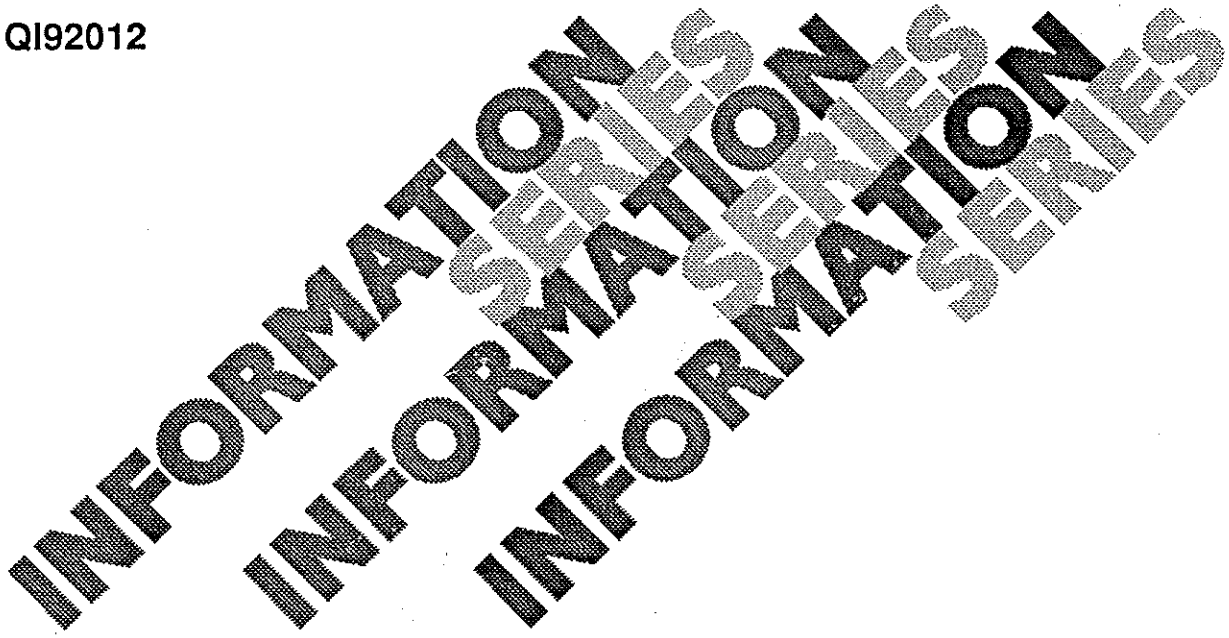
QI92012



Seagrass beds and juvenile prawn and fish nursery grounds

Cairns to Bowen

R.G. Coles, W.J. Lee Long, S.A. Helmke,
R.E. Bennett, K.J. Miller and K.J. Derbyshire

Department of Primary Industries
Queensland

Information Series QI92012

Seagrass beds and juvenile prawn and fish nursery grounds

Cairns to Bowen

R. G. Coles, W. J. Lee Long, S. A. Helmke,
R. E. Bennett, K. J. Miller and K. J. Derbyshire

Fisheries

Department of Primary Industries
Brisbane

ISSN 0727-6273
Agdex 486/96

This publication was prepared for officers of the Department of Primary Industries. It may be distributed to other interested individuals and organisations.

Department of Primary Industries, Queensland
GPO Box 46
Brisbane Qld 4001

CONTENTS

LIST OF FIGURES AND TABLES.

INTRODUCTION

The ecological importance of seagrass habitats in marine systems, their primary production rates and value as animal habitat, nursery grounds and substrate stabilizers, have been noted by various authors (McRoy 1974; Zieman 1975; McRoy and Helfferich 1977). Most Australian research on seagrass has occurred in recent years, contributing to an increased general awareness of the importance of these habitats. The recent treatise on Australian seagrasses (Larkum *et al.* 1989) will be an important foundation for the development of all aspects of seagrass research in Australia. Coles *et al.* (1989) provide a summary of the history of seagrass research in north-eastern Queensland.

Seasonal and long-term changes in ecology, distribution and productivity of these tropical and sub-tropical seagrass beds are not well understood. Recognition of the economic value of seagrasses as nursery grounds for many commercial prawn and fin-fish fisheries, and support for seagrass research by the authorities responsible for fisheries management and coastal zone planning has ensured continuation of research on seagrasses. The Fishing Industry Research Committee and the Queensland Department of Primary Industries have supported extensive surveys and ecological studies of seagrass and juvenile prawn and fish populations for the coastline between Cape York and Cairns (Coles *et al.* 1985b, b; Coles *et al.* 1987b) and in the eastern Gulf of Carpentaria (Coles and Lee Long 1985; Poiner *et al.* 1987). The Great Barrier Reef Marine Park Authority and the Queensland Department of Primary Industries supported the present survey between Cairns and Bowen, and surveys from Bowen to Yeppoon (Coles *et al.* 1987a) and Yeppoon to Hervey Bay (in prep.). The objectives of these surveys were to describe areas of seagrass habitats in Queensland coastal waters and investigate their value as nursery grounds for juvenile commercial prawn and fish species.

The results of the seagrass survey between Cairns and Bowen, maps of seagrass beds and details of the seagrass communities and the fauna sampled, are presented in this paper, the only extensive set of information available on these habitats. Together with the results of similar surveys this information provides a vital input for coastal zone management. This information is of particular value where the survival of these habitats affect the continuation of coastal fisheries and other marine faunal populations.

METHODS

Sampling area

The coastal region surveyed (from Cairns to Bowen) is in the central part of the Great Barrier Reef Lagoon (Fig. 1). In this region the reef is between ten and forty nautical miles offshore. Water depth increases gradually from shore to average approximately 35 m in the mid-lagoon and approximately 55 m in the inter-reef areas.

Continental islands are common and the coast is characterised by many large headlands and bays facing north and north-east. These bays are sheltered from the south-east trade winds and usually contain mangrove-lined inlets, where sediments are mud and sand (Maxwell, 1968). Major ports and urban centres are also usually sited on or near these bays. Between Cairns and Ingham short, fast-flowing rivers which originate from the rainforest-covered Great Dividing Range, drain summer monsoonal rainwaters. Between Ingham and Bowen, rivers are less common and the coastal plain is wider and drier than in the north. There are major industrial and urban centres at Cairns, Townsville and Bowen, and special ship loading facilities at Mourilyan (near Innisfail), Lucinda (near Ingham) and Abbot Point (near Bowen). The coast in between is generally only lightly populated.

Winds are predominantly south-easterly trades, strongest during winter but weaker and with a north-easterly element in summer months (Maxwell 1968). The coast is protected against oceanic swells by the complex reefs and shoals of the Great Barrier Reef system. Tides in this region are semi-diurnal and tidal amplitude varies between a minimum of 2.7 m near Cairns and a maximum of 3.3 m near Bowen (Maxwell 1968). Average annual coastal rainfall ranges between a minimum of 1 015 mm at Bowen and a maximum of 3 813 mm at Innisfail (Climatic Averages - Australia 1988).

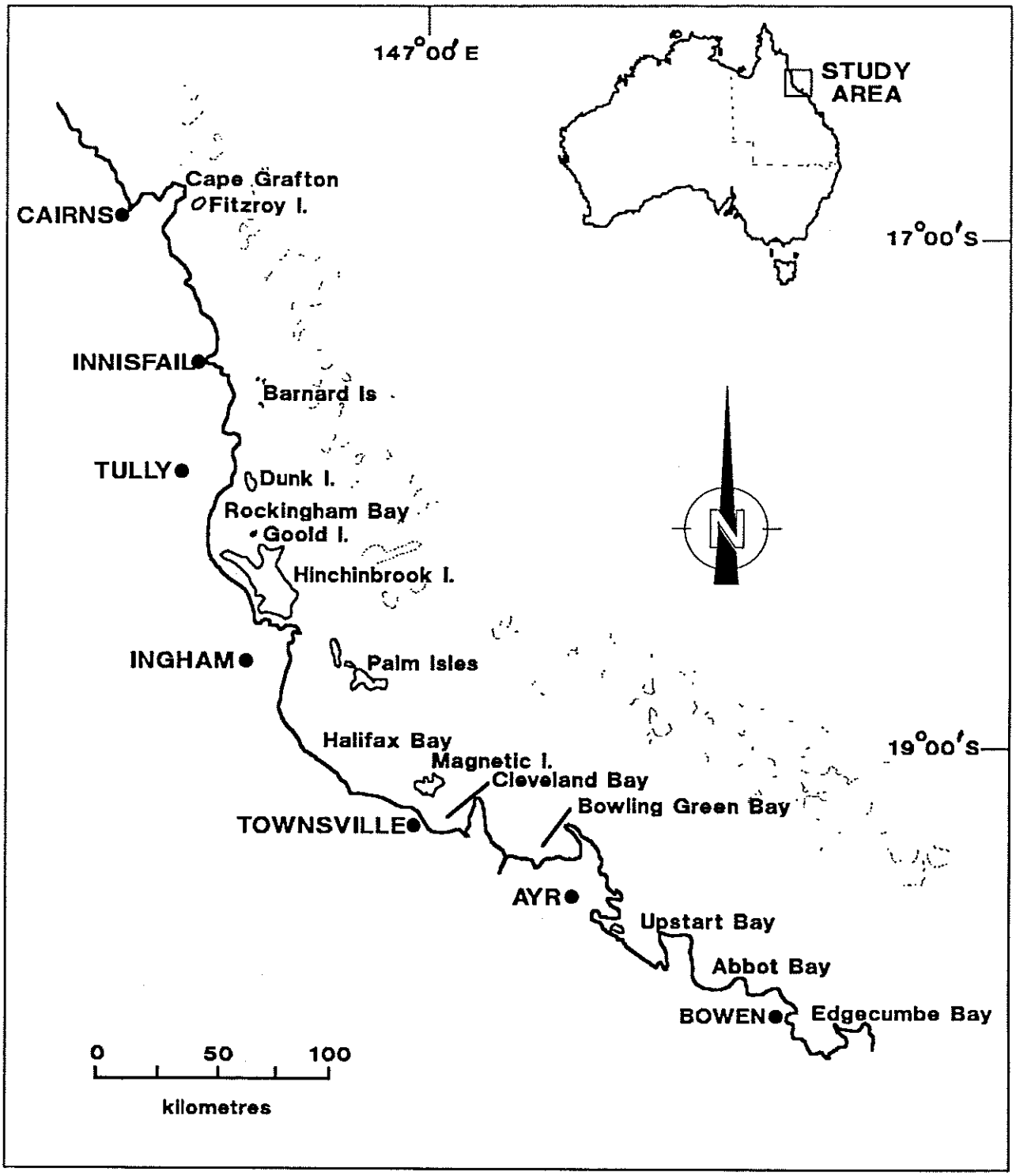


Figure 1. The survey region.

Seagrasses

Methods for surveying and sampling seagrasses and beam trawling sampling for juvenile prawns and fish were based on methods outlined in Coles *et al.* (1987a). 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.

Bottom type was recorded on each of 1 124 dives, conducted during the survey between 19 October 1987 and 6 November 1987. When seagrasses were observed, samples were kept for taxonomic purposes. One hundred and six quadrat samples were collected for detailed laboratory analyses. Maps of sampling sites and survey vessel tracks indicate the areas surveyed (Appendix 1). The area surveyed does not include Cairns Harbour. A detailed study of Cairns Harbour seagrass beds is the subject of a separate report.

In the present survey, the sea bottom type was recorded at 370 m intervals on transects and at intervals of at least every one nautical mile between transects. Transects were continued seaward until no seagrass was found. The spatial intensity of sites where divers observe, record and sample bottom type is affected by the prevailing weather conditions and the allowable time and resources for the survey. As a general rule, this survey did not investigate areas at depths greater than 20 m. It is possible that seagrass occurs at very low densities in deep water beyond our survey areas.

Seagrass beds were mapped by extrapolating from the records of bottom vegetation and sediment at each dive site. Sequential sites with seagrass were mapped as a continuous zone of seagrass habitat. Estimating a measure of accuracy for the maps of seagrass habitat is difficult. The major sources of error are in position fixing and as a result of the intensity of spatial observations of bottom type. Accuracy of position fixing is affected by the accuracy of navigation charts in inshore areas, resolution of position fixing devices such as radars, and the accuracy of chart plotting on the vessel . During preparation of the maps, there are additional errors associated with the original coastal charts, the thickness of lines on maps, and paper shrinkage etc. (Walker 1989).

Halophila ovalis, Halophila ovata, Halophila tricostata, and *Halodule uninervis* had several leaf and/or shoot morphologies. For these species and an undescribed *Halophila* species, classification and nomenclature is under revision by taxonomists (Kuo, pers comm.). Pending these revisions, we have used the classifications used by den Hartog (1970) and Lanyon (1986).

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

In a total 1 124 dives, seagrasses were observed on 321 (28.6%) occasions. Nineteen maps describing the distribution of seagrass habitat have been compiled based on visual estimates from the surface of seagrass area and on diver estimates of the percentage of the bottom covered by seagrasses (Appendix 2, Maps 1-19). Seagrasses are mapped in three categories according to the percentage cover.

These are: less than 10%; between 10% and 50%; and greater than 50% cover.

Table 1. Distribution of seagrass species in coastal areas between Cairns and Bowen.

COASTAL AREAS	*Halodule uninervis*	*Halodule pinifolia*	*Halophila decipiens*	*Halophila ovalis*	*Halophila ovata*	*Halophila tricostata*	*Halophila spinulosa*	*Cymodocea serrulata*	*Cymodocea rotundata*	*Zostera capricorni*	*Thalassia hemprichii*	*Syringodium isoetifolium*	*Halophila* sp.
SEAGRASS SPECIES													
Mission Bay	■	■											
Cape Grafton to Russell Heads	■	■		■									
Mourilyan Harbour	■		■		■								
Cowley Beach region	■	■	■	■	■		■						
Mission Beach region		■											
Rockingham Bay	■		■										
Cardwell to Lucinda	■	■	■	■		■	■						
Halifax Bay	■	■	■	■			■				■		
Cleveland Bay	■	■	■	■	■		■	■					
Bowling Green Bay	■	■	■							■			
Upstart Bay	■	■	■	■		■	■	■		■			
Abbot Bay to Cape Edgecumbe	■	■	■	■	■		■						■
Edgecumbe Bay	■	■		■	■				■	■	■	■	

Table 2. Distribution of seagrass species around islands between Cairns and Bowen.

ISLANDS	*Halodule uninervis*	*Halodule pinifolia*	*Halophila decipiens*	*Halophila ovalis*	*Halophila ovata*	*Halophila tricostata*	*Halophila spinulosa*	*Cymodocea serrulata*	*Cymodocea rotundata*	*Zostera capricorni*	*Thalassia hemprichii*	*Syringodium isoetifolium*	*Halophila* sp.
SEAGRASS SPECIES													
Fitzroy Island		■	■			■							
High Island				■									
North Barnard Islands			■		■	■							
South Barnard Islands				■									
Dunk/Family Islands	■	■	■	■	■	■	■				■		
Goold Island	■		■	■									
Hinchinbrook Island	■	■	■	■	■	■							
Palm Isles	■	■		■	■		■	■	■				
Magnetic Island	■	■	■	■	■	■	■	■	■			■	

Coastal sites where seagrasses were found were grouped into 13 geographic areas (Table 1). The occurrence of seagrass species at nine island locations was recorded (Table 2). Thirteen species of seagrasses, from two families and six genera were collected:

Family Potamogetonaceae
Cymodocea rotundata Ehrenb. et Hempr. ex Aschers.
Cymodocea serrulata (R.Br.) Aschers. and Magnus.
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 sp. (identification uncertain).
Thalassia hemprichii (Ehrenb.) Aschers.

A *Halophila* species which was found at Abbot Point and Magnetic Island, and was also observed during a survey of the coast south of Bowen (Coles *et al.* 1987a) could not be identified beyond genus level.

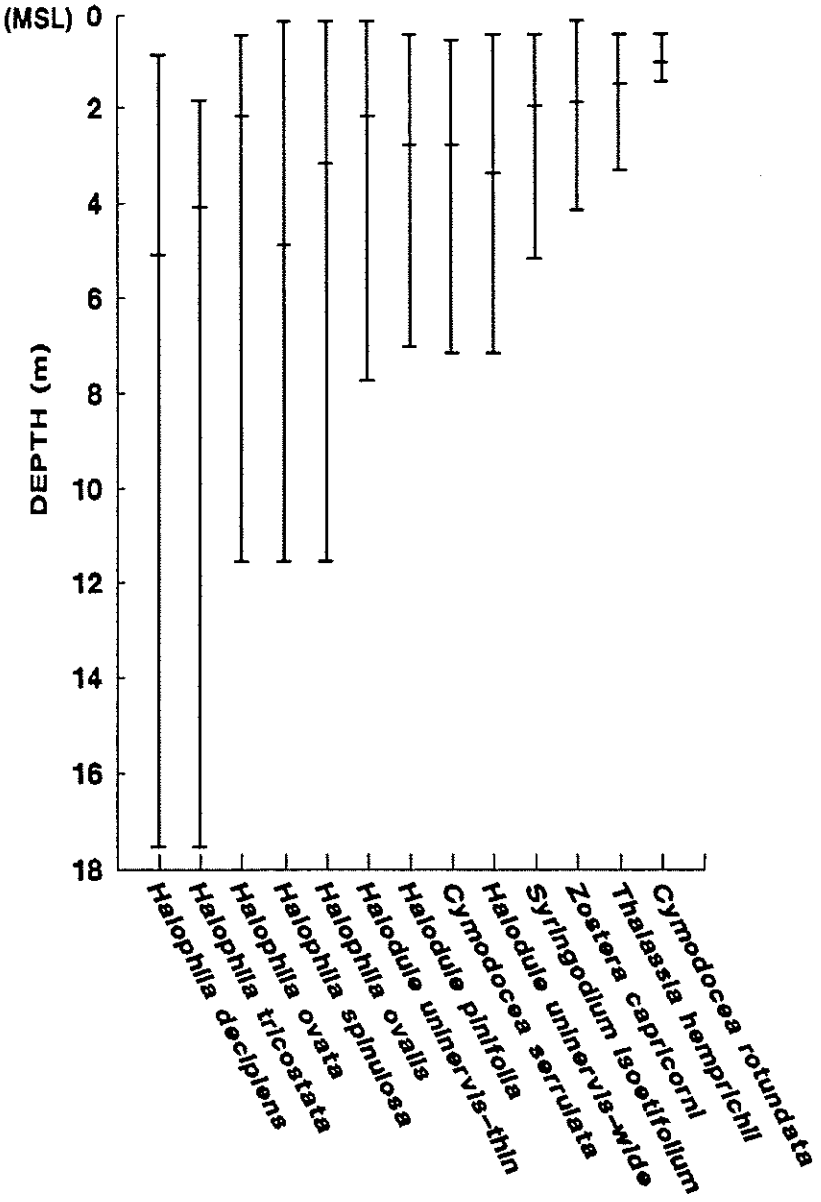


Figure 2. Range and average depths below mean sea level (MSL) at which seagrasses were found between Cairns and Bowen.

The two most commonly found seagrass species were *H. uninervis*, and *H. pinifolia*. *Halophila ovalis* and *H. decipiens* also occurred in most of the geographic areas surveyed (Tables 1 and 2). Most other species occurred at less than half of all the areas sampled. All species occurred in two or more areas. Almost all species were observed at both coastal and island sites with the exception of *Z. capricorni* which was not found at island sites. *Halophila tricostata* occurred at sheltered, leeward sites of the continental islands, and this survey recorded from the Hinchinbrook Channel and Upstart Bay the first observations of *H. tricostata* at coastal sites.

The greatest number of seagrasses found at any site was six species on the north-west of Dunk Island. Five species were found at two sites in Upstart Bay and also at a site on the south-west of Dunk Island.

Seagrass distribution was restricted to below mean sea level (MSL) (Fig. 2). The average recorded depths of the seagrasses were all between one and five metres below MSL. Except for *Halophila decipiens, H. tricostata,* and *H. spinulosa* , the average depths at which seagrass species were found were less than 4m. *Cymodocea rotundata, T. hemprichii* and *Z. capricorni* all occurred on average at depths less than 2 m and did not appear at depths of more than 4 m. Only the five *Halophila* species: *H. decipiens, H. tricostata, H. ovalis, H. spinulosa,* and *H. ovata* were found deeper than 10 m below MSL.

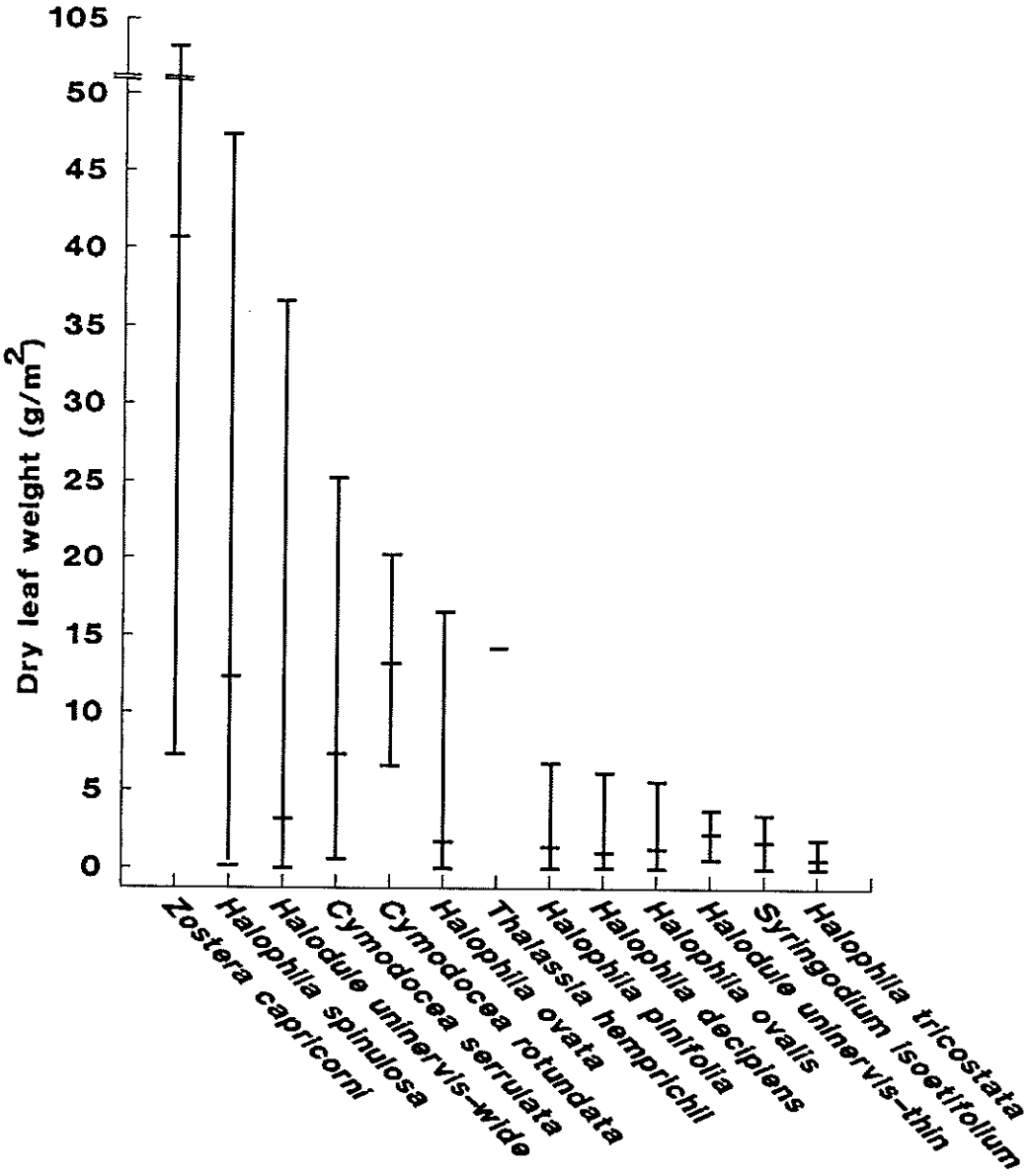


Figure 3. The average and range of dry leaf weights of seagrasses found between Cairns and Bowen.

Zostera capricorni at Upstart Bay had the highest leaf and root dry weights for any species: 102.9 g m^{-2} and 84.6 g m^{-2} respectively. *Zostera capricorni* also had the highest average biomass of leaf and roots in samples from this survey (Figures 3 and 4). The broad leafed species, *C. serrulata, C. rotundata, T. hemprichii* and *Z. capricorni* showed high average leaf and root dry weights and wide ranges in biomass. In the *Halophila* species, *Halodule* species, and *S. isoetifolium* both leaf area and root average dry weights were generally below 5 g m^{-2} (Figures 3 and 4).

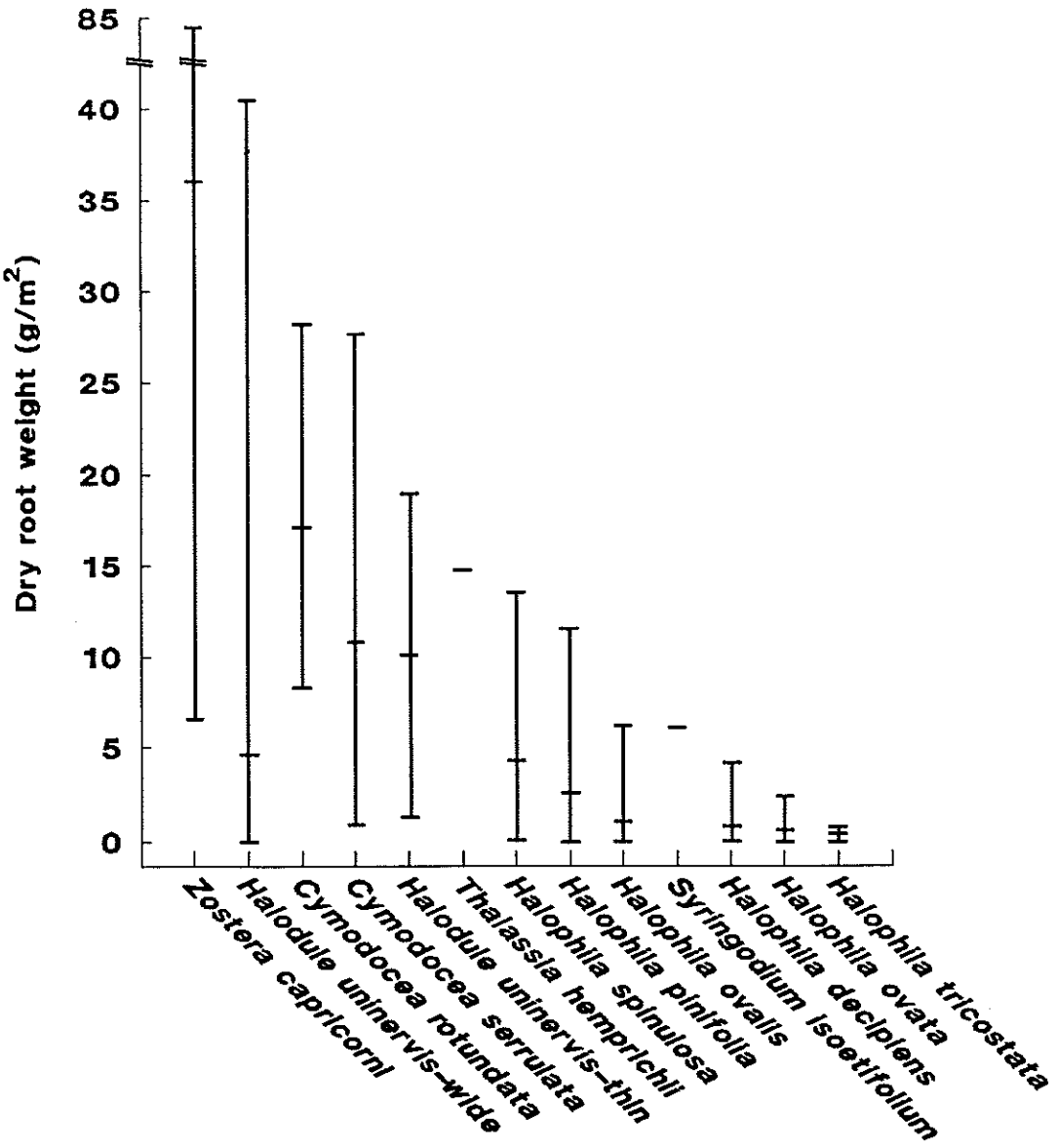


Figure 4. The average and range of dry root weights of seagrasses found between Cairns and Bowen.

From 24 beam trawl samples collected from eight locations, 1 070 penaeid prawns were caught, including nineteen species, from five genera (Table 3). Juvenile commercial penaeids were the most abundant group in our prawn samples. Of the five commercially important penaeid prawn species caught, brown tiger *(Penaeus esculentus)* and true endeavour *(Metapenaeus endeavouri)* prawns were the most common (Table 4). The highest catch rates during the survey occurred in Upstart Bay where *P. esculentus*, *M. endeavouri* and the western king prawn *(Penaeus latisulcatus)* were numerically dominant (Table 4). High catch rates also occurred in Hinchinbrook Channel and at Magnetic Island, where brown tiger and endeavour prawns were the predominant species. In Mission Bay *P. latisulcatus* was the most abundant species in samples.

Table 3. Penaeid prawn species identified in trawl catches from seagrass beds between Cairns and Bowen.

SPECIES	COMMON NAME	NUMBER OF PRAWNS
Metapenaeopsis mogiensis	Velvet prawn	9
Metapenaeopsis novaeguineae	Northern velvet prawn	40
Metapenaeopsis palmensis	Southern velvet prawn	126
Metapenaeopsis rosea	Rosy prawn	8
Metapenaeopsis wellsi	Coral prawn	17
Metapenaeus bennettae	Greentail prawn	20
Metapenaeus eboracensis	York prawn	15
Metapenaeus endeavouri	True endeavour prawn	297*
Metapenaeus ensis	False endeavour prawn	15*
Parapenaeopsis cornuta	Coral prawn	1
Parapenaeopsis tenella	Smoothshell prawn	1
Penaeus esculentus	Brown tiger prawn	261*
Penaeus latisulcatus	Western king prawn	98*
Penaeus longistylus	Red spot king prawn	2*
Penaeus monodon	Leader prawn	1*
Penaeus semisulcatus	Grooved tiger prawn	4*
Trachypenaeus anchoralis	Northern rough prawn	44
Trachypenaeus curvirostris	Southern rough prawn	80
Trachypenaeus fulvus	Brown rough prawn	31
TOTAL		**1070**

* Species of major economic importance in northern Australia.

Table 4. The number of prawns of five commercially important penaeid prawn species caught per hour of trawling over seagrass beds between Cairns and Bowen.

Table 4. The number of prawns of five commercially important penaeid prawn species caught per hour of trawling over seagrass beds between Cairns and Bowen.

SITE	*Penaeus esculentus*	*Metapenaeus endeavouri*	*Penaeus latisulcatus*	*Metapenaeus ensis*	*Penaeus semisulcatus*	
Mission Bay			51	6		57
Mourilyan Harbour	38	24				62
Hinchinbrook Island	63	62				125
Magnetic Island	100	116		2	4	222
Cleveland Bay	8	18	4	1		31
Bowling Green Bay	32	48		2	4	86
Upstart Bay	86	152	154	4		396
Abbot Bay	3	3	3			9
TOTAL	**330**	**423**	**212**	**15**	**8**	**988**

Fish and crabs

Overall, 811 individual fish were caught in the survey. The numerically dominant fish sampled were ponyfishes (Leiognathidae) and trumpeters (Teraponidae), representing 21.6% and 21.5% of the total fish abundance respectively (Table 5). These groups are considered by the prawn trawl fishery as small non-commercial "trash fish". By weight, trumpeters (37.7% of the total biomass) and flatheads (15.4%) were dominant. The only commercially or recreationally valuable fish common in beam trawl samples was the flathead, *Cymbacephalus nematophthalmus.* An emperor, *Lethrinus* sp., was also common as juveniles in samples. The common names of each of the 35 fish families and a brief description of their habits are listed in Appendix 3.

Table 5. Size, weight and abundance of fish in 35 fish families caught in seagrass beds between Cairns and Bowen.

Family	S.L. Range (mm)	Average S.L. (mm)	Weight (g)	% Biomass of total catch	Numb.	% Abund. of total catch
Ambassidae	3	36.0	1.1	0.11	1	0.12
Antennariidae	43	43.0	5.8	0.60	1	0.12
Apogonidae	17-36	27.8	4.7	0.49	4	0.49
Atherinidae	26-93	49.5	39.5	4.08	16	1.97
Belonidae	85	85.0	0.9	0.09	1	0.12
Blennidae	29-38	33.5	1.0	0.10	2	0.25
Callionymidae	18-35	26.4	1.4	0.14	5	0.61
Chaetodontidae	10-11	10.5	0.3	0.03	2	0.25
Cynoglossidae	52-72	60.3	15.5	1.60	6	0.74
Engraulididae	10-34	20.2	5.1	0.53	64	7.86

Family	S.L. Range	Average S.L.	Weight	% Biomass of total catch	Numb.	% Abund. of total catch
Gerreidae	30	30.0	0.6	0.06	1	0.12
Gobiidae	7-83	18.5	13.8	1.43	36	4.42
Haemulidae	11-35	20.4	3.2	0.33	13	1.60
Hemiramphidae	28-74	46.6	12.3	1.27	19	2.33
Labridae	18-24	19.6	1.0	0.10	5	0.61
Leiognathidae	7-55	17.7	52.3	5.41	176	21.62
Lethrinidae	17-43	22.9	11.2	1.16	28	3.44
Monacanthidae	14-88	32.1	62.6	6.47	22	2.70
Mugiloididae	38	38.0	0.7	0.07	13	1.60
Mullidae	21-35	27.2	4.9	0.51	13	1.60
Ostraciidae	12	12.0	1.1	0.11	1	0.12
Paralichthyidae	26-79	57.2	21.3	2.20	5	0.61
Platycephalidae	22-170	46.5	149.1	15.41	33	4.05
Scorpaenidae	15-36	25.0	20.4	2.11	26	3.19
Serranidae	38-84	56.4	58.5	6.05	8	0.98
Siganidae	21-52	26.8	27.1	2.80	56	6.88
Sillaginidae	21-28	21.4	0.6	0.06	5	0.61
Soleidae	50-77	63.5	10.7	1.11	2	0.25
Sphyraenidae	51	51.0	0.8	0.08	1	0.12
Syngnathidae	98-116	104.3	4.2	0.43	6	0.74
Synodontidae	30-32	31.0	0.4	0.04	2	0.25
Taeniodidae	27	27.0	0.4	0.04	3	0.37
Teraponidae	13-69	33.1	365.2	37.74	175	21.50
Tetraodontidae	12-64	19.6	67.3	6.96	66	8.11
Triacanthidae	11-22	18.5	1.6	0.17	6	0.74
TOTAL	-	**36.0**	**966.6**		**823**	

Sixty-five fish species from 35 families were identified from the beam trawl catches during the survey, and are listed along with arbitrary abundance classifications of rare (less than ten individuals = R), common (between ten and 100 individuals = C) and abundant (more than 100 individuals = A) (Table 6). Abundance classifications from Jones and Derbyshire (1988) and site classifications from Watson and Goeden (1989) are also shown (Table 6) as a comparison of the occurrence of fish species in our beam trawl samples with that in demersal trawl samples on adjacent commercial prawn fishing grounds.

Of the 65 fish species caught in beam trawls on seagrass beds between Cairns and Bowen, 28 species (43%) also occurred in demersal trawl samples on adjacent commercial prawn fishing grounds (Jones and Derbyshire 1988). Five species, including the ponyfish *(Leiognathus splendens)*, goatfish *(Upeneus* c.f. *tragula)*, flathead *(Inegocia lsacanthus)*, scorpionfish *(Paracentropogon longispinus)* and trumpeter *(Pelates quadrilineatus)* were classified as at least common in both beam trawl samples on seagrasses and demersal trawl samples on commercial trawl grounds (Table 6). Four species, *Yongelchthys criniger* (Gobiidae), *Parapercis cylindrica* (Mugiloididae), *Siganus fuscescens* (Siganidae) and *Pelates quadrilineatus* (Teraponidae), from beam trawl samples occur in a checklist of fishes of the Great Barrier Reef Marine Park, Capricornia Section (Russell, 1983).

Seventeen species of crabs from five families occurred in beam trawl samples. Most numerous was the blue-legged swimmer crab *(Portunus pelagicus)* (Table 7). This species is also common in demersal trawls on commercial prawn fishing grounds in this region (Jones and Derbyshire, 1988).

Table 6. Fish species identified in beam trawl catches from seagrass beds between Cairns and Bowen. Abundances in beam trawl samples and demersal trawl samples on adjacent commercial prawn fishing grounds (see zones 1, 2 and 3 in Watson and Goeden (in press)) are allocated for each species.

	Abundance classification in beam trawl samples[1]	Abundance classification in demersal trawl samples with site classification[2]
AMBASSIDAE		
Ambassis gymnocephalus	R	-
ANTENNARIIDAE		
Tathicarpus butleri	R	C 1, 2, 3, 2/3
APOGONIDAE		
Apogon nigripinnis	R	C 1, 2, 3, 2/3
Apogon sp.		R -
Siphamia roseigaster	R	-
ATHERINIDAE		
Atherinomorous endrachtensis	C	-
Atherinomorous lacunosus	R	-
Atherinomorous ogilbyi	R	-
BELONIDAE		
Strongylura strongylura	R	-
BLENNIIDAE		
Petroscirtes variabilis	R	-
CALLIONYMIDAE		
Repomuscenus belcheri	R	A 1, 2, 2/3
CHAETODONTIDAE		
Chaetodontidae sp.	R	-
CYNOGLOSSIDAE		
Cynoglossus puncticeps	R	-
Cynoglossus sp.		R -
ENGRAULIDIDAE		
Engraulididae larvae	C	-
Engraulididae sp.		C -
Stolephorus sp.		R -
GERREIDAE		
Gerres ovatus		R -

	Abundance classification in beam trawl samples[1]	Abundance classification in demersal trawl samples with site classification[2]
GOBIIDAE		
Gobiidae sp.1		R R 1
Gnatholepis sp.		R -
Cryptocentrus sp.	R	-
Gobiidae sp.		R -
Yongeichthys criniger	C	R 1*
AEMULIDAE		
Pomadasys kaakan	R	-
Pomadasys maculatus	R	C 1, 2
Pomadasys sp.		R -
HEMIRAMPHIDAE		
Hemiramphidae sp.	C	-
Hyporhampus australis	R	-
LABRIDAE		
Choerodon sp.1		R A1,2,3
LEIOGNATHIDAE		
Gazza minuta		R R 1
Leiognathus decorus	C	R 1
Leiognathus splendens	C	A 1, 2
Leiognathus sp.		A -
Secutor ruconius	R	R 1
LETHRINIDAE		
Lethrinus sp.		C -
MONACANTHIDAE		
Monacanthus chinensis	R	-
Paramonacanthus sp.1	C	R 1, 2
MUGILOIDIDAE		
Parapercis cylindrica	R	-*
MULLIDAE		
Upeneus c.f. *tragula*	C	A 1, 2, 3
Upeneus sp.		R -
OSTRACIIDAE		
Rhyncostracion nasus	R	C 1, 2, 3
PARALICHTHYIDAE		
Pseudorhombus elevatus	R	A 1, 2, 3
Pseudorhombus jenynsii	R	-
PLATYCEPHALIDAE		
Cymbacephalus nematophthalmus	C	R 1, 2
Inegocia lsacanthus	C	A 1, 2, 3
Suggrundus sp.		R -

	Abundance classification in beam trawl samples[1]	Abundance classification in demersal trawl samples with site classification[2]
SCORPAENIDAE		
Paracentropogon longispinus	C	A 1, 2, 3
Scorpaenidae sp.1	R	-
SERRANIDAE		
Centrogenys vaigiensis	R	R 1
Epinephalus sexfasciatus	R	C 1, 2, 3
SIGANIDAE		
Siganus canaliculatus	C	-
Siganus fuscescens	R	C 1, 2, 2/3 *
Siganus sp.		R -
SILLAGINIDAE		
Sillago sp.		R -
SOLEIDAE		
Dexillichthys muelleri	R	R 1
SPHYRAENIDAE		
Sphyraena sp.		R -
SYNGNATHIDAE		
Bombonia spicifer	R	-
SYNODONTIDAE		
Saurida sp.1		R R 1
Synodontidae larvae	R	-
TAENIODIDAE		
Crenotrypauchen microcephalus	R	-
TERAPONIDAE		
Pelates quadrilineatus	A	C 1, 2 *
Pelates sexlineatus	C	R 1, 2
Terapon puta		R R 1
TETRAODONTIDAE		
Arothron immaculatus	C	R 1
TRIACANTHIDAE		
Trixiphichthys weberi	R	R 1, 2

1. Abundances of species from beam trawl samples are classified as: rare (R), less than ten individuals; common (C), between ten and 100 individuals; abundant (A), more than 100 individuals.

2. Abundances of species from demersal trawl samples are classified as: rare (R), less than 100 individuals; common (C), between 100 and 1 000 individuals; abundant (A), more than 1 000 individuals. (After Jones and Derbyshire 1988). Site classifications; "coastal" (1); "inshore" (2), "inter-reef" (3); "transitional" between "inshore" and "inter-reef" (2/3), (from Watson and Goeden 1989).

* Present in the Capricorn-Bunker group of the Great Barrier Reef (Russell 1983).

Table 7. Crab species identified in trawl catches from seagrass beds between Cairns and Bowen.

Family	Common Name	Species	Number of Crabs
CALAPPIDAE	Box crabs	*Mutata lunaris*	3
DORIPPIDAE	Crabs	*Dorippe australiensis*	4
		Dorippe frascone	1
MAJIDAE	Spider crabs	*Paramithrax barbicornis*	1
		Hyastenus diacanthus	6
		Hyastenus oryx	17
PARTHENOPIDAE	Crabs	*Parthenope contrarius*	4
PORTUNIDAE	Swimming crabs	*Charybdis anisodon*	4
		c.f. *Charybdis* sp.	1
		Portunus brockii	1
		Portunus hastatoides	8
		Portunus pelagicus	69
		Portunus sp.1	4
		Thalamita anomala	1
		Thalamita sp.1	1
		Thalamita sp.2	3
		Thalamita sp.	4

General

Information on seagrasses, prawns, fish and crabs for each location where beam trawls were conducted (Table 8) was analysed using a Shannon-Wiener diversity index to compare the complexity of prawn, fish and crab communities from different seagrass habitats. Fish species numbers and diversities were highest at Hinchinbrook Channel, Bowling Green Bay and Upstart Bay (Table 8). Samples from Hinchinbrook Channel also had the highest crab species diversity. Regardless of above-ground seagrass biomass on the trawl site, prawn, fish and crab species numbers and diversities were generally high. Prawns were numerous in both small seagrass biomass habitats and large seagrass biomass habitats (Table 8).

DISCUSSION

Seagrasses

Halodule uninervis and *H. pinifolia*, both considered pioneering species which colonize bare substrates (den Hartog 1970), were the most commonly observed seagrasses between Cairns and Bowen. In other coastal surveys north and south of this region, *H. uninervis* was also present in most major areas where seagrass was found (Coles *et al.* 1985c, Coles *et al.* 1987a).

All of the species found in this survey occurred in other surveys north and south of this region (Coles *et al.* 1987a, Coles *et al.* 1987b). None of the species showed any apparent limitations in latitudinal distribution within this region. Seagrasses in this area were most common in sheltered bays and behind islands, and occurred only below MSL. Although seagrasses were found to depths of about 17 m, the average depth of

occurrence for any species was between 1 m and 5 m below MSL. Seagrasses were only found in water deeper than 5 m around islands where the water was relatively clear. Where there was high turbidity inshore, seagrasses were restricted to shallow areas. The depth distribution, and therefore spatial distribution, of seagrasses in these tropical waters thus appear to be limited by turbidity. The distribution limits of large seagrass beds in Florida are controlled nearshore primarily by increased water turbidity and lower salinity around river mouths and offshore by attenuation of photosynthetically active radiation at depth (Iverson and Bittaker, 1986). Activities which significantly increase water turbidities in the long-term should be minimised if reduction in the extent of deeper water seagrass in north Queensland waters is not to occur.

Table 8. Above-ground seagrass biomass, prawn catches and diversity and fish and crab species numbers and diversity from beam trawl samples over seagrass beds from Cairns to Bowen.

Site	Seagrass Biomass g/m²	Prawns/ Hour Trawled	Prawn Species Diversity (H)	Number of Fish Species	Fish Species Diversity (H)	Number of Crab Species	Crab Species Diversity (H)	Prawn Fish Crab Diversity (H)
Mission Bay	0.4	60	0.52	10	1.75	1	0.00	3.10
Mourilyan Harbour	0.4	242	1.69	14	2.01	5	1.56	2.73
Hinchinbrook Chl.	2.2	135	1.53	26	2.32	10	2.08	3.92
Magnetic Island	0.2	284	1.41	10	1.83	2	0.67	2.53
Cleveland Bay	7.99	52	1.81	9	1.78	4	1.24	2.73
Bowling Green Bay	*	452	1.87	21	2.83	9	1.68	2.98
Upstart Bay	28.2	420	1.32	21	2.20	5	1.52	3.54
Abbot Bay	*	21	1.48	15	1.92	8	1.55	4.19

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.

Very little is understood about what factors cause a particular species or group of species to dominate an area. For example, it is difficult to explain why *H. pinifolia* was the most abundant species in Mission Bay near Cairns, whilst in Cleveland Bay, near Townsville, a similar shape and type of bay, *C. serrulata* predominated, and in Upstart Bay, near Home Hill, *H. spinulosa, Z. capricorni* and *H. uninervis* all grew in dense stands. *H. tricostata* was generally found in clear water 10-20 m deep near islands. In this survey it was observed for the first time at coastal locations in Upstart Bay and Hinchinbrook Channel.

Specimens identified as *H. tricostata* include plants of two distinct morphological types. One type conforms to the descriptions of Greenway (1979) and Lanyon (1986). The second type forms a low profile mat, sometimes with a dense cover. The two types can be distinguished by differences in the shape of the leaf margins and the number of leaf nodes and whorls per shoot. *Halophila tricostata* (Greenway) has distinctly serrate leaf margins and at least five leaf nodes or leaf whorls per shoot. The low profile

morphology has a relatively smooth leaf margin with very few, minute serrations, and has only one node and leaf whorl per shoot. It is possible that the morph with few leaf nodes and few leaf margin serrations represents young plants of the species described as *H. tricostata*. Further collections of the two morph types are required to clarify the significance of these differences.

A *Halophila* plant, from Magnetic Island and Cape Edgecumbe, had elongate leaves and could not be identified to species level. Variations in morphologies of *Halophila* species present taxonomic problems and a reasonable explanation for this awaits further collections and the revision of the *Halophila ovalis* group.

The preferred environmental conditions and the range of conditions acceptable to survival differed between seagrass species. The pioneering species *H. uninervis, H. pinifolia, H. ovalis* and *H. ovata*, for example, had wide depth ranges, occurred in both sheltered and exposed sites, and were found on both muddy and sandy substrates. *Halophila decipiens, H. tricostata* and *H. spinulosa* which have delicate morphologies, also occurred in a wide range of depths, but always below intertidal levels and in areas sheltered from heavy wave action. *Syringodium isoetifolium* was in this survey restricted to depths below -1 m and to sheltered water with low turbidity.

The three broad-leafed species, *Z. capricorni, T. hemprichii* and *C. rotundata* were generally found in sheltered shallow waters and restricted to depths of less than 4 m. These species may require particular light wavelengths which are attenuated at depths greater than 4 m.

The pioneering or colonizing species *H. uninervis, H. pinifolia, H. ovalis* and *H. ovata* occurred at the most sites in this survey. They are very small seagrasses and they rarely produced stands of high biomass. In some areas the wide-leafed *H. uninervis* produced beds of high biomass per unit area. The other broad-leafed seagrasses, *Z. capricorni* in particular, produced the highest biomasses but were not as commonly found. Seagrass beds of high biomass per unit area, although not common, were usually extensive in area, covering many hectares, such as at Mission Bay, Cleveland Bay, Magnetic Island, Upstart Bay and Edgecumbe Bay.

In some large bays such as Halifax Bay, Bowling Green Bay and Upstart Bay, diver observations revealed very patchy but extensive distributions of very low density seagrasses (less than 1% cover), particularly for *H. ovalis* and *H. decipiens*. At such low densities the seagrass is difficult to find in turbid water and it is possible that the distribution of those seagrasses may be more consistent than was revealed by the dive survey. In a current Queensland Department of Primary Industries study at Fitzroy Island, near Cairns *Halophila tricostata and H. decipiens* display marked seasonal blooms in deep, clear water. The timing and extent of these blooms is little understood and we should consider the possible role that these seagrasses play in the ecology of marine fauna such as prawns, fish, turtles and dugong.

Our survey was conducted once only during October and November (late spring) and whilst identifying areas of seagrass habitat, does not provide a measure of seasonal change in the growth and distribution of seagrasses in the region. Our other surveys of seagrass beds between Cairns and Cape York, north of this region, have recorded marked seasonal decreases in seagrass biomass from summer to winter. An extraordinary lack of information on seasonal variability of seagrasses and associated faunal communities makes assessment of the value of these habitats difficult. The impacts on marine fauna from natural long-term changes and from large-scale damage to seagrass beds caused by cyclones or floods also merit investigation.

The maps generated from this survey identify seagrass habitat areas and are essential information for use by management in zoning and protecting important areas. More information is required on the nature of temporal changes in tropical seagrass habitats and their associated faunal populations to fully assess the implications these factors have on management of seagrass habitat. Information on the distribution and importance of deep water and reef-platform seagrasses is also needed.

Prawns

The four commercial penaeid species which were common in this survey (*P. esculentus, P. semisulcatus, P. latisulcatus* and *M. endeavouri*) also occurred commonly on seagrass beds north and south of this region (Coles *et al.* 1987a, Coles *et al.* 1987b). Brown tiger (*P. esculentus*) and endeavour prawns (*M. endeavouri*), the two most common species in beam trawl catches during this survey, are also two of the

most common species in the night-time commercial trawl fishery in this region (Coles *et al.* 1985a, Gribble and Dredge 1989). The false endeavour prawn (*M. ensis*) was caught in very low numbers in this survey and was not found in a survey of the coast south of Bowen (Coles *et al.* 1987a), but forms a substantial portion of commercial prawn catches between Mackay in the south to Cape York in the north. Three other commercially important species caught in tropical Queensland waters: *P. merguiensis, P. longistylis* and *P. monodon*; did not occur in beam trawl samples on seagrass beds in this region. The banana prawn (*P. merguiensis*) and leader prawn (*P. monodon*) are not normally found on seagrass beds as juveniles, but juvenile red-spot king prawns (*P. longistylis*) have previously been collected on seagrass beds in the Escape River and on Wizard Reef in far northern Queensland (Coles *et al.* 1987b), and at Shaw Island in the central coast (Coles *et al.* 1987c).

Coral prawns (*Parapenaeopsis* spp.), velvet prawns (*Metapenaeopsis* spp.) and rough prawns (*Trachypenaeus* spp.) were not as common as commercial prawn species on seagrass beds in this survey. However, these prawns have been caught in large numbers during other Queensland Department of Primary Industries surveys on both seagrass covered and bare substrates (R. Coles, unpublished data).

The timing of the peak abundance of juvenile commercial prawn species on seagrass beds may vary between species and between regions (Coles and Lee Long 1985; Coles *et al.* 1985a). Patterns of species composition and prawn abundance and distribution depicted in this survey will therefore be different to those obtained at different times of the year.

Seagrass beds at Upstart Bay supported the highest densities of juvenile commercial penaeid prawns. Seagrass beds at Magnetic Island and Hinchinbrook Channel also supported high densities of juvenile commercial penaeid prawns. Catch rates of juvenile commercial prawns appear to be generally high in areas where seagrass density is high, although penaeid prawns can also be very common in low-density seagrass beds. Between Cairns and Bowen, almost all seagrass beds with more than 10% bottom cover supported populations of juvenile commercial penaeid prawns and can therefore be considered important to sustaining fisheries stocks of these species.

Because few formal studies have investigated the variety of factors which can influence survival of juvenile prawns in seagrass beds, there remains little explanation for why particular seagrass beds along this coast support greater populations of juvenile prawns than others. Although some seagrass species, by their leaf shape and biological characteristics may be more favourable to juvenile prawn survival than others, it appears that between Cairns and Bowen other factors override these. The affect of predators, competitors, food, shelter and behaviour on distribution and abundance of animals such as juvenile prawns in seagrass beds has received some attention in the recent literature (Howard *et al.* 1989). Quality and quantity of food and shelter offered in seagrass beds may be two important factors which favour survival of juvenile prawns, yet these factors have received little attention in ecological studies.

Fish

Results from beam trawl samples suggest that the fish assemblages in seagrass beds between Cairns and Bowen are characterised by high species number and species diversities. The number of fish species and species diversity in beam trawl catches during this survey are comparable to those from a similar survey between Bowen and Water Park Point, which caught seventy-six fish species in thirty-nine families (Coles *et al.* 1987c). The number of fish species from a single site ranged from nine in Cleveland Bay to twenty-six in Hinchinbrook Channel. Numbers of fish species sampled by beam trawling on other tropical seagrass beds are comparable. Sheridan and Livingstone (1983) collected twenty-three species of fish, mostly juveniles, in one year of monthly trawls on a *Halodule wrightii* meadow in Apachicola Bay, Florida. Yanez -Arancibia (1981) recorded thirty-one fish species, mostly transients on *Thalassia testudinum* beds in Puerto Real Inlet, Mexico. It should be noted that beam trawling does not provide completely representative samples of the fish fauna associated with seagrass beds. Larger and more motile species can be sampled using seine and gill nets.

Fish obtained by beam trawl are usually slow, very small, or sedentary species. Some species from our samples are permanent residents of the seagrass beds. These include the burrowing species of goby (Gobiidae), the leatherjackets (Monacanthidae), some blennies (Blenniidae), frogfish (Antennariidae), waspfish (Scorpaenidae), small wrasse (Labridae), and pipefish (Syngnathidae) (Appendix 1).

Species of the Family Leiognathidae, which dominated numbers in our fish samples, are also common over

bare substrates inshore and on demersal trawl fishing grounds (Jones and Derbyshire, 1988). These very small fish are considered as "trash" fish in Australia. The trumpeter, *Pelates quadrilineatus* (Teraponidae), which was abundant in this survey, is also common in other seagrass habitats surveyed in Queensland waters and in some places is used as live bait.

Juveniles of fish species of commercial or recreational value, which as adults also inhabit areas other than seagrass beds, appeared in samples, but were less common, eg., grunters *(Pomadasys maculatus)*, rock cod *(Epinephalus sexfasciatus)* and flatfish *(Pseudorhombus jenynsii)*. The flathead, *Cymbacephalus nematophthalmus*, was the only fish species of commercial value which appeared frequently in beam trawl samples over seagrass beds in this region. Juvenile garfish, a food and bait fish, were common in our samples and were often seen under torch light in the upper water column over seagrass beds. Grant (1982) reported that the garfish *Hyporhampus ardelio* and *H. australis* used seagrass beds for food, shelter or spawning.

Of four fish species which occurred in both beam trawl samples from seagrass beds and a checklist of species from the Great Barrier Reef (Russell, 1983), none are of economic significance. Few of the seagrass beds sampled are adjacent to reefal habitats, therefore few reef fish species would be expected on these coastal seagrass beds. Utilization of reef-top seagrass beds by reef fishes has been reported from studies of beam trawl samples on Warrior Reef, Torres Strait (Derbyshire and Dennis, in press). A large proportion (43%) of the sixty-five fish species caught by beam trawls were recorded by Jones and Derbyshire (1988) from nearby demersal trawl grounds, but only five of these species were common in both areas (Table 6), and none of them are highly valued by commercial or recreational fishermen. Little is known about the biology and ecology of these species, and very few inferences can be made on the relationship between these populations.

To fully understand the importance of seagrass beds to marine fish populations, sampling programmes should address temporal changes in fish populations and determine the full range of species which utilize seagrass beds, including residents, transients, small grazers and large predators. Until more complete investigations of fish assemblages on seagrass beds are made, it is unclear of what potential importance populations of juvenile fish on seagrass beds are to adult stocks in nearby habitats.

Crabs

Swimmer crabs, in particular the blue-legged swimmer crab (*P. pelagicus*) were the dominant crab species in beam trawl catches in this survey. *P. pelagicus* is a species highly valued by commercial and recreational fishermen in southern Queensland, but on trawl grounds in the Great Barrier Reef region it rarely grows to commercial size and is of lesser importance.

The only major crab species of value to commercial fishermen in this region, *Scylla serrata* (mud crab), did not appear in our beam trawl samples. Most of the seventeen crab species caught between Cairns and Bowen were small and often cryptic species in the seagrass beds. Only three species in this survey were also found in beam trawl samples taken from the region south between Bowen and Water Park Point.

CONCLUSIONS

Maps of seagrass bed distribution and information on seagrass species and abundance provided here are the first extensive set of data on seagrass habitats between Cairns and Bowen, and form part of a series of similar reports for almost all Queensland coastal areas. The data are the results of single, systematic dive surveys inshore and around continental islands, in waters less than 20 m deep. Thirteen of the fourteen seagrass species recorded for Queensland waters were recorded in this survey. *Halodule uninervis, H. pinifolia, Halophila ovalis* and *H. decipiens* were the most commonly found species. *Zostera capricorni* and *H. spinulosa* had the highest above ground biomasses.

Seagrass beds occurred in areas which are sheltered from the south-east trade winds, eg., bays and lee sides of islands and peninsulas. Most seagrass beds in this region are in shallow water in the littoral and sub-littoral zones. Because high turbidities and lowered light levels can limit the growth and distribution of seagrass beds inshore, any activities or conditions which significantly increase water turbidities in the long-term should be minimised.

Large seagrass beds at Mission Bay, Hinchinbrook Channel, Cleveland Bay, Upstart Bay and Edgecumbe Bay all support large populations of juvenile commercial penaeid prawns. The importance of these particular seagrass beds to commercial prawn fisheries should be considered in management of coastal systems.

All seagrass beds in the region, regardless of complexity or density, supported populations of juvenile prawns, fish and crabs and therefore contribute to the maintenance of fisheries stocks of these species. Some overlap exists between the fish assemblages in seagrass, demersal trawl ground and reef habitats of the Great Barrier Reef.

Information from this survey is essential for management and conservation of seagrass habitat. More information is required on the nature of temporal changes in seagrasses and associated fauna and how these changes may affect management of these areas.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge operations and diving assistance provided by Glen Chisholm, Jane Mellors, Irena Zagorskis, and Yvette Beurteaux. Laboratory processing of seagrass and prawn samples was completed by Shirley Veronise and Bev Squire.

REFERENCES

Bell, J.D. and **Pollard, D.A.** (1989). Ecology of fish assemblages and fisheries associated with seagrasses. In: 'Biology of Seagrasses'. (Eds A.W.D. Larkum, A. J. McComb and S. A. Shepherd.) pp. 565-609. (Elsevier: Amsterdam, New York.)

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

Coles, R.G., Lee Long, W.J., Mellors, J.E. and **Goeden, G.B.** (1985a). An assessment of the 1985 Queensland east coast prawn trawling closure, Queensland Department of Primary Industries Fisheries Information Series QI85023. (Queensland Department of Primary Industries Fisheries: Brisbane.)

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

Coles, R.G., Lee Long, W.J. and **Squire, L.C.** (1985c). Seagrass beds and prawn nursery grounds between Cape York and Cairns, Queensland Department of Primary Industries Fisheries Information Series QI185017. (Queensland Department of Primary Industries: Brisbane.)

Coles, R.G., Mellors, J.E., Bibby, J.M. and **Squire, B.A.** (1987a). Seagrass beds and juvenile prawn nursery grounds between Bowen and Water Park Point, Queensland Department of Primary Industries Fisheries Information Series QI87021. (Queensland Department of Primary Industries: Brisbane.)

Coles, R.G., Lee Long, W.J., Squire, B.A., Squire, L.C. and **Bibby, J.M.** (1987b). Distribution of seagrasses and associated juvenile commercial penaeid prawns in north-eastern Queensland waters. *Australian Journal of Marine and Freshwater Research* **38,** 103-119.

Coles, R.G., Mellors, J.E., Bibby, J.M. Derbyshire, K., Squire, B.A., Squire, L.C. and **Lee Long, W.J.** (1987c). Distribution of seagrasses and associated juvenile commercial prawns and fish between Bowen and Water Park Point, a report to the Great Barrier Reef Marine Park Authority. (Queensland Department of Primary Industries: Brisbane.)

Coles, R.G., Poiner, I.R. and **Kirkman, H.** (1989). Regional studies - seagrasses of North-eastern Australia. In 'Biology of Seagrasses'. (Eds A.W.D. Larkum, A. J. McComb and S. A. Shepherd.) pp. 261-278. (Elsevier: Amsterdam, New York.)

Climatic Averages Australia - Meteorological Summary, July 1988. Bureau of Meteorology, Department of Administration Services, Australian Govternment Publication Service.

Derbyshire, K.J. and **Dennis, D.M.** (1990). Seagrass fish fauna and predation on juvenile prawns. In: 'Torres Strait prawn project: a review of research 1986-1988'. Queensland Department of Primary Industries Fisheries Information Series QI90018. (Ed. J. E. Mellors.) pp. 83-97. (Queensland Department of Primary Industries: Brisbane.)

Grant, E.M. (1982). 'Guide to Fishes', 5th Edition. (The Department of Harbours and Marine: Brisbane, Queensland.)
Greenway, M. (1979). *Halophila tricostata* (Hydrocharitaceae) a new species of seagrass from the Great Barrier Reef region. *Aquatic Botany* **7**, 67-70.
Gribble, N.A. and **Dredge, M.C.L.** (1989). Evaluation of the Seasonal Closure to Queensland's Northern and Central Prawn Fisheries, Queensland Department of Primary Industries Fisheries Information Series (in press). (Queensland Department of Primary Industries: Brisbane.)
Hartog, C. den (1970). 'The Seagrasses of the World. (North-Holland Publishing Company: Amsterdam.)
Howard, R.K., Edgar, G.J. and **Hutchings, P.A.** (1989). Faunal assemblages of seagrass beds. In: ' Biology of Seagrasses'. (Eds A.W.D. Larkum, A. J. McComb and S. A. Shepherd.) pp. 536-564. (Elsevier: Amsterdam, New York.)
Iverson, R.L. and **Bittaker, H.F.** (1986). Seagrass distribution and abundance in eastern Gulf of Mexico coastal waters. *Estuarine, Coastal, and Shelf Sci.ence* **2(5),** 577-602.
Jones, C.M. and **Derbyshire, K.J.** (1988). Sampling the demersal fauna from a commercial penaeid prawn fishery off the central Queensland coast. *Memorandums of the Queensland Museum* **25(2),** 403-415.
Lanyon, J. (1986). Seagrasses of the Great Barrier Reef, Great Barrier Reef Marine Park Authority Special Publication Series No. 3. (Great Barrier Reef Marine Park Authority: Townsville.)
Larkun, A.W.D.,McComb, S.J., and Shepherd, S.A. (1989). 'Biology of Seagrasses: A treatise on the biology of seagrass with special reference to the Australian region.' (Elsevier Science Publishing Company: Amsterdam, New York.)
Maxwell, W.G.H. (1968). 'Atlas of the Great Barrier Reef.' (Elsevier Publishing Company: Amsterdam, New York.) 258p.
McRoy, P. (1974). Seagrass productivity: carbon uptake experiments in eelgrass, *Zostera marina*. *Aquaculture* **4,** 131-137.
McRoy, C.P. and **Helfferich, C.** (1977). Seagrass ecosystems: A scientific perspective. *Marine Science Series* **4.** (Marcel Dekker Inc.)
Poiner, I.R., Staples, D.J: and **Kenyon, R.** (1987). Seagrass communities of the Gulf of Carpentaria, Australia. *Australia Journal of Marine and Freshwater Research* **38,** 121-133.
Russell, B.C. (1983). Annotated checklist of The Coral Reef Fishes in the Capricorn-Bunker Group Great Barrier Reef Australia, Great Barrier Reef Marine Park Authority Special Publication Series (1). Great Barrier Reef Marine Park Authority: Townsville.)
Sheridan, P.F. and **Livingstone, R.J.** (1983). Abundance and seasonality of infauna and epifauna inhabit Ing a *Halodule wrightii* meadow in Apalachicola Bay, Florida. *Estuaries* **4,** 407-419.
Walker, D.I. (1989) (Ed.). Methods for monitoring seagrass habitat, Report of workshop held on 20-22 June, 1988, Melbourne, Australia. VIMS Working Paper No. 18.
Watson, R.A. and **Goeden, G.** (1989). Temporal and spatial zonation of the demersal trawl fauna of the central Great Barrier Reef. *Memorandums of the Queensland Museum* **27(2),** 611-620.
Yanez-Arancibia, A. (1981). Ecological studies in Puerto Real Inlet, Laguna de Terminus, Mexico: Discus sion on the trophic structure of fish communities on *Thalassia testudinum*, in Coastal Lagoon Research, Present and Future, Proceedings of Seminar, Duke University marine Laboratory, Beaufort, NC, U.S.A., August 1978 (UNESCO, IABO). *UNESCO Tech.nical Papers in Marine Science* **33,** 191-231.
Zieman, J.C. (1975). Seasonal variation of turtlegrass, *Thalassia testudinum* (Konig), with reference to temperature and salinity effects. *Aquatic Botany* **2,** 107-123.

TAXONOMIC REFERENCES

Dall, W. (1957). A revision of the Australian species of Penaeidae (Crustacea:Decapoda:Penaeidae). *Australian Journal Marine Freshwater Research* **8,** 136-239.
Fisher, W. and **Bianchi, G.** (Eds) (1984). ' FAO Species Identification Sheets for Fishery Purposes: Western Indian Ocean Fishing Area 51.' (FAO: Rome.)
Gloerfelt-Tarp, T. and **Kailola, P.J.** (1985). 'Trawled Fishes of Southern Indonesia and north-western Australia' (ADAB, Australia; DGF, Indonesia; GTZ, Federal Republic of Germany).
Grant, E.M. (1982). 'Guide to Fishes.' (The Department of Harbours and Marine: Brisbane, Queensland).
Gray, D.L., Dall, W. and **Baker, A.** (1983). 'A Guide to the Australian Penaeid Prawns.' (Northern Territory Government Printing Office: Darwin, Australia.)

Hutchins, J.B. (1977). Descriptions of three new genera and eight new species of Monocanthid fishes from Australia. *Records of the Western Australian Museum* **8(1),** 3-57.

Johnson, C.R. (1971). Revision of the Callionymid Fishes referable to the Genus *Callionymus* from Australian waters. *Memoirs of the Queensland Museum* **16(1),** 103-140.

Jones, G. (1985). Revision of the Australian species of the fish family Lelognathidae. *Australia Journal Marine Freshwater Research* **36,** 559-613.

Lanyon, J. (1986). Guide to the identification of seagrass in the Great Barrier Reef Region. Great Barrier Reef Marine Park Authority Special Publications Series, **3.** (Great Barrier Reef Marine Park Authority: Townsville.) pp. 54.

Leis, J.M. and **Rennis, D.S.** (1981). 'The Larvae of Indo-Pacific Coral Reef Fishes.' (New South Wales University Press and University of Hawaii Press).

Lewis, A.D., Smith, B.R. and **Ellway, C.P.** (1983). 'A Guide to the Common Tuna Baitfishes of the South Pacific Commission Area. S.P.C. Handbook No. 23.'

Marshall, T.C. (1964). 'Fishes of the Great Barrier Reef and coastal waters of Queensland.' (Angus and Robertson: Australia).

Masuda, H., Araga, C. and **Yohino, J.** (1975). 'Coastal Fishes of Southern Japan.' (Tokai University Press: Japan).

Munro, I.S.R. (1967). 'The Fishes of New Guinea.' (Department of Agriculture, Stock and Fisheries: Port Moresby, New Guinea).

Russell, B.C. (1983). 'Annotated checklist of the Coral Reef Fishes in the Capricorn-Bunker Group, Great Barrier Reef, Australia.' Great Barrier Marine Park Authority Special Publications Series **1,** p. 184.

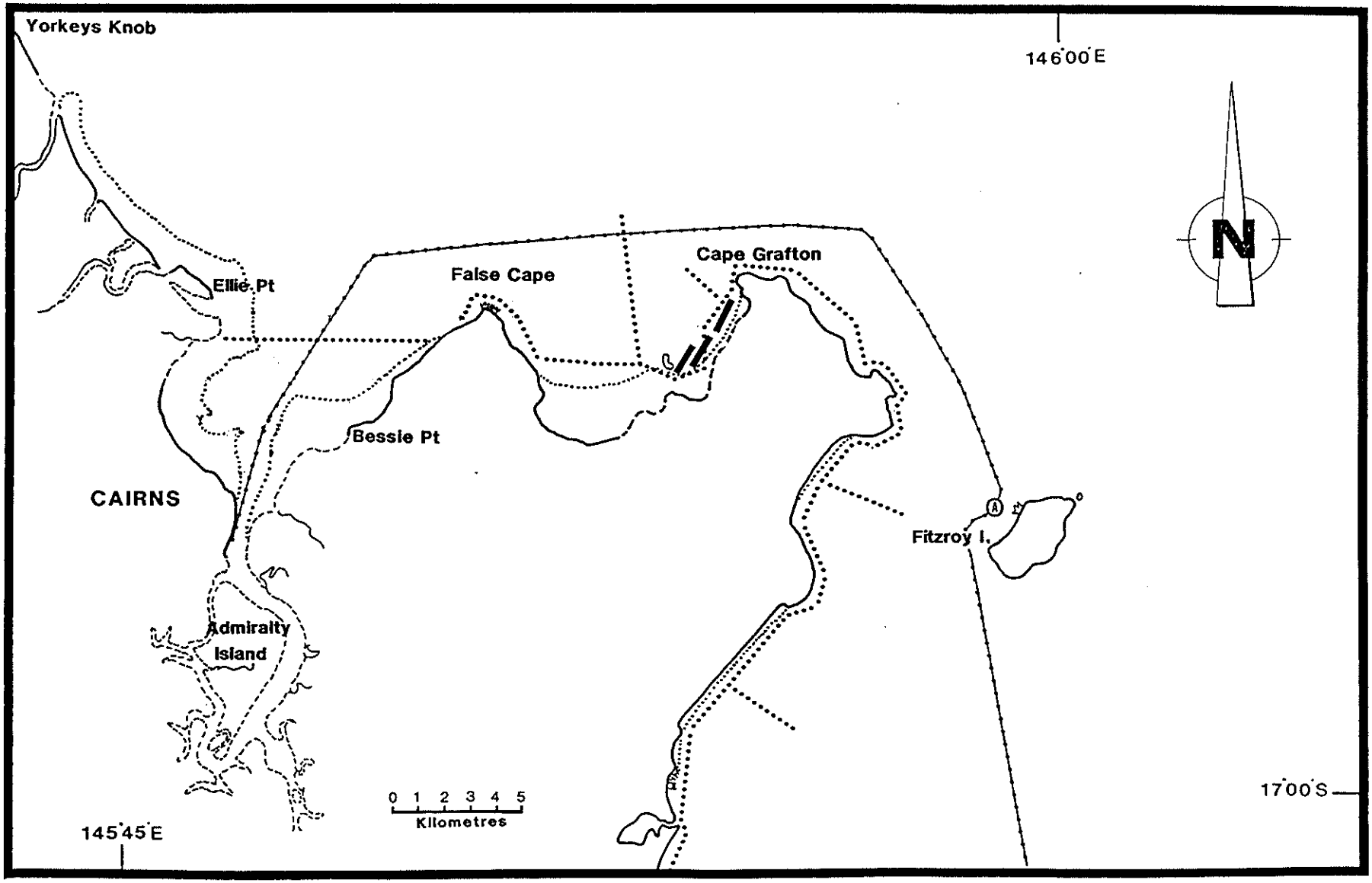
Whitehead, P.J.P. (1965). A review of the Elopid and Clupeoid fishes of the Red Sea and adjacent areas. *Bulletin British Museum (Natural History)* **12,** 227-281.

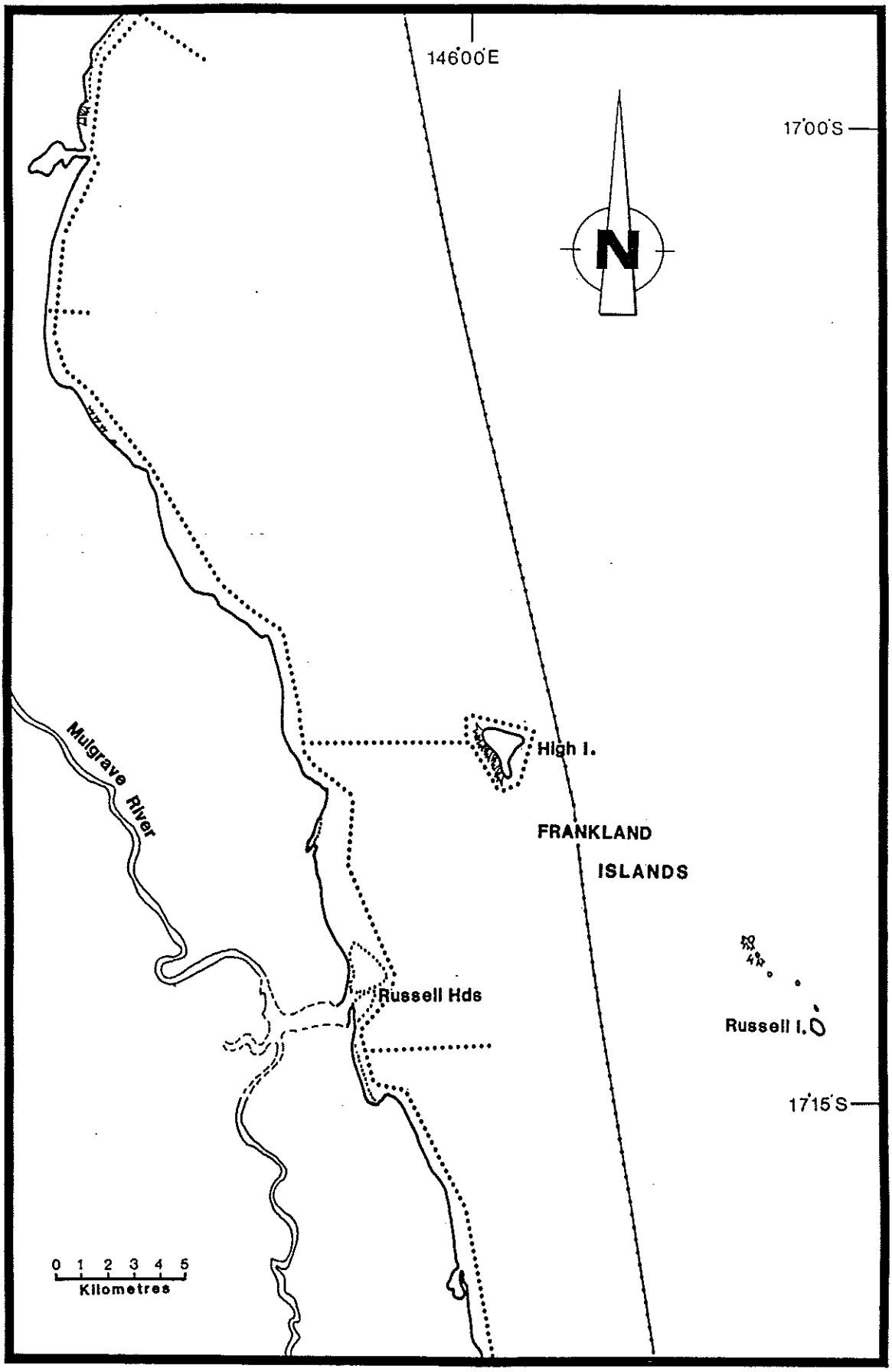
APPENDIX 1

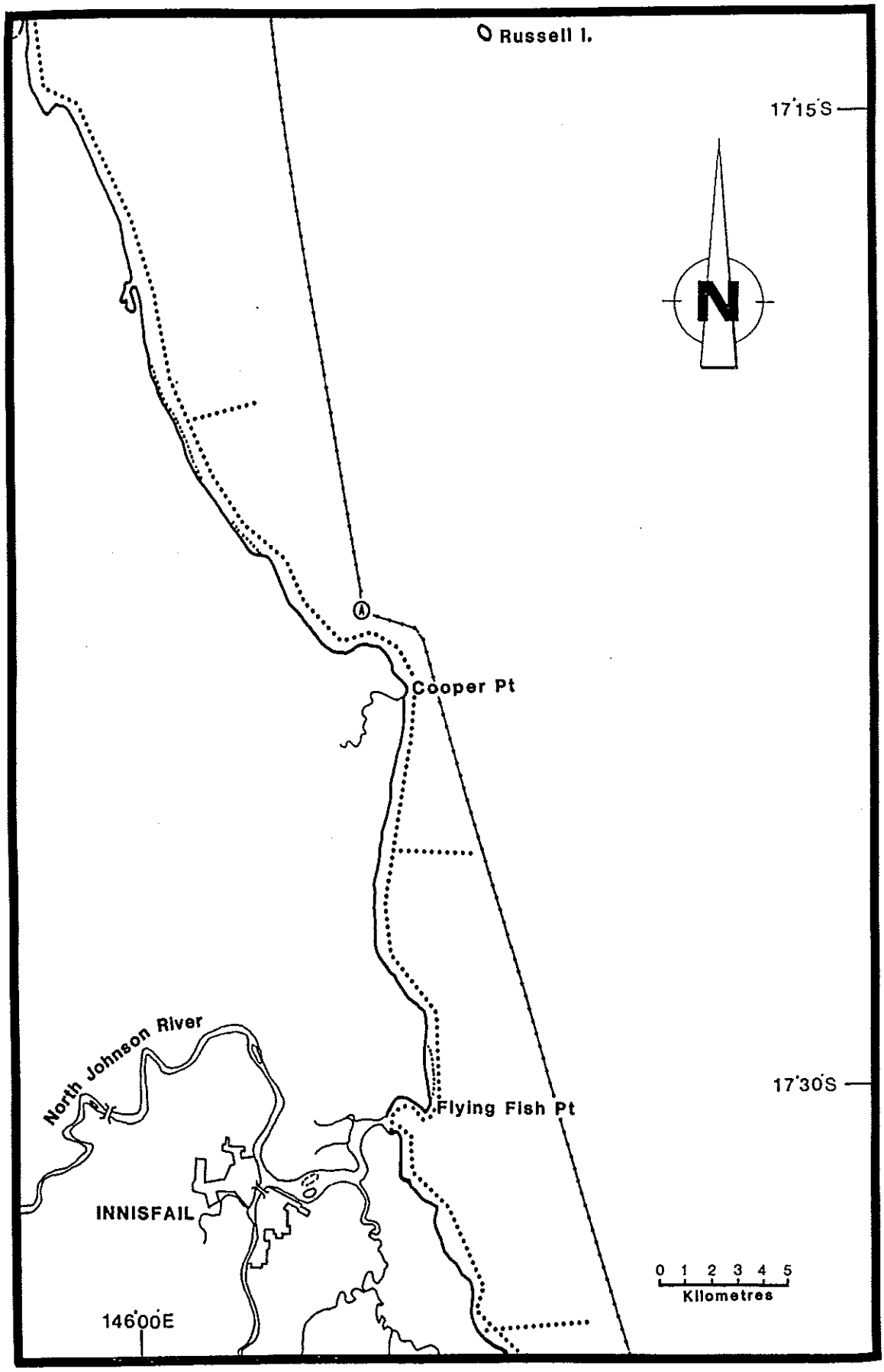
Tracks of research vessels and sites of beam trawl samples during the survey of coastal seagrass habitats between Water Park Point and Hervey Bay. The survey was conducted between the dates 25 October 1988 and 14 November 1988.

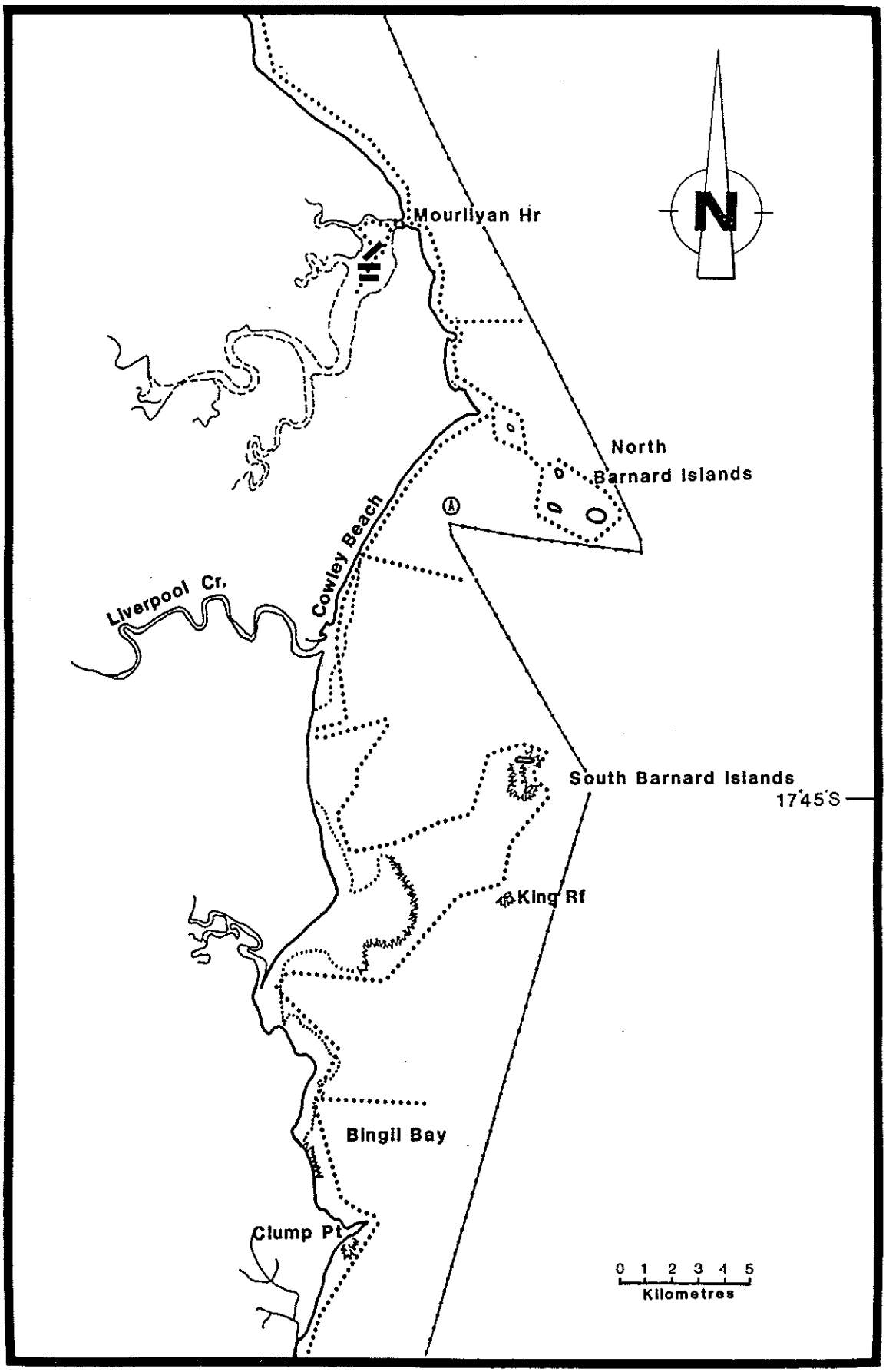
Map Legend

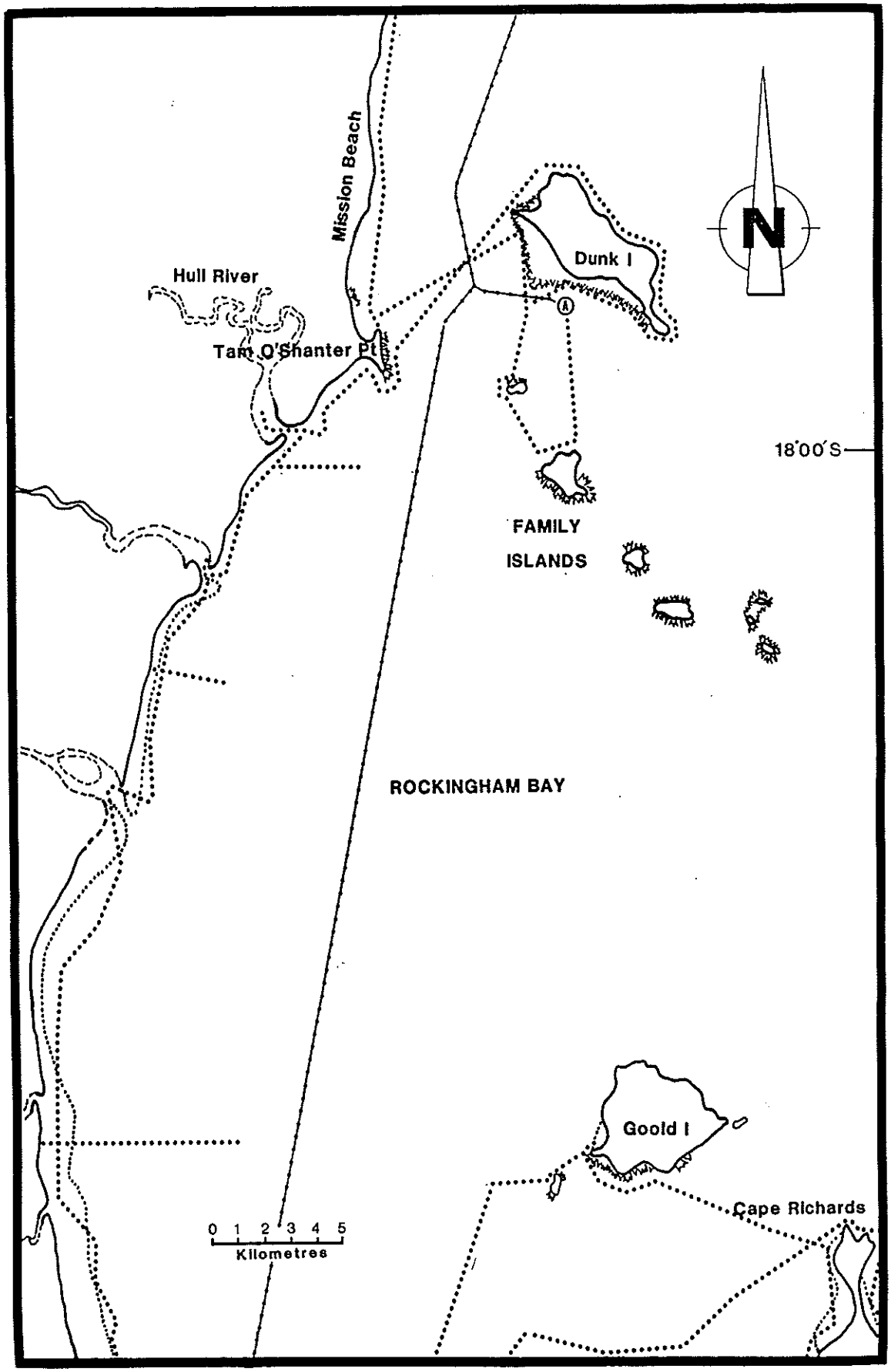
Course taken by the FRV "Gwendoline May"	-•-•-•-
Course taken by the FV "Tiger Star"	••••••••
Dingy tracks	——
Daily anchorages	Ⓐ
Sites trawled	*****

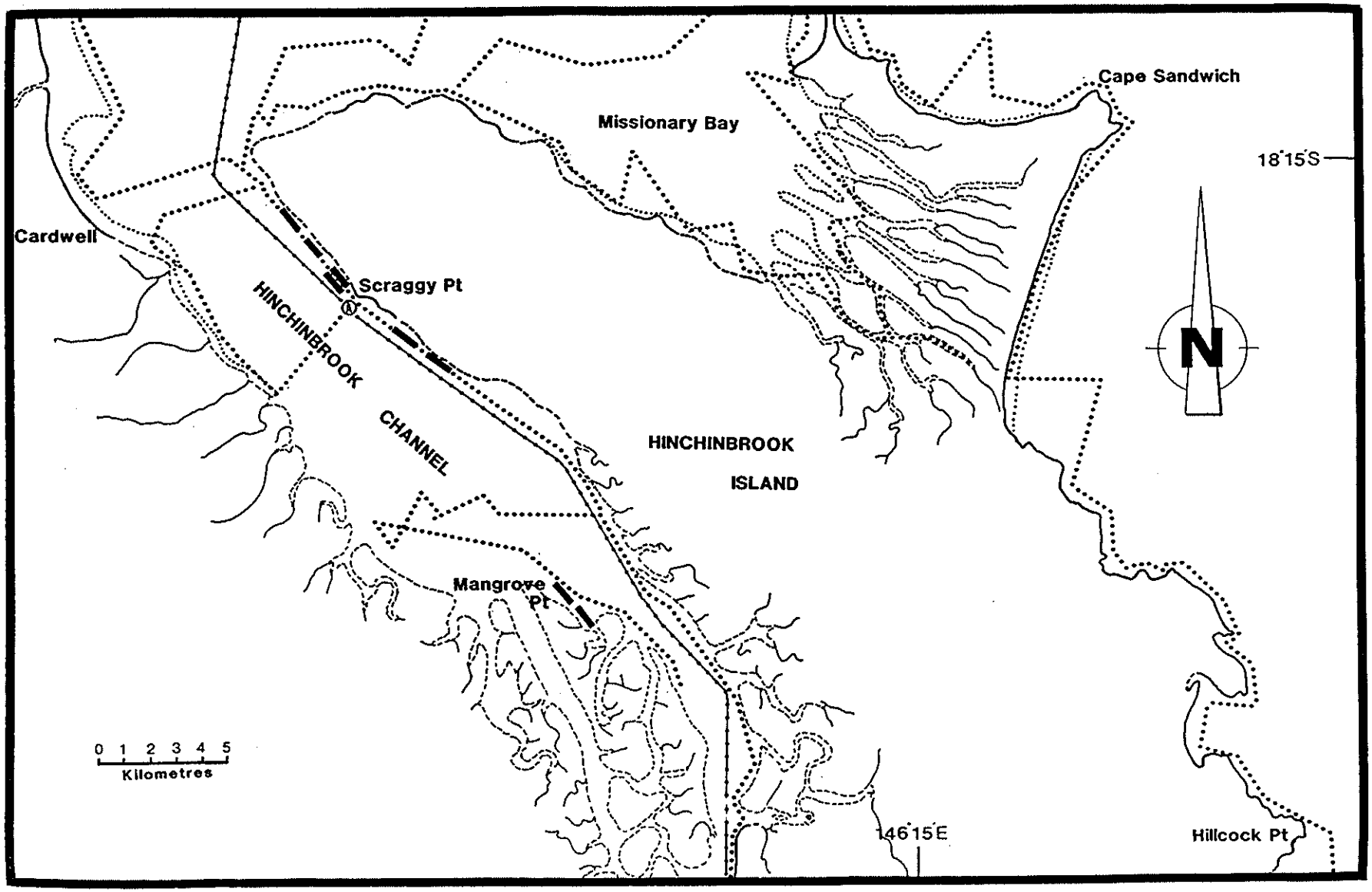

Yorkeys Knob
146°00'E
N
Ellie Pt
False Cape
Cape Grafton
Bessie Pt
CAIRNS
Fitzroy I.
Admiralty
Island
0 1 2 3 4 5
Kilometres
145°45'E
17°00'S

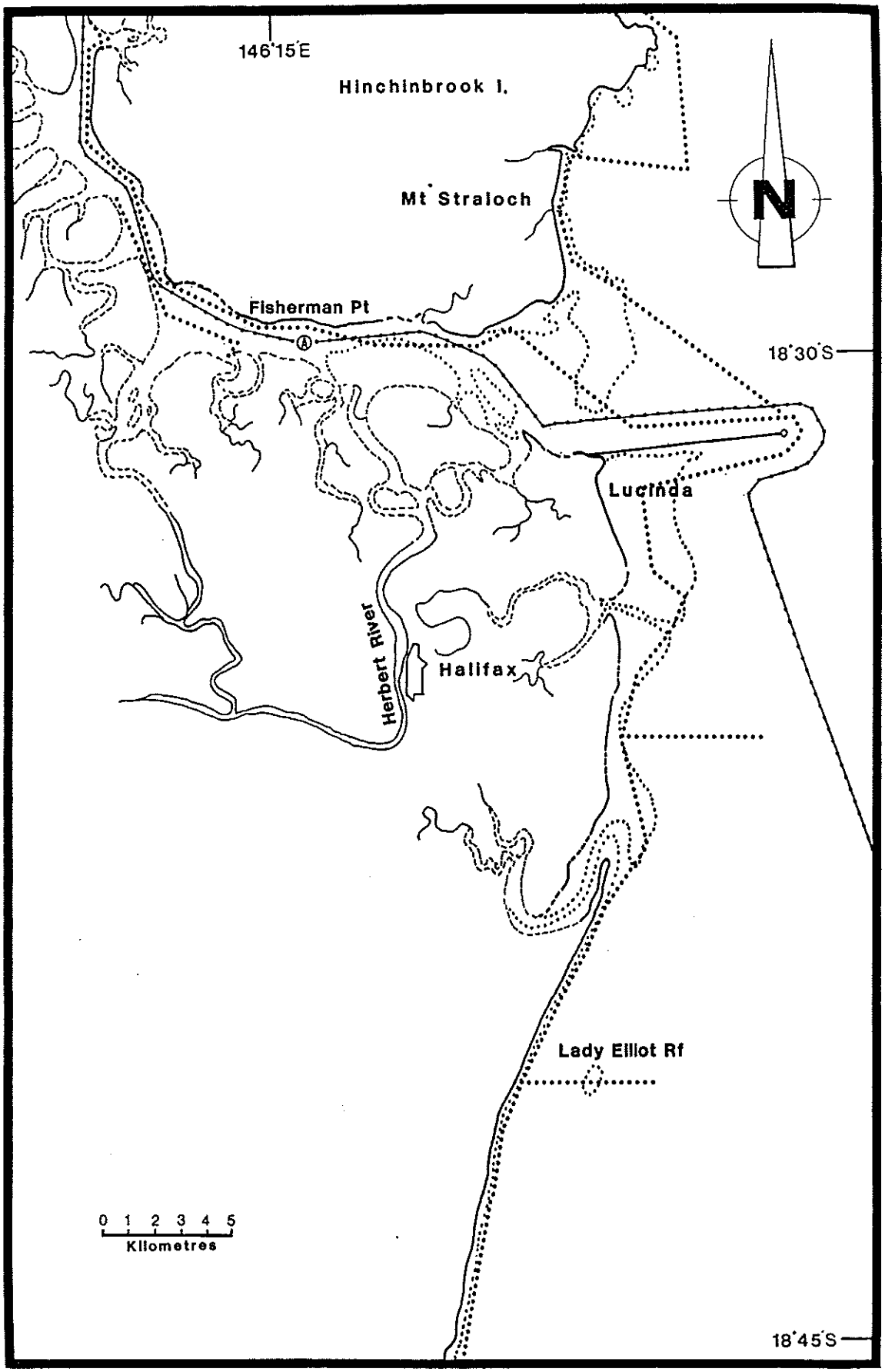

146°00'E
17°00'S
N
Mulgrave River
High I.
FRANKLAND
ISLANDS
Russell Hds
Russell I.
17°15'S
0 1 2 3 4 5
Kilometres

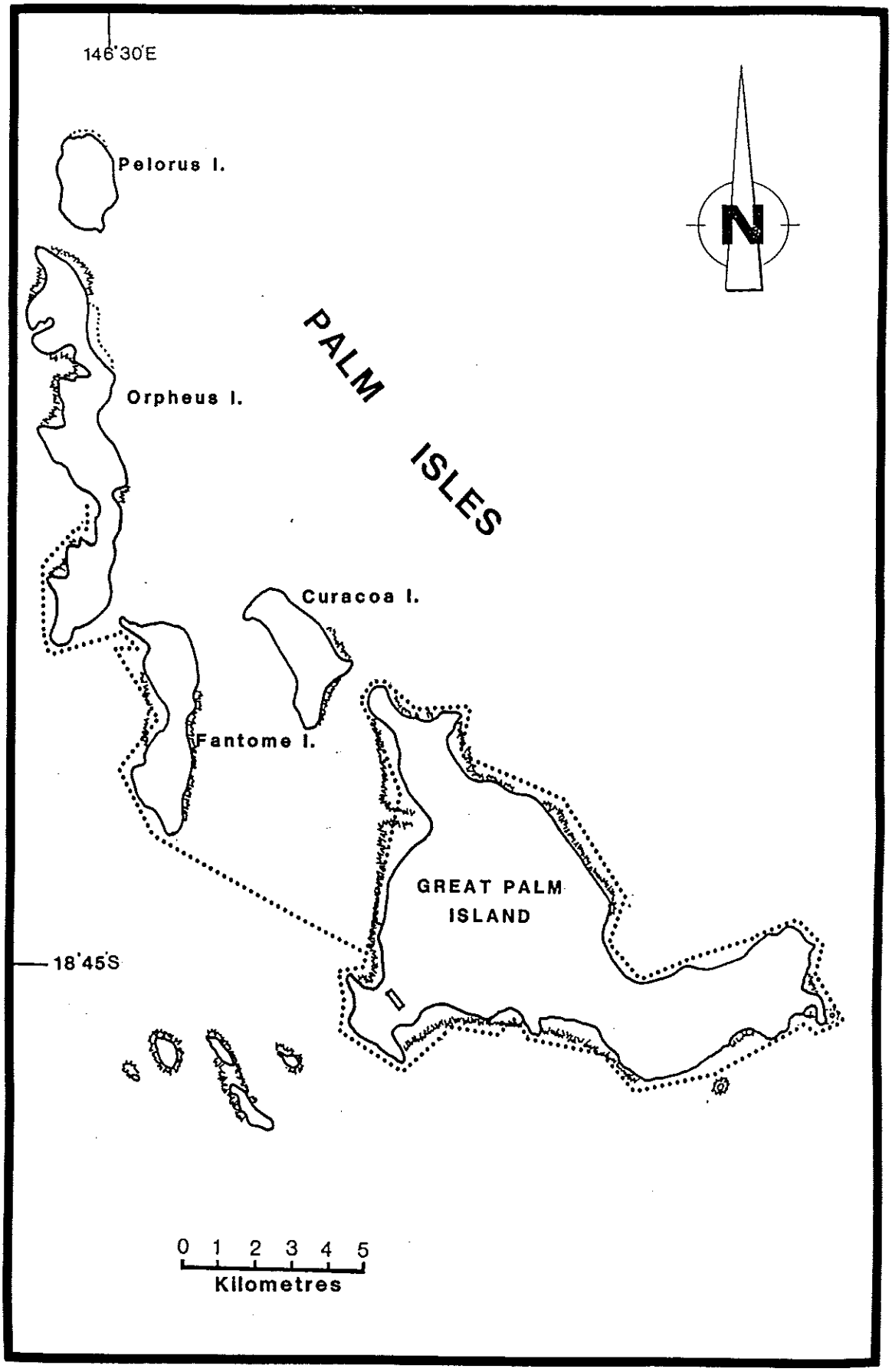

Russell I.
17°15'S
N
Cooper Pt
North Johnson River
17°30'S
Flying Fish Pt
INNISFAIL
0 1 2 3 4 5
Kilometres
146°00E

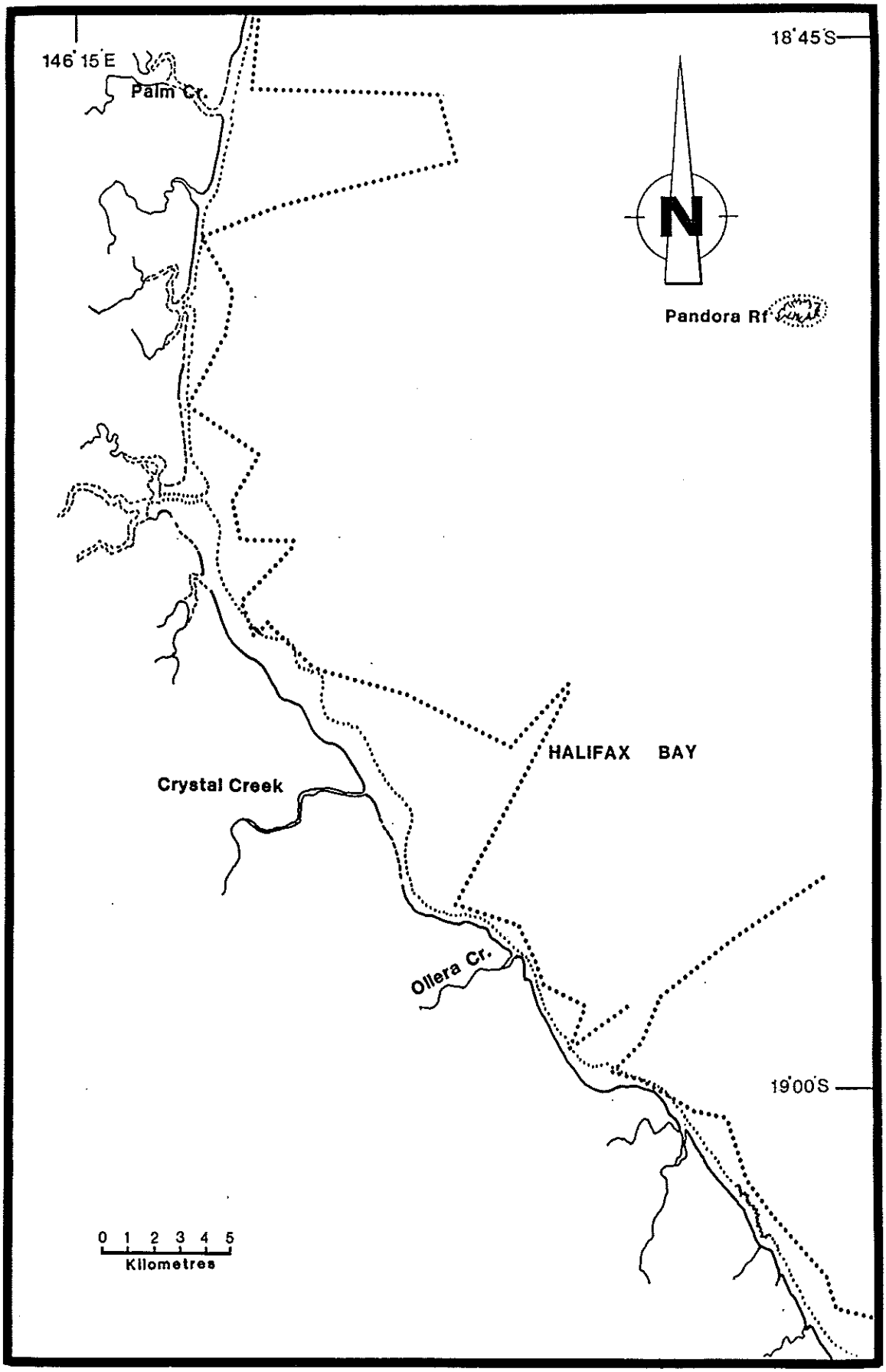

N
Mourilyan Hr
North
Barnard Islands
Cowley Beach
Liverpool Cr.
South Barnard Islands
17°45'S
King Rf
Bingil Bay
Clump Pt
0 1 2 3 4 5
Kilometres

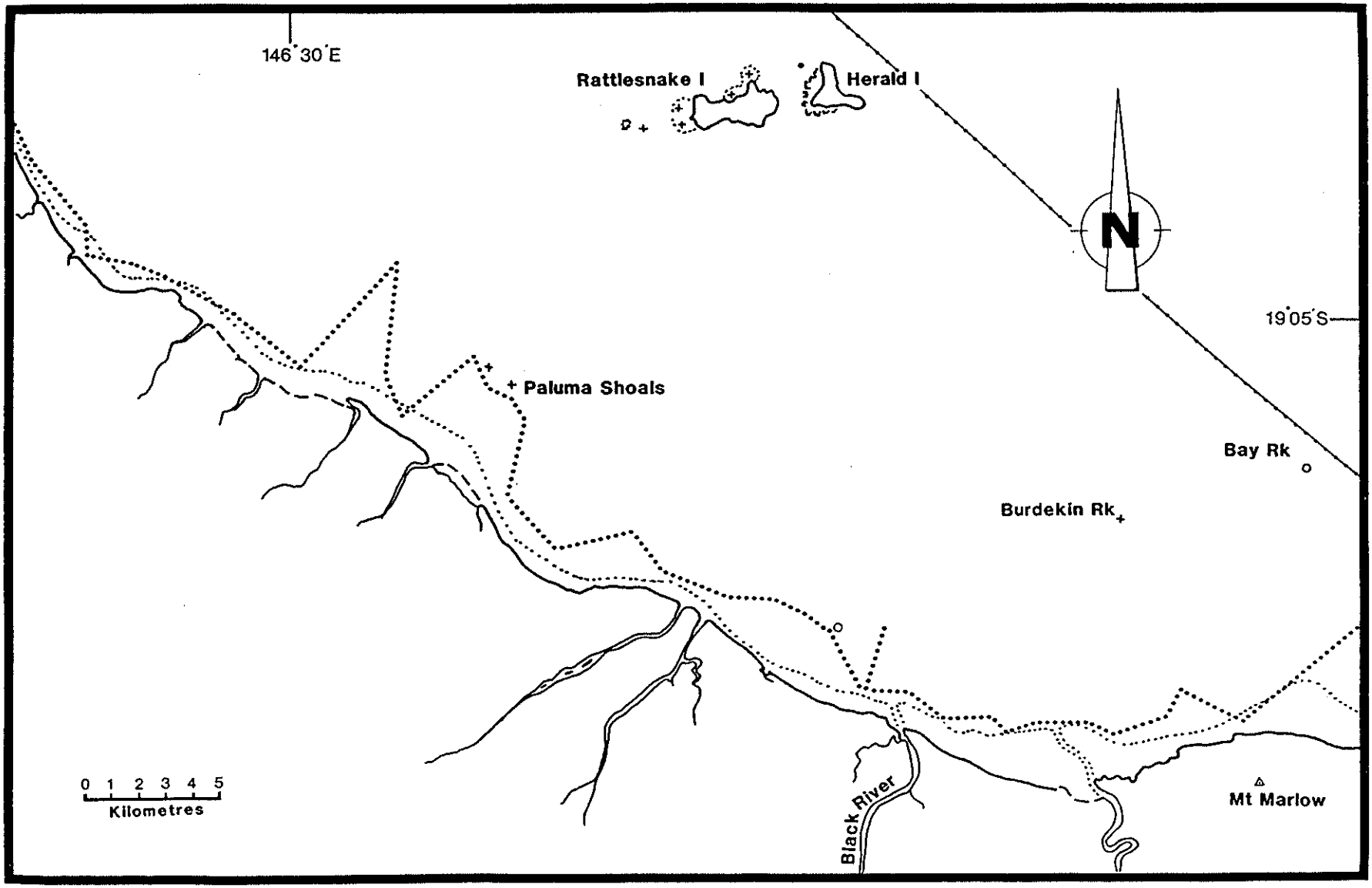

Mission Beach
Hull River
Tam O'Shanter Pt
Dunk I
N
18°00'S
FAMILY
ISLANDS
ROCKINGHAM BAY
Goold I
Cape Richards
0 1 2 3 4 5
Kilometres

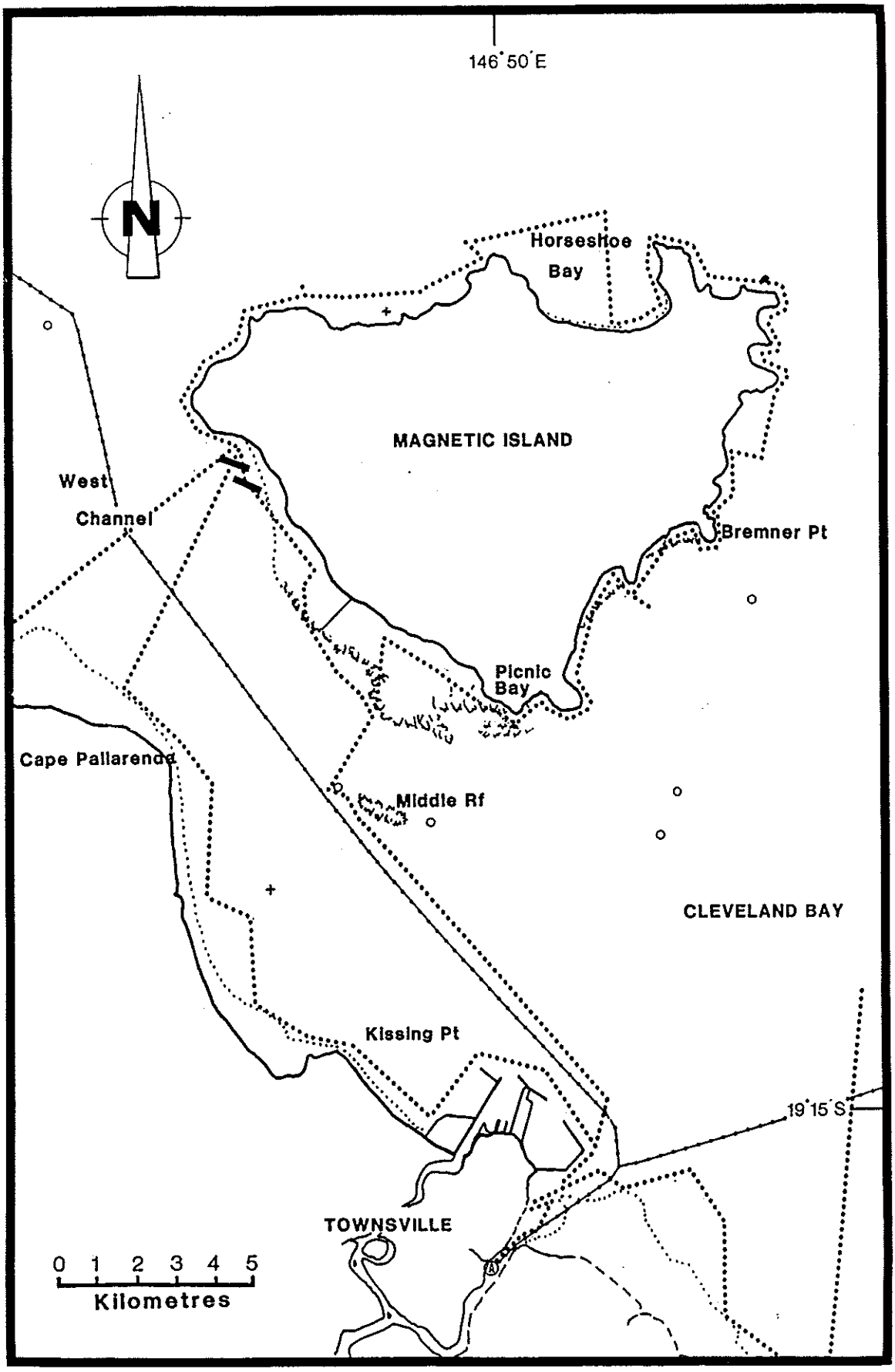

Cape Sandwich
Missionary Bay
18°15'S
Cardwell
Scraggy Pt
HINCHINBROOK
CHANNEL
HINCHINBROOK
ISLAND
N
Mangrove
Pt
0 1 2 3 4 5
Kilometres
146°15'E
Hillcock Pt

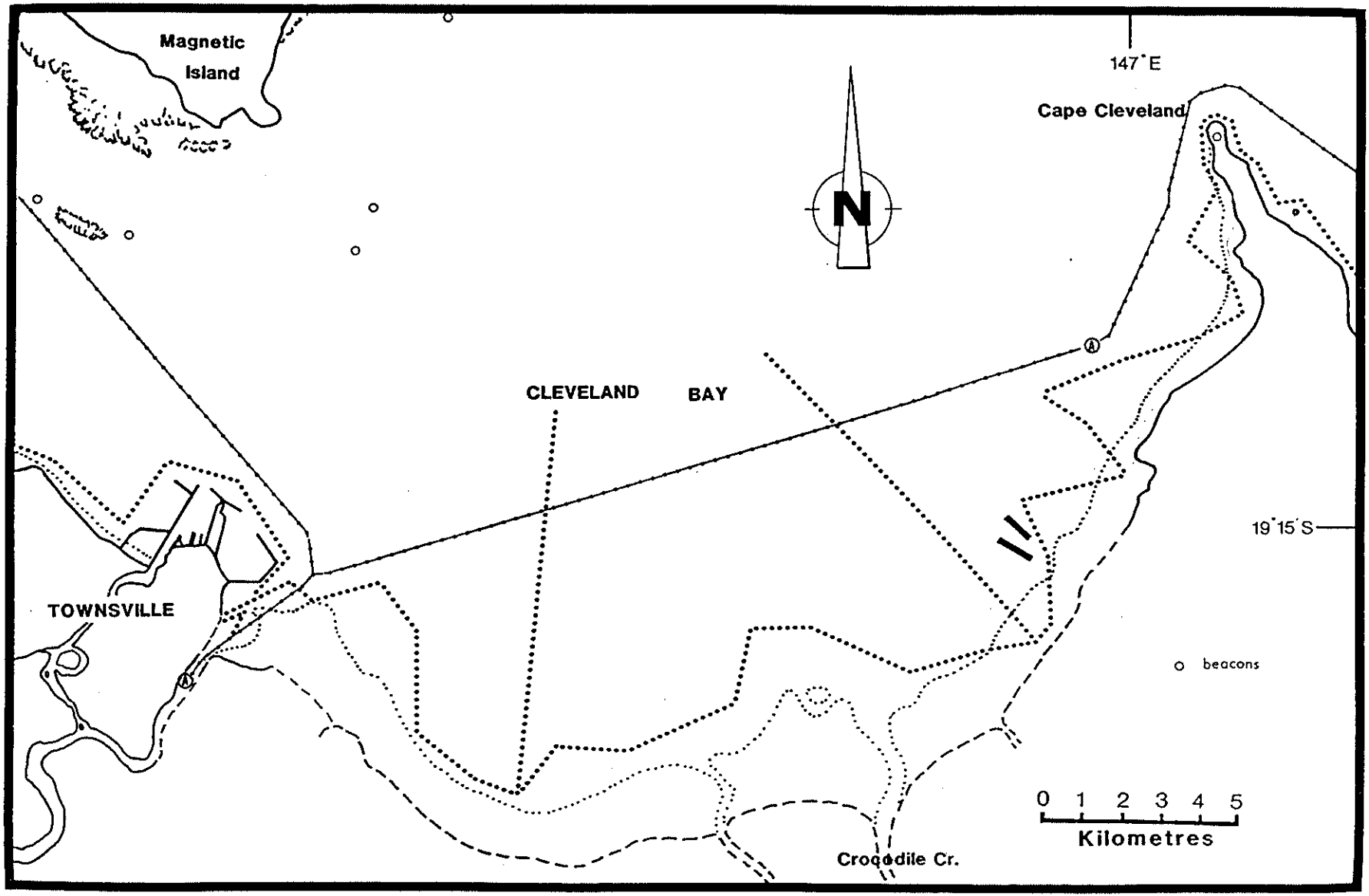

146°15'E
Hinchinbrook I.
Mt Straloch
N
Fisherman Pt
18°30'S
Lucinda
Herbert River
Halifax
Lady Elliot Rf
0 1 2 3 4 5
Kilometres
18°45'S

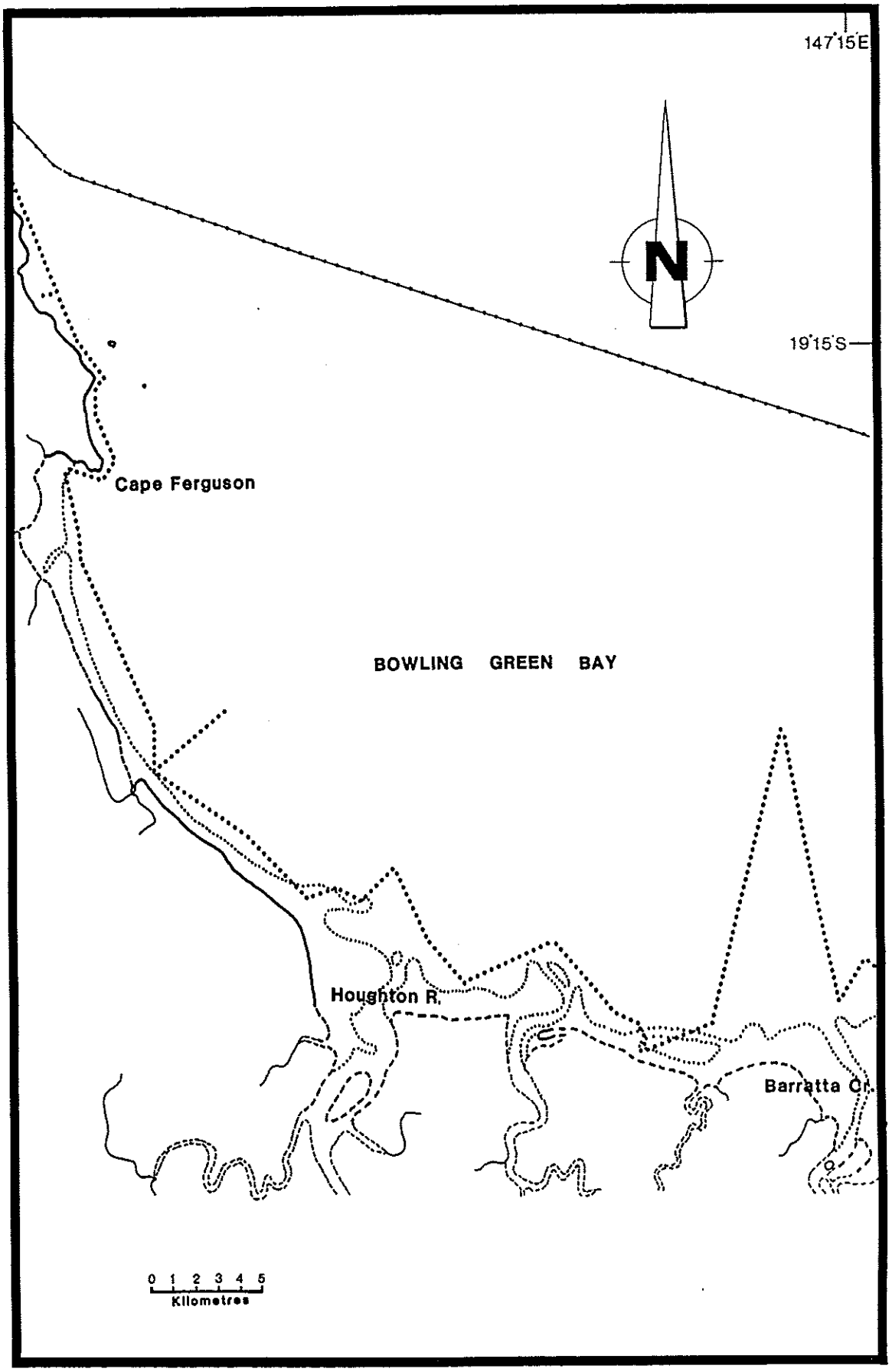

146°30'E
Pelorus I.
N
PALM ISLES
Orpheus I.
Curacoa I.
Fantome I.
GREAT PALM ISLAND
18°45'S
0 1 2 3 4 5
Kilometres

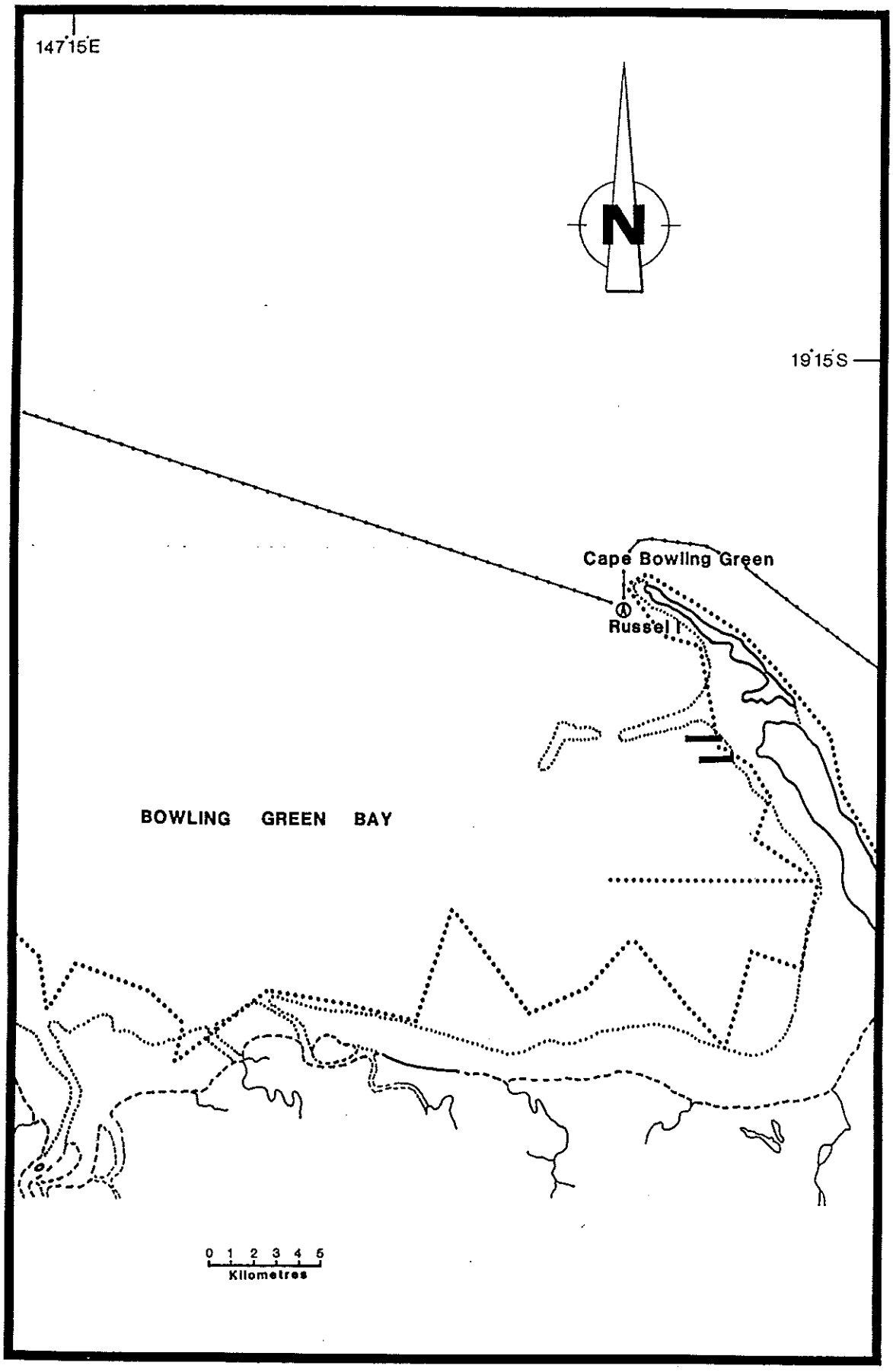

146°15'E
18°45'S
Palm Cr.
N
Pandora Rf
HALIFAX BAY
Crystal Creek
Ollera Cr.
19°00'S
0 1 2 3 4 5
Kilometres

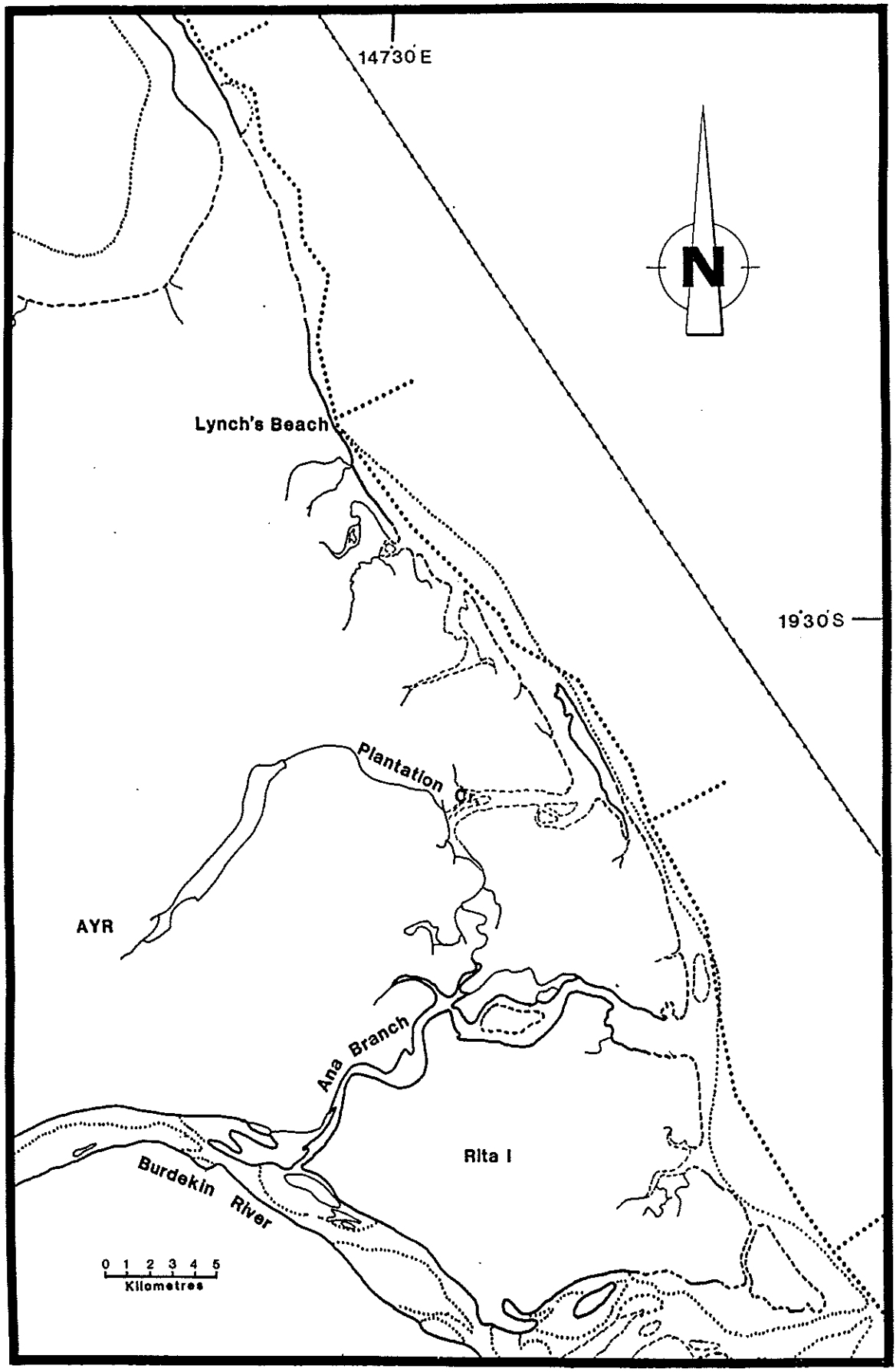

146°30'E
Rattlesnake I
Herald I
N
19°05'S
Paluma Shoals
Bay Rk
Burdekin Rk
0 1 2 3 4 5
Kilometres
Black River
Mt Marlow

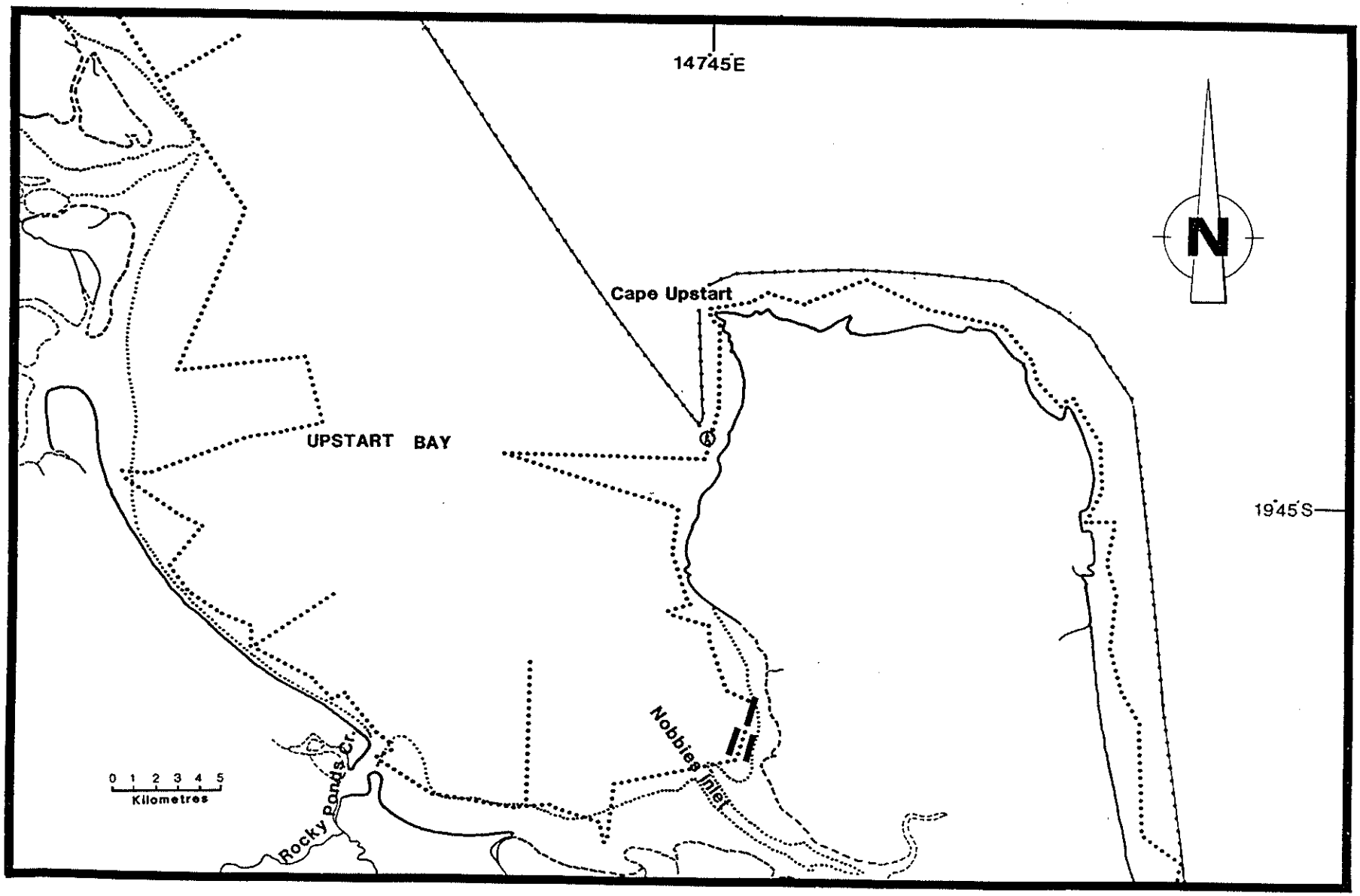

146°50'E
N
Horseshoe Bay
MAGNETIC ISLAND
West Channel
Bremner Pt
Picnic Bay
Cape Pallarenda
Middle Rf
CLEVELAND BAY
Kissing Pt
19°15'S
TOWNSVILLE
0 1 2 3 4 5
Kilometres

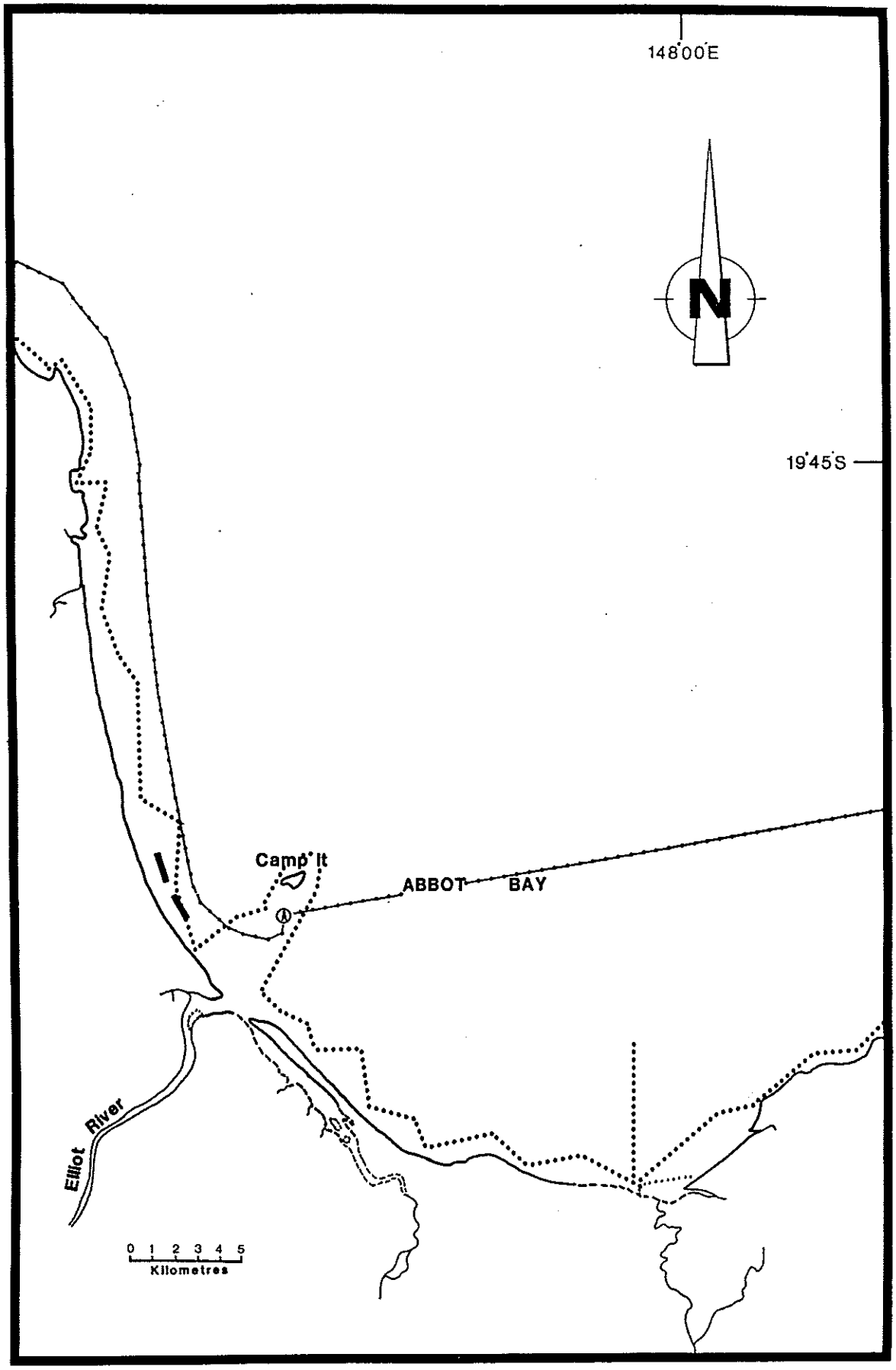

Magnetic
Island
147°E
Cape Cleveland
N
CLEVELAND
BAY
19°15'S
TOWNSVILLE
beacons
0 1 2 3 4 5
Kilometres
Crocodile Cr.

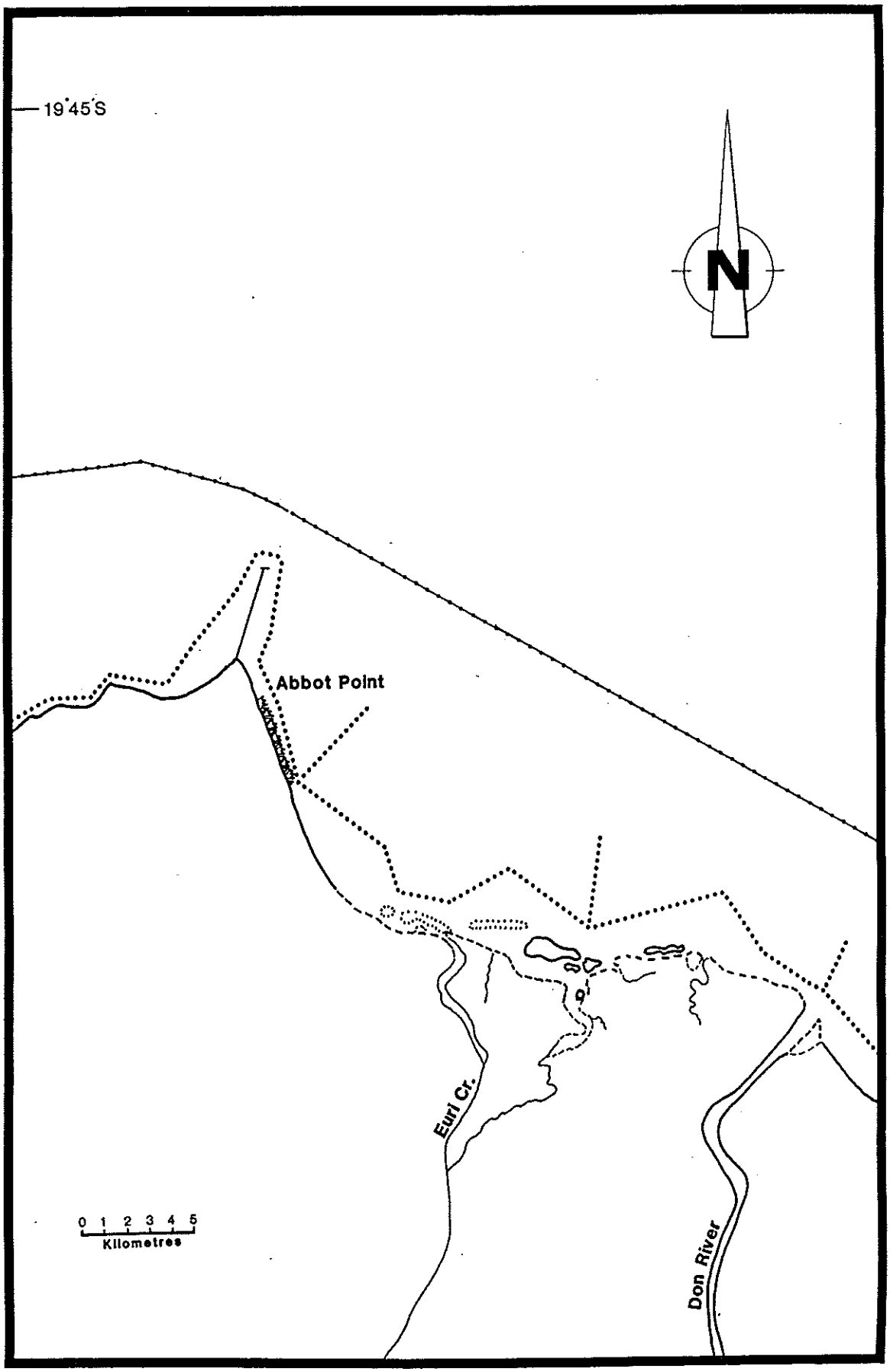

147°15'E
N
19°15'S
Cape Ferguson
BOWLING GREEN BAY
Houghton R.
Barratta Cr.
0 1 2 3 4 5
Kilometres

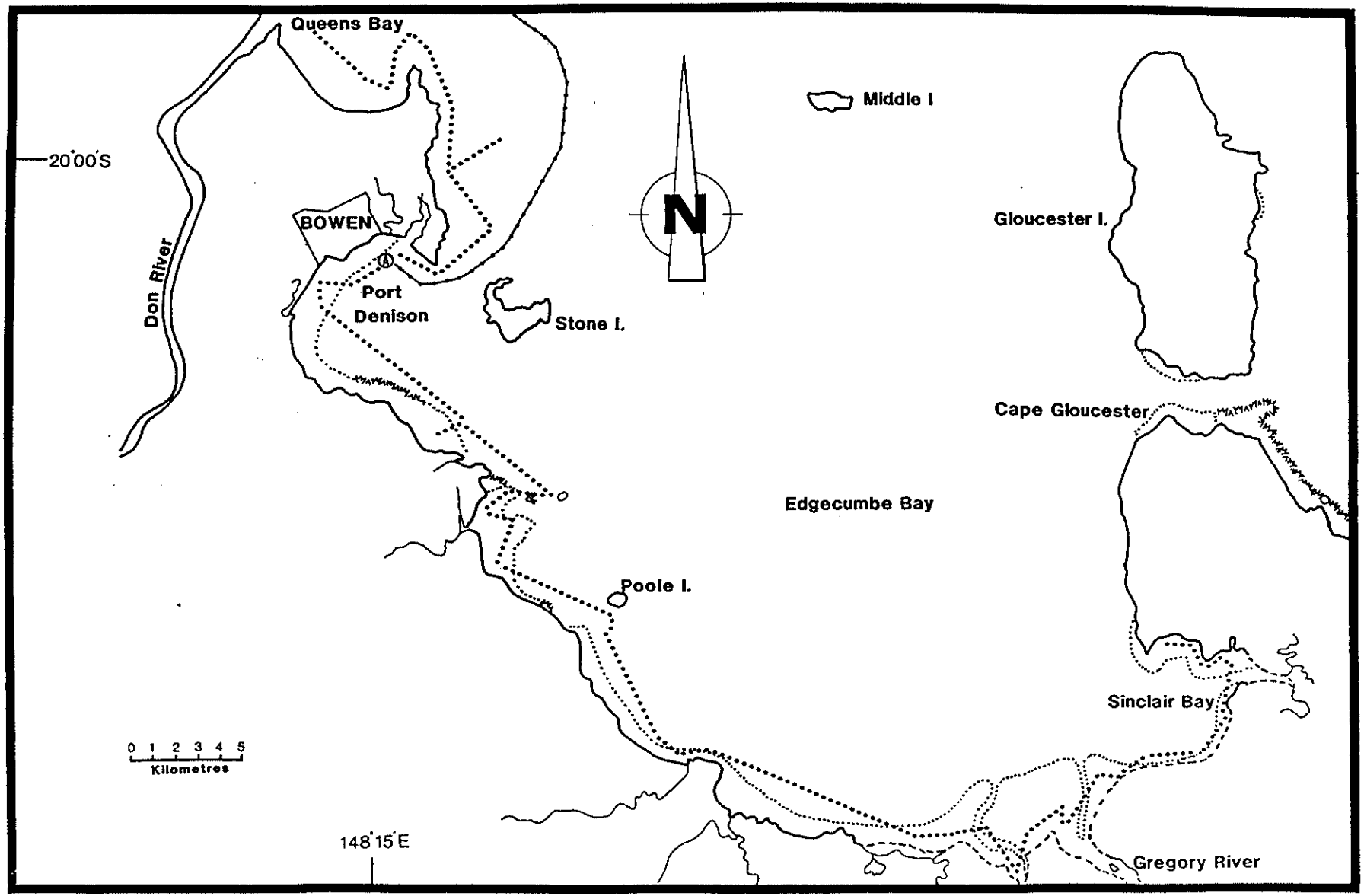

147°15'E
N
19°15'S
Cape Bowling Green
Russell I.
BOWLING GREEN BAY
0 1 2 3 4 5
Kilometres


147°30'E
N
Lynch's Beach
19°30'S
Plantation Cr.
AYR
Ana Branch
Rita I
Burdekin River
0 1 2 3 4 5
Kilometres


14745E
N
Cape Upstart
UPSTART BAY
1945'S
Nobbies Inlet
Rocky Ponds Cr
0 1 2 3 4 5
Kilometres


148°00'E
N
19°45'S
Camp It
ABBOT BAY
Elliot River
0 1 2 3 4 5
Kilometres


19°45'S
N
Abbot Point
Euri Cr.
Don River
0 1 2 3 4 5
Kilometres


Queens Bay
20°00'S
Don River
BOWEN
Port
Denison
Stone I.
N
Middle I
Gloucester I.
Cape Gloucester
Edgecumbe Bay
Poole I.
Sinclair Bay
0 1 2 3 4 5
Kilometres
148°15'E
Gregory River

APPENDIX 2

Maps 1-19 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

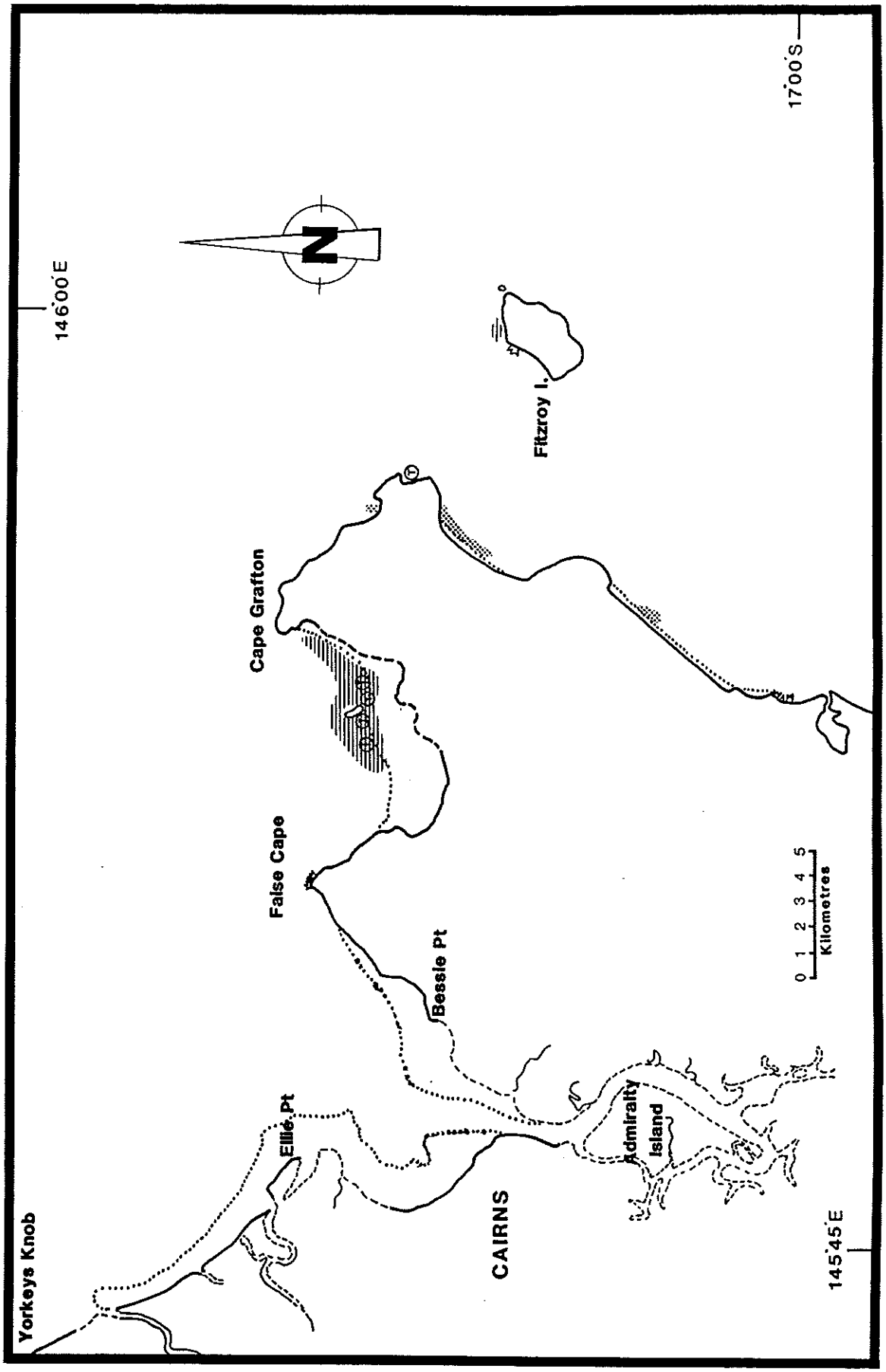
<10% cover 

Between 10% and 50% cover 

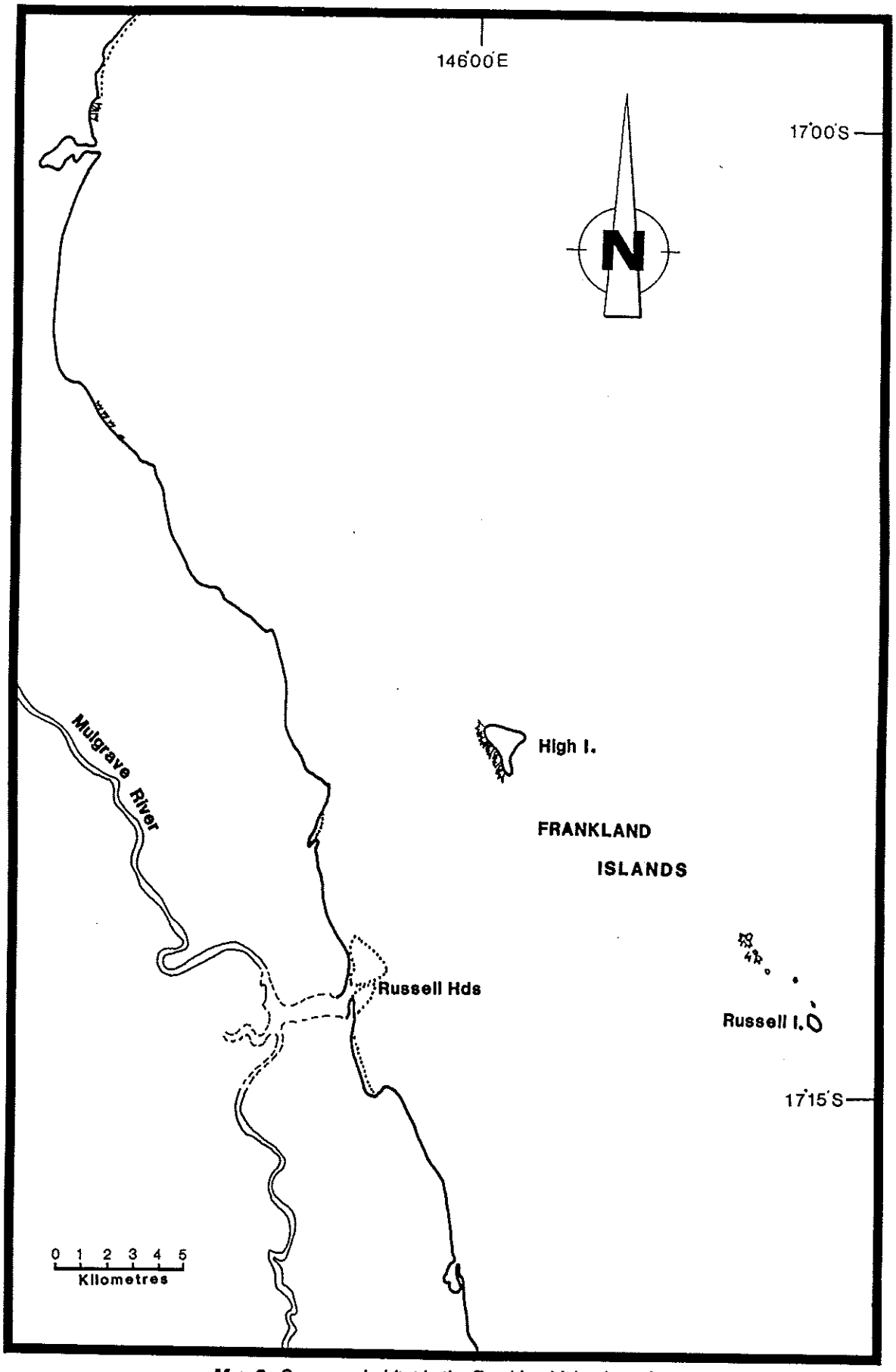
>50% cover 

Dugong sightings Ⓓ

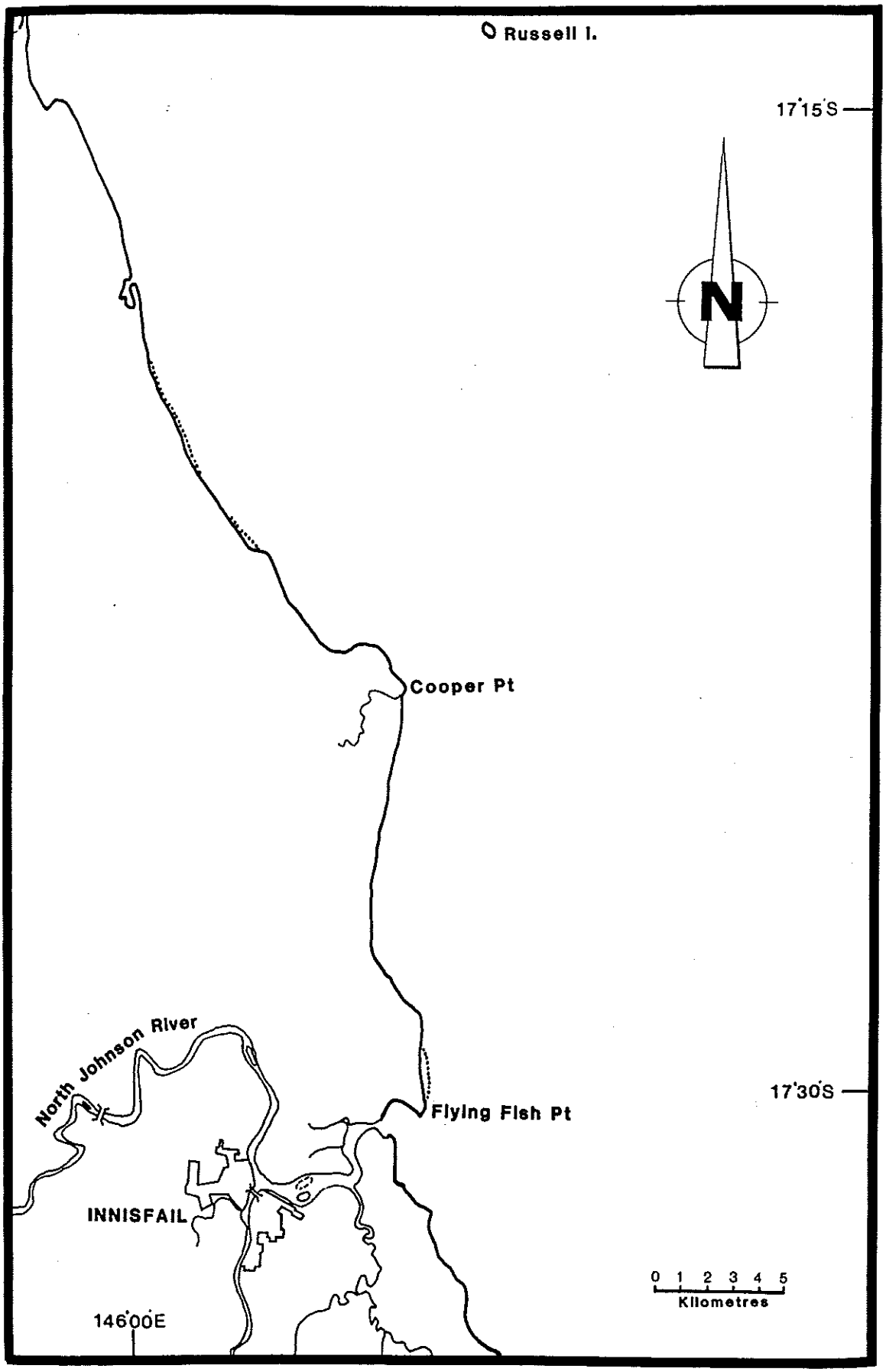
Turtle sightings Ⓣ



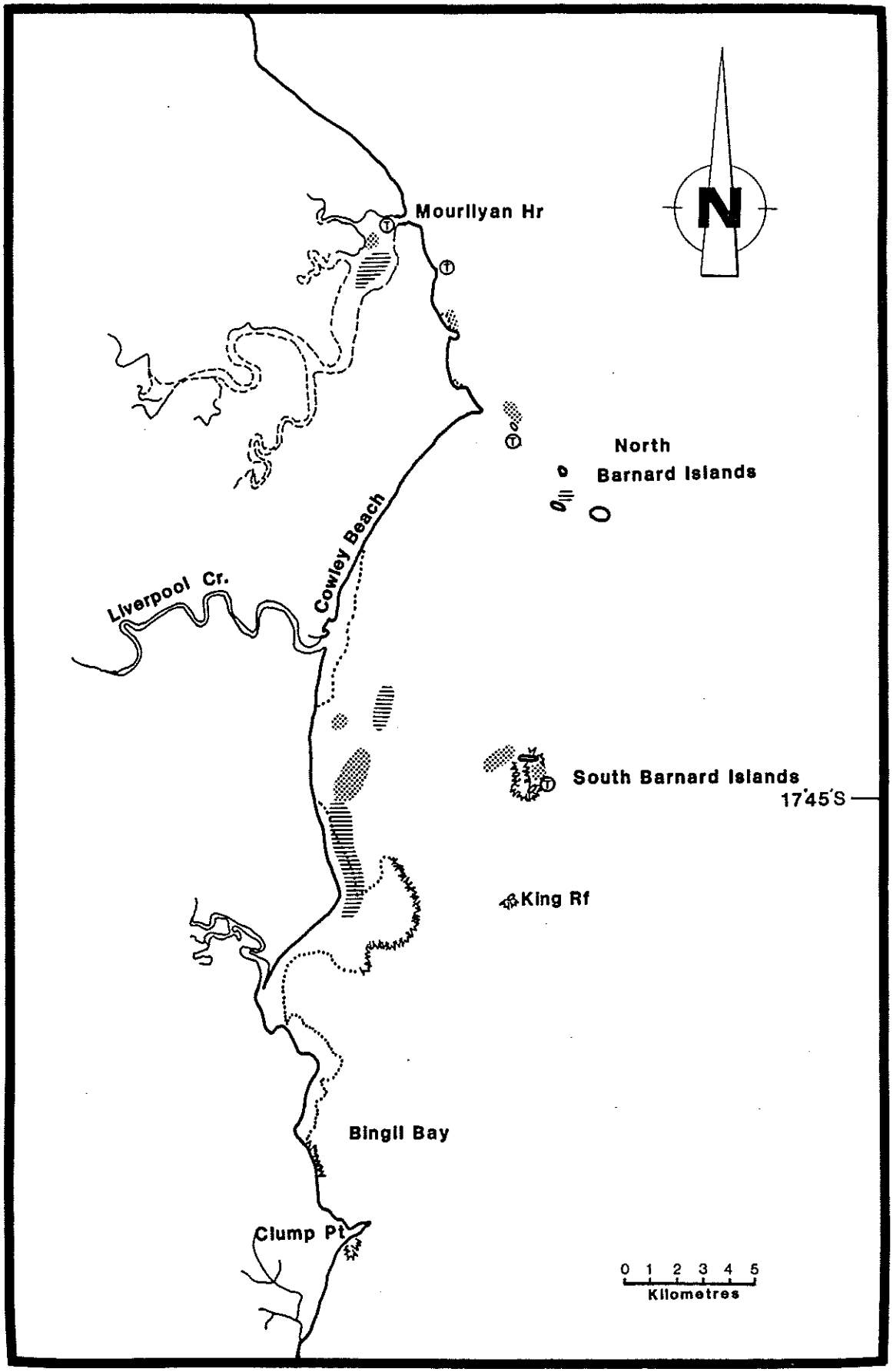
Map 1. *Seagrass habitat from False Cape to Fitzroy Island.*



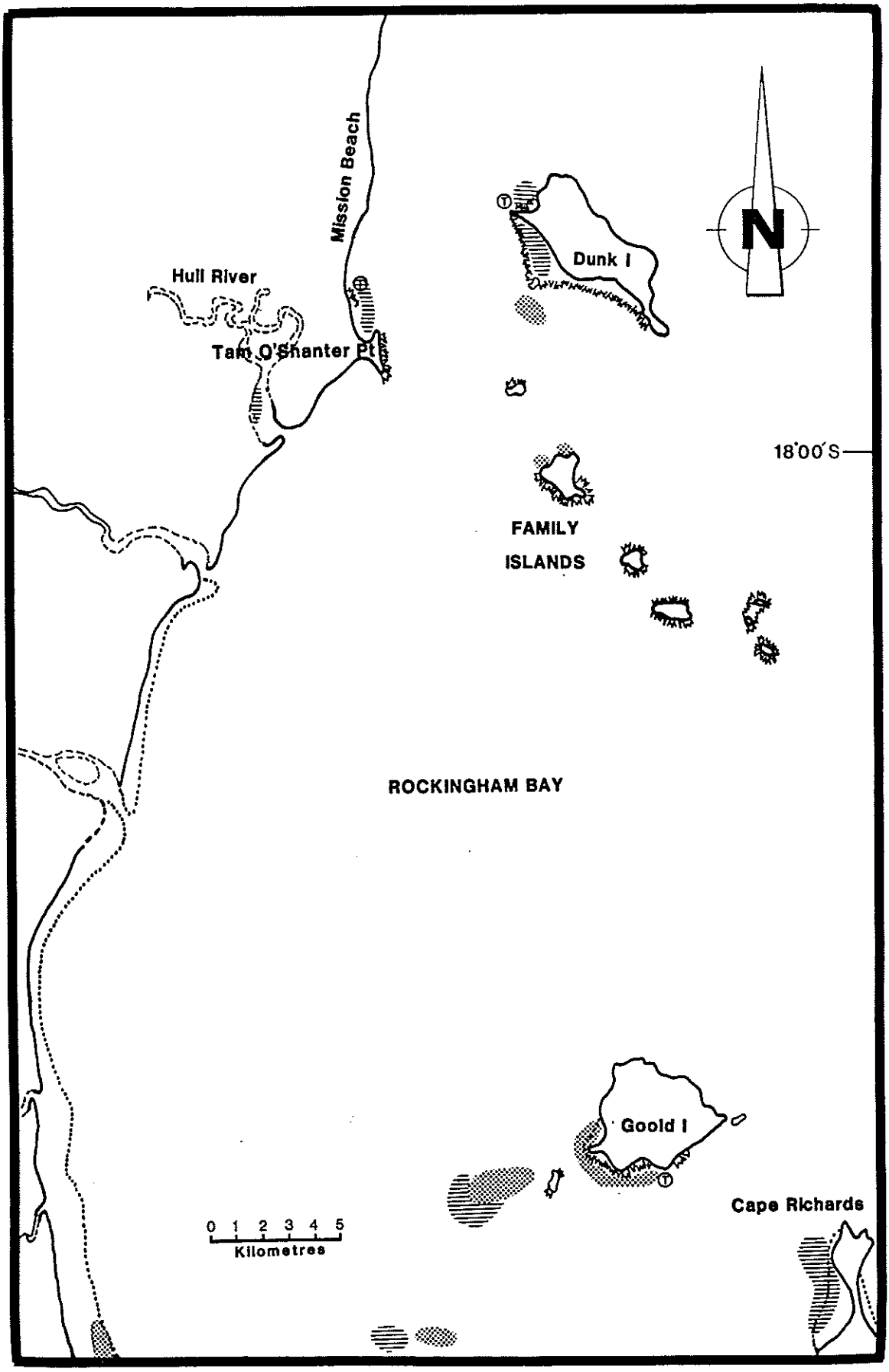
Map 2. *Seagrass habitat in the Frankland Islands region.*



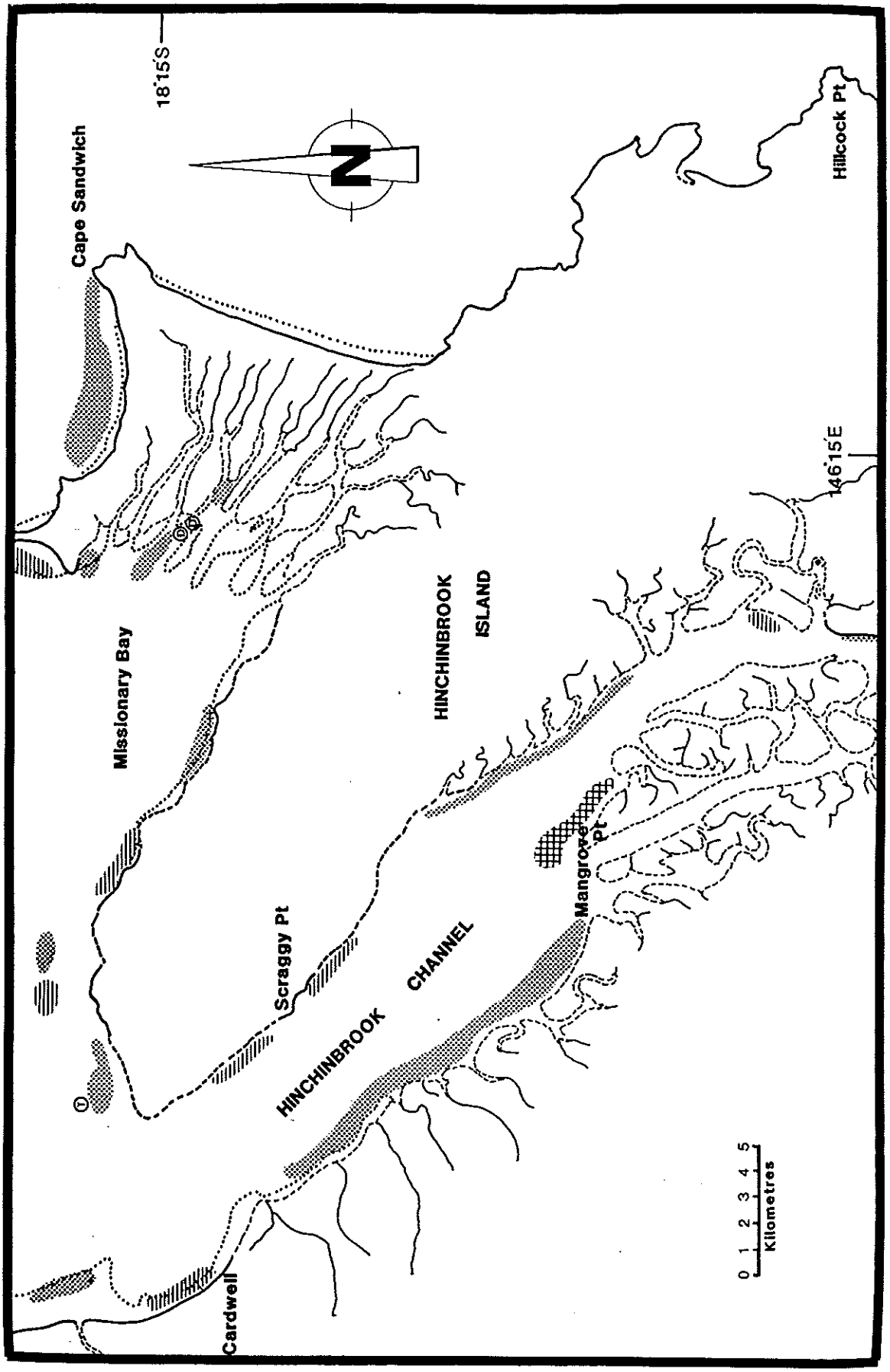
Map 3. *Seagrass habitat from Bramston Beach to Innisfail.*



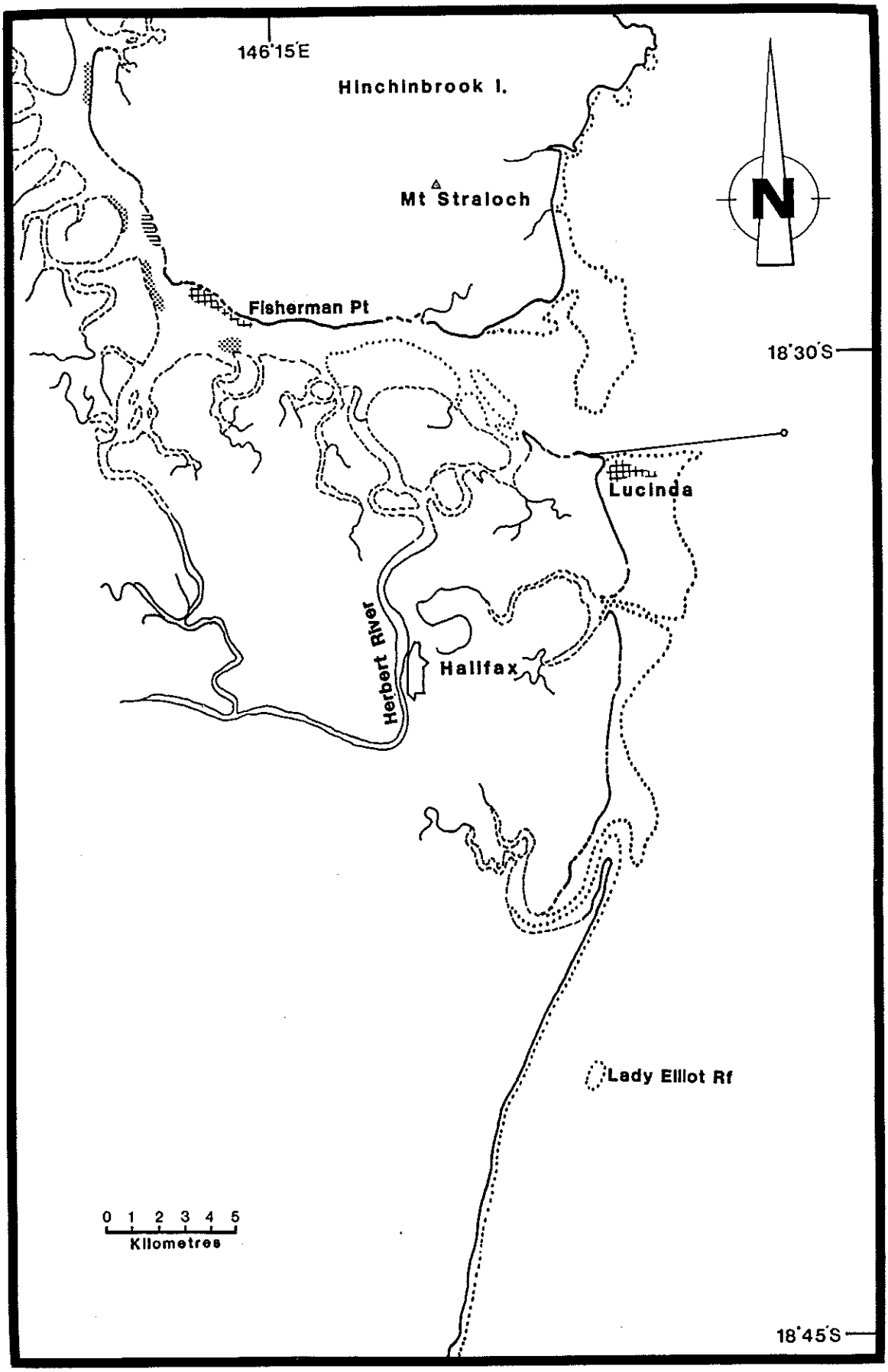
Map 4. *Seagrass habitat from Mourilyan Harbour to Clump Point.*



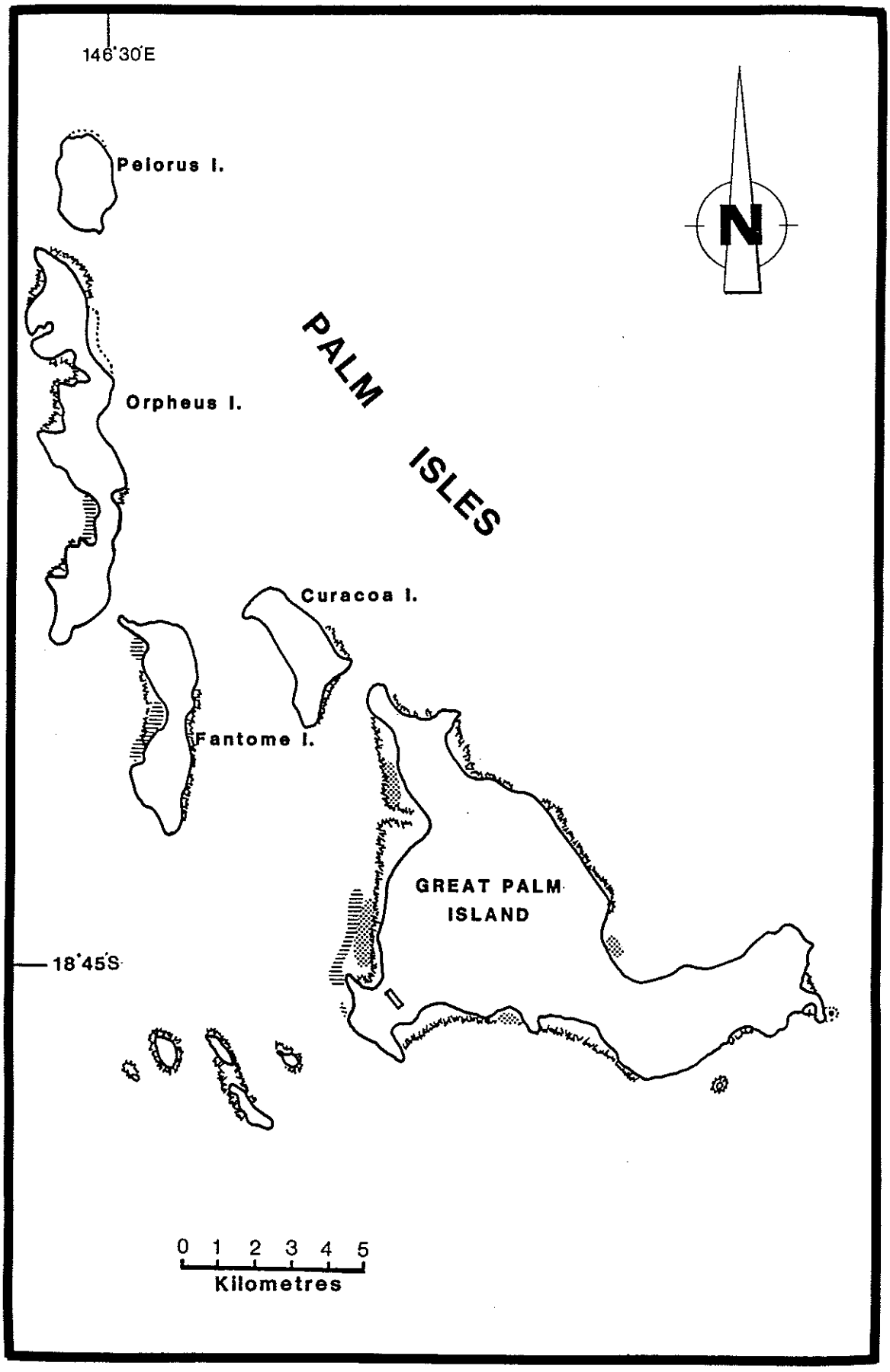
Map 5. *Seagrass habitat from Dunk Island to Goold Island and coast.*



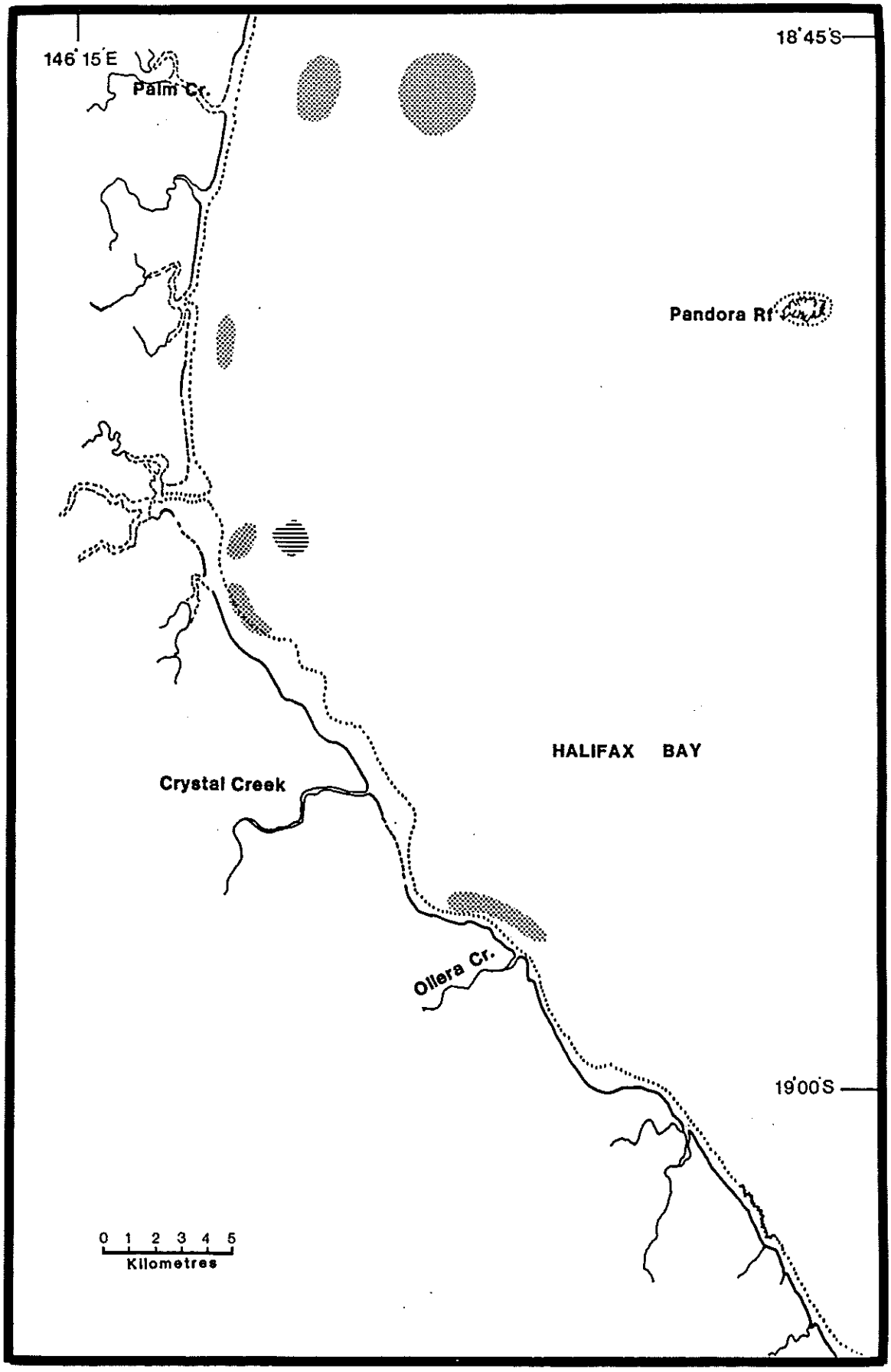
Map 6. Seagrass habitat in the northern Hinchinbrook Channel and Hinchinbrook Island area.



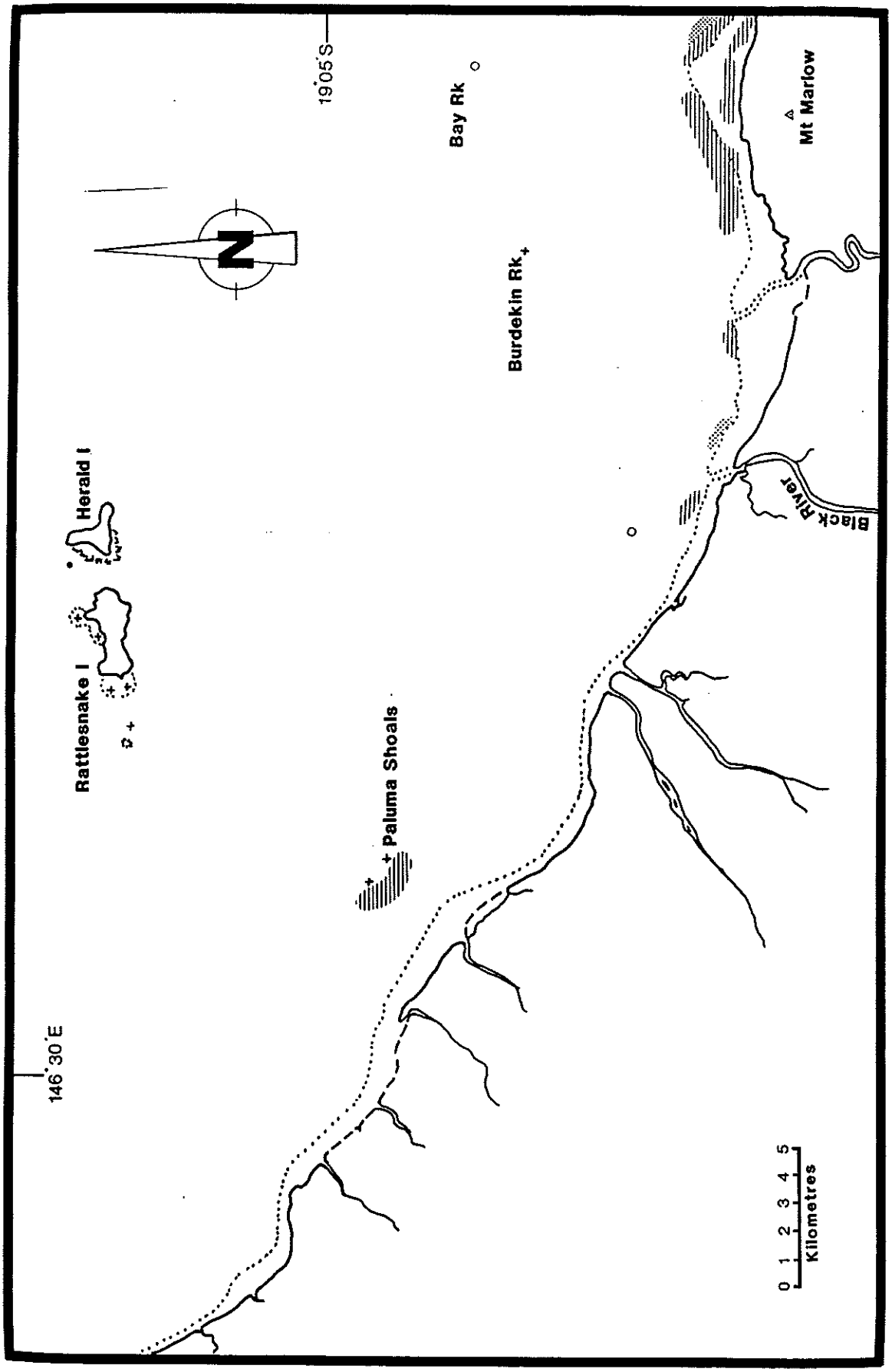
Map 7. *Seagrass habitat in the southern Hinchinbrook Channel and Lucinda region.*



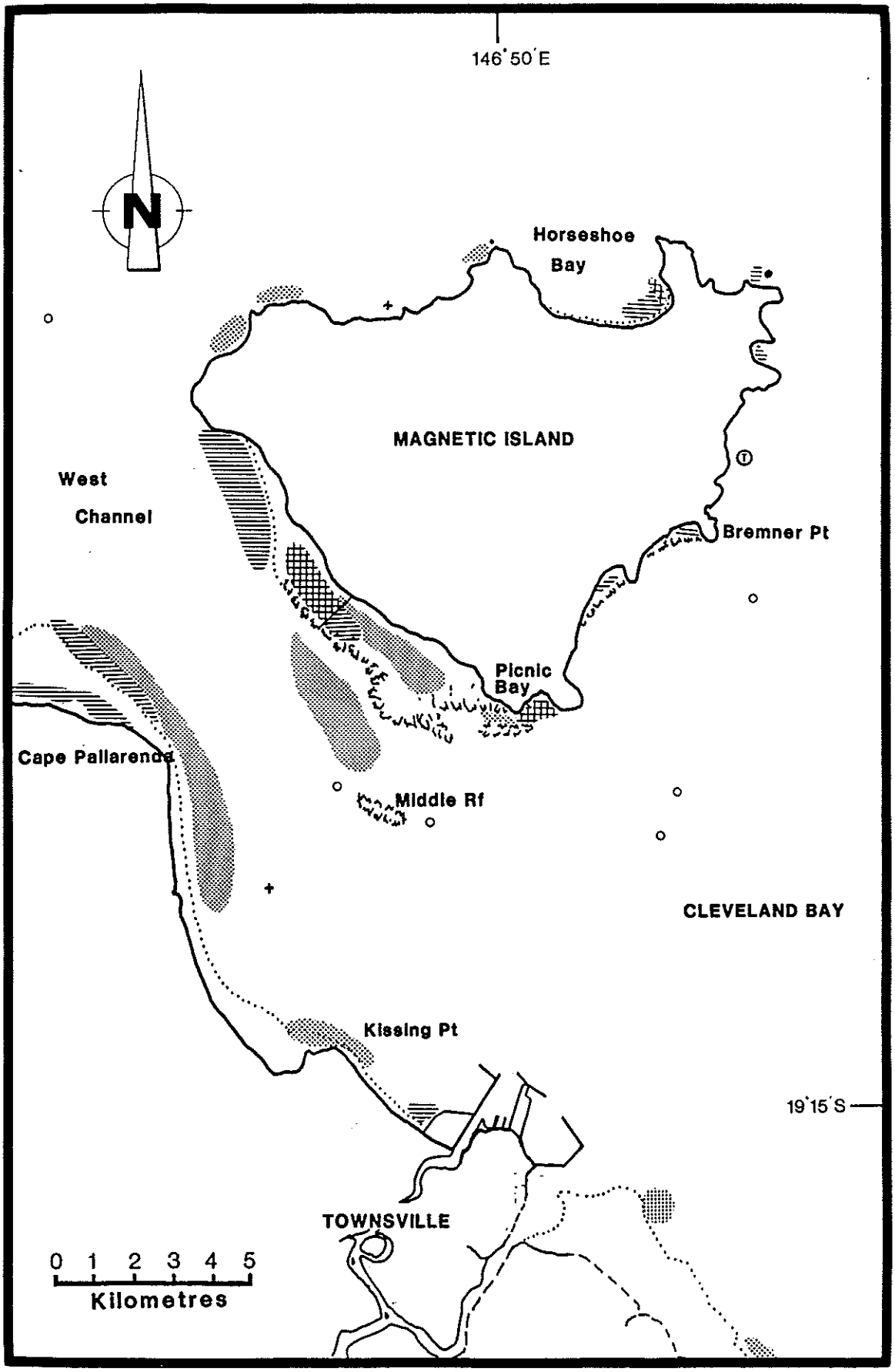
Map 8. *Seagrass habitat around the Palm Islands.*



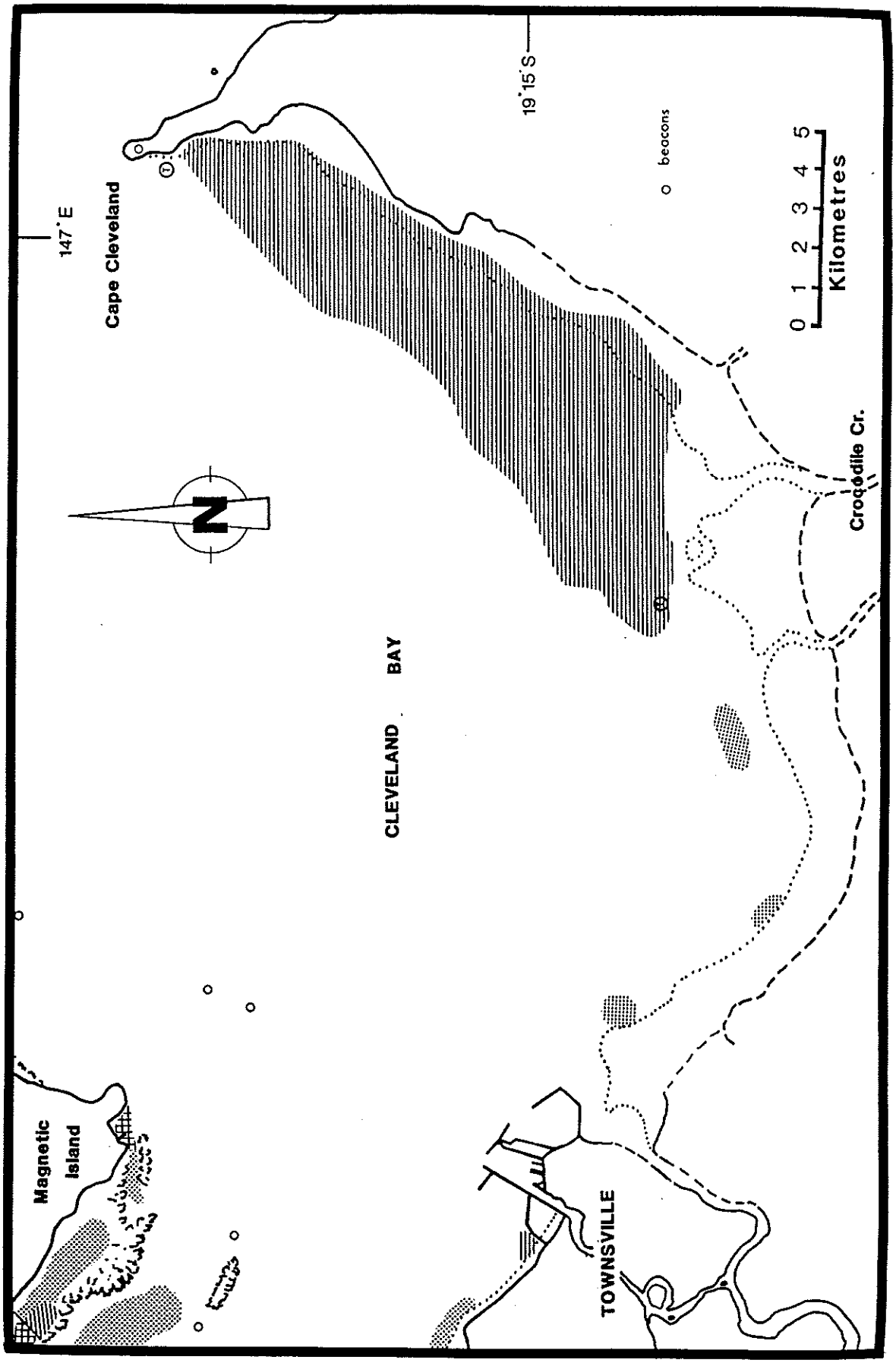
Map 9. *Seagrass habitat in the northern Halifax Bay.*



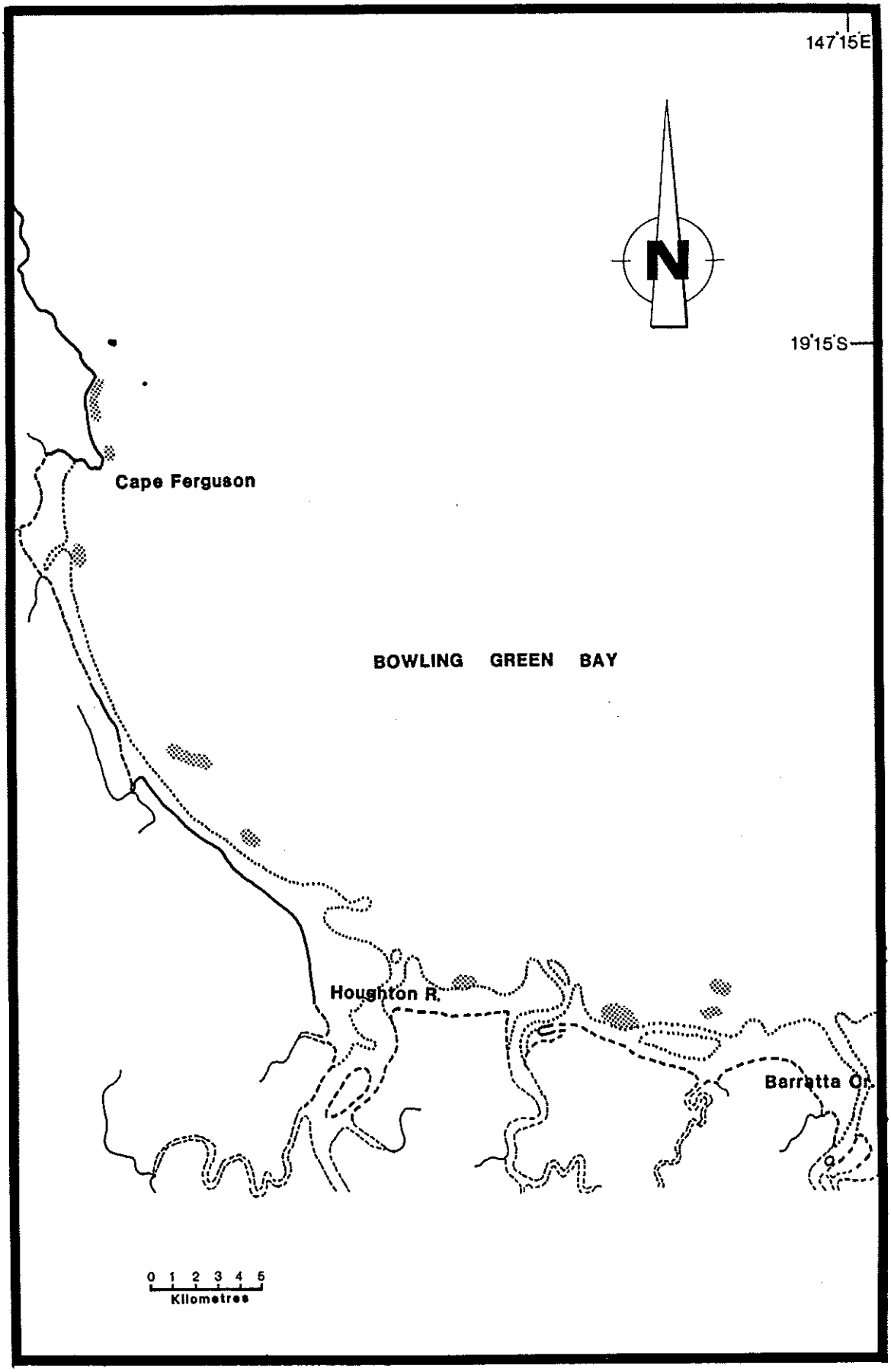
Map 10. *Seagrass habitat in Southern Halifax Bay.*



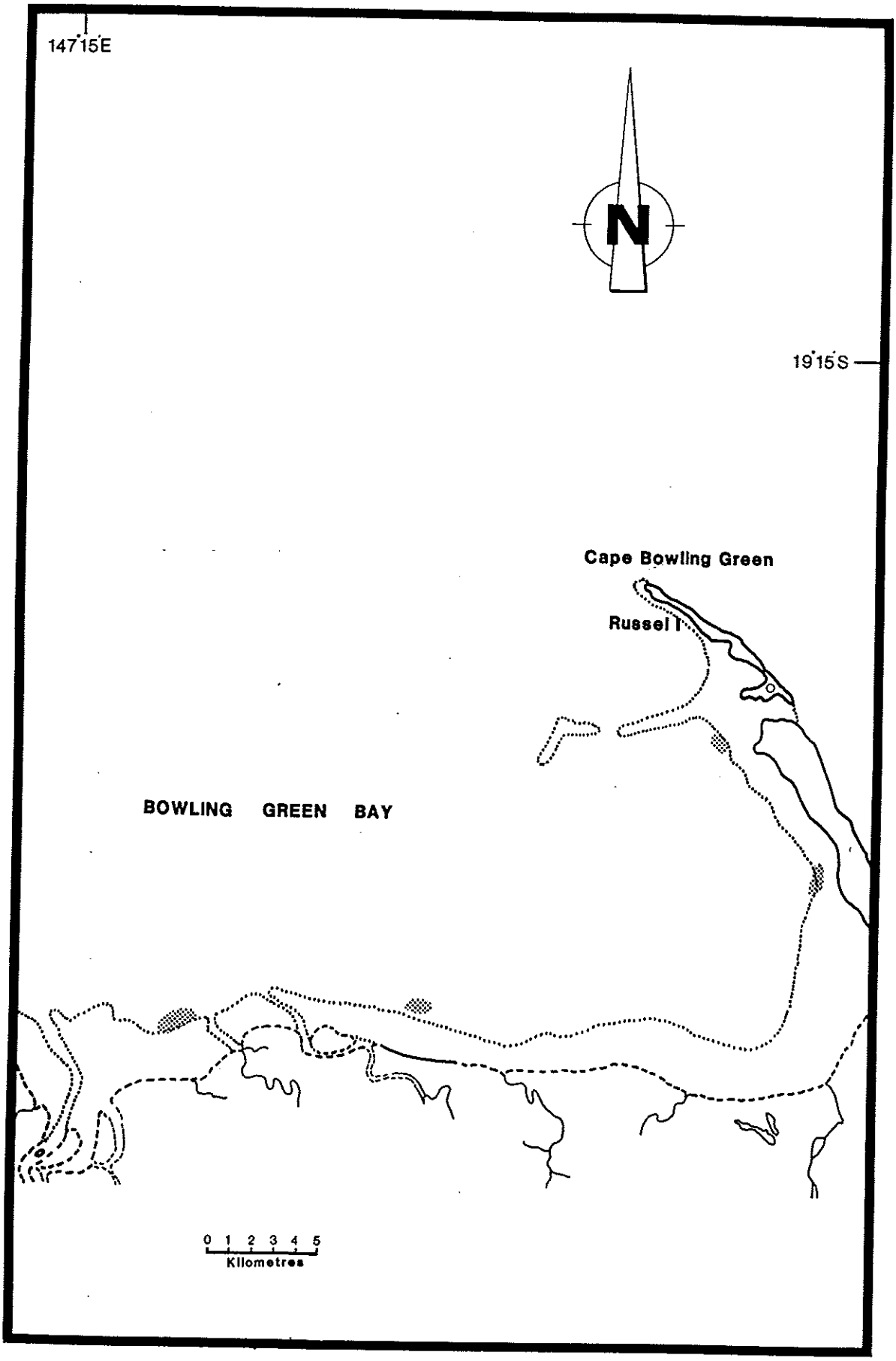
Map 11. *Seagrass habitat around Magnetic Island and Townsville.*



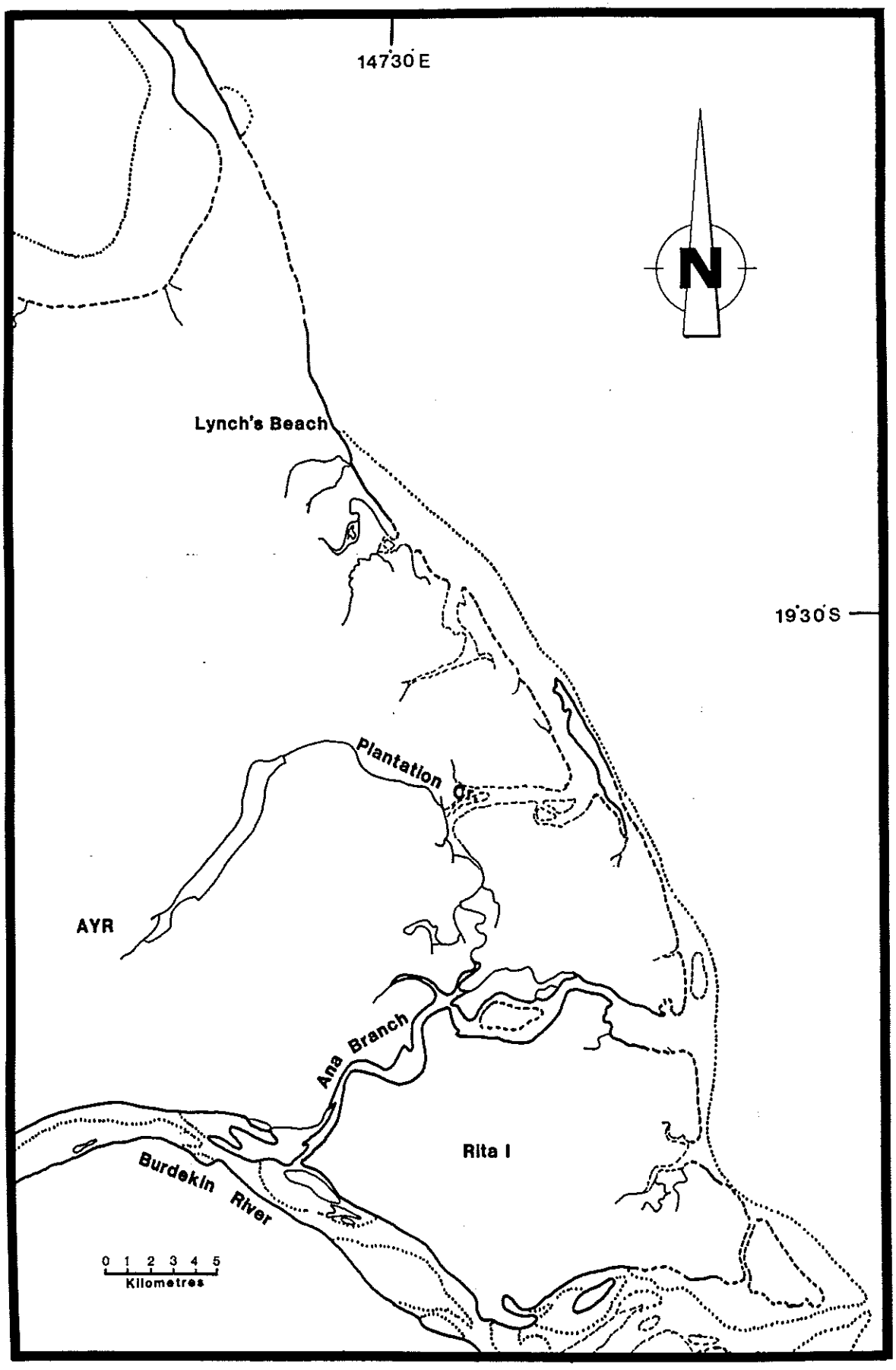
Map 12. *Seagrass habitat in Cleveland Bay.*



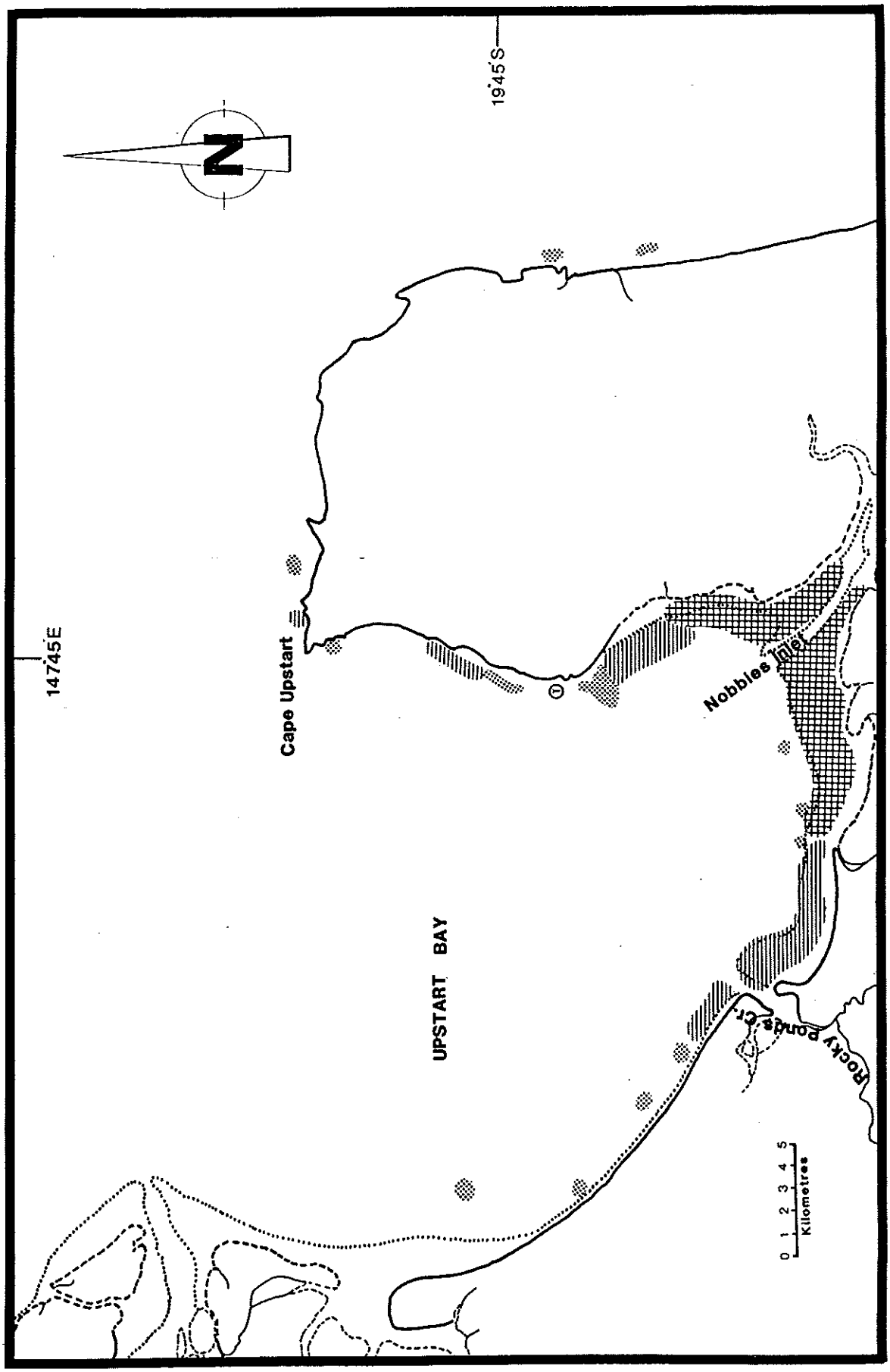
Map 13. *Seagrass habitat in western Bowling Green Bay.*



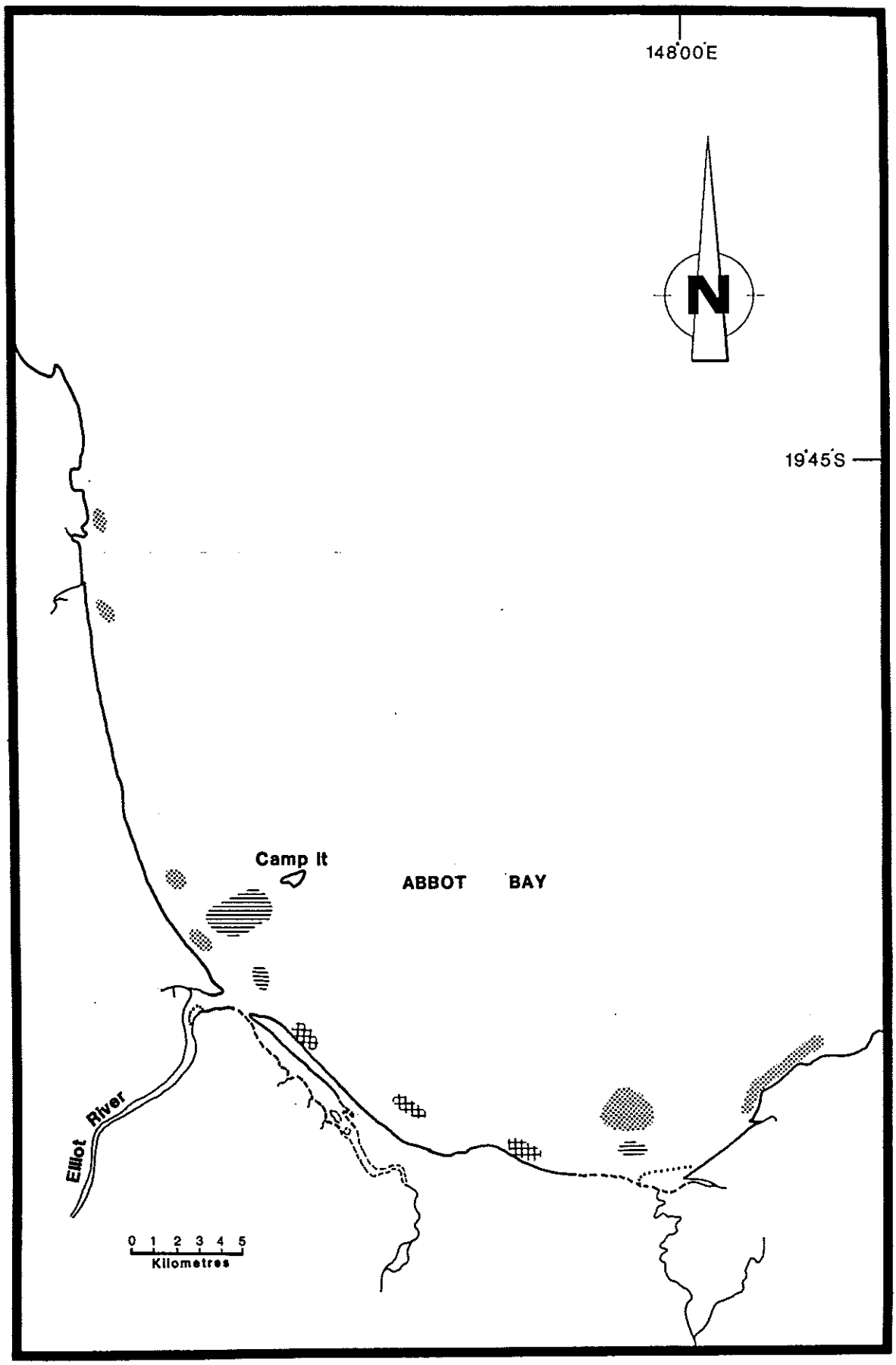
Map 14. *Seagrass habitat in eastern Bowling Green Bay.*



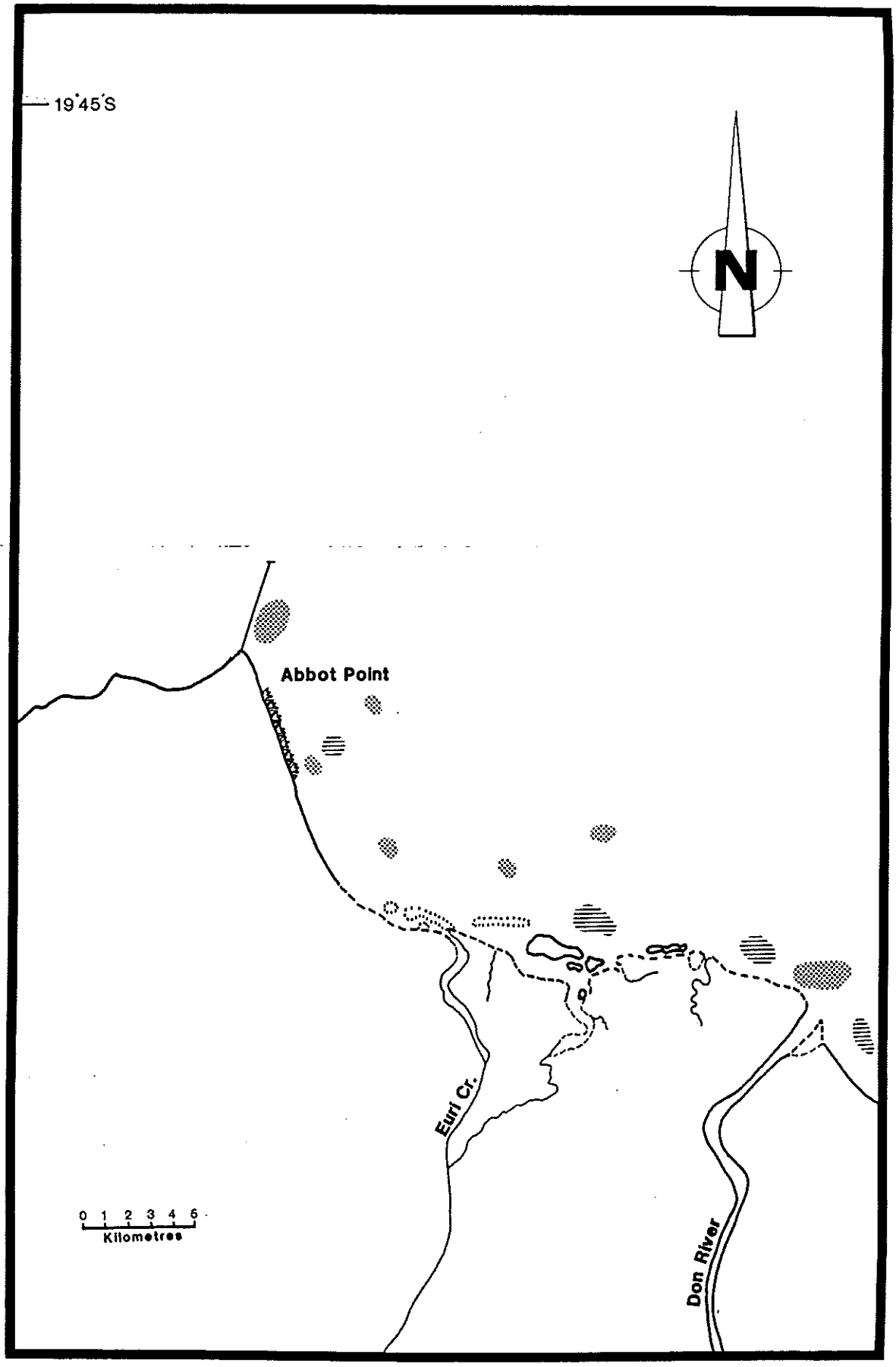
Map 15. *The coast between Cape Bowling Green and Burdekin River.*



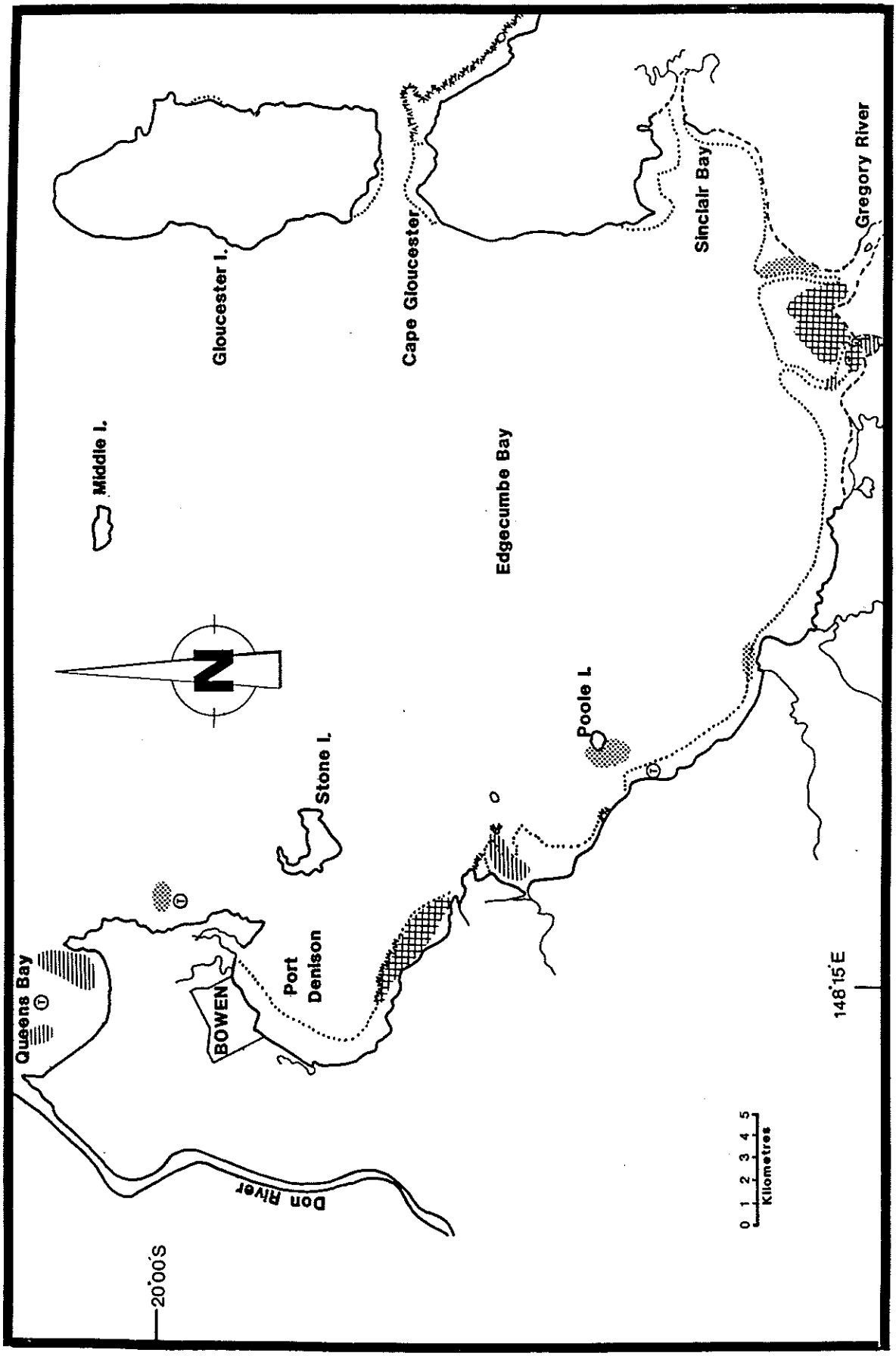
Map 16. *Seagrass habitat in Upstart Bay.*



Map 17. *Seagrass habitat in Abbot Bay.*



Map 18. *Seagrass habitat from Abbot Point to Queens Bay.*



Map 19. *Seagrass habitat in Edgecumbe Bay.*

APPENDIX 3

Common names of the fish families caught in beam trawls during the survey and notes on their habits. After Grant (1982), Munro (1967), Marshall (1964), Fisher and Bianchi (1984).

FAMILY	COMMON NAME	DESCRIPTION
AMBASSIDAE	Perchlets, Glassfish	These small translucent fish are a useful bait fish and the larger individuals can be eaten by humans. Some freshwater species are popular aquarium fish.
ANTENNARIIDAE	Fishing-frog-fish, anglerfish	Sluggish, flabby-bodied fish which depend on concealment from avoid estuarine predators.
APOGONIDAE	Cardinalfishes	Apogonids are small to moderate sized fishes of coastal tropical waters. Oral gestation occurs in several species.
ATHERINIDAE	Hardyheads	Small schooling fishes preyed upon by larger species such as bream and tuna, these fishes are often used as bait. Atherinid eggs have sticky filaments which anchor them to aquatic plants until hatching.
BELONIDAE	Long-toms, Needlefish	Carnivorous, pelagic fish which often congregate in schools. These fish are edible but are unpopular because of the large number of bones.
BLENNIIDAE	Blennies	Small, agile, carnivorous fish, they inhabit coral reefs and rocky shores. Often cryptic, they have previously been found in marine grass beds. They have no commercial value.
CALLIONYMIDAE	Dragonets	These are 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 not a commercially important species in Queensland.
CHAETODONTIDAE	Butterflyfishes	Mainly living around coral reefs, these are solitary fish, carnivorous on small prey items. Commercially important as aquarium fishes, and *Parachaetodon ocellatus* in particular is popular as an aquarium subject.
CYNOGLOSSIDAE	Tongue Soles	Most of these fishes inhabit sandy bottoms near river mouths and in shallow coastal waters. They are small and of no commercial value.
ENGRAULIDIDAE	Anchovies	Small gregarious fishes sometimes occuring in large schools over muddy bottoms in river estuaries. The strong-flavoured flesh is used to flavour fish pastes.
GERREIDAE	Silver Biddies	These useful baitfish occur in large schools usually along sandy shores. They are commercially important as food fishes in other countries. Estuarine prawn trawlers catch large numbers in Queensland.
GOBIIDAE	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.
HAEMULIDAE	Grunters, Sweetlips	The flesh of these small to moderate-sized fish has a pleasant flavour and they are valued game and table fish.

FAMILY	COMMON NAME	DESCRIPTION
HEMIRAMPHIDAE	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	Wrasses	Wrasses live in or about coral or weed and are usually carnivorous. Valued food fishes if large, they are usually speared or line caught.
LEIOGNATHIDAE	Ponyfishes	These are small carnivorous fishes found in shallow coastal waters. They are often abundant forming large schools in sheltered bays and estuaries. Although non-commercial in Australia, they are commercially important in S.E. Asia. Regarded as trash by prawn trawlermen.
LETHRINIDAE	Emperors	Emperors inhabit rocky outcrops and coral reefs and are carnivorous. These fish are commercially valuable. They are caught by handlines and are a prized amateur catch fish. *Lethrinus nematacanthus* is not as highly prized as some other emperors.
MONACANTHIDAE	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	Grubfishes	Most of these fish are small, agile, carnivorous bottom-dwellers of coastal and reef waters. They are tropical species of little economic importance.
MULLIDAE	Goatfishes	Goatfishes are carnivorous species which probe the substrate for prey with chin barbels. They are good eating, but some are reputed to be poisonous. They are of commercial importance in overseas countries.
OSTRACIIDAE	Boxfishes, Cowfishes	These are slow swimming fishes found near rocky and coral reefs and sand, weed and sponge covered bottom to 100 metres. The flesh of some species is toxic if eaten.
PARALICHTHYIDAE	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.
PLATYCEPHALIDAE	Flatheads	Flatheads bury in bottom sediments with their eyes exposed. They are carnivorous. Most (including *Cymbacephalus nematophthalmus*) are valuable food fishes and are caught commercially in Queensland.
SCORPAENIDAE	Wespfishes, Scorpion fishes, etc.	Most of these fishes are feeble swimmers and depend on concealment to avoid predators. They are generally bottom dwellers in coastal areas. Many have venomous fin spines.
SERRANIDAE	Groupers, Rock Cod, Coral Trout	Serranids such as *Epinephalus sexfasciatus,* are voracious and rank amongst the more important food fishes of tropical seas. However, *Centrogenys vaiglensis*, the other species caught during this survey, grows only to a few centimetres and resembles a scorpaenid.

FAMILY	COMMON NAME	DESCRIPTION
SIGANIDAE	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	Whiting	These moderate sized coastal species are valued food fishes and are caught in seines or by hand lining. They are carnivorous, digging in the bottom for worms and crustaceans. Smaller species are used as bait.
SOLEIDAE	Soles	These fish are oval and compressed and inhabit muddy and sandy bottoms. When disturbed they settle into the substrate to try and avoid detection. They are a valued food fish but are difficult to catch with either net or line.
SPHYRAENIDAE	Barracudas, Sea Pike	These carnivorous, fast swimming fish are very voracious. Some of the larger species can pose a threat to humans.
SYNGNATHIDAE	Pipefishes, Seahorses	Small, highly 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.
SYNODONTIDAE	Lizardfishes, Grinners	Bottom dwelling carnivorous fishes, synodontids have edible flesh and are of commercial importance in SE Asia. They are common on trawl grounds.
TAENIODIDAE	Burrowing Gobies	These fish have adapted to burrowing in muddy bottoms. The body is elongated and the eyes are reduced in size. They are commonly found in the brackish waters of estuaries.
TERAPONIDAE	Grunters, Trumpeters	These are carnivorous fishes. *Pelates quadrilineatus*, the most abundant species in our trawls, grows to 200 mm and is common in seagrass covered mud flats. Teraponids are of commercial value as live bait in Queensland.
TETRAODONTIDAE	Pufferfishes, Toadfishes	Inhabiting moderately shallow coastal water, pufferfishes inflate when provoked. Their flesh is toxic, although some are eaten in Japan after special preparation.
TRIACANTHIDAE	Tripod fishes	These benthic fish are found on flat, sandy or weed covered bottoms and feed on bottom-dwelling invertebrates. Tripod fish can grow to moderate size.