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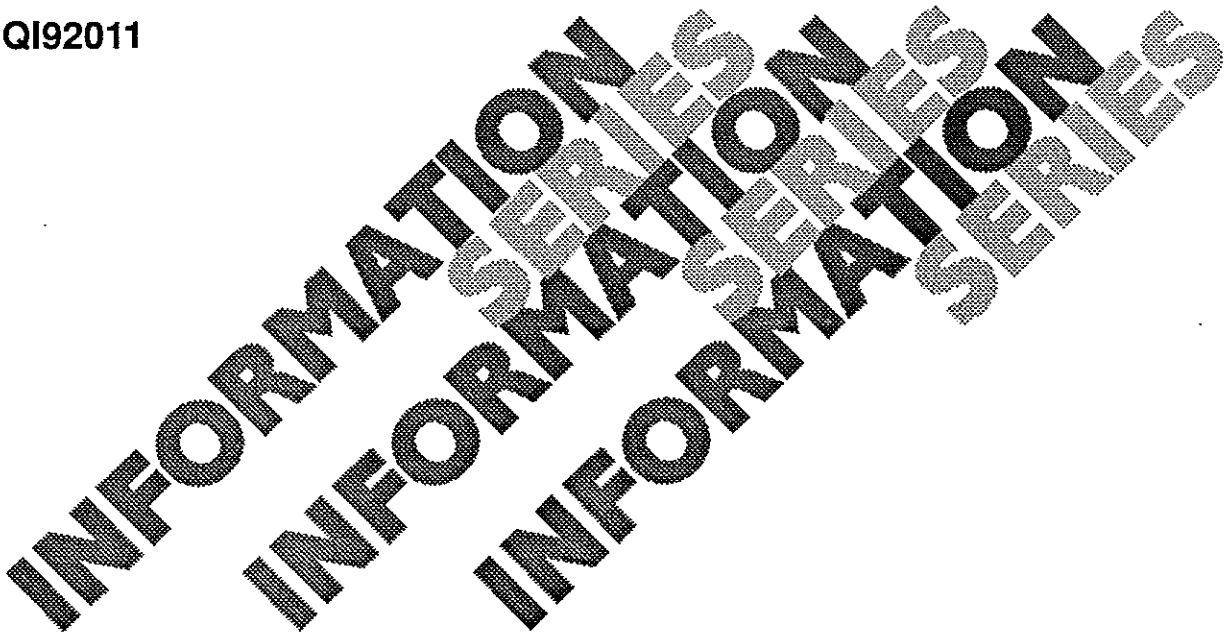

Seagrass beds and juvenile prawn and fish nursery grounds

Water Park Point to Hervey Bay, Queensland

W.J. Lee Long, R.G. Coles, K.J. Miller, K.P. Vidler and K.J. Derbyshire

Department of Primary Industries
Queensland

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INTRODUCTION

Studies of seagrass beds in tropical Australian waters have increased in recent years with recognition of seagrass habitats as important dugong feeding grounds and nursery grounds for juveniles of commercial penaeid prawns and fish. Recent reviews of seagrass research in Australia (Larkum *et al*. 1989; Walker 1989) outline the growing importance attached to these habitats in marine fisheries and environmental research. Support for seagrass research also extends to studies of seasonal and long-term changes in ecology, distribution and productivity of these habitats. These subjects are essential to understanding how seagrasses interact with populations of economically important marine fauna, and with species of conservation value.

To manage these habitats, authorities responsible for fisheries management and coastal zone planning require maps of the distribution of seagrasses and information on their value to commercial prawn and fish stocks and marine fauna such as dugong and turtle.

The Queensland Department of Primary Industries has conducted extensive surveys to map seagrass beds in most of Queensland's coastal waters and to investigate populations of juvenile prawns and fish associated with these habitats. The Fishing Industry Research and Development Committee and the Queensland Department of Primary Industries have supported extensive surveys and ecological studies of seagrasses and juvenile prawn and fish populations between Cape York and Cairns (Coles *et al.* 1985; Coles *et al.* 1987a), between Cairns and Bowen (Coles *et al.* 1989) and in the eastern Gulf of Carpentaria (Coles and Lee Long 1985; Poiner *et al.* 1987). The Great Barrier Reef Marine Park Authority supported the present survey between Water Park Point and Hervey Bay and surveys between Cairns and Bowen (Coles *et al.* 1989) and Bowen and Water Park Point (Coles *et al.* 1987b, 1987c).

This paper provides the first extensive description of seagrass habitats between Water Park Point and Hervey Bay. Together with the results of similar surveys of other coastal regions, this information provides an important input for management of seagrass habitats.

METHODS

The survey region

The coastal region from Water Park Point (latitude 23°S) to Hervey Bay (latitude 25°15'S) is sub-tropical and lies at the southern end of the Great Barrier Reef province (Fig. 1). Industrial and urban centres include Rockhampton on the Fitzroy River, Bundaberg on the Burnett River and the port of Gladstone, where there is a large bauxite smelter and ship loading facility. Most of the remaining coastline is only lightly populated. North of Bundaberg there is mostly a wide coastal plain of open eucalypt woodlands. The region around Bundaberg and Hervey Bay is cultivated for sugar cane and small crops agriculture. The Fitzroy and Burnett Rivers are the only two major rivers, the former flowing into a large, mangrove-lined delta system. Extensive mangrove-lined waterways also occur south of this delta behind Curtis Island, a large continental island, and in Colosseum Inlet, south of Gladstone. In the northern part of the survey region the Keppel Islands lie approximately 40 kilometres offshore and the Capricorn and Bunker Groups of reefs and islands lie approximately 55 to 75 kilometres from the coast on the outer edge of a wide continental shelf. Hervey Bay, in the southern part of the survey region, is sheltered from South Pacific Ocean swells by Fraser Island.

Waters close to the large rivers and mangrove-lined inlets are generally very turbid and shallow, with predominently muddy sediments. Along stretches of open coastline away from river mouths, silt loads are relatively low and sediments predominently sand (Maxwell 1968). In the survey region the 20 m depth contour is between one and four kilometres from shore.

Average tidal amplitudes in the region vary from 2.4 m in Hervey Bay to approximately 5 m near Water Park Point (Maxwell 1968). Precipitation is monsoonal between December and March, and recorded annual average rainfalls range from 806 mm at Cape Capricorn to 1 342 mm at Yeppoon (Australian Bureau of Meteorology 1988). Apart from the summer monsoonal months, winds are predominantly south-easterly and often accompany a light south-easterly ocean swell.

Seagrass sampling

Seagrass habitats in coastal waters between Water Park Point and Hervey Bay were surveyed and sampled between 25 October 1988 and 14 November 1988. The method for extensive surveys and mapping of seagrass beds was based on that described in Coles *et al.* (1987b) and used in all other Queensland Department of Primary Industries surveys of Queensland coastal seagrasses. At selected sites, divers investigated bottom type and vegetation over an area of at least 5 m². The area observed was greater than 5 m² when underwater visibility was good. On each dive, sediment type and estimates of seagrass cover were recorded and samples of seagrasses were kept for later identification. Estimates of seagrass bottom cover were in categories of 0 - 10%, 10 - 20%, 20 - 30%, etc. Standardisations of bottom cover estimates were maintained by frequent review between divers. The five divers were also rotated between teams, to ensure consistent standards of estimation. Seagrasses were identified according to classifications used by den Hartog (1970) and Lanyon (1986). Where weather and sea conditions allowed, four 0.25 m² quadrats of seagrass roots and leaves were collected from randomly selected positions at the site for biomass measurements in the laboratory.

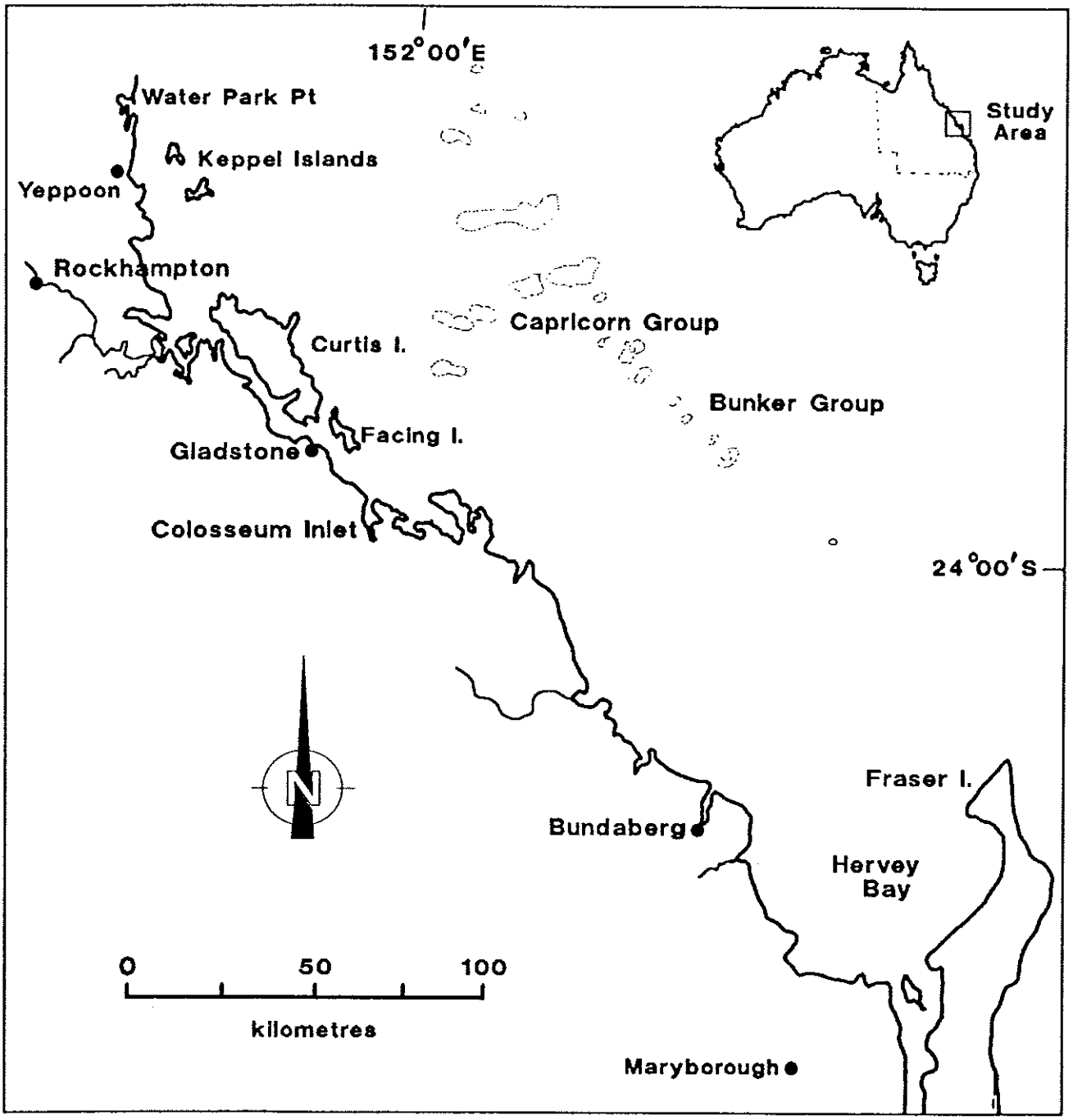

Figure 1. The Survey Region. Seagrass sampling

The survey pattern included dives at 0.2 nm (370 m) intervals along selected transects which were perpendicular to shore. Transects continued seaward at least until no seagrass was found. Between transects, dives were made at least every one nautical mile at varied depths and distances from shore to check for continuity of bottom vegetation, including in the entrances of rivers and inlets. Factors which affected the spatial regularity of dive sites included weather conditions and constraints on compressed-air dive time. In shallow, clear-water areas the distribution of bottom vegetation was recorded from surface observation.

Juvenile prawn and fish sampling

Juvenile prawns and fish were sampled at night using two 1.5 m wide, 2 mm mesh size, beam trawls towed at approximately 0.5 m s^{-1} (Coles and Lee Long 1985). Sites for night-time prawn and fish sampling were selected during daytime sampling of seagrass and are marked on survey maps (Appendix 1). Trawls of five to twenty minutes duration were conducted at night at these sites. All prawns caught were identified to species and their carapace lengths (CL) were measured to the nearest 0.1 mm. Fish were identified to at least genus level, and their standard lengths and weights were measured to the nearest 0.1mm and 0.1 g respectively.

A total of twenty-eight beam trawl samples were taken from six seagrass sites. The locations and number of beam trawl samples were affected by tidal conditions and accessibility of seagrass sites from night-time anchorages. Data from beam trawl samples was used to compare prawn and fish fauna from different seagrass beds, although a complete description of fish and prawn communities on these sites would require more intensive sampling than was possible in this and other similar surveys.

RESULTS

Seagrasses

Maps of sample sites, vessel tracks and transect positions show the coastal and island areas surveyed (Appendix 1). Bottom type was recorded on a total 743 dives and seagrass was observed on 193 (25%) of

Table 1. Distribution of seagrass species in coastal areas between Yeppoon and Hervey Bay.

COASTAL SITES	SEAGRASS SPECIES: *Halodule uninervis*	*Halodule pinifolia*	*Halophila decipiens*	*Halophila ovalis*	*Halophila ovata*	*Halophila tricostata*	*Halophila spinulosa*	*Zostera capricorni*	*Syringodium isoetifolium*
Water Park Pt to Fitzroy R.									
Gladstone Harbour			■		■	■	■	■	
Collosseum Inlet	■			■				■	
Rodd's Harbour	■			■			■	■	
Rodd's Peninsular	■			■			■	■	
Bustard Bay to Burnett R.			■	■			■	■	
Elliot Hds to Theodolite Ck				■				■	
Hervey Bay	■	■	■	■			■	■	
Urangan	■	■	■	■			■		
Platypus Bay	■	■	■	■	■		■	■	

Table 2. Distribution of seagrass species around Islands between Yeppoon and Hervey Bay.

ISLANDS	SEAGRASS SPECIES								
	Halodule uninervis	*Halodule pinifolia*	*Halophila decipiens*	*Halophila ovalis*	*Halophila ovata*	*Halophila tricostata*	*Halophila spinulosa*	*Zostera capricorni*	*Syringodium isoetifolium*
Great Keppel Island	■		■			■		■	
Humpy Island			■			■			
Wedge Island	■								
Curtis Island	■		■		■		■		
Quoin Island			■	■	■			■	
Facing Island	■		■	■				■	

these dives. Seagrass samples for biomass measurements were collected at twenty-five sites. These sites are marked on maps in Appendix 2. Maps of the distribution of seagrass habitat are based on observations of seagrass areas from the surface and on diver estimates of the percentage of bottom covered by seagrass (Maps 1-10, Appendix 2). Seagrass habitats are mapped in three categories according to percentage cover. These are: less than 10%, between 10% and 50%; and greater than 50% bottom cover. Coastal sites where seagrass was found were grouped into ten geographic areas (Table 1). Seagrass was also found around six island areas (Table 2).

Nine species of seagrasses from two families and four genera were collected:

Family Potamogetonaceae:
Halodule pinifolia (Miki) den Hartog.
Halodule uninervis (Forsk.) Aschers.
Syringodium isoetifolium (Aschers.) Dandy.
Zostera capricorni Aschers.

Family Hydrocharitaceae:
Halophila decipiens Ostenfeld
Halophila ovalis (R.Br.) Hook.F.
Halophila ovata Gaud.
Halophila spinulosa (R.Br.) Aschers.
Halophila tricostata Greenway

Halophila ovalis and *H. uninervis* were the most commonly found seagrass species and they occurred in most of the coastal and island areas surveyed. *Halophila spinulosa* and *Z. capricorni* were also common. *Zostera capricorni* was found mostly in coastal areas. *Halophila decipiens, H. ovata, S. isoetifolium, H. tricostata* and *H. pinifolia* were less frequently found. *Halodule pinifolia* and *H. tricostata* were not found at island sites. *Syringodium isoetifolium* was found only at one island site.

The greatest number of seagrass species found at any single dive site was four species near Mud Island in Gladstone Harbour. At one site on Pelican Bank nearby, *Z. capricorni, H. ovata* and the wide and thin leafed *H. uninervis* were found. Three seagrass species were recorded at thirteen sites in the survey.

No seagrass species were found above mean sea level (MSL), and the average depth of occurrence of most species was less than 5 m (Fig. 2). *Halophila spinulosa, H. ovalis* and *H. decipiens* had the greatest depth ranges in the survey, all occurring to depths greater than 18 m. The average depths of occurrence of these three species were between six and eight metres.

Biomass of above ground vegetation (stems and leaves) was greatest for the tall, broad-leafed seagrasses, such as *Z. capricorni* and *H. spinulosa* (Fig. 3). The highest recorded above ground dry weights for any

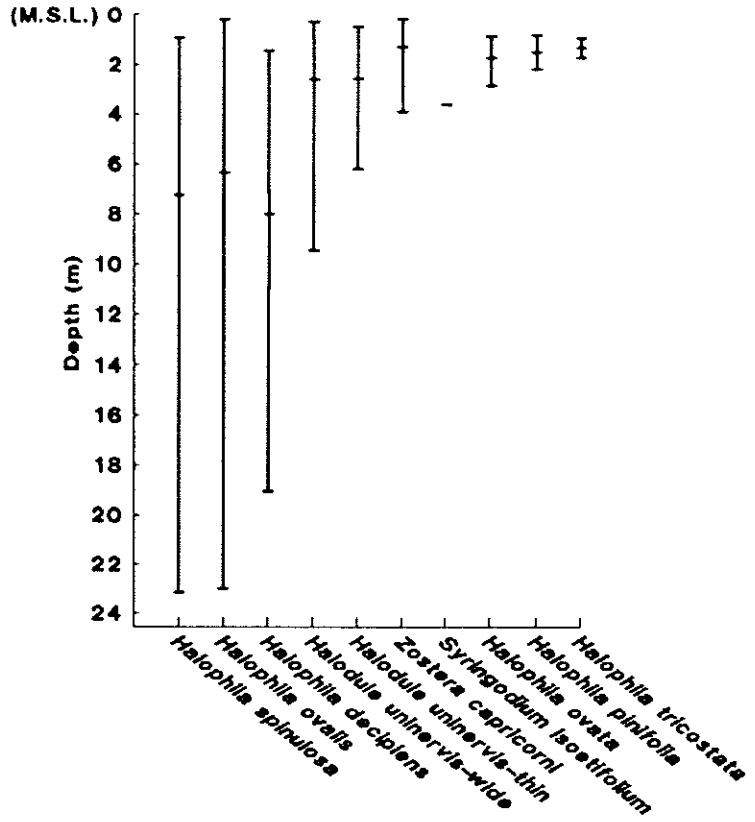

Figure 2. Averages and ranges of depths below mean sea level (MSL) at which seagrasses were found between Water Park Point and Hervey Bay.

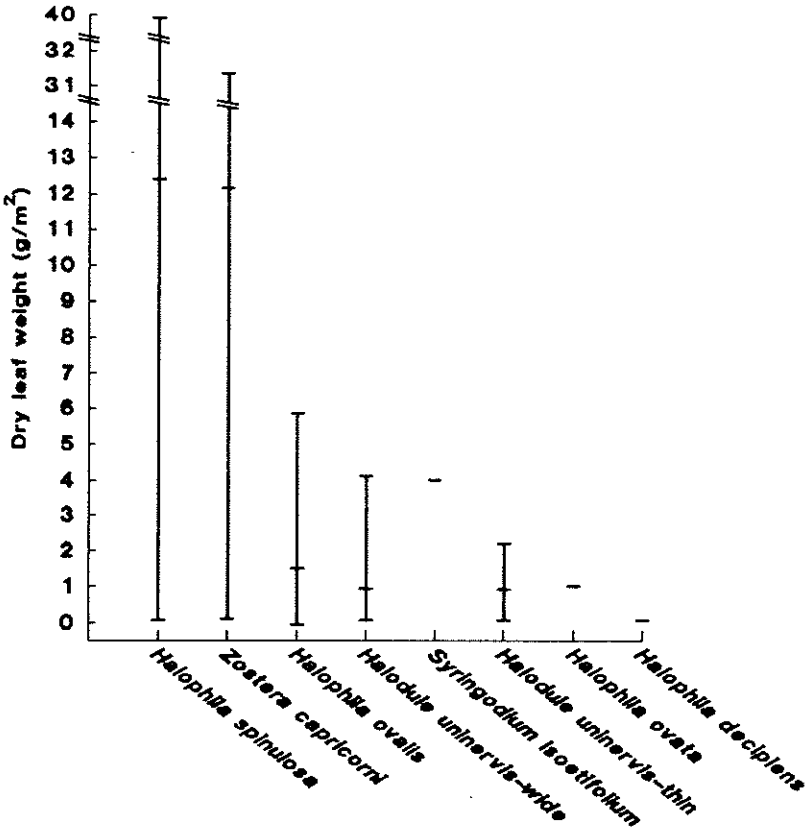

Figure 3. Averages and ranges of above ground biomasses (leaf and shoot dry weights) of seagrasses sampled between Water Park Point and Hervey Bay.

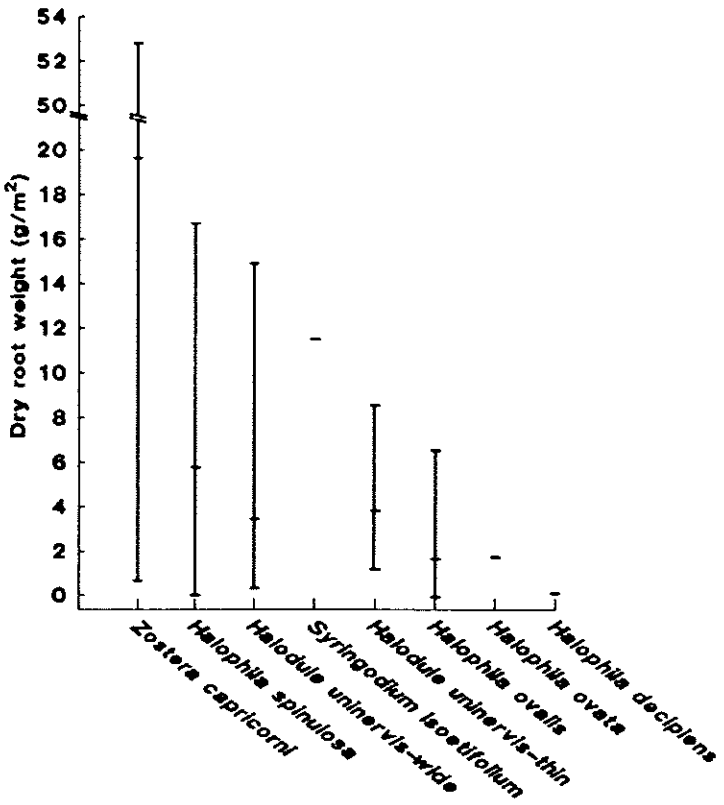

Figure 4. Averages and ranges of above ground biomasses (root and rhizome dry weights) of seagrasses sampled between Water Park Point and Hervey Bay.

species was 33.0 g m^{-2} of *H. spinulosa* at Urangan. Maximum recorded above ground biomass of *Z. capricorni* exceeded 31.0 g m^{-2} at Elliott Heads and Theodolite Creek. For the other *Halophila* species, *S. isoetifolium* and the wide and thin leaf *H. uninervis*, above ground dry weights were usually less than 5 g m^{-2}.

Below ground biomasses (roots and rhizomes dry weights) for *Z. capricorni* and *H. uninervis* were often greater than above ground biomasses. *Z. capricorni* had the highest average and maximum below ground biomass (Fig. 4). Maximum root and rhizome dry weights for *H. spinulosa* and the wide leaf *H. uninervis* were relatively high, but average below ground dry weights of these species were low.

Penaeid prawns

Seagrass sites where beam trawl samples were taken are described in Table 3. In a total of twenty-eight beam trawl samples, 582 penaeid prawns were caught, including thirteen species from five genera (Table 4). The most common species caught was the western king prawn *(Penaeus latisulcatus)*. Other commercially important species caught were the true endeavour prawn *(Metapenaeus endeavouri), the* false endeavour prawn *(M. ensis)*, the brown tiger *prawn (P. esculentus)*, grooved tiger prawn *(P. semisulcatus)* and eastern king prawn (*P. plebejus*), although these species were relatively uncommon in our samples. The southern velvet prawn *(Metapenaeopsis palmensis)* and the southern rough prawn *(Trachypenaeus curvirostrus)* were more common than most commercial species. The highest catch rates of juvenile commercial penaeid prawns occurred at Great Keppel Island, where *P. latisulcatus* was the only commercial species caught (Table 5). *Penaeus latisulcatus* was also the most common species in samples from Pancake Creek and Rodds Harbour. In samples from seagrass beds at Facing Island and Gladstone Harbour, *M. endeavouri* was numerically dominant.

Fish

Fish from beam trawl samples included fifty-five species from thirty families (Appendix 3). A total of 634 fish were caught in beam trawl samples (Table 6). No fish species of commercial or recreational importance were caught in large numbers. Gobies (Gobiidae) and leatherjackets (Monacanthidae) were most

common, representing 35.0% and 19.1% of the total fish abundance respectively (Table 6). Other groups of fish were generally caught in low numbers. By weight, toadfish (22.0% of total weight) and leatherjackets (15.3%) were dominant. Most fish caught in beam trawls were small, rarely exceeding 50 mm standard length; the average standard length was 22.2 mm.

General

Shannon-Wiener diversity indices for prawn and fish catches were highest for samples from Gladstone Harbour (Table 7). Beam trawl samples in Gladstone Harbour were taken on a dense *Z. capricorni* meadow. On a another densely vegetated (50% cover) *Z. capricorni* meadow in Pancake Creek, prawn and fish diversities were relatively low. In contrast, high fish diversities at Rodds Harbour, and high catch rates of *P. latisulcatus* at Great Keppel Island, were recorded for samples from seagrass meadows with low biomass.

Table 3. Description of beam trawl sites on seagrass beds between Water Park Point and Hervey Bay, 1988.

LOCATION	SAMPLE DATE	DEPTH BELOW DATUM	SUBSTRATE	SEAGRASS SPECIES	BOTTOM COVER %	ABOVE GROUND BIOMASS (g m^{-2})	NO. OF 5 MIN TRAWLS
Facing Island	28.10.88	0.97	Mud	*H. decipiens* <	10	0.40	4
Gladstone Harbour	29.10.88	2.0	Mud	*Z. capricorni* *H. ovalis*	100	*	6
Great Keppel Island	31.10.88	3.8	Sand, shell grit	*H. spinulosa* *H. ovalis*	20	76.27	3
Pancake Creek	03.11.88	0.4	Sand	*Z. capricorni* *H. ovalis*	50	306.92	2
Platypus Bay	12.11.88	9.8	Sand, shell grit	*H. spinulosa* *H. ovalis*	20	55.74	4
Rodds Harbour	28.10.88	1.2	Sand	*H. uninervis* (thin) *Z. capricorni*	20	18.20	4

* No biomass sample taken.

Table 4. Penaeid prawn species identified in trawl catches from seagrass beds between Water Park Point and Bowen.

SPECIES	COMMON NAME	NUMBER OF PRAWNS
Metapenaeopsis mogiensis	Velvet prawn	1
Metapenaeopsis novaeguineae	Northern velvet prawn	25
Metapenaeopsis palmensis	Southern velvet prawn	71
Metapenaeopsis rosea	Rosy prawn	8
Metapenaeus endeavouri	True endeavour prawn	40*
Metapenaeus ensis	False endeavour prawn	5*

SPECIES	COMMON NAME	NUMBER OF PRAWNS
Penaeus esculentus	Brown tiger prawn	7
Penaeus latisulcatus	Western king prawn	348*
Penaeus plebejus	Eastern king prawn	7
Penaeus semisulcatus	Grooved tiger prawn	1*
Sicyonia vitulans		3
Trachypenaeus curvirostris	Southern rough prawn	68
Trachypenaeus fulvus	Brown rough prawn	3
TOTAL		**582**

* Species of major economic importance in northern Australia.

Table 5. The number of prawns of five commercially important penaeid prawn species caught per hour of trawling over seagrass beds between Yeppoon and Hervey Bay.

SITE	*Penaeus esculentus*	*Penaeus semisulcatus*	*Metapenaeus endeavouri*	*Penaeus latisulcatus*	*Penaeus plebejus*	TOTAL
Facing Island	3	-	15	-	7	25
Gladstone Harbour	4	1	17	-	-	22
Great Keppel Is.	-	-	-	231	-	231
Pancake Creek	-	-	-	84	-	84
Platypus Bay	-	-	-	-	-	0
Rods Harbour	-	-	8	33	-	41
TOTAL	7	1	40	348	7	403

Table 6. Size, weight and abundance of fish in 30 fish families caught in seagrass beds between Water Park Point and Hervey Bay.

Family	S.L. Range (mm)	Average S.L. (mm)	Weight (g)	% Weight of total catch	Number	% Abundance of total catch
Ambassidae	19-41	24.2	6.1	1.45	12	1.89
Aploactinidae	45	45.0	4.2	1.00	1	0.16
Apogonidae	11-53	20.4	14.9	3.55	35	5.52
Atherinidae	23-95	48.0	15.6	3.71	3	0.47
Bothidae	26-79	44.5	20.8	4.95	8	1.26
Callionymidae	15-37	23.1	3.4	0.81	19	3.00
Clupeidae	20-36	25.5	2.4	0.57	8	1.26
Congridae	117-121	119.0	1.4	0.33	2	0.32
Cynoglossidae	67-89	75.0	19.7	4.69	4	0.63
Eleotridae	38-61	49.5	5.8	1.38	2	0.32
Engraulidae	16-58	24.3	10.2	2.43	32	5.05
Gobiidae	9-37	17.3	38.0	9.05	222	35.02
Hemirhamphidae	44	44.0	0.3	0.07	1	0.16
Labridae	10-58	16.3	7.7	1.83	44	6.94
Lethrinidae	15-51	26.9	3.8	0.90	10	1.58
Lutjanidae	17-38	22.8	0.7	0.17	4	0.63
Monacanthidae	8-40	19.3	64.3	15.31	121	19.09
Mugiloididae	12-30	24.0	1.1	0.26	4	0.63
Mullidae	27-34	29.0	4.3	1.02	11	1.74
Paralichthyidae	16-97	36.3	29.9	7.12	6	0.95
Pegasidae	26-35	30.3	0.6	0.14	4	0.63
Platycephalidae	18-104	48.3	21.9	5.21	6	0.95
Scorpaenidae	14-35	26.6	18.4	4.38	18	2.84
Siganidae	20-27	22.0	6.7	1.59	20	3.15
Sillaginidae	17-28	22.7	1.0	0.24	6	0.95
Sphyraenidae	50	50.0	0.7	0.17	1	0.16
Syngnathidae	123	123.0	1.0	0.24	1	0.16
Teraponidae	14-65	26.1	20.5	4.88	20	3.16
Tetraodontidae	8-104	60.3	92.2	21.95	3	0.47
Triacanthidae	11-18	14.0	0.7	0.17	4	0.63
TOTAL	-	**22.2**	**420.1**	**100.0**	**634**	**100.0**

Table 7. Seagrass biomass, prawn catches and diversity and fish species numbers and diversity from beam trawl samples over seagrass beds between Water Park Point and Hervey Bay.

Site	Seagrass Biomass g/m²	Prawns/ Hour Trawled	Prawn Species Diversity (H)	Number of Fish Species	Fish Species Diversity (H)
Facing Island	0.4	174	1.29	8	1.29
Gladstone Harbour	*	200	1.30	21	2.73
Great Keppel Is.	76.27	2655	0.91	24	1.91
Pancake Creek	306.90	1032	0.13	9	1.23
Platypus Bay	55.74	20	0.97	15	2.01
Rodds Harbour	18.20	378	1.11	19	2.41

NB:Seagrass biomass was calculated on wet weight of leaves (g/m²) from samples at the trawl sites.
H = Shannon-Wiener diversity index.
* = No Biomass Sample.

DISCUSSION

Seagrass

Exposure to the air and drying are probably limiting factors to the shoreward distribution of seagrasses, as no seagrasses were found above mean sea level. Similar findings have been previously reported from other parts of Queensland (Coles *et al.* 1987a; Coles *et al.* 1987b; Coles *et al.* 1989). In areas which provide suitable shelter for seagrass growth, the depth to which seagrasses occur probably depends on the availability of light and the light requirements of each species. In this and other studies (Coles *et al.* 1987a; Coles *et al.* 1987b; Coles *et al.* 1989) the commonly occurring species *H. uninervis* and *Z. capricorni* were not found beyond 9 m depth. In contrast, *H. ovalis, H. spinulosa* and *H. decipiens* were often found at depths below 15 m. The ability of *H. spinulosa* to grow in deep or turbid water has been attributed to low light requirements (Young and Kirkman 1975). Josselyn *et al.* (1986) also attributed the ability of *H. decipiens* to grow in deep or turbid water to low light requirements for this species. *Zostera capricorni* had the highest biomass and was often the dominant species, or was co-dominant with *H. uninervis* in extensive meadows, for example, on banks north of Gladstone Harbour, in Pancake Creek, and in Collosseum Inlet. *Halophila spinulosa,* the dominant species in extensive seagrass areas of Hervey Bay, also had some of the highest above ground biomasses. Dense ground covers of mostly *H. decipiens* (eg., at Facing Island) and *H. ovalis* and *H. uninervis* (eg., at Great Keppel Island and Pelican Bank) had a relatively low plant biomass when measured.

There were fewer seagrass species found in the survey than have been recorded from surveys in tropical latitudes in Queensland (Coles *et al.* 1987a, Coles *et al.* 1987b, Coles *et al.* 1989). Species richness, measured as number of species, at any single dive site was also relatively low in the present survey compared to that for sites surveyed north of this region (Coles *et al.* 1987b). Larkum and den Hartog (1989) note a decrease in the number of recorded species of seagrasses from tropical to temperate regions on the east Australian coast.

Cymodocea rotundata Ehrenb. et Hempr. ex Aschers, *Cymodocea serrulata* (R.Br.) Aschers and Magnus,

and *Thalassia hemprichii* (Ehrenb.) Aschers, did not appear in this survey, but have been found further north in surveys between Water Park Point and Cairns (Coles *et al.* 1987b, Coles *et al.* 1989). In those surveys the most southern site recorded for *Cymodocea serrulata* was in western Shoalwater Bay, latitude 22°15'S and *C. rotundata* was found only as far south as the Lindeman Island Group at 20°30'S (Coles *et al.* 1987b). In southern Moreton Bay, Hyland *et al.* (1989) recorded meadows of *C. serrulata* inside North Stradbroke Island (27°28'S) in areas with oceanic influence. *Thalassia hemprichii* has not been found in our coastal and island surveys south of Shute Bay 20°15'S (Coles *et al.* 1987b), but this species is common on reef platforms, and may be present on reefs of the Great Barrier Reef south of Shute Bay. Two species, *H. ovata* and *H. pinifolia*, which were common at both coastal and island sites in the survey north of Water Park Point (Coles *et al.* 1987b), were less common in this survey. The most southern siting of *H. tricostata* to date on the east Australian coast was recorded at Gladstone Harbour. Extensive studies of seagrass habitats south of this region (Young and Kirkman 1975; Hyland *et al.* 1989) have not recorded this species.

Seagrass beds occurred usually on the lee side of islands and peninsulas which provide shelter from south-east trade winds and swells, and where water clarity allows sufficient light penetration for photosynthetic growth. In the region from Water Park Point to Hervey Bay, these areas are few and generally small, and most of the coastline is exposed to south-east winds. Large areas of seagrass were well established at Great Keppel Island, north of Gladstone Harbour, on Pelican Bank, in Pancake Creek and near Dayman Point in southern Hervey Bay. The survey of Hervey Bay identified a large meadow of *H. spinulosa* and *H. ovalis* in deep water (18-30 m). This may be one of the largest single areas of seagrass habitat in Queensland. Prevailing weather conditions restricted the spatial regularity and distribution of dive observations in Hervey Bay. A more detailed study of this area would be desirable. The large seagrass meadow in Hervey Bay may be attributable to the shelter provided by Fraser Island from south-easterly weather, and to the relatively clear water that occurs in this bay.

In the relatively sheltered areas near the Fitzroy River delta system, lack of seagrass habitat may be due to extremely high loads of suspended silt and associated high turbidities. In Florida, seagrass distribution was limited inshore primarily by high turbidities and lowered salinities around river mouths and offshore by the attenuation of photosynthetically active radiation at depth (Iverson and Bittaker 1986). Immediately behind Facing Island and Curtis Island near Gladstone, water clarity appears to be suitable for growth of seagrasses. An increase in water turbidity in these areas may threaten the survival of these seagrass habitats.

The present survey was conducted once only during October and November 1988 and does not provide a measure of seasonal change in the seagrass communities of the region. Coles *et al.* (1989) noted that a particular lack of information on seasonal and long-term change in seagrasses and associated faunal communities makes assessment of the value of these habitats difficult. The maps and qualitative information of seagrass habitats provide a baseline data set for management and for future studies which address the phenomenon of temporal changes in seagrass habitats.

Prawns

The thirteen species of penaeid prawns found in beam trawl samples is fewer than those found in comparable surveys of tropical latitudes. Seventeen species in five genera were caught in a similar survey between Cairns and Bowen, northern Queensland (Coles *et al.* 1989). Prawn species diversity indices for samples from seagrass beds were also lower in this survey than in the survey conducted between Cairns and Bowen. Whilst measures of prawn species diversity are useful for comparison between seagrass beds, caution is required in assessing these, given the limited within-site frequency of beam trawl samples allowed in these surveys. Results from these surveys have indicated areas of seagrass which appear to support large numbers of juvenile prawns.

Large numbers of the western king prawn *(P. latisulcatus)* from samples at Great Keppel Island made this the most common species. *Penaeus latisulcatus* forms only a small component of the commercial trawl fishery of this region (M. Dredge pers. comm.). Catch rates of the juvenile commercial prawns *M. endeavouri, M. ensis, P. esculentus, and P. semisulcatus* were small although these species are important in the nearby commercial fisheries. On seagrass beds in Cairns Harbour, northern Queensland, juvenile brown and grooved tiger prawns were most abundant in the months December to March (Coles, unpublished information). Although the time of peak abundance of these species may differ between regions, the low catches of tiger and endeavour prawns in this survey might be explained by seasonal variability in abundance. Coral prawns, including the velvet prawns and southern rough prawn, were more common

than most penaeid prawns in our samples and form part of the commercial by-catch of the trawl fishery.

Juvenile eastern king prawns *(P. plebejus)* were not caught in surveys north of this region and our catches at Facing Island may be the most northerly records for juvenile *P. plebejus* to date. Stocks of adult *P. plebejus* are fished most commonly in southern Queensland and northern New South Wales, but recently established deepwater fisheries of this species extend to the northern Swain Reefs of the Great Barrier Reef at approximately 21°S (Potter and Dredge 1984). North of Urangan in Hervey Bay there are no substantial coastal fisheries of *P. plebejus.*

Penaeus latisulcatus was common on seagrass beds with sandy sediments sampled at Great Keppel Island, Rodds Harbour and Pancake Creek. *Metapenaeus endeavouri,* and the two tiger prawn species *(P. esculentus* and *P. semisulcatus)*, were the only commercial prawns in samples from seagrass beds with muddy substrates at Facing Island and Gladstone Harbour. There have been few investigations of the detailed habitat preferences of juvenile penaeid prawns and the environmental factors which affect juvenile prawn abundance and distribution. Changes in the size or nature of the seagrass habitats may also affect the populations of these commercial prawn species. The characteristics of seagrass habitats which influence juvenile prawn abundance should be examined if changes in seagrass habitats ultimately affect the size of important stocks of commercial prawns.

Patterns of juvenile penaeid prawn abundance recorded in this survey come from a single sampling time and do not provide a measure of seasonal change. To fully assess the value of any seagrass bed, abundance patterns of juvenile prawns need to be measured regularly against a background of natural changes in environmental conditions in the seagrass habitats.

Fish

Measures of Shannon-Wiener diversity indices of fish fauna in beam trawl samples (Table 7) suggest that seagrass sites in this region support complex fish faunas. The number of fish species caught in this survey is high, although during similar surveys of regions north of here more species have been caught. During the present survey there were also fewer areas of seagrass which could be sampled, so that numbers of sites and beam trawl samples were less in this region than in others further north. Between Water Park Point and Bowen, beam trawl samples caught seventy-six species in thirty-nine families (Coles *et al.* 1987c) and there were sixty-five fish species in thirty-five families between Bowen and Cairns (Coles *et al.* 1989).

Fish in our beam trawl samples are mostly small, sedentary and slow moving animals. They include grazers, carnivores and omnivores. Small fish which graze the seagrass leaves for epiphytes, such as the gobies (Gobiidae) and leatherjackets (Monacanthidae), which were numerically dominant in our samples may compete with juvenile prawns for food. The tiger prawn species *(Penaeus esculentus)* also eat polychaetes, gastropods and seagrass seeds in *Zostera capricorni* meadows (Wassenberg and Hill 1987). Some fish in seagrass beds also eat small epibenthic crustacea (Pollard 1984) and probably prey on juvenile penaeid prawns. Species in our samples which are potential predators of small prawns include the cardinal fish (Apogonidae), emperors (Lethrinidae), sweetlips (Lutjanidae), flatheads (Platycephalidae) and trumpeters (Teraponidae).

Fish in our beam trawl samples which are targeted commercial or recreational species include the river garfish *(Hyporhamphus ardelio),* flathead *(Cymbacephalus nematophthalmus),* whiting (*Sillago* sp.) and barracuda (*Sphyraenidae* sp.). None of these were common in samples.

Beam trawl samples alone cannot provide a complete measure of prawn and fish species diversities. Populations of large and fast swimming fish species need to be sampled using methods other than beam trawls. Seine and gill net sampling on seagrass meadows in Queensland would be a useful aid to our understanding of the value of these habitats to the larger fish, in particular those species of commercial and recreational importance. Coles *et al.* (1989) emphasized the need to understand the nature of natural and man-induced changes in seagrass habitats and their associated fish and prawn fauna. Studies which address the temporal changes in seagrass communities will allow better informed and responsible management of these important habitats.

SUMMARY

Much of the coast between Water Park Point and Hervey Bay is exposed to south-easterly weather and seagrass beds are found in the few sheltered areas behind islands and peninsulas. An absence of seagrass areas in the Fitzroy River delta region may be due to high silt loads and turbidities. Seagrass beds in the Gladstone Harbour region were well established in areas which receive sufficient shelter and light. High turbidities may limit the depth and size of seagrass beds in this area. A large meadow of mostly *H. spinulosa* and *H. ovalis* covers much of Hervey Bay and is possibly one of the largest seagrass meadows in Queensland.

Surveys between Bowen and Hervey Bay have identified the southern limits of the seagrass species *Cymodocea rotundata* and *Halophila tricostata* on the east Australian coast.

A large but low biomass seagrass habitat at Great Keppel Island supported large numbers of juvenile western king prawns. Areas important to the survival of juvenile tiger, endeavour and king prawns also include seagrass habitat in the Gladstone Harbour area, at Rodds Peninsula and in Pancake Creek. These habitats also support diverse and abundant communities of small fish, which are probably part of a larger productive fish community.

The number of species of seagrasses, prawns, and fish in samples during this survey were less than in similar surveys further north between Water Park Point and Cairns.

Preliminary studies of the associated prawn and fish fauna provide information on the quality and value of these seagrass areas. The survey highlights the need to study the nature of seasonal and long-term changes in seagrass and associated fauna for a correct assessment of the value of these habitats and for reliable management decisions.

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APPENDIX 1

Tracks of research vessels and sites of beam trawl samples during the survey of coastal seagrass habitats between Water Park Point and Hervey Bay. The survey was conducted between the dates 25 October 1988 and 14 November 1988.

Map Legend

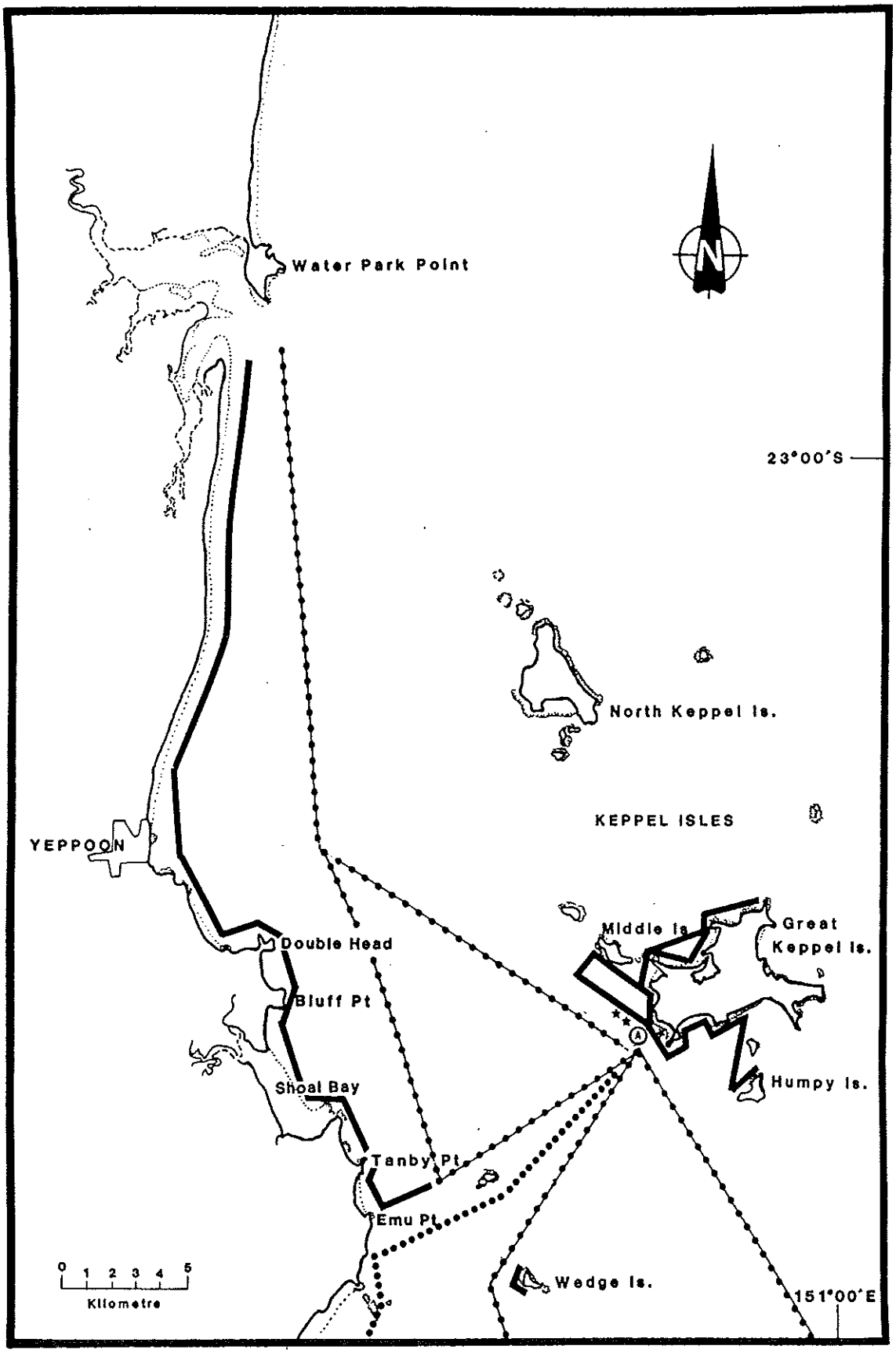
Course taken by the FRV "Gwendoline May" -•-•-•-

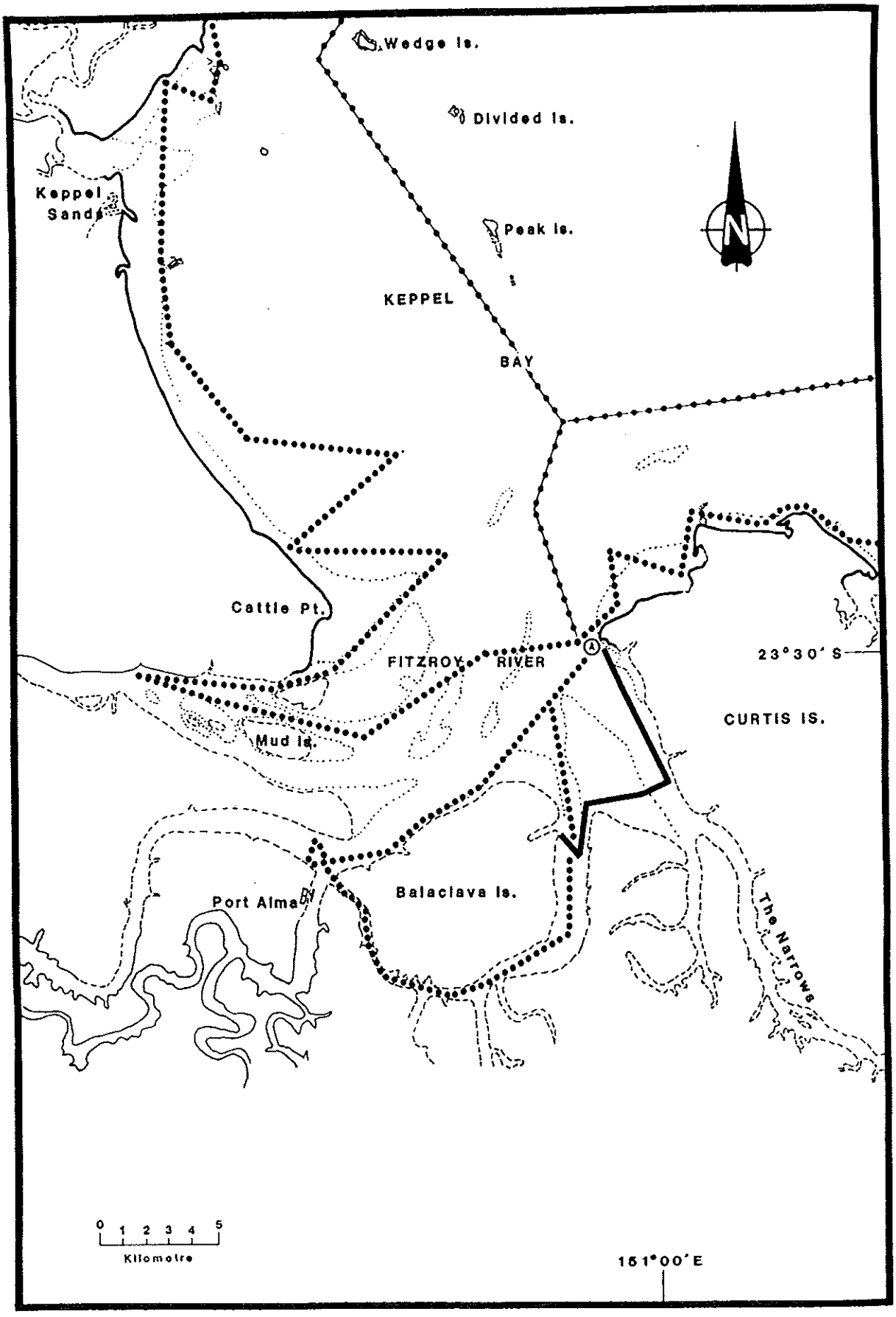
Course taken by the FV "Tiger Star" ••••••••

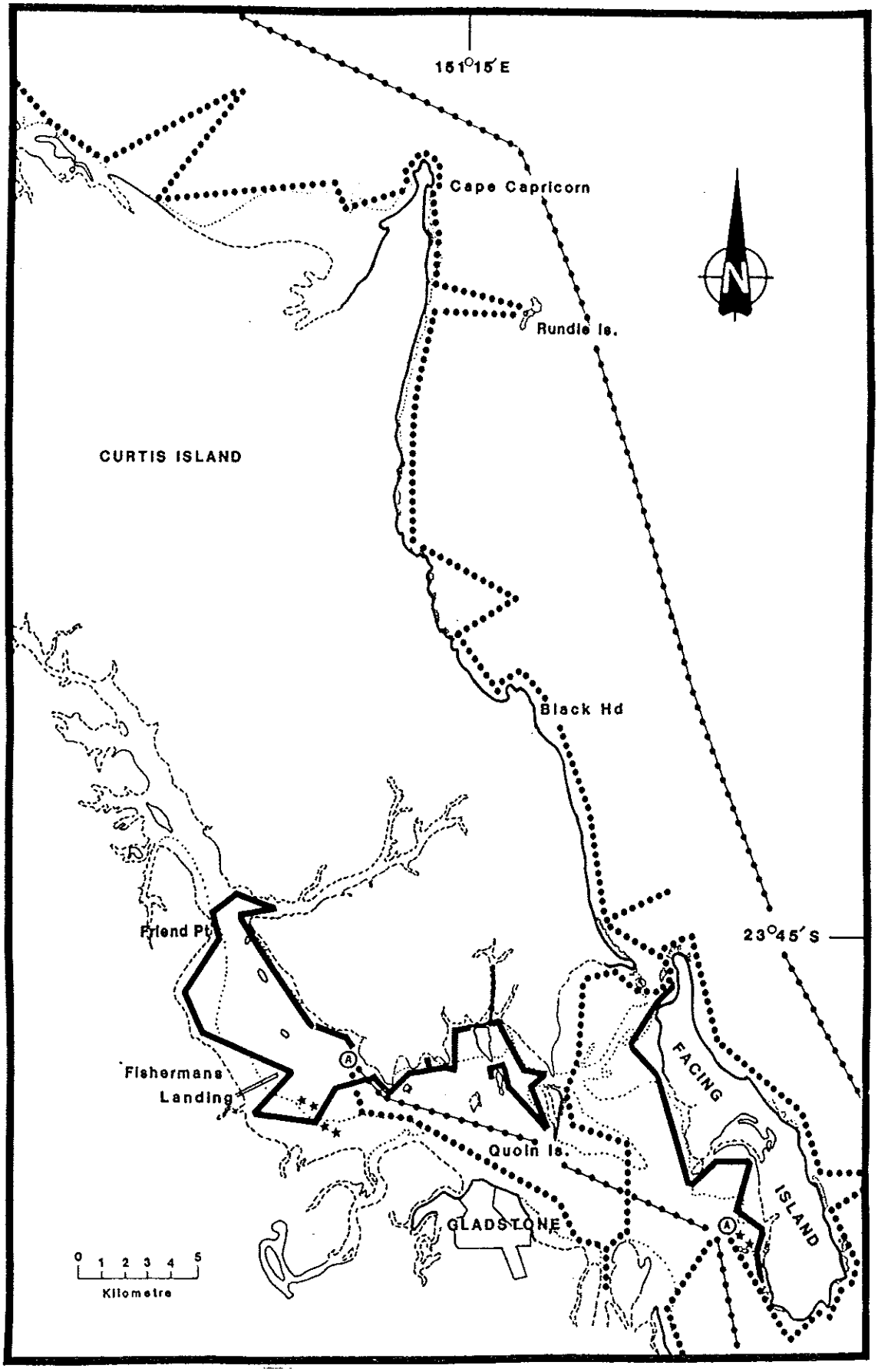
Dingy tracks ——

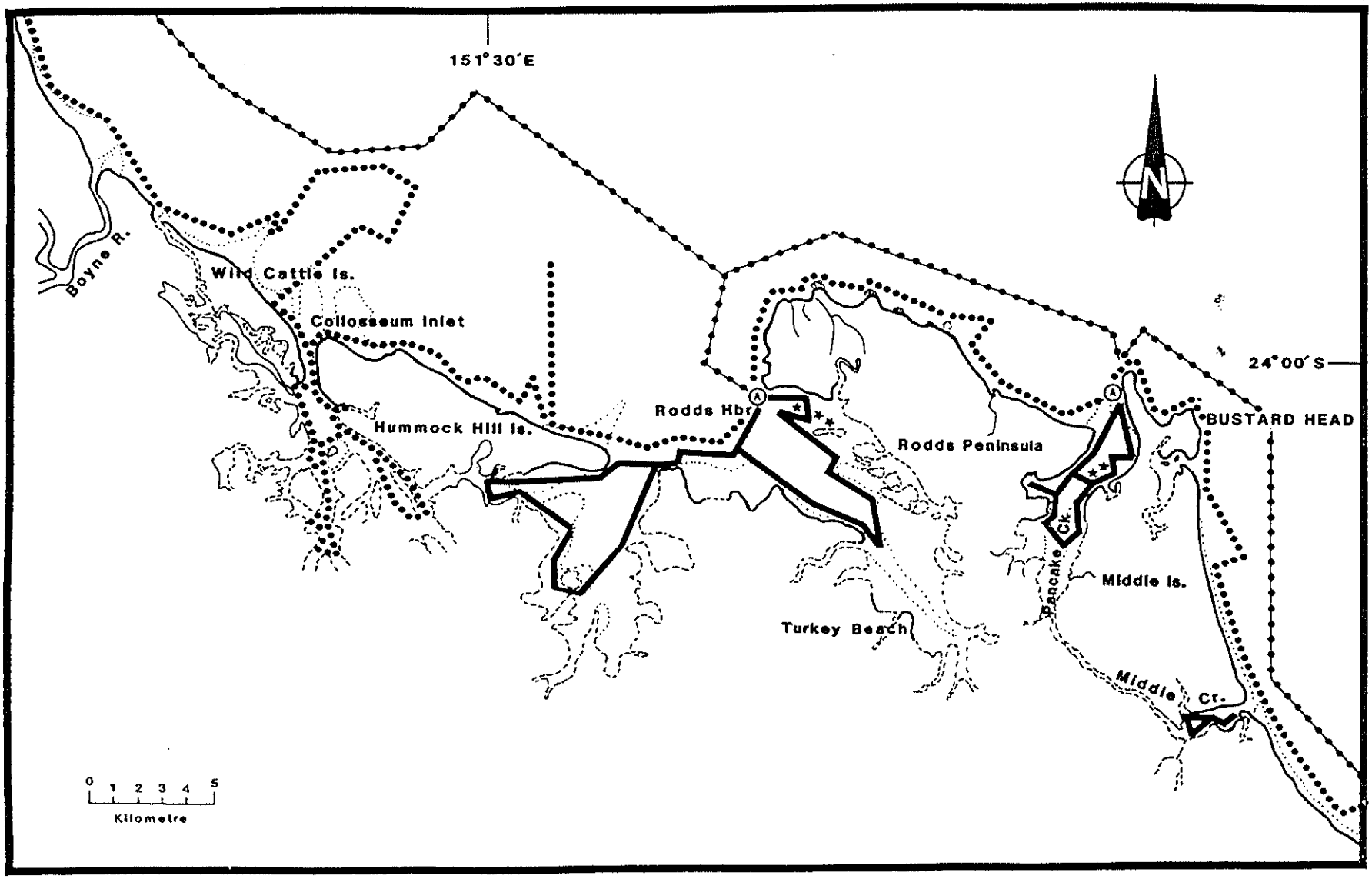
Daily anchorages Ⓐ

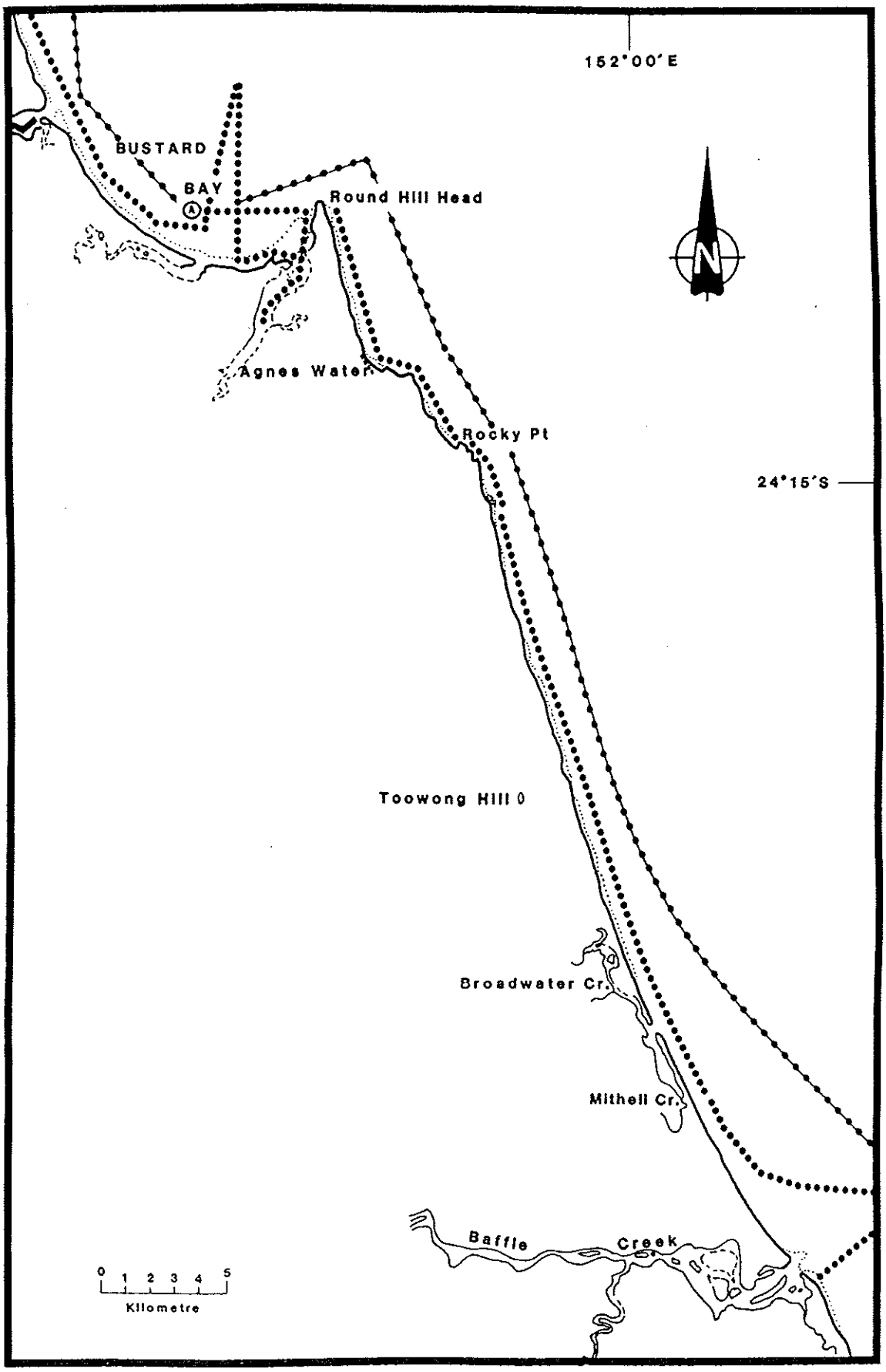
Sites trawled *****

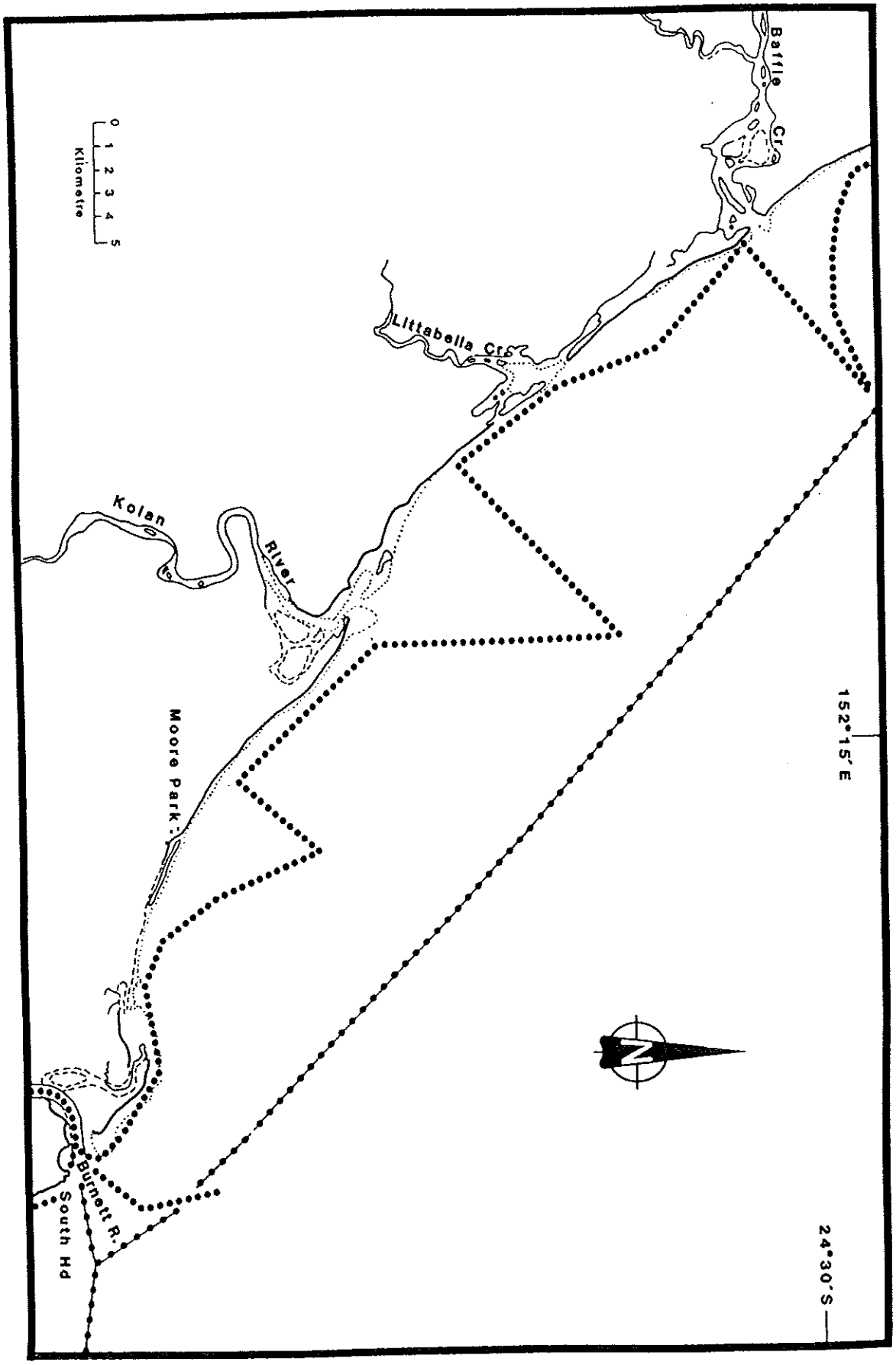

Water Park Point
N
23°00'S
North Keppel Is.
KEPPEL ISLES
YEPPOON
Middle Is
Great Keppel Is.
Double Head
Bluff Pt
Shoal Bay
Humpy Is.
Tanby Pt
Emu Pt
Wedge Is.
151°00'E
0 1 2 3 4 5
Kilometre

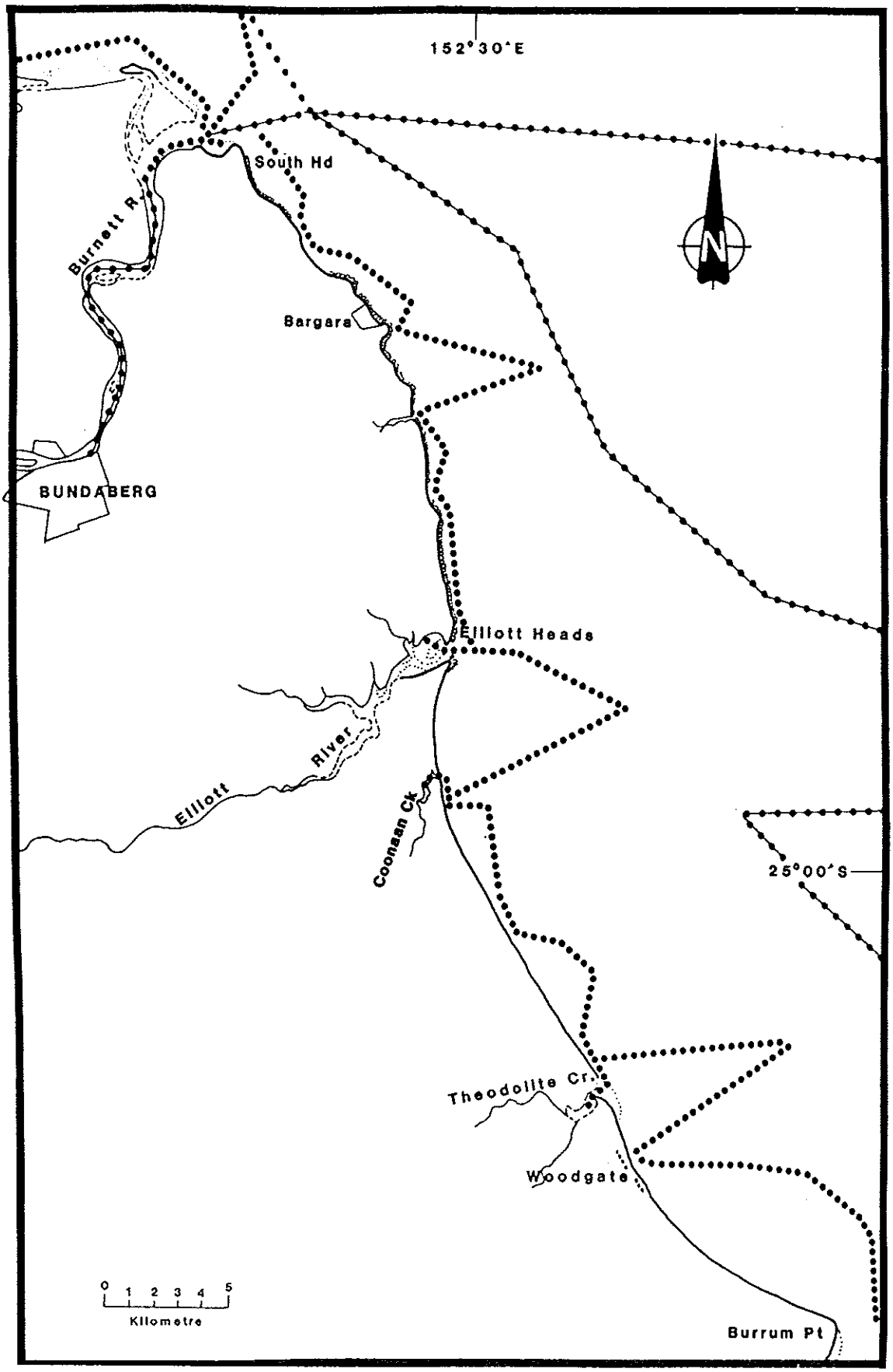

Wedge Is.
Divided Is.
Keppel Sand
Peak Is.
KEPPEL
BAY
Cattle Pt.
FITZROY RIVER
23°30'S
CURTIS IS.
Mud Is.
Port Alma
Balaclava Is.
The Narrows
0 1 2 3 4 5
Kilometre
151°00'E

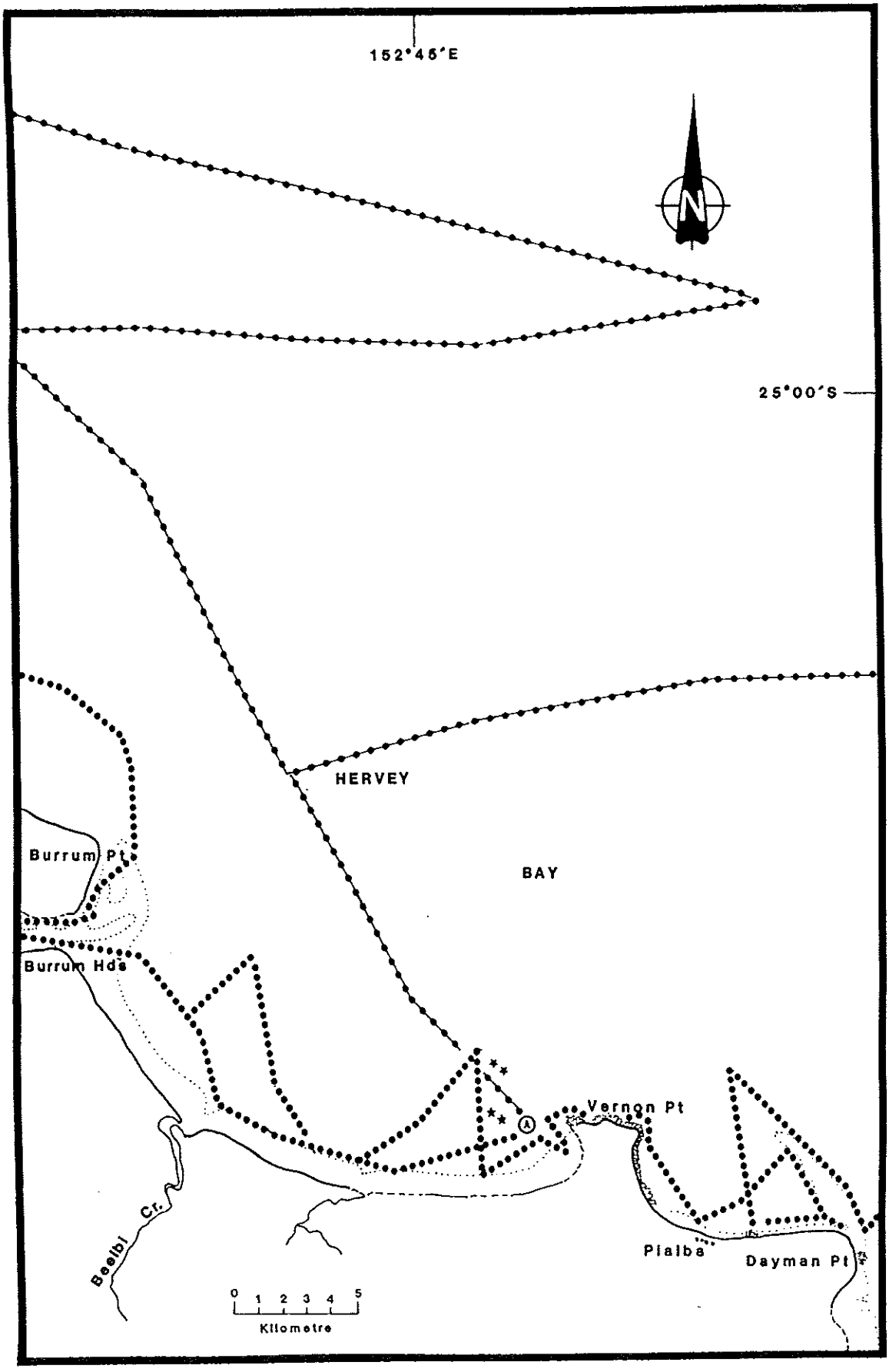

151°15'E
Cape Capricorn
N
Rundle Is.
CURTIS ISLAND
Black Hd
Friend Pt
23°45'S
Fishermans
Landing
FACING
ISLAND
Quoin Is.
GLADSTONE
0 1 2 3 4 5
Kilometre

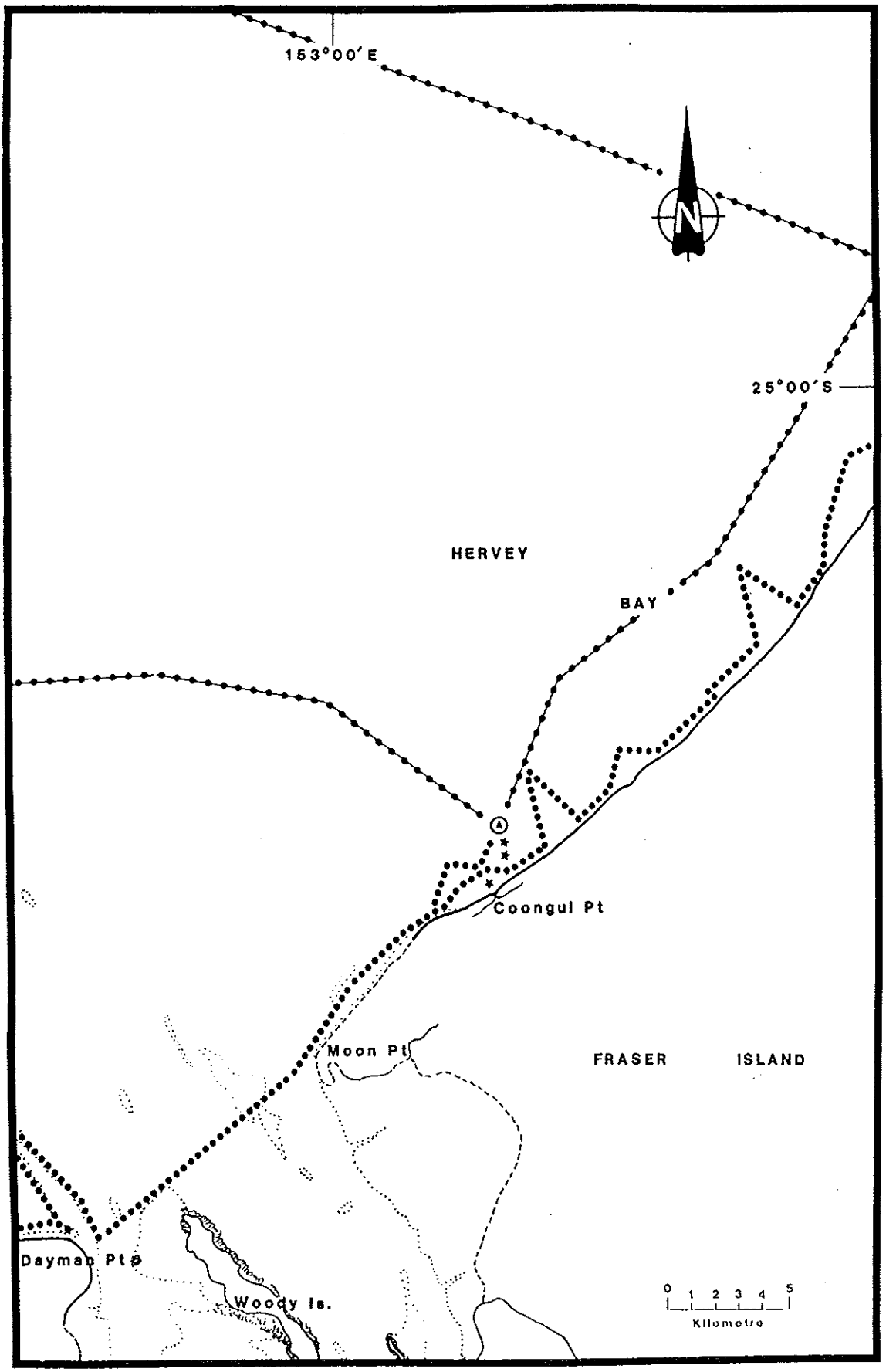

151°30'E
24°00'S
Boyne R.
Wild Cattle Is.
Colloseum Inlet
Hummock Hill Is.
Rodds Hbr
Rodds Peninsula
BUSTARD HEAD
Pancake Ck
Middle Is.
Turkey Beach
Middle Cr.
0 1 2 3 4 5
Kilometre

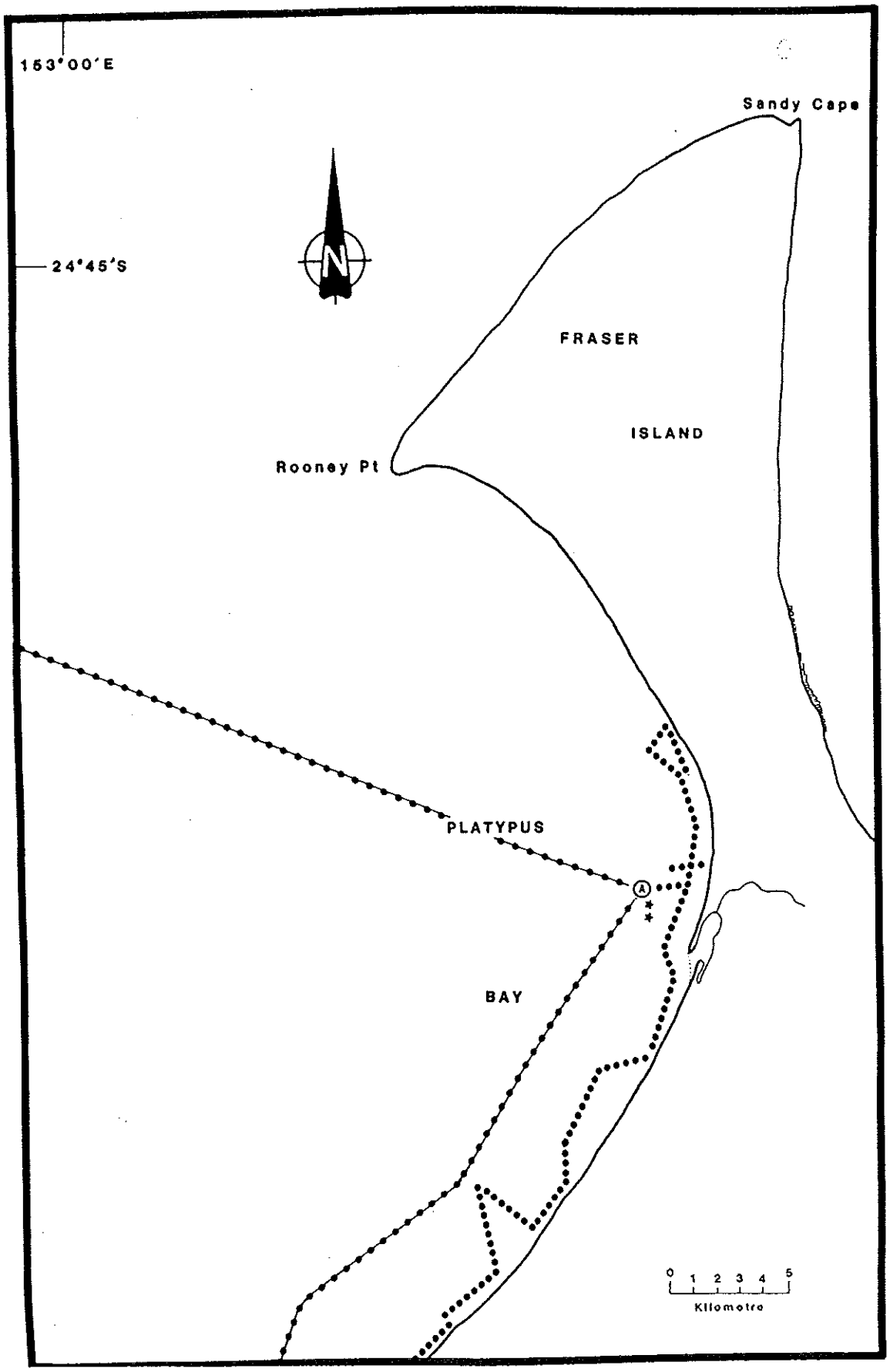

152°00'E
BUSTARD
BAY
Round Hill Head
N
Agnes Water
Rocky Pt
24°15'S
Toowong Hill 0
Broadwater Cr.
Mithell Cr.
Baffle Creek
0 1 2 3 4 5
Kilometre


Baffle Cr
Littabella Crs
Kolan River
Moore Park
South Hd
Burnett R.
0 1 2 3 4 5
Kilometre
152°15' E
24°30' S


152°30'E
South Hd
Burnett R.
Bargara
BUNDABERG
Elliott Heads
Elliott River
Coonean Ck
25°00'S
Theodolite Cr.
Woodgate
Burrum Pt
0 1 2 3 4 5
Kilometre


152°45'E
N
25°00'S
HERVEY
BAY
Burrum Pt
Burrum Hds
Vernon Pt
Beelbi Cr.
Pialba
Dayman Pt
0 1 2 3 4 5
Kilometre


153°00'E
25°00'S
HERVEY
BAY
A
Coongul Pt
Moon Pt
FRASER
ISLAND
Dayman Pt
Woody Is.
0 1 2 3 4 5
Kilometre


153°00'E
24°45'S
N
Sandy Cape
FRASER
ISLAND
Rooney Pt
PLATYPUS
BAY
A
0 1 2 3 4 5
Kilometre

APPENDIX 2

Maps 1-10 show areas of seagrass in three categories of bottom cover of all seagrass species combined. These categories are less than 10%, between 10% and 50% and greater than 50% cover. Incidental sightings of dugong and turtles are also marked.

Map Legend

Seagrass cover

<10% cover 

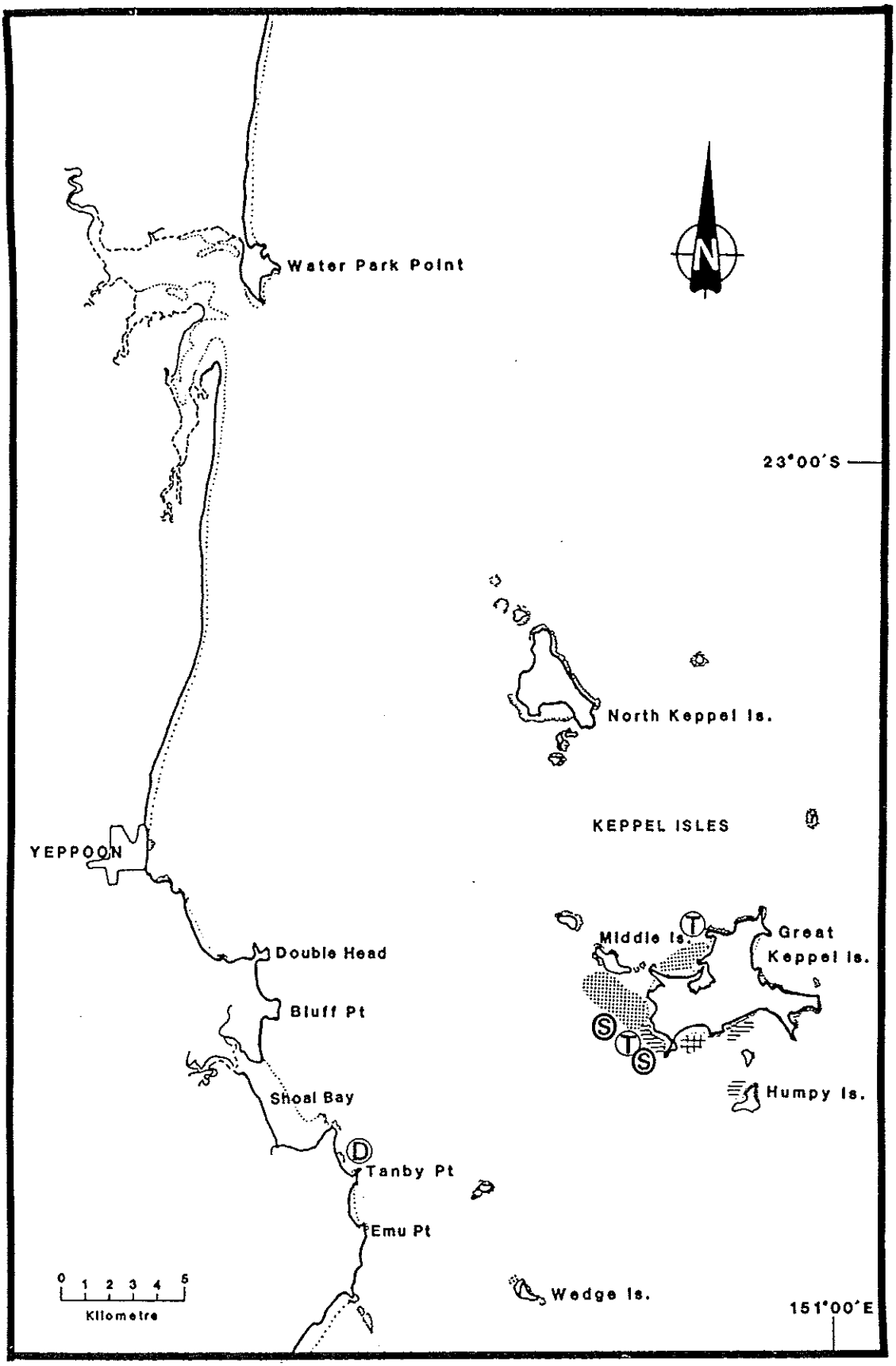
Between 10% and 50% cover 

>50% cover 

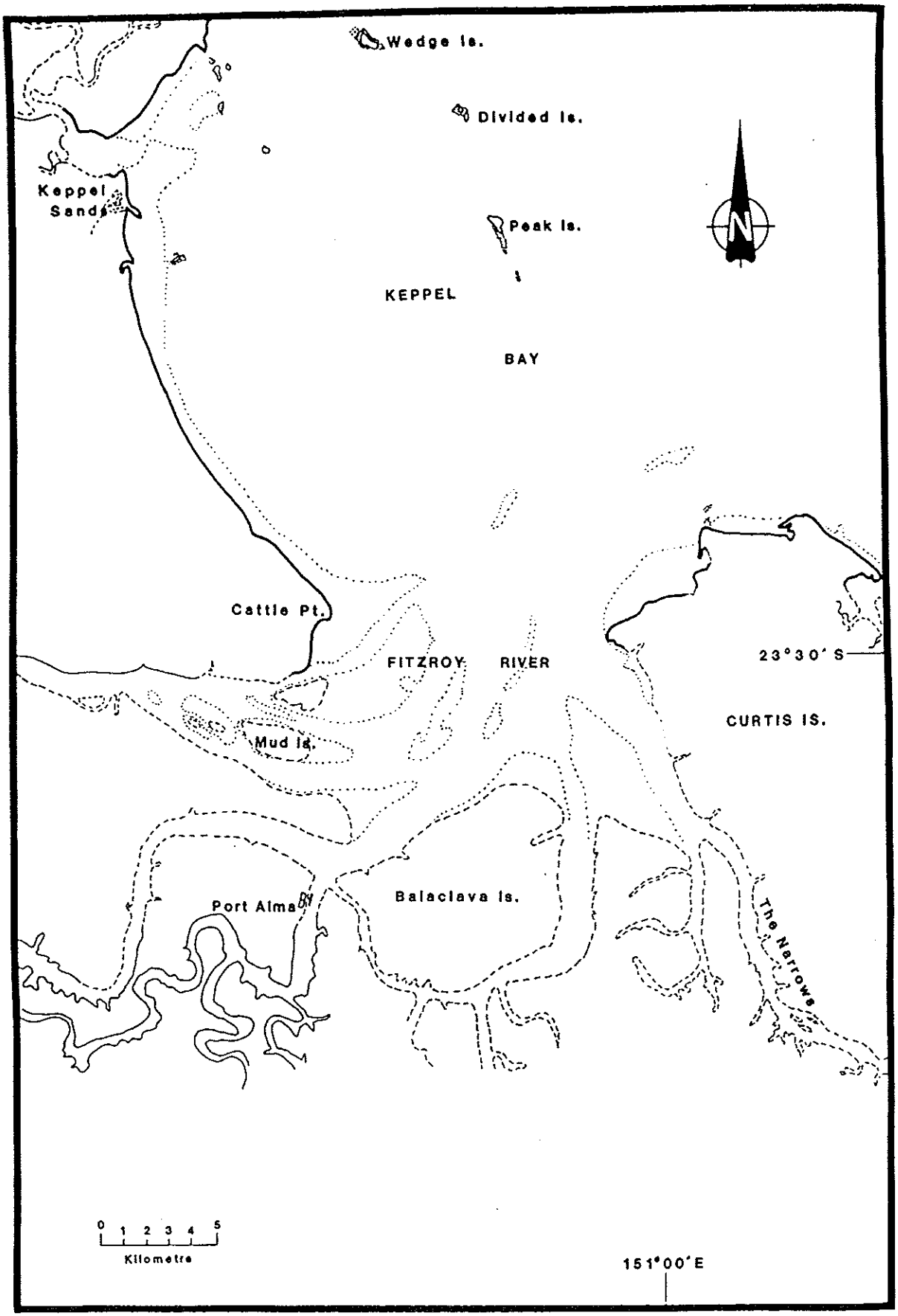
Dugong sightings Ⓓ

Turtle sightings Ⓣ

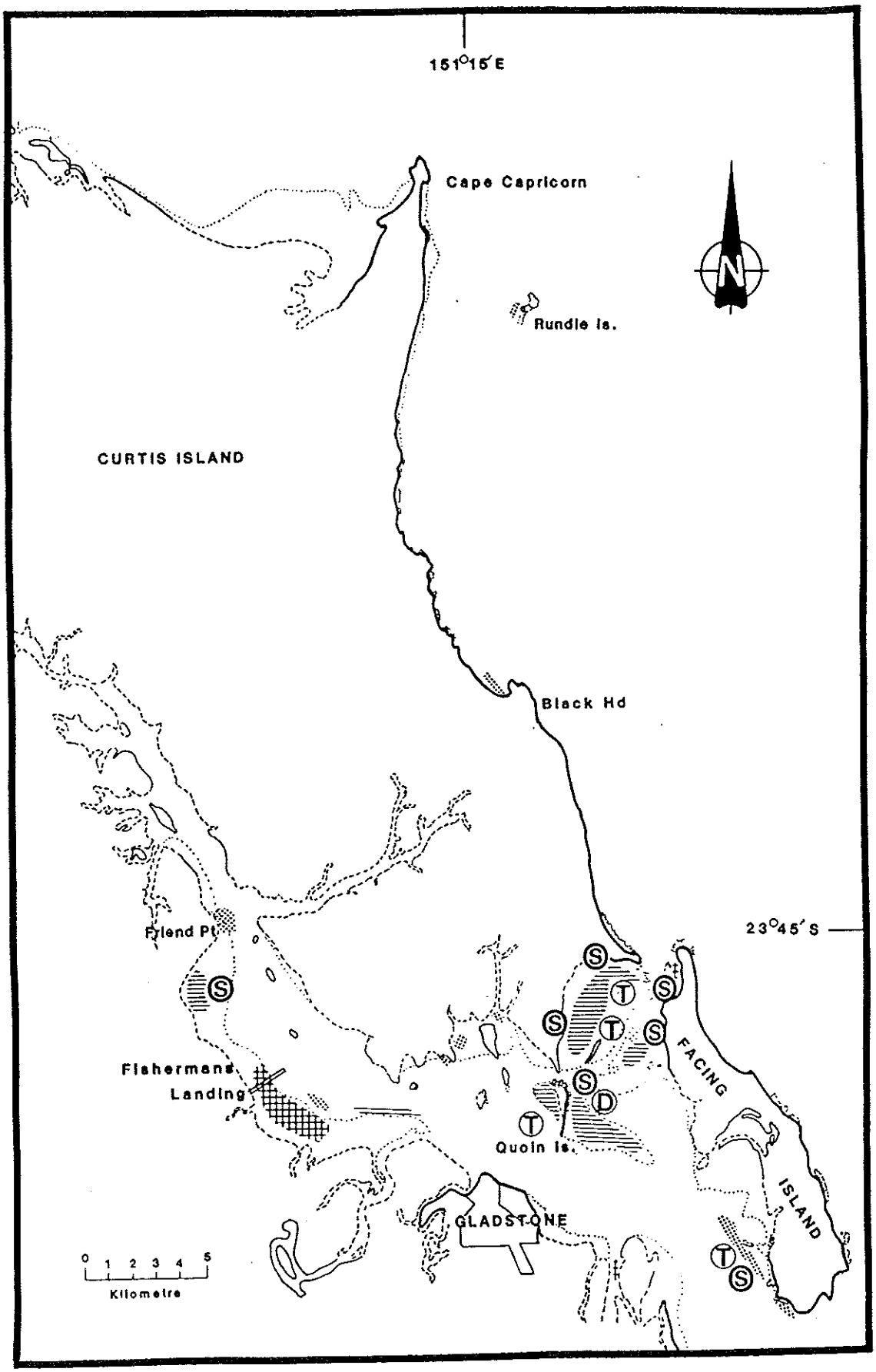
Seagrass biomass sample site Ⓢ



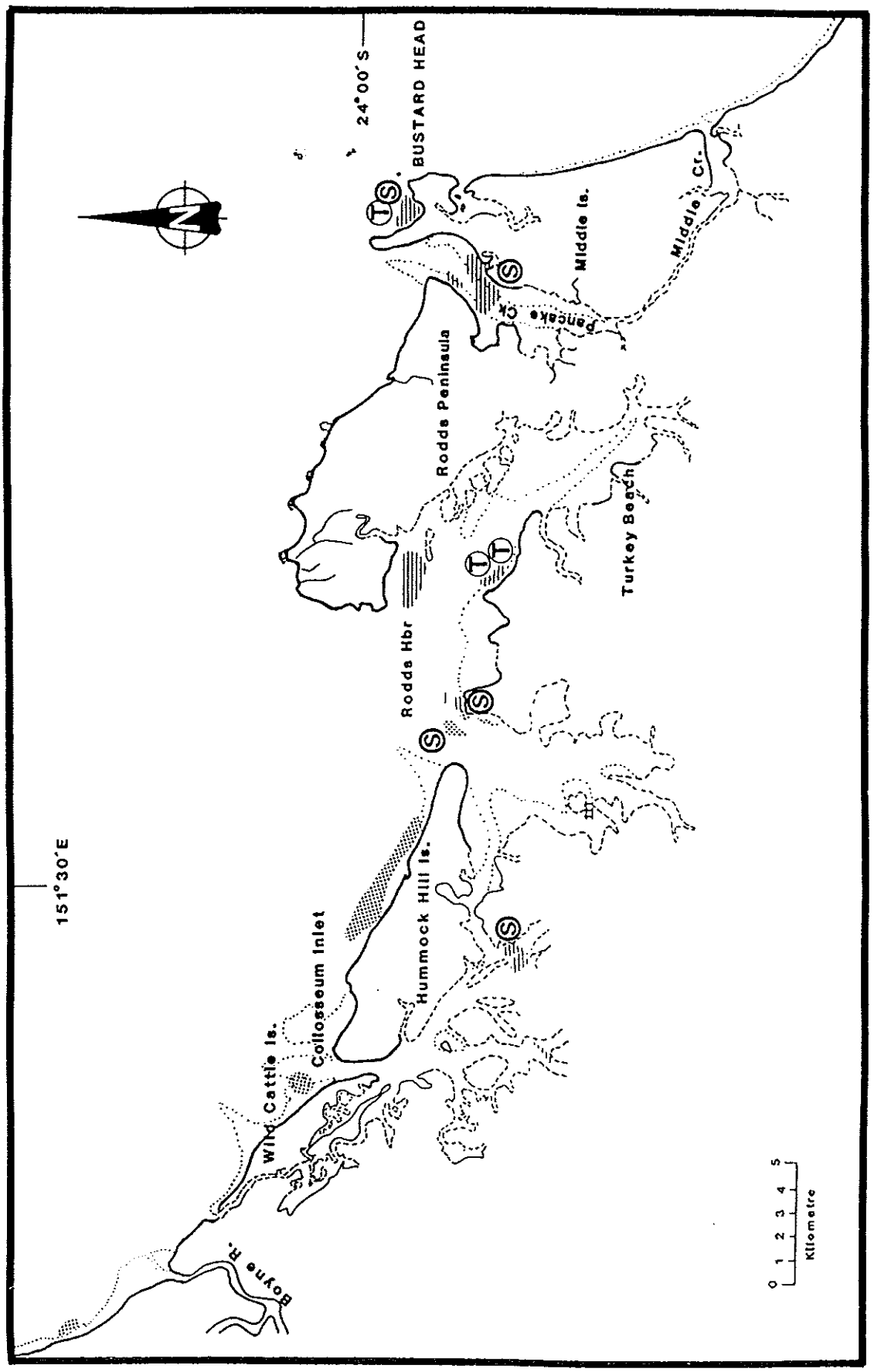
Map 1. *Seagrass habitat from Water Park Point to Wedge Island.*



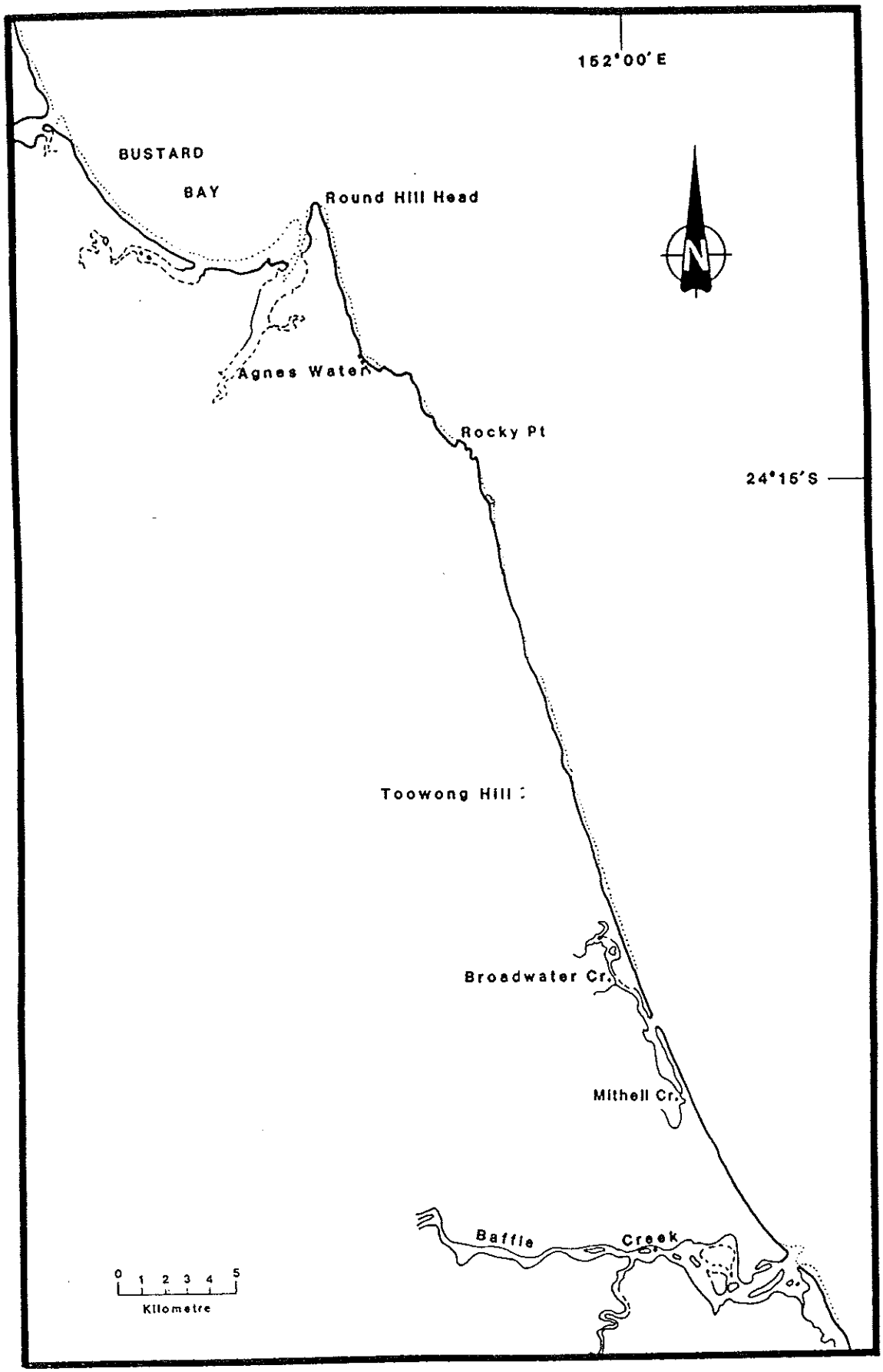
Map 2. *Seagrass habitat from Wedge Island to Fitzroy River.*



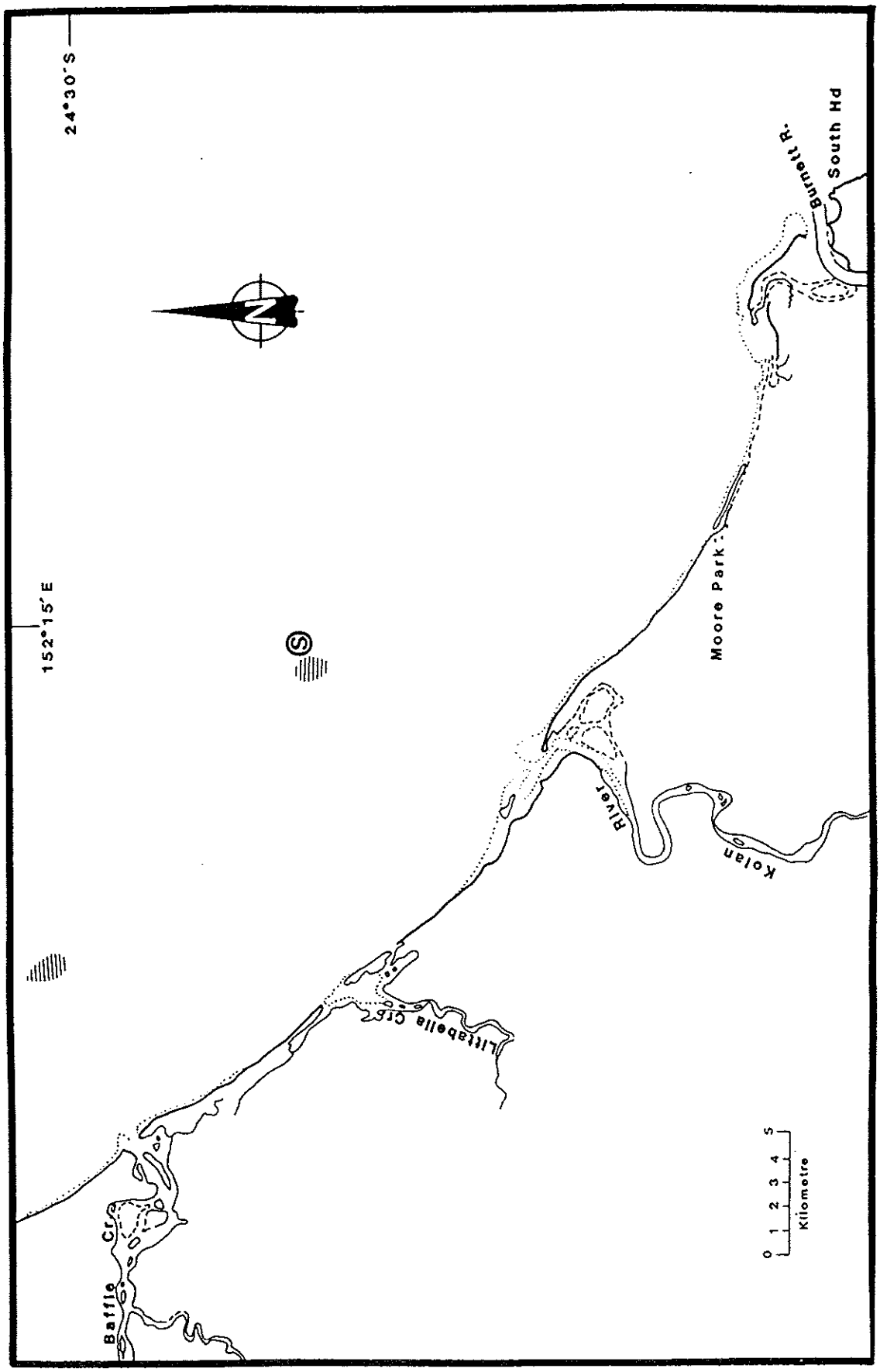
Map 3. *Seagrass habitat around Curtis Island and Gladstone Harbour.*



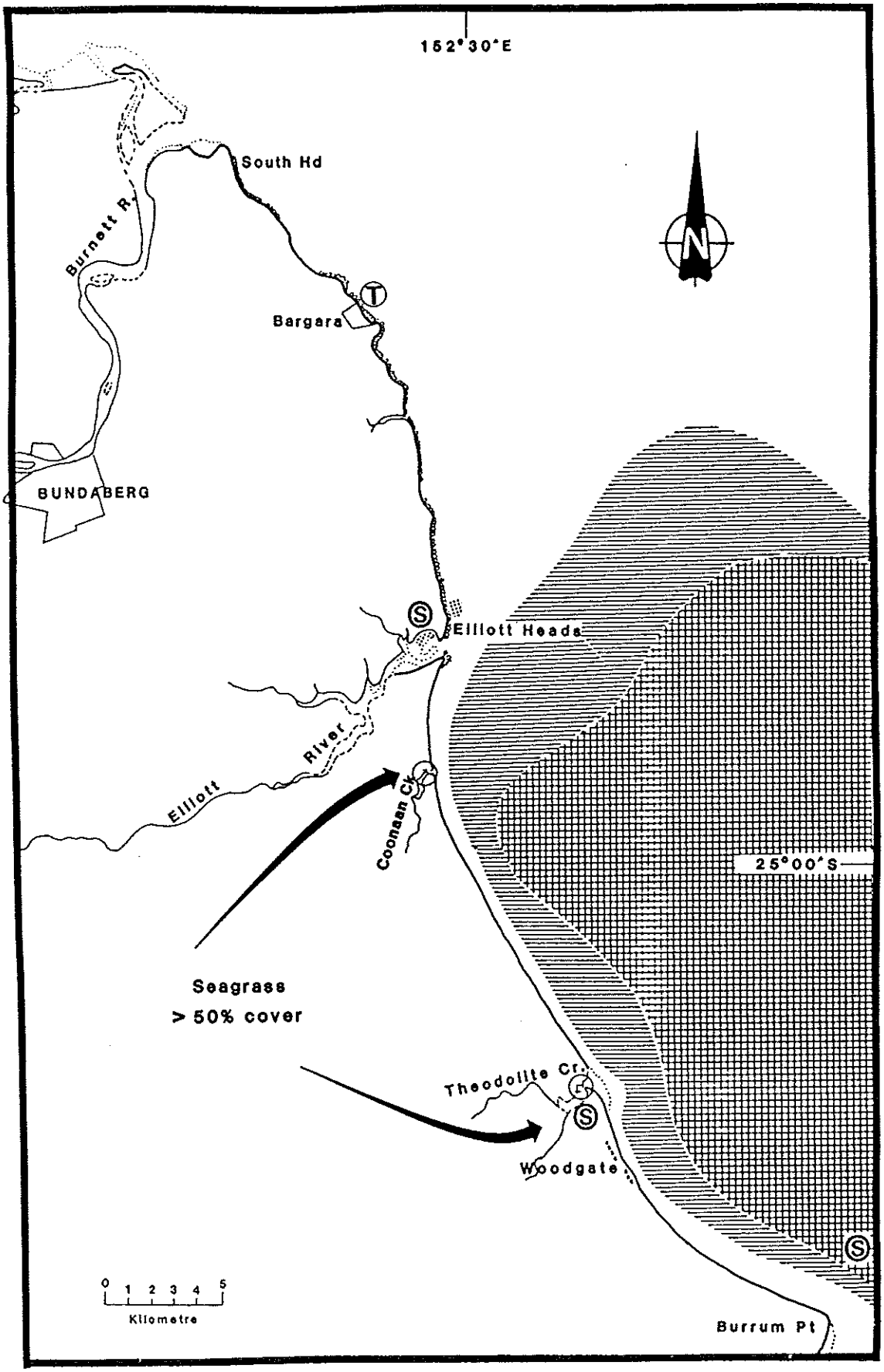
Map 4. Seagrass habitat from Boyne River to Bustard Head including Rodds Harbour area



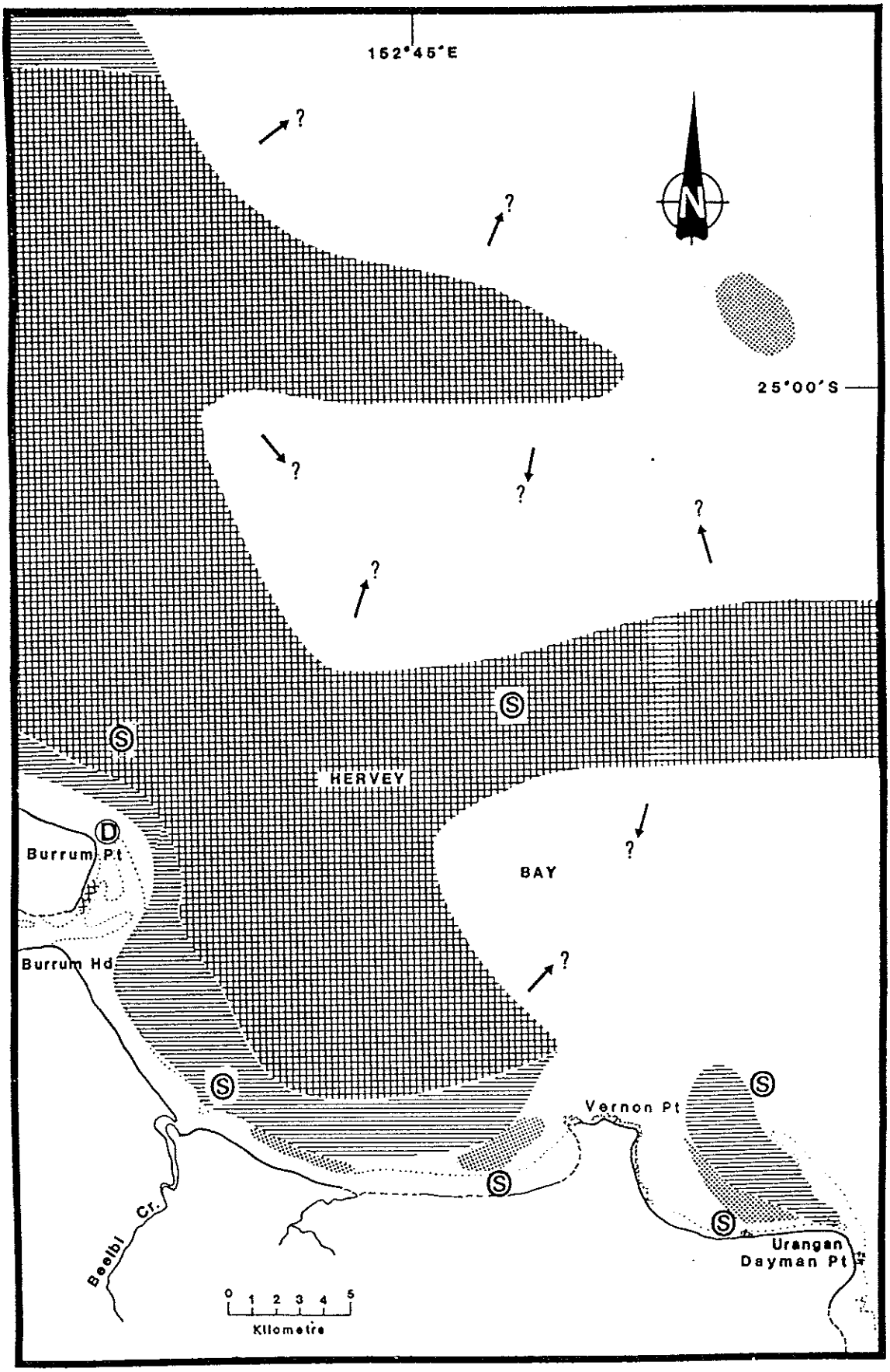
Map 5. *Seagrass habitat from Bustard Bay to Baffle Creek.*



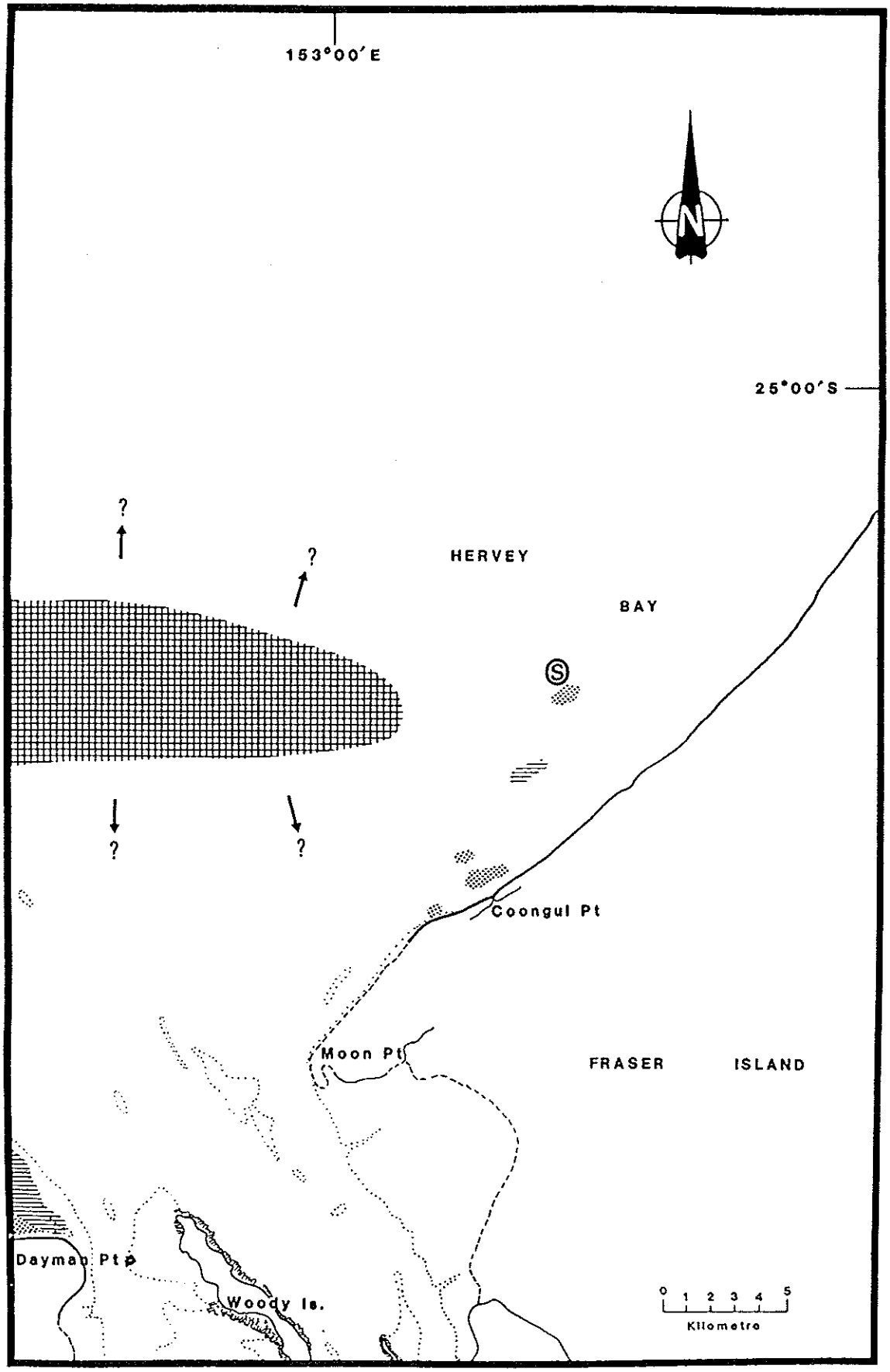
Map 6. *Seagrass habitat from Baffle Creek to Burnett River.*



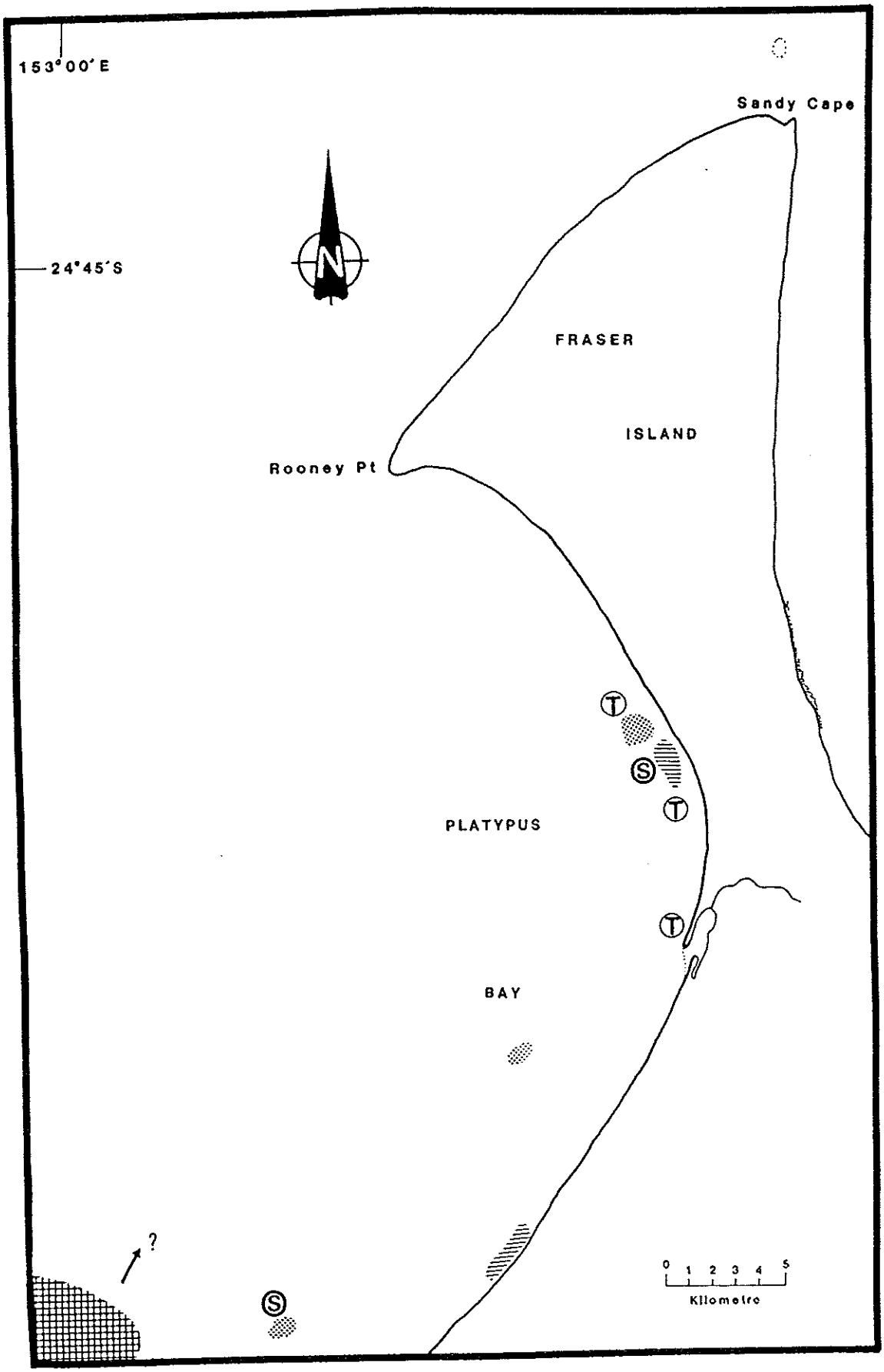
Map 7. *Seagrass habitat from Bundaberg to Burrum Point.*



Map 8. *Seagrass habitat of western side of Hervey Bay.*



Map 9. *Seagrass habitat of eastern side of Hervey Bay.*



Map 10. *Seagrass habitat of eastern Hervey Bay including north-western side of Fraser Island.*

APPENDIX 3

List of fish species caught in beam trawls on seagrass beds between Water Park Point and Hervey Bay. Common names and brief descriptions are given for each Family of fishes caught.

Scientific Name	Common Name	Description
AMBASSIDAE *Ambassis* sp. *A. gymnocephalus*	Perchlets, Glassfish	These small translucent fish are a useful baitfish and the larger individuals can be eaten by humans. Some freshwater species are popular aquarium fish.
APLOACTINIDAE *Paraploactis* sp.	Velvet fishes	Small to moderate sized fishes. Scales absent but covered with velvet-like villi. Found in depths of up to 100 m.
APOGONIDAE *Apogon nigripinnis* *A. semilineatus* *A. septemstriatus* *Apogon* sp. 1 *Apogon* sp. 2 *Cheilodipterus* sp.	Cardinal fishes	Small to moderate sized fishes of coastal tropical waters. Oral gestation occurs in several species.
ATHERINIDAE *Atherinidae sp.* *Atherinomorous sp.* *Hypoatherina lacunosa*	Hardyheads	Small schooling fishes preyed upon by larger species such as bream and tuna, these fishes are often used as bait. Eggs have sticky filaments which adhere to aquatic plants until hatching.
BOTHIDAE *Arnoglossus waitei* *Engyprosopon* sp.	Flounder	Some species are of commercial importance. Eyes are commonly positioned on the left side.
CALLIONYMIDAE *Repomuscenus belcheri*	Dragonets	Small to moderate sized bottom dwellers which range from the coast to deeper shelf waters. They bury in sandy bottoms for concealment during daytime. There are no commercially important species in Queensland.
CLUPEIDAE *Pranesus ogilbyi*	Hardyhead	Small, silvery fishes. Commonly inshore, pelagic fishes. Some very important bait species.
CONGRIDAE *Heteroconger* sp.	Conger Eel	Scales absent. Body long and robust. Found in benthic regions. Are of little commercial importance.
CYNOGLOSSIDAE *Cynoglossus puncticeps*	Tongue Soles	Most of these fish inhabit sandy bottoms near river mouths and in shallow coastal waters. They are small and of no commercial value.
ELEOTRIDAE *Eleotridae* sp.	Sleepy Cods	Small fishes, often less than 20 cm. Mostly benthic fishes, some free-swimming. Mainly found in fresh and estuarine waters.
ENGRAULIDAE *Stolephorus devisi* *S. indicus*	Anchovies	Small gregarious fishes sometimes occurring in large schools over muddy bottoms in river estuaries. The strong-flavoured flesh is used to flavour fish pastes.

Scientific Name	Common Name	Description
GOBIIDAE *Goblidae* sp. *Goblidae* sp. 1 *Goblidae* sp. 2 *Yongelchthys criniger*	Gobies	Small, sluggish, littoral fishes, they are found in rock pools, on coral reefs and in sheltered, weedy estuaries. They are the largest family of primarily marine fishes and have no commercial value in Queensland.
HEMIRAMPHIDAE *Hyporhamphus ardelio*	Garfishes	Abundant pelagic schooling fishes inhabiting coastal waters. These herbivorous fishes breed in lagoons and estuaries where their large eggs adhere to plants by means of sticky threads. Juveniles of some species have previously been reported to use seagrass for food and shelter. These are important food fishes taken in commercial quantities by net fishermen.
LABRIDAE *Choerodon cephalotes*	Wrasses	Live in or about coral or weed and are usually carnivorous. Valued food fishes if large, they are usually speared or line caught.
LETHRINIDAE *Gnathodentex* sp. *Lethrinus* sp.	Emperors	Inhabit rocky outcrops and coral reefs and are carnivorous. These fish are commercially valuable. They are caught by handlines and are prized by amateur anglers.
LUTJANIDAE *Lutjanus* sp.	Sea Perch	Oblong moderately, compressed perch-like fishes. Mostly bottom fish to 550 m. Important commercially.
MONACANTHIDAE *Brachaluteres taylori* *Monacanthus chinensis*	Leatherjackets	Residents of shallow tropical and temperate seas, these fish are edible although not popular in Queensland. Some species have value as aquarium fishes.
MUGILOIDIDAE *Parapercis macrophthalmus* *Parapercis* sp.	Grubfishes	Mostly small, agile, carnivorous bottom dwellers of coastal and reef waters. They are tropical species of little economic importance.
PARALICHTHYIDAE *Pseudorhombus elevatus* *Pseudorhombus* sp.	Flatfishes, Flounders	These are very important commercially overseas but Australian species are generally too small and are not popular with consumers. They are often taken in trawl catches. These fish are carnivorous, and can change colour to match the bottom on which they live.
PEGASIDAE *Pegasus volitans*	Dragonfish, Seamoth	Have an armoured body and long, flattened snout. Shape and colour assist in concealment amongst weed.
PLATYCEPHALIDAE *Cymbacephalus nematophthalmus* *C. ematophthalmus*)	Flatheads	Bury in bottom sediments with their eyes exposed. They are carnivorous. Most (including are valuable food fishes and are caught commercially in Queensland.
SCORPAENIDAE *Paracentropogon longispinus*	Scorpionfishes, Waspfishes etc.	Most are feeble swimmers and depend on concealment to avoid predators. They are generally bottom dwellers in coastal areas. Many have venomous fin spines.

Scientific Name	Common Name	Description
SIGANIDAE *Siganus* sp.	Rabbitfishes, Happy Moments, Spinefeet	Small to moderate size fishes found in the tropical Indo-Pacific. They are herbivorous and inhabit reefs and weedy bottoms. The fin spines are venomous. The flesh is edible but not popular with Queensland line fishermen. Prized as a delicacy in some coastal aboriginal and islander communities.
SILLAGINIDAE *Sillago* sp.	Whiting	These moderate sized coastal species are valued food fishes and are caught in seine nets or by hand lining. They are carnivorous, digging in the bottom for worms and crustaceans. Smaller species are used as bait.
SPHYRAENIDAE Sphyraenidae sp.	Barracudas, Sea pike	These carnivorous, fast-swimming fish are very voracious. Some of the larger species can pose a threat to humans.
SYNGNATHIDAE *Halicampus macrorhynchus*	Pipefishes, Seahorses	Small, lightly armoured, specialised fishes. They have a commercial value as ornaments and costume jewellery. They are poor swimmers and some anchor to seagrass by means of their prehensile tails.
TERAPONIDAE *Pelates quadrilineatus* Teraponidae sp.	Grunters, Trumpeters	These are carnivorous fishes. *P. quadrilineatus,* the most abundant species in our trawls, grows to 200 mm and is common in seagrass covered mudflats. Teraponids are of commercial value as live bait in Queensland.
TETRAODONTIDAE *Arothron immaculatus* *Arothron* sp.	Pufferfishes, Toadfishes	Inhabiting moderately shallow coastal waters, pufferfishes inflate when provoked. Their flesh is toxic, although some are eaten in Japan after special preparation.
TRIACANTHIDAE *Triacanthus* sp. *Trixiphichthys weberi*	Tripodfishes	These benthic fish are found on flat, sandy or weed covered bottoms and feed on bottom-dwelling invertebrates. Tripodfish can grow to moderate size.
TRICHONOTIDAE *Trichonotus setigerus*	Sand divers, Sand eels	Resemble Mugiloididae but the body is more translucent to transparent in colour. Found in shallow water on sandy bottoms.