawns that occur in the northern Queensland commercial trawl catch, the banana prawn, P. merguiensis de Mann, and the leader prawn, P. monodon Fabricus, were absent in our samples from seagrass beds.

DISCUSSION

Seagrasses

Marine angiosperms are important in shallow water ecosystems. In particular in north-eastern Australia, they form a vital role as nursery grounds in the life history of the commercial penaeid prawns (Young 1978; Staples 1984; Coles and Lee Long 1985). The recognition of the very real economic value of seagrasses to both commercial and amateur fisheries has led to the recent upsurge in seagrass research. Although the present project has identified and described seagrasses between Cape York and Cairns, large areas of the coast of Queensland remain to be studied.

Little information is available for seagrasses between Cairns and Townsville and in the high tidal range regions between Townsville and Hervey Bay. The hydrographic conditions of this part of the coast are unique and ecological studies here would provide valuable information on the stress, emersion and tidal current tolerances of a host of seagrass species.

Inter-reef and reef platform seagrasses and their requirements for survival in these environments have not previously been studied. Our recent discovery that reef platform seagrasses also play a part as nursery grounds for commercially important penaeid prawn species (Coles *et al*. 1987) adds impetus to the need for seagrass research in reef regions. It is possible that deep rooted species such as *Thalassia hemprichii* may also play a role in the stabilization of reef top sediments and thus in the growth of reef platforms themselves.

The 13 seagrass species that we have found represent a large proportion of the world's described species. *Halodule uninervis* and *Halophila ovalis*, relatively small and shallow rooted pioneering species (den Hartog 1970), were the most common seagrass species in coastal waters. *Enhalus acoroides* and *Thallassia hemprichii* were rare in coastal waters between Cape York and Cairns, although they are the climax species in the

Torres Strait (sensu Bridges et al. 1982) and are often the dominant species in the tropics (Womersley 1981). Their position in the seagrass community was occupied by C. serrulata, which formed the densest stands sampled. The rarity of the larger climax species in our samples and our survey technique, which included many samples of low density, resulted in our standing crop estimates (above ground plant material) being comparatively less than reported elsewhere (e.g., Ogden and Ogden 1982).

Seagrass zonation patterns are closely related to depth. Monospecific seagrass beds were generally uncommon. They did occur in depths greater than 11 m (H. decipiens) and on open coastlines such as between Cooktown and Cape Tribulation (where sparse beds of Halodule uninervis were found).

Cymodocea serrulata formed dense stands along the North Queensland coast as it did in southern Queensland (Young and Kirkman 1975), but in a greater variety of habitats including estuaries and muddy bays where it was common.

The species composition found in our study support the contention of Bridges et al. (1982) that environmental stress is of paramount importance in determining the location and composition of tropical seagrass communities. It is likely, however, that in north-eastern Queensland coastal waters the seasonal reduction in salinity and high turbidity associated with the summer rainfall pattern, rather than exposure at low tide, determines seagrass species distribution. This annually recurring period of environmental change prevents the establishment of a true climax community and of zonation patterns expected from more constant environments else where. Instead, most seagrass communities in north Queensland are characterized by a high diversity of species and a relatively small total biomass in a highly variable environment.

Seagrass biomass changed during the year. There appears to be a seagrass spring growth period and this seems to occur prior to the period of environmental stress - when large temperature, salinity and turbidity fluctuations are associated with the summer monsoonal wet season. This region of the coast is strongly influenced in summer by the north-west monsoon and may also be affected by intense winds associated with cyclonic disturbances (Brandon 1973).

Juvenile penaeid prawns

The two prawn species that constitute the major component of the commercial trawl catch M. endeavouri and P. esculentus (Coles et al. 1985), were found in virtually all our trawl samples across seagrass beds. Penaeus semisulcatus and P. latisulcatus were found less frequently and in fewer numbers, reflecting their proportions in the commercial catch (Coles et al. 1985). Of the prawn species important to the commercial trawl fishery, only P. merguiensis and P. monodon were absent from seagrass beds. P. merguiensis is commonly found on bare muddy substrata adjacent to mangrove areas (Staples 1984) and P. monodon juveniles are rarely found in north Queensland.

Juvenile P. longistylus were present on two of the three reefs which were sampled. They have subsequently been collected from coral reef platforms in the Torres Strait and Townsville regions (personal communications from R. Watson and M. Dredge, Queensland Department of Primary Industries). The juvenile phase of P. longistylus appears to be adapted to exploit shallow reef platform habitats, but they may settle and survive in estuaries and bays where conditions are suitably "reef like".

Management of seagrass habitat

Although large areas of seagrass prawn nursery grounds occur in north-eastern Queensland (Coles et al. 1985) most are located in only a few major regions. These include areas around the Escape River delta, Shelburne, Margaret, Weymouth and Princess Charlotte Bays, the Starke River region, and Trinity Bay near Cairns. Parts of several of these regions are protected by Queensland State and Commonwealth marine park legislation. However, major areas of north-eastern Australian seagrasses are still vulnerable to damage from pollution, dredging and harbour development, or irresponsible prawn trawling operations. These include major penaeid prawn nursery areas in Trinity Bay, near Cairns, coastal areas in the Princess Charlotte Bay region and Shelburne Bay.

Prawn trawl operations have the potential to damage seagrass beds. However, recent legislation and education programmes should protect the majority of seagrass beds that occur in shallow coastal waters from damage by trawlers. Unfortunately, the protection of seagrasses near population centres, in areas where development is necessary is much more difficult. In these areas careful management of seagrass habitats can only be achieved with the commitment of the community as a whole. Where damage has occurred, new developments in seagrass transplanting may prove of significant value in the re-establishment of one of the marine environment's most valuable communities.

Future research

Mapping of seagrasses is continuing with a further FIRTA grant for surveys of the Queensland coast between Cape York and Karumba and Cairns and Bowen. Fisheries Research Branch will use its own resourses and additional external funding to complete surveys of the Queensland coast from Cairns to Bundaberg. This will provide maps of seagrasses and a description of the prawn populations found for almost the entire Queensland coast.

The Fisheries Research Branch is also continuing seagrass research, extending the value of the results of the FIRTA project, by starting two long-term studies. Based at the Northern Fisheries Research Centre in Cairns, the studies are designed to examine the relationship between prawn numbers and the biomass and structure of the different seagrass species. The long-term management of the coastal seagrass beds is vital to the future of the prawn fishing industry, a fact recognized in the priority afforded seagrass research by the Queensland Department of Primary Industries.

REFERENCES

Brandon, D.E (1973). Geomorphology of eastern Queensland in relation to the Great Barrier Reef. In "Biology and Geology of Coral Reefs." Vol. 1 (Eds O.A. Jones and R. Endean) pp. 188-132. (Academic Press:New York).

Bridges, K.W., Phillips, R.C., and Young, P.C. (1982). Patterns of some seagrass distribution in the Torres Strait, Queensland Aust. J. Mar. Freshw. Res. 33, 273-288.

Coles, R.G. and Lee Long, W.J. (1985). Juvenile prawn biology and the distribution of seagrass prawn nursery grounds in the southeastern Gulf of Carpentaria. In 'Second Australian Prawn Seminar' (Eds. P.C. Rothlisberg, B.J. Hill and D.J. Staples) pp. 55-60 (NPS2:Cleveland).

Coles, R.G., Lee Long, W.J., Mellors, J.E., and Goeden G.B. (1985). An assessment of the 1985 Queensland east coast prawn trawling closure. Qld Dept Primary Indust. Information Series Q185023.

Coles, R.G., Lee Long, W.G., Squire, B.A., Squire, L.C., and Bibby, J.M. (1987). Distribution of seagrasses and associated juvenile commercial penaeid prawns in north-eastern Queensland waters. Aust. J. Mar. Freshw. Res. 38 (In press).

Dall, W. (1957). A revision of the Australian species of Penaeinae (Crustacea:Decapoda:Penaeidae): Aust. J. Mar. Freshw. Res. 8, 136-239.

Hartog, C. den (1970). 'The Seagrasses of the World' (North-Holland Publ. Co:Amsterdam).

Kershaw, K.A. (1980). 'Quantative and Dynamic Plant Ecology'. (Edward Arnold:London).

Kirkman, H. (1986). 'Seagrasses of the Great Barrier Reef.' Great Barrier Reef Marine Park Authority Special Publication Series (3) (Townsville).

Larkum, A.W.D. (1976)a. The ecology of Botany Bay. I. The growth of *Posidonia australia* (Brona) Hook *f*. in Botany Bat and other bays of the Sydney Basin. Aust. J. Mar. Freshw. Res. 27, 117-127.

McRoy, P. (1974) Seagrass productivity: carbon update experiments in eelgrass, *Zostera marine*. Aquaculture 4:131-137.

McRoy, C.P. and Helfferick, C. (Eds.) (1977). Seagrass Ecosystems: a scientific perspective. Marine Sciences 4. M. Dekker, New York. 314 pp.

Ogden, J.C., and Ogden, N.B. (1982). A preliminary study of two representative seagrass communities in Palau, Western Caroline Island (Micronesia). Aquat. Bot. 12, 229-44.

Shapiro, M.A. (Ed.) (1975). A preliminary report of the Westernport Bay Environmental Study. Ministry of Conservation, 240, Victoria Parade, East Melbourne Victoria 3002.

Staples, D.J. (1984). Habitat requirements of juvenile prawns. In 'The Potential of Aquaculture in Queensland'. (Eds. B.R. Pollock and R.H. Quinn) pp. 87-102. Qld Dept Primary Indust. Qld Conf. Workshop Series QC83012.

Womersley, H.B.S. (1981). Marine ecology and zonation of temperate coasts. In 'Marine Botany: An Australian Perspective'. (Eds. M.N. Clayton and R.J. King) pp. 211-240. (Longman Cheshire: Melbourne).

Young, P.C., and Kirkman, H. (1975). The seagrass communities of Moreton Bay, Queensland. Aquat. Bot. 1, 191-202.

Zieman, J.C. (1974). Methods for the Study of the growth and production of the turtlegrass, Thalassia testudinum Konij. Aquaculture 4: 139-143.

PUBLICATIONS ARISING FROM THIS PROJECT

Coles, R.G. (1986). More study on seagrass beds. The Queensland Fisherman, December, 1986 p. 34.

Coles, R.G., Lee Long, W.J. and Squire, L.C. (1985). Seagrass beds and prawn nurseries mapped in north Queensland. Australian Fisheries 44(9):24-25.

Coles, R.G., Lee Long, W.J. and Squire, B.A., Squire, L.C. and Bibby J.M. (1987). Distribution of seagrasses and associated juvenile commercial penaeid prawns in north-eastern Queensland waters. Aust. J. Mar. Freshw. Res. 38. (in press).

Coles, R.G. and Bibby, J.M. (1987). The distribution of prawn nursery grounds in north-eastern Queensland coastal waters. Proceedings of the West Pac Conference. Townsville 1986 (submitted).

Lanyon, J. (1986). 'Seagrasses of the Great Barrier Reef.' Great Barrier Reef Marine Park Authority Special Publication Series No. 3. (GBRMPA:Townsville).