Port of Weipa Seagrass Monitoring Baseline Surveys, April & September 2000

Report to the
Ports Corporation of Queensland

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PORTS CORPORATION QUEENSLAND

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Disclaimer

Information contained in this publication is provided as general advice only and supersedes data presented in previous interim reports. For application to specific circumstances, professional advice should be sought.

The Department of Primary Industries, Queensland has taken all reasonable steps to ensure the information contained in this publication is accurate at the time of the survey. Seagrass distribution and abundance can change seasonally and between years, and readers should ensure that they make appropriate enquiries to determine whether new information is available on the particular subject matter.

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Summary

This report provides the results of wet (April 2000) and dry (September 2000) season baseline surveys of seagrass resources within the Port of Weipa. It provides data required to develop a comprehensive monitoring plan for Weipa seagrasses for the Ports Corporation of Queensland.

The major findings of the surveys were:

1. The Port of Weipa had extensive seagrass meadows throughout the Hey, Embley and Mission Rivers, Pine River Bay and Albatross Bay.

2. Total seagrass area mapped in April and September 2000 surveys (3511 ±528 & 4688 ±418 ha respectively) was larger than mapped in previous surveys of the Port of Weipa.

3. An additional species of seagrass, *Halophila decipiens,* that had not been reported previously from Weipa, was found in the baseline surveys.

4. High biomass seagrass habitats were located adjacent to port infrastructure and facilities between Evans and Jessica Points and on banks adjacent to dredged channels in the Embley River. Port development and maintenance programs will need to consider these meadows due to their proximity to port facilities. Continued monitoring of these meadows is likely to provide a good indication of the port's environmental health given their proximity to likely sources of impact.

5. The Embley River had the densest and largest continuous seagrass meadows in the Port of Weipa survey area. These ecologically important *Enhalus acoroides* meadows are known to support local commercial, recreational and traditional fisheries.

A further year of monitoring for seagrasses for the Port of Weipa has been funded by PCQ. Continued monitoring of the seagrass resources will provide valuable information for understanding seasonal and interannual trends in Weipa seagrasses and options for ongoing work will be developed following the surveys to be undertaken in 2001.

Introduction

Consultancy Brief

The Ports Corporation of Queensland (PCQ) is the port authority for Weipa and leases the Port assets to Comalco Minerals & Alumina (Comalco). Port activities at Weipa centre around the export of bauxite and require permanent deepwater access to the shore loading facilities. Maintenance dredging is undertaken by PCQ approximately every two years to maintain navigable depth in the access channel.

PCQ has developed a Long-Term Dredge Material Management Plan for the Port of Weipa. As part of this plan, dredged material from the maintenance dredging has been relocated to three sites within Albatross Bay. Until recently, one of the sites at Hey Point was situated close (200m) to known seagrass meadows. Hey Point has now been discontinued as a relocation site (May 2000).

PCQ are responsible for the management of port environments and recognise that seagrasses are ecologically important and environmentally sensitive habitats of the port of Weipa. PCQ aims to minimise impacts of future port activities and infrastructure development by establishing baseline information on seagrass resources with a view to monitoring and maintaining the health of the Weipa port environment. The Marine Plant Ecology Group through the Department of Primary Industries was commissioned to undertake these baseline seagrass surveys.

Port of Weipa Seagrasses

The importance of seagrass meadows as structural components of coastal ecosystems is well recognised. These marine angiosperms are important for stabilising coastal sediments; providing food and shelter for a diverse variety of organisms; as a nursery ground for many prawns and fish of commercial importance; and for nutrient trapping and recycling (Short 1987; Larkum *et al.* 1989; Edgar and Kirkman 1989). Seagrass/algae beds have been rated the third most valuable ecosystem globally (on a per hectare basis) for ecosystem services, preceded only by estuaries and swamps/flood-plains (Costanza *et al.* 1997).

Seagrass distribution and species composition has been documented for Weipa during surveys by CSIRO in 1982 and 1989 (Dames & Moore 1995), during a broadscale survey by QDPI in 1986 (Coles et al. in prep), and more recently by WBM (1991) and Fisheries Research Consultants (1994) (Dames & Moore 1995). Collectively, the surveys have found up to six seagrass species in meadows located in the Embley, Hey and Mission Rivers and in an area south of Pine River Bay. No seagrasses were mapped in Pine River Bay. These surveys did not measure seagrass abundance or seasonal changes and most were performed without modern mapping aids such as differential Global Positioning Systems (dGPS) and Geographic Information Systems (GIS).

As seagrass abundance and distribution can vary significantly between seasons at other locations (McKenzie *et al.* 1998, Rasheed *et al.* 2001) and Weipa is subject to well defined wet and dry seasons, it was considered important to establish wet and dry season baselines of Weipa seagrass resources for future monitoring.

Study Site

The Port of Weipa is on the far north-west coast of Cape York Peninsula at approximately 12° 45’ S and 141° 53’ E. The region is in the wet-dry tropics and is subject to severe tropical cyclones (November - April). Weipa has a mean annual rainfall of 1768mm, the majority of which falls between November and April. Mean daily temperature minima range from 18.8°C in August to 24.0°C in January and maxima range from 30.5°C in July to 34.8°C in October (Australian Bureau of Meteorology 2001). Prevailing winds are south-easterly during the dry season and north-westerly during the wet season. (Figure 1).

Weipa is in the Albatross Bay catchment which is fed by the Mission, Hey, Pine and Embley Rivers and Nomenade Creek. The catchment has high biological diversity and comprises extensive wetlands, coastal dunes, sedgeland, saltpans and mangrove areas bordered by areas of vine, gallery and eucalypt forest on the bauxite plateaux (Weipa Catchment Coordinating Group 2000). The coastal area and catchments from Albatross Bay to Port Musgrave have been identified as wetlands of national conservation significance (Weipa Catchment Coordinating Group 2000).

Albatross Bay and its associated rivers and wetlands are important to commercial, recreational and local community subsistence fisheries. Seagrass meadows and mangrove areas in the Port of Weipa contribute to fishery catches by providing habitat for commercially important juvenile prawns and fish (Staples *et al.* 1985, Blaber *et al.* 1989, Haywood *et al.* 1995). Gill netting and trawling are not permitted in the Embley, Hey and Mission Rivers, nor in the upper region of the Pine River.

Sampling Approach

The sampling approach for the baseline seagrass surveys was based on the need to establish data on the area of seagrass meadows and seagrass characteristics such as above-ground biomass, seagrass species composition, percent cover of algae, and sediment characteristics of the major seagrass meadows. Results of the April and September 2000 baseline surveys will be used to develop an effective monitoring program for seagrass resources within the Port of Weipa. The aims were to:

1. Conduct baseline surveys of seagrass distribution and abundance within the port limits of Weipa in April and September 2000.

2. Provide quantitative data on the Port of Weipa seagrass communities from which a monitoring program can be developed to estimate and assess changes.

3. Determine the most suitable seagrass meadows for continued monitoring.

PCQ is considering the need to continue seasonal seagrass monitoring for an additional 2 years to determine seasonal changes. It has commited to funding two seasonal surveys in 2001. Following this, a long term seagrass monitoring program for the Port of Weipa will be developed.

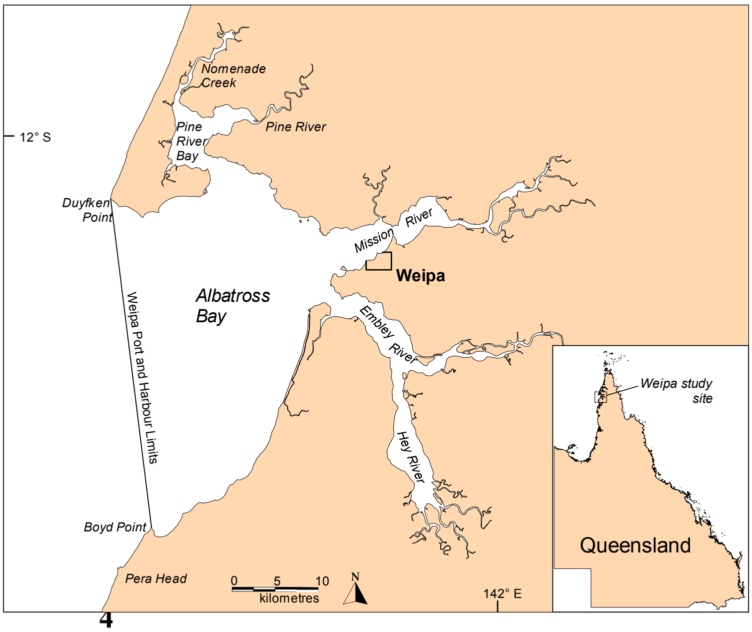


Figure 1. Locality map of Weipa showing port limits.

Methods

Seagrass baseline surveys were conducted from the 8th to 14th of April and from the 20th to 28th September 2000. The survey area extended to the Weipa Port and Harbour Limits, including Albatross Bay from Boyd Point to Duyfken Point, Pine River Bay and the tidal reaches of the Hey, Embley and Mission Rivers (Figure 1).

A variety of sampling methods were used to survey the seagrass meadows within the Port of Weipa. Methods applied were based on existing knowledge of seagrass distribution and physical characteristics of the area such as depth, visibility, logistical and safety constraints. Logistical constraints included the large area to be surveyed, the presence of crocodiles and the occurrence of seagrass both intertidally and subtidally.

In areas exposed at low tide, helicopter based mapping and sampling methods were used. In submerged areas, sampling methods were boat based and used underwater video and Van Veen sediment grabs. Helicopter based sampling is a time and cost effective method for surveying extensive intertidal areas at low tides. Helicopter reconnaissance can also direct boat based sampling effort to habitat areas likely to contain seagrass.

Helicopter based seagrass sampling methods included:

1. Reconnaissance, mapping and species validation – Exposed habitats were overflown at low tide to determine seagrass presence. Where seagrass was present, ground truthing of the habitat while hovering less than a metre above the ground determined the range of seagrass species, meadow landscape category (Figure 2) and sediment categories. The boundary of each meadow was mapped while hovering directly over the meadow edge and the position fixed using a dGPS. The position of submerged areas likely to contain seagrass was noted to help focus effort during the boat-based surveys.

2. Above-ground seagrass biomass sampling – Seagrass meadow characteristics was collected at ground truth sites scattered 100 to 200m apart within the seagrass meadows while hovering less than a metre above the habitat. Site positions were recorded using a dGPS. Only meadows that were considered suitable for inclusion in a future seagrass monitoring program were sampled for above-ground biomass.

Submerged intertidal and subtidal areas were mapped and sampled using boat-based methods. A real time underwater video camera system was deployed from a small boat and used to assess seagrass habitats. Ground truth sites were located every 100-200 m along transects that extended for 1 to 2 km perpendicular from the shoreline and were spaced from 1 to 5 km apart. Sites were scattered between transects to determine habitat continuity. A greater density of transects and sites were used where habitat complexity was high or reconnaissance surveys indicated areas were likely to contain seagrass. Where submerged seagrass meadows were found, transects extended from upper intertidal reaches to at least 200 m beyond meadow edges or a minimum of 2 sites with no seagrass presence. A Van Veen grab was used to confirm the seagrass species identified on the camera monitor, to determine presence of seagrass rhizome, and to assess sediment type.

At each seagrass biomass sampling site, seagrass meadow characteristics including seagrass species composition, above-ground biomass, % algae cover, water depth (boat only), sediment type, time and differential Global Positioning System (dGPS) fixes were recorded.

Seagrass biomass (above-ground) was determined using a modified "visual estimates of biomass" technique described by Mellors (1991). This technique involves an observer ranking seagrass biomass in the field in 3 random placements of a 0.25m^2 quadrat at each site by referring to a series of quadrat photographs of similar seagrass habitats for which the above-ground biomass has been measured. This method was used for the helicopter and boat/camera based techniques. Three separate biomass ranges were used in Weipa; low-biomass, high biomass and very high biomass (*Enhalus acoroides*). The relative proportion of each seagrass species within each survey quadrat was also recorded. These ranks were then converted into above-ground biomass estimates in grams dry weight per square metre (g DW m^{-2}) using a linear regression for the ranks of the reference quadrat photographs. Sampling methods varied according to whether habitat was exposed or submerged at low tide.

Depths were recorded with an echo-sounder and converted to depths (m) below mean sea level, correct to tidal plane datums for the localities surveyed. Field descriptions of sediment categories from hand or Van Veen grab samples were recorded for each site. Sediment categories used were mud, sand, shell, gravel, rubble, rock and reef. Sediment categories were determined by the dominant sediment type (eg. sand/mud = more sand than mud). Portable dGPS were used in the field to determine geographic position (± 5 metres) of all sampling sites.

The presence and types of meadows determined in the baseline surveys was based on above-ground seagrass evidence only. Below-ground rhizome presence was not assessed during helicopter sampling although sediment grab samples from the boat survey were checked for all evidence of seagrass.

Isolated seagrass patches - The majority of area within the meadows consisted of unvegetated sediment interspersed with isolated patches of seagrass.

Aggregated seagrass patches - Meadows comprised of numerous seagrass patches but still featured substantial gaps of unvegetated sediment within the meadow boundaries

Continuous seagrass meadow - The majority of area within the meadows was comprised of continuous seagrass cover interspersed with a few gaps of unvegetated sediment.

Figure 2. Seagrass meadow landscape categories used in the Port of Weipa, April and September 2000 baseline surveys.

Geographic Information System

All survey data were entered onto a Geographic Information System (GIS) for presentation of seagrass species distribution and abundance. The seagrass GIS was created in Mapinfo® using the survey information. Three GIS layers were created for each survey to describe Weipa seagrasses:

1. Site information – Point data containing all the information collected at seagrass characterisation sites.
2. Seagrass meadows and characteristics- Polygon or area data for the seagrass meadows with summary information on the meadow characteristics.
3. Seagrass meadow cover type – Polygon layer displaying the seagrass meadow cover categories.

A variety of methods were used to determine seagrass meadow boundaries. Rectified colour aerial photographs (June 1989, 1:25000) (courtesy Beach Protection Authority), topographic maps, and aerial photography taken from the helicopter during the survey assisted with mapping. Where possible, meadow boundaries were mapped in the field using a dGPS from low level helicopter. In subtidal areas where meadows could not be viewed from the air, boundaries were determined by underwater camera surveys. Other information including depth below MSL, substrate type, the shape of existing geographical features such as banks and embayments, and evidence of strong wave energy or tidal currents was also interpreted and used in determining meadow boundaries. Boundary mapping using computer modelling techniques (*eg.* Qld. Department of Environment & Heritage 1997) does not take into account these additional factors and is therefore less accurate.

Errors associated with mapping varied according to the mapping methods used for each meadow. Mapping error estimates for each meadow were determined taking into account the various sources of error. Each seagrass meadow was assigned a qualitative mapping value (±m), determined by the data sources and accuracy of mapping (Table 1). Estimates of reliability in mapping the boundaries of the seagrass meadows were based on the range of mapping information available for each meadow (Table 1). Other sources of mapping error associated with digitising and rectifying aerial photographs and topographic charts onto basemaps and with dGPS fixes for survey sites were assumed to be embedded within mapping method errors. The area for the mapping error was calculated using Mapinfo®.

Table 1. Ranks of mapping quality for seagrass meadows mapped in the Port of Weipa

Map Quality	Data sets	Comments	Error
1	Helicopter boundary mapping with high density of dGPS mapping sites & ground truthing (helicopter or camera)	Detailed mapping of meadow boundary during helicopter surveys. Meadows completely exposed or visible at low tide. High number of ground truthing sites.	0.5-5m
2	Helicopter boundary mapping with low density of dGPS mapping sites & limited ground truthing (helicopter or camera)	Meadow boundaries mapped by helicopter with a low density of dGPS mapping sites and limited ground truthing.	10-15m
3	Helicopter reconnaissance with limited dGPS mapping points	Meadow boundaries mapped with helicopter at higher altitude and limited ground truthing	20-50m
4	Underwater video survey only	Meadow boundaries determined by camera ground truth surveys only. Error based on distance between camera survey sites.	50m
5	Helicopter reconnaissance only	Meadow boundaries hand drawn on chart during helicopter reconnaissance. No dGPS mapping sites.	50-100m

Results

Seagrass species, distribution and abundance

Seven seagrass species (from 2 families) were identified in the Port of Weipa during April and September 2000 baseline surveys:

Family **CYMODOCEACEAE** Taylor

Halodule pinifolia (Miki) den Hartog
Halodule uninervis (wide leaf morphology) (Forsk.) Aschers
Syringodium isoetifolium (Aschers.) Dandy

Family **HYDROCHARITACEAE** Jussieu

*Enhalus acoroides (*L.*f*.) Royle
Halophila decipiens Ostenfield
Halophila ovalis (Br.) D.J. Hook.
Thalassia hemprichii (Ehrenb.) Aschers. in Petermann

246 underwater video camera and 113 helicopter sites were surveyed in April (Maps 1-10), and 252 video camera and 214 helicopter sites were surveyed in September (Maps 1-10). Most seagrass was found in intertidal or shallow subtidal areas on mud, mud/shell and sandy substrates. No seagrass was found in depths greater than 4.0m below MSL in April and 5.3m below MSL in September. The total area of seagrass habitat mapped was 3511 ±528 ha in April and 4688 ±418 ha in September in 74 meadows in both surveys (Maps 1-10; Table 2).

Six mixed species meadow types were identified in April (Table 2). These were categorised according to each meadow's dominant species:

1. *Enhalus acoroides*
2. *Halodule pinifolia*
3. *Halophila decipiens*
4. *Halophila ovalis*
5. *Halophila ovalis/Halodule pinifolia*
6. *Thalassia hemprichii*

An additional 3 meadow types were identified in September (Table 2):

1. *Halodule pinifolia/Halophila decipiens*
2. *Halodule uninervis* (wide)
3. *Syringodium isoetifolium*

Halophila ovalis meadows were the most common meadow type in April and September (37% and 41% of total seagrass area, respectively), followed by *Halophila ovalis/Halodule pinifolia* meadows (35% and 31%, respectively) and *Enhalus acoroides* dominated meadows (24% and 23%, respectively) (Table 2; Maps 11-20).

The distribution of meadows dominated by *Halophila ovalis* and/or *Halodule pinifolia* within the Port of Weipa was highly variable between surveys. By September, several new meadows with these species had formed, some meadows identified in April were absent, and several smaller isolated meadows (Andoomajettie Point, Evans Point, and Hey River) increased in distribution and joined with nearby meadows (Maps 11-20).

The majority of meadows in April were isolated seagrass patches (42% of all meadows), while in September the majority of meadows consisted of aggregated seagrass patches

(47% of all meadows). More meadows were of continuous seagrass cover in September than April (24% and 16%, respectively) (Table 2).

Mean above-ground biomass of seagrass meadows dominated by lower biomass species (*Halophila ovalis*, *Halodule pinifolia*) showed an increase from April to September in the Port of Weipa while higher biomass species dominated meadows (*Enhalus acoroides*, *Thalassia hemprichii*) decreased (Figure 3). The range of biomass for *Enhalus acoroides* meadows decreased while all other meadows increased (Figure 3).

Many dugong feeding trails were observed within a *Halophila/Halodule* meadow along the eastern shore of the Embley River, although no dugongs were sighted during our helicopter surveys. Large (> 3 metres) crocodiles were frequently seen throughout both surveys on banks and swimming along the edges of seagrass meadows in all three rivers and Pine River Bay.

Table 2. Mean above-ground biomass, number of individual meadows, and distribution for each seagrass meadow type identified in the Port of Weipa in April and September 2000.

(Numbers in brackets indicate the number of meadows where biomass data were collected; R is an estimate of reliability associated with mapping meadow boundaries; na indicates no biomass data collected, - indicates the meadow type was not found during that survey)

Meadow type	Number of meadows		Total meadow area ±R (ha)		Mean meadow biomass (g DW m^{-2}) ±SE	
	April	Sept	April	Sept	April	Sept
Enhalus acoroides	23 (8)	27 (11)	842 ±70	1083 ±83	78.25 ±23.80	51.45 ±8.26
Halodule pinifolia	5 (5)	4 (2)	92 ±65	11 ±7	0.71 ±0.22	0.21 ±0.06
Halodule pinifolia/Halophila decipiens	-	1 (1)	-	118 ±38	-	1.44
Halodule uninervis (wide)	-	2 (1)	-	2.7 ±2.0	-	7.84
Halophila decipiens	1 (0)	2 (2)	0.6 ±0.2	1.4 ±1.1	*na*	0.15 ±0.02
Halophila ovalis	20 (7)	13 (10)	1299 ±178	1914 ±172	2.56 ±1.44	5.07 ±2.76
Halophila ovalis/Halodule pinifolia	23 (15)	15 (14)	1241 ±209	1449 ±101	8.84 ±2.68	19.24 ±6.67
Syringodium isoetifolium	-	2 (2)	-	31 ±3	-	14.85 ±0.55
Thalassia hemprichii	2 (2)	8 (5)	37 ±6	77 ±11	64.11	40.07 ±15.34
TOTAL	**74 (37)**	**74 (48)**	**3511 ±528**	**4688 ±418**	**24.55 ±7.56**	**23.46 ±4.40**

Table 3. Percentages of seagrass meadow types within each cover type in the Port of Weipa, April and September 2000.

Meadow type	% of meadows with					
	Continuous cover		Aggregated patches		Isolated patches	
	April	September	April	September	April	September
Enhalus acoroides	13	12	30	44	57	44
Halodule pinifolia	60	25	40	50	0	25
Halodule pinifolia/Halophila decipiens	-	100	-	0	-	0
Halodule uninervis (wide)	-	100	-	0	-	0
Halophila decipiens	0	0	100	50	0	50
Halophila ovalis	15	23	60	46	25	31
Halophila ovalis/Halodule pinifolia	9	13	65	74	26	13
Syringodium isoetifolium	-	100	-	0	-	0
Thalassia hemprichii	50	50	50	38	0	12
TOTAL	**16**	**24**	**42**	**47**	**42**	**29**

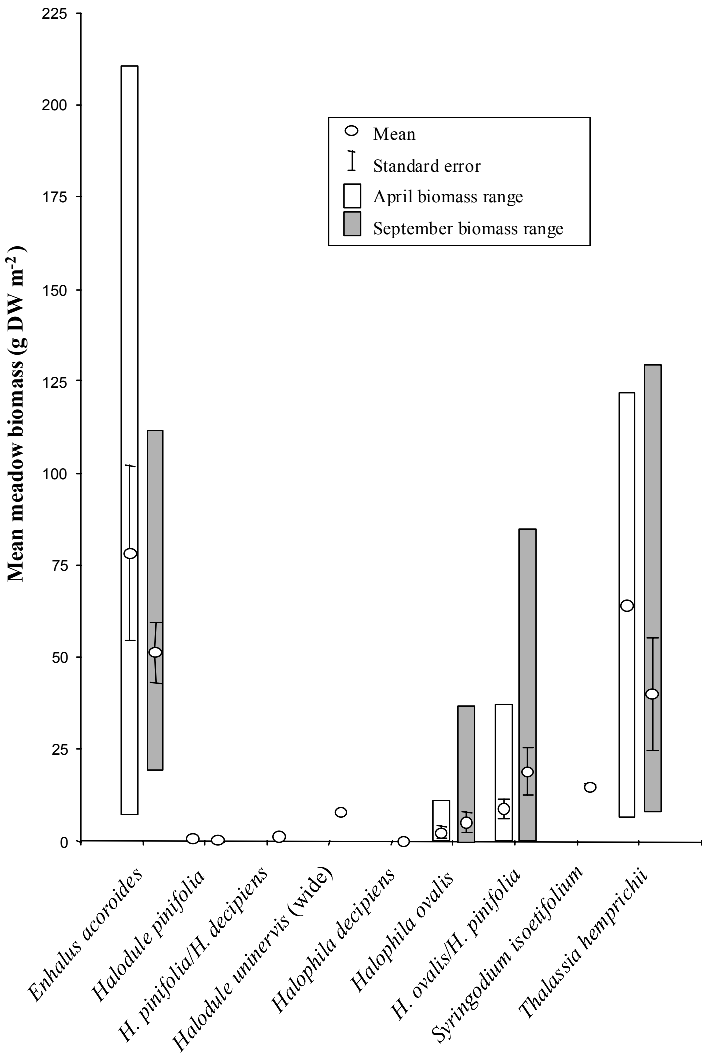


Figure 3. Mean, standard error and range of above-ground biomass for each seagrass meadow type in the Port of Weipa, April and September 2000.

Pine River Bay Seagrasses

Pine River Bay had a diverse range of seagrass types which covered large areas of the bay in both surveys. Two seagrass habitat types covered the majority of the bay; patchy *Halophila ovalis* meadows on intertidal mud banks, and patchy *Halophila ovalis/Halodule pinifolia* meadows on intertidal sand/mud banks (Maps 11 & 12). The area of these meadows increased from April to September, particularly in the central region of the bay and along the south-eastern shoreline. No seagrass was found in deeper channel regions within Pine River Bay.

Other seagrass habitats in the Pine River Bay area included small *Halophila ovalis/Halodule pinifolia* meadows in Crawford Creek, several small patchy *Enhalus acoroides* meadows along the western shore, and *Thalassia hemprichii* meadows along the southern shore of the bay. Three additional *Thalassia hemprichii* meadows were identified in September along the southern shoreline and adjacent to Bagley Channel (Map 12). *Halodule pinifolia* meadows were identified on sandy substrates along the shoreline between Pine River Bay and Hatchman Point in April, one of which was absent in the September survey. An isolated *Enhalus acoroides* meadow was found in a tidal lagoon near Bagley Channel (maps 11&12).

Two additional seagrass species were identified in Pine River Bay in September (Map 12). A *Syringodium isoetifolium* dominated meadow was identified on mud/sand substrate on the eastern side of the bay. *Halodule uninervis* (wide leaf morphology) meadows were also found; one at the mouth of a creek neighbouring Crawford Creek and another on a narrow intertidal mud/shell bank bordering a small mangrove island in Nomenade Creek in the northern most reaches of the bay (Maps 11&12).

Andoomajettie Point and Mission River Seagrasses

Seagrasses in Mission River were less diverse than Pine River Bay. Patchy *Halophila ovalis* and *Halophila ovalis/Halodule pinifolia* meadows occurred downstream of the Mission River bridge, and very patchy *Enhalus acoroides* meadows dominated upstream of the bridge. Total area of these meadows increased from April to September (Maps 13&14).

Patchy *Halophila ovalis/Halodule pinifolia* meadows on intertidal mud/shell banks near Andoomajettie Point had joined to become a single meadow by September. Two small *Thalassia hemprichii* meadows, a small patchy *Enhalus acoroides* meadow and another smaller *Halophila ovalis* meadow were identified in shallow bays near Rhum Point in September (Maps 13&14).

Embley and Hey River Seagrasses

The Embley River had the densest and largest continuous seagrass meadows in the Port of Weipa survey area (Maps 15&16). Dense meadows of *Enhalus acoroides* dominated in the river north of Hey Point and large *Halophila/Halodule* meadows were found on Cyclone Island and along the eastern shore. *Enhalus acoroides* meadows on the eastern side of the Embley River were generally less dense than the western side. The large continuous *Enhalus acoroides* meadow found along the western bank had separated into two meadows by September. *Enhalus acoroides* meadows along the eastern bank increased in area from April to September. Additional small patchy meadows of *Enhalus acoroides* were identified in September off the end of Humbug Wharf, and close to shore, west of Evans Landing (Map 16).

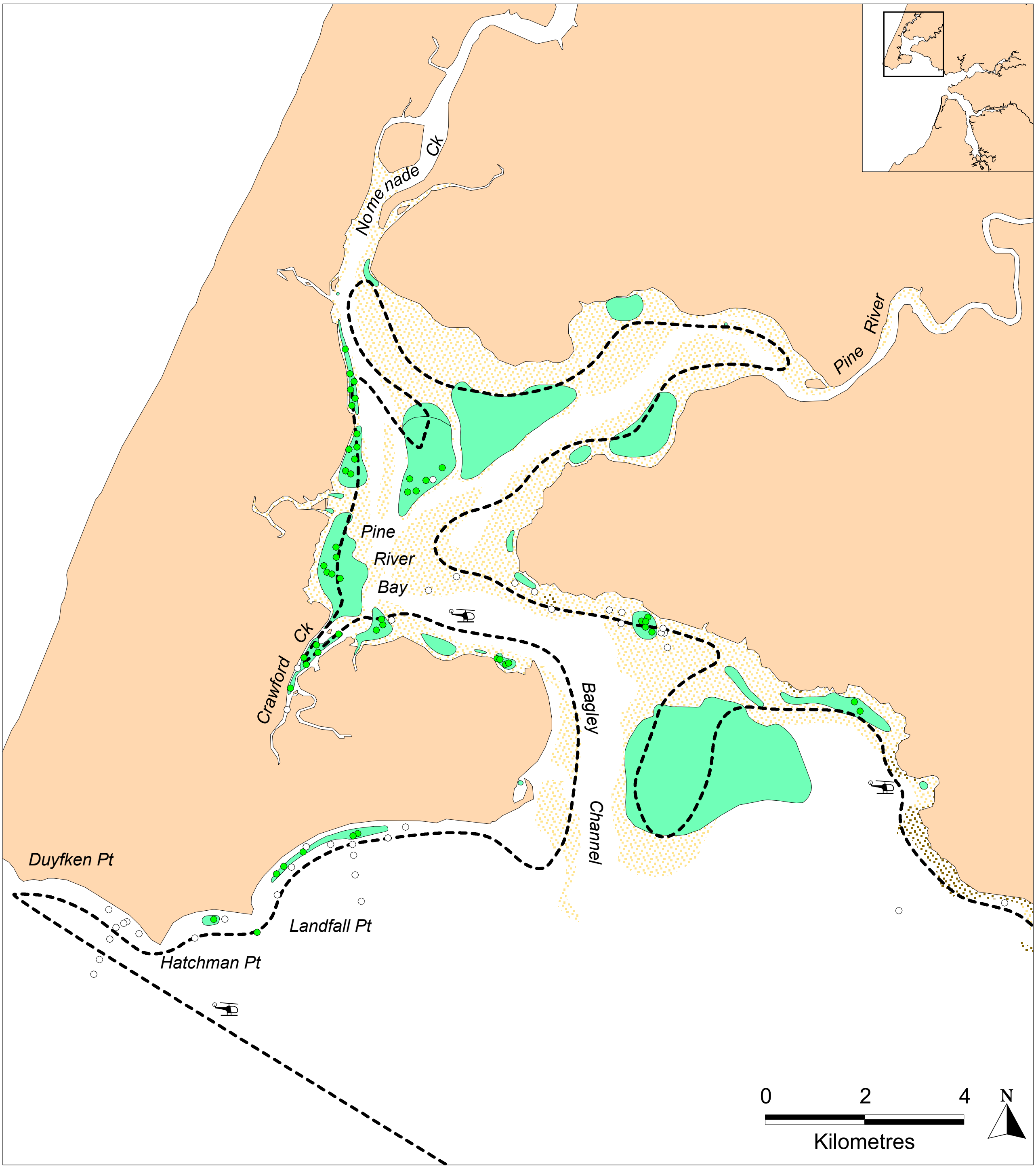
A *Thalassia hemprichii* meadow on mud/sand substrate near Evans Point had merged with a nearby *Halophila ovalis/Halodule pinifolia* meadow by September (map 16). *Halophila ovalis* and *Halodule pinifolia* meadows identified on intertidal mud banks upstream from Hey Point, were absent in September (Maps 15&16).

Major seagrass habitats in the Hey River comprised large patchy *Halophila ovalis/Halodule pinifolia* meadows on mud substrates along the western shore in April and September (Maps 17&18).

Hey River to Boyd Point Seagrasses

Only one seagrass meadow was found in April in southern Albatross Bay; a *Halodule pinifolia* meadow in the bay east of Boyd Point (Map 19). This meadow increased in area by September and also contained *Halophila decipiens* (Map 20). An additional small *Halophila decipiens* meadow was identified further north of Boyd Point on sand/mud/shell substrate in September (Maps 19&20).

MAP 1. Seagrass meadows, biomass sampling sites and helicopter flight path in Pine River Bay, April 2000.



LEGEND

- Approximate helicopter flight path
- Sampling site with no seagrass
- Sampling site with seagrass
- Seagrass meadow
- Sand and mud banks
- Intertidal reefs

Source:
Roelofs, A.J., Rasheed, M.A. and Thomas, R. (2001). Port of Weipa Seagrass Monitoring Baseline Surveys, April & September 2000. *Ecoports Monograph Series No. 21*. (Ports Corporation of Queensland, Brisbane). 38 pp.

Sampling dates: 8 - 14th April 2000:
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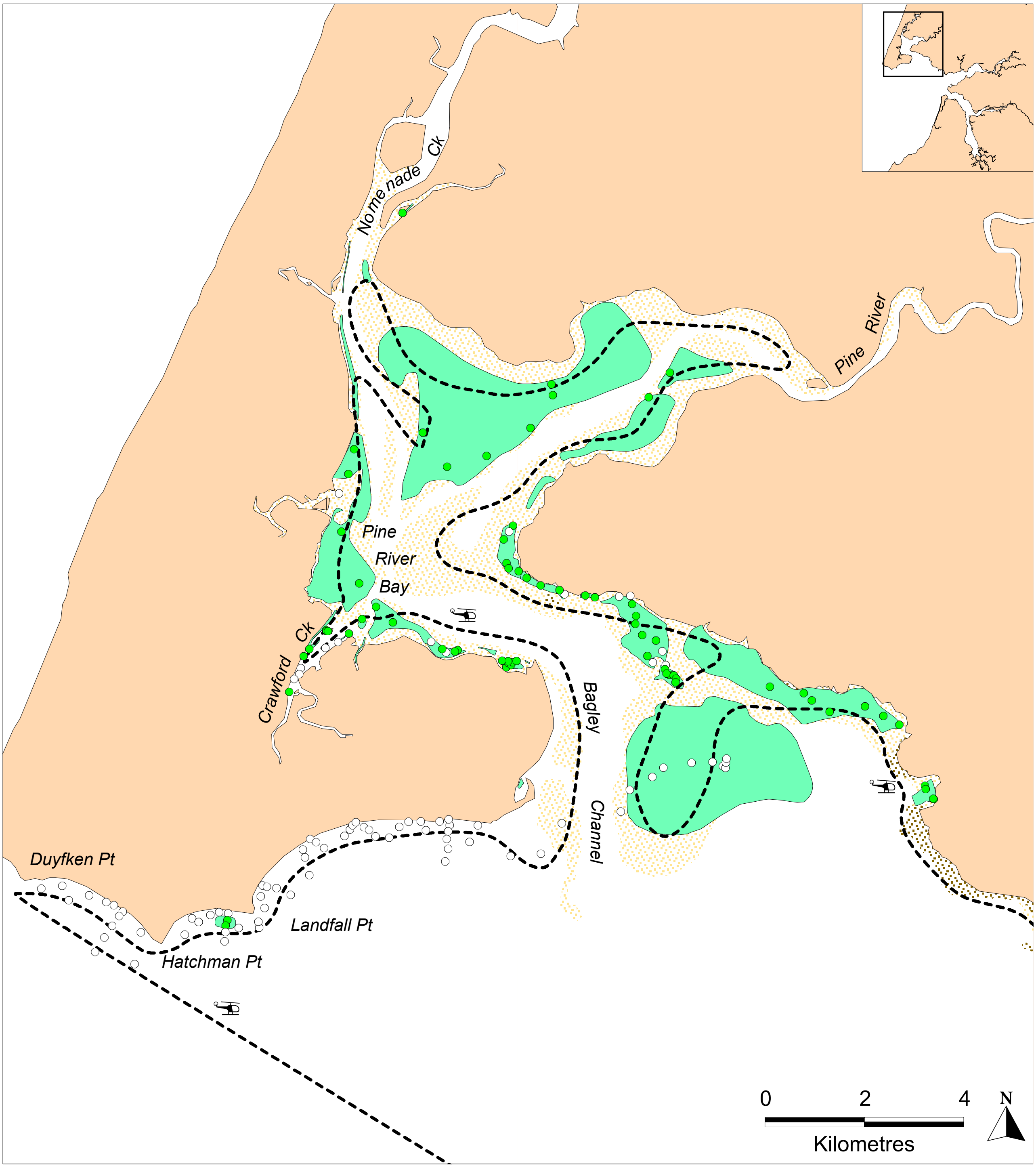
MAP 2. Seagrass meadows, biomass sampling sites and helicopter flight path in Pine River Bay, September 2000.



LEGEND

- Approximate helicopter flight path
- Sampling site with no seagrass
- Sampling site with seagrass
- Seagrass meadow
- Sand and mud banks
- Intertidal reefs

Source:
Roelofs, A.J., Rasheed, M.A. and Thomas, R. (2001). Port of Weipa Seagrass Monitoring Baseline Surveys, April & September 2000. *Ecoports Monograph Series No. 21*, (Ports Corporation of Queensland, Brisbane). 38 pp.

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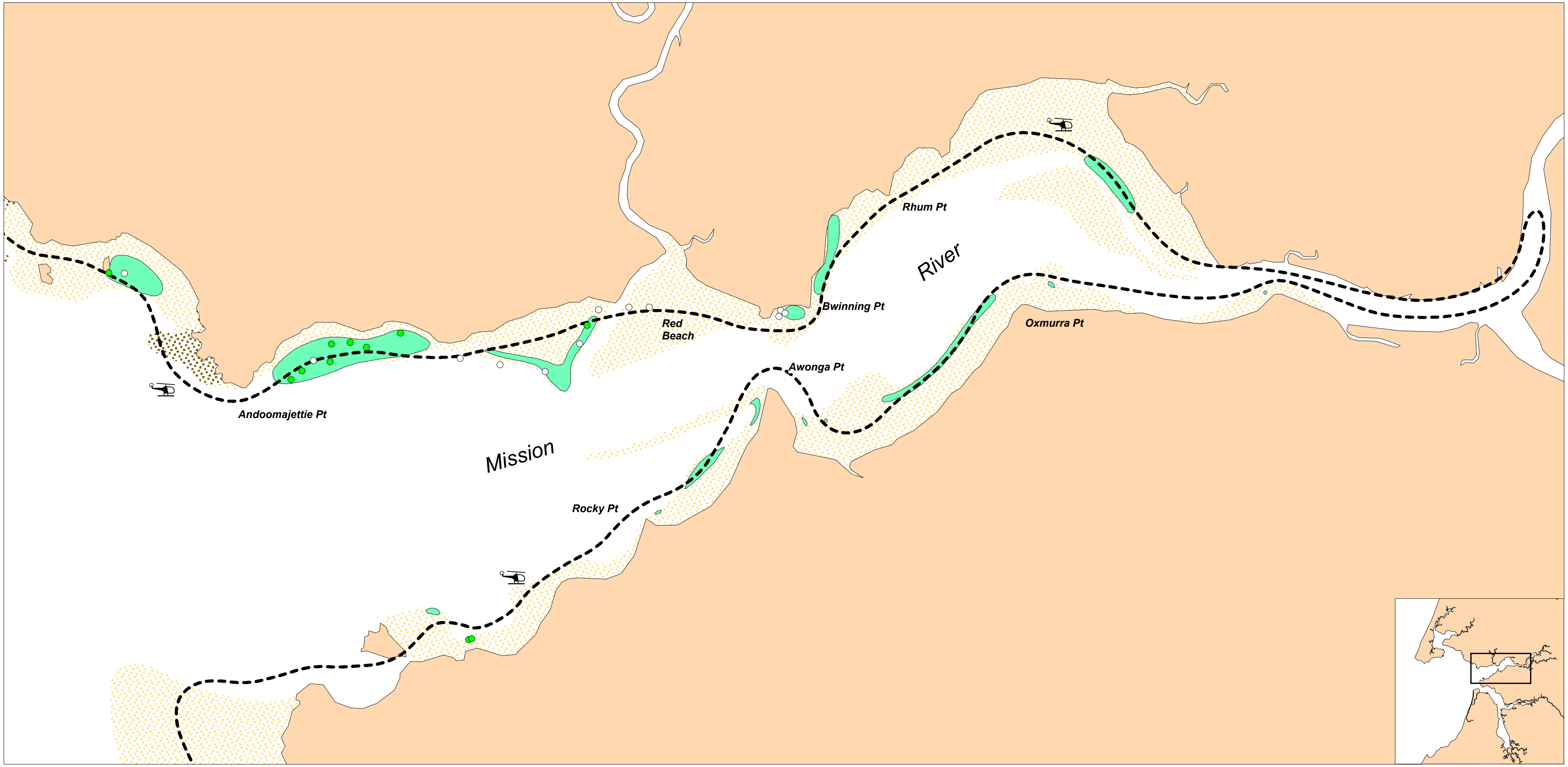
MAP 3. Seagrass meadows, biomass sampling sites and helicopter flight path in the Mission River, April 2000.



0 2 4
Kilometres
N

LEGEND

- Approximate helicopter flight path
- Sampling site with no seagrass
- Sampling site with seagrass
- Seagrass meadow
- Sand and mud banks
- Intertidal reefs

Source:
Roelofs, A.J., Rasheed, M.A. and Thomas, R. (2001). Port of Weipa Seagrass Monitoring Baseline Surveys, April & September 2000. *Ecoports Monograph Series No. 21.* (Ports Corporation of Queensland, Brisbane) 38 pp.

Sampling dates: 8 - 14th April; 20 - 25th September 2000.

Funded by the Ports Corporation of Queensland and the Queensland Fisheries Service (QFS).

Produced by the Marine Plant Ecology Group, QFS,
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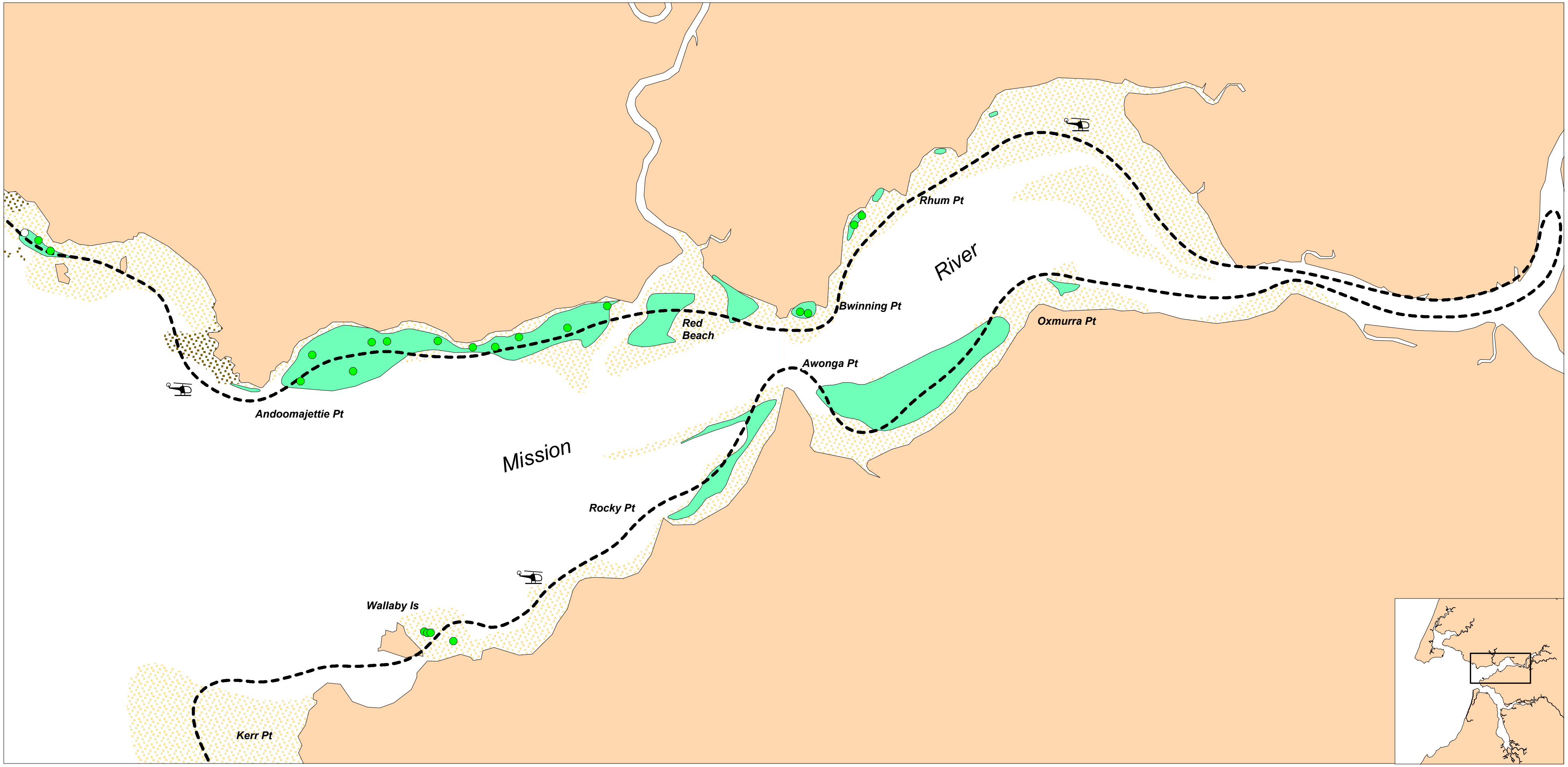
MAP 4. Seagrass meadows, biomass sampling sites and helicopter flight path in the Mission River, September 2000.



LEGEND

- Approximate helicopter flight path
- Sampling site with no seagrass
- Sampling site with seagrass
- Seagrass meadow
- Sand and mud banks
- Intertidal reefs

Source:
Roelofs, A.J., Rasheed, M.A. and Thomas, R. (2001). Port of Weipa Seagrass Monitoring Baseline Surveys, April & September 2000. *Ecoports Monograph Series No. 21.* (Ports Corporation of Queensland, Brisbane) 38 pp.

Sampling dates: 8 - 14th April; 20 - 25th September 2000.

Funded by the Ports Corporation of Queensland and the Queensland Fisheries Service (QFS).

Produced by the Marine Plant Ecology Group, QFS,
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0 2 4
Kilometres

N

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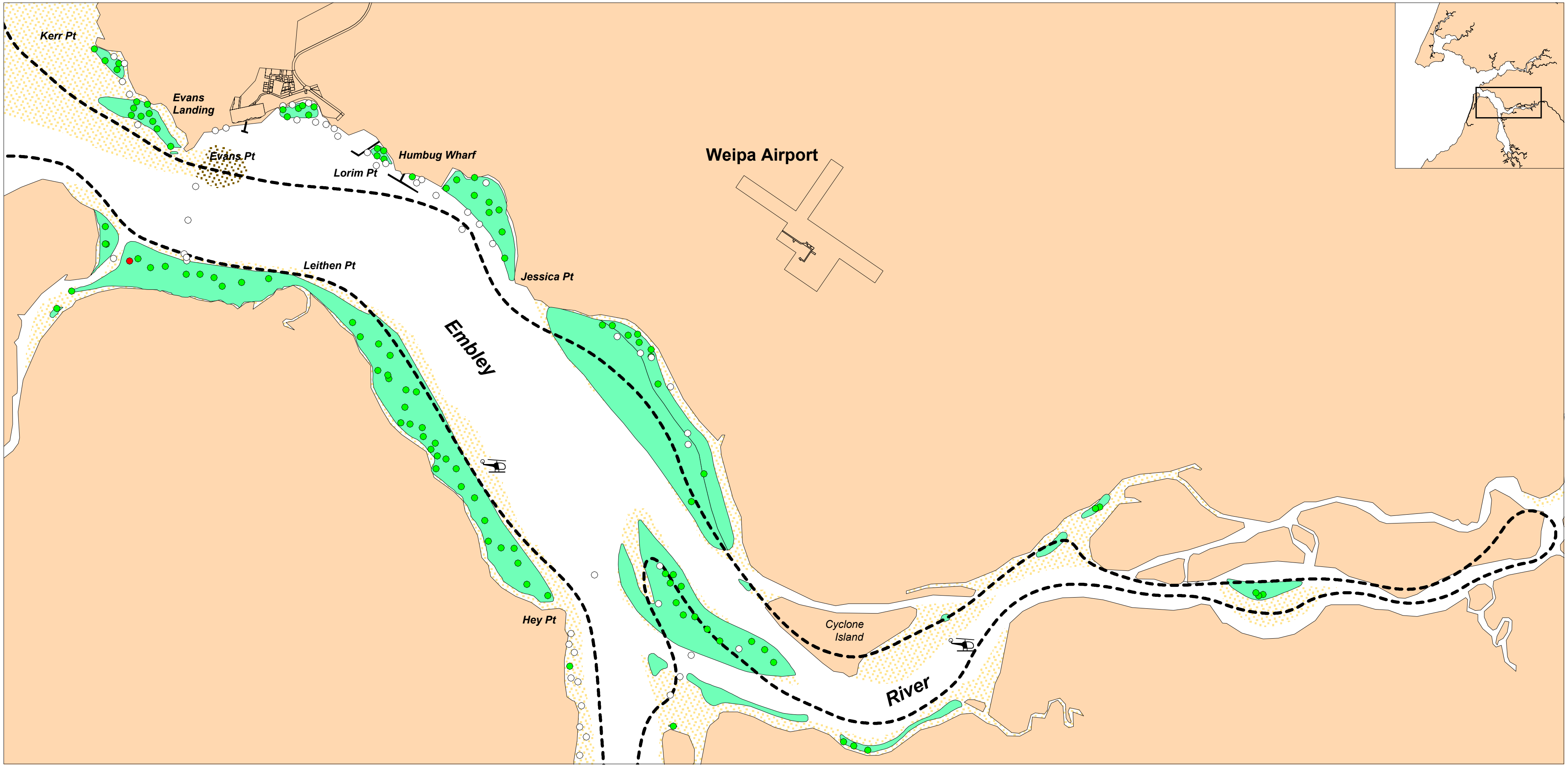
MAP 5. Seagrass meadows, biomass sampling sites and helicopter flight path in the Embley River, April 2000.



LEGEND

- Approximate helicopter flight path
- Sampling site with no seagrass
- Sampling site with seagrass
- Seagrass meadow
- Sand and mud banks
- Intertidal reefs

0 2 4

Kilometres

N

Source:
Roelofs, A.J., Rasheed, M.A. and Thomas, R. (2001). Port of Weipa Seagrass Monitoring Baseline Surveys, April & September 2000. *Ecoports Monograph Series No. 21.* (Ports Corporation of Queensland, Brisbane) 38 pp.

Sampling dates: 8 - 14th April; 20 - 25th September 2000.

Funded by the Ports Corporation of Queensland and the Queensland Fisheries Service (QFS).

Produced by the Marine Plant Ecology Group, QFS,
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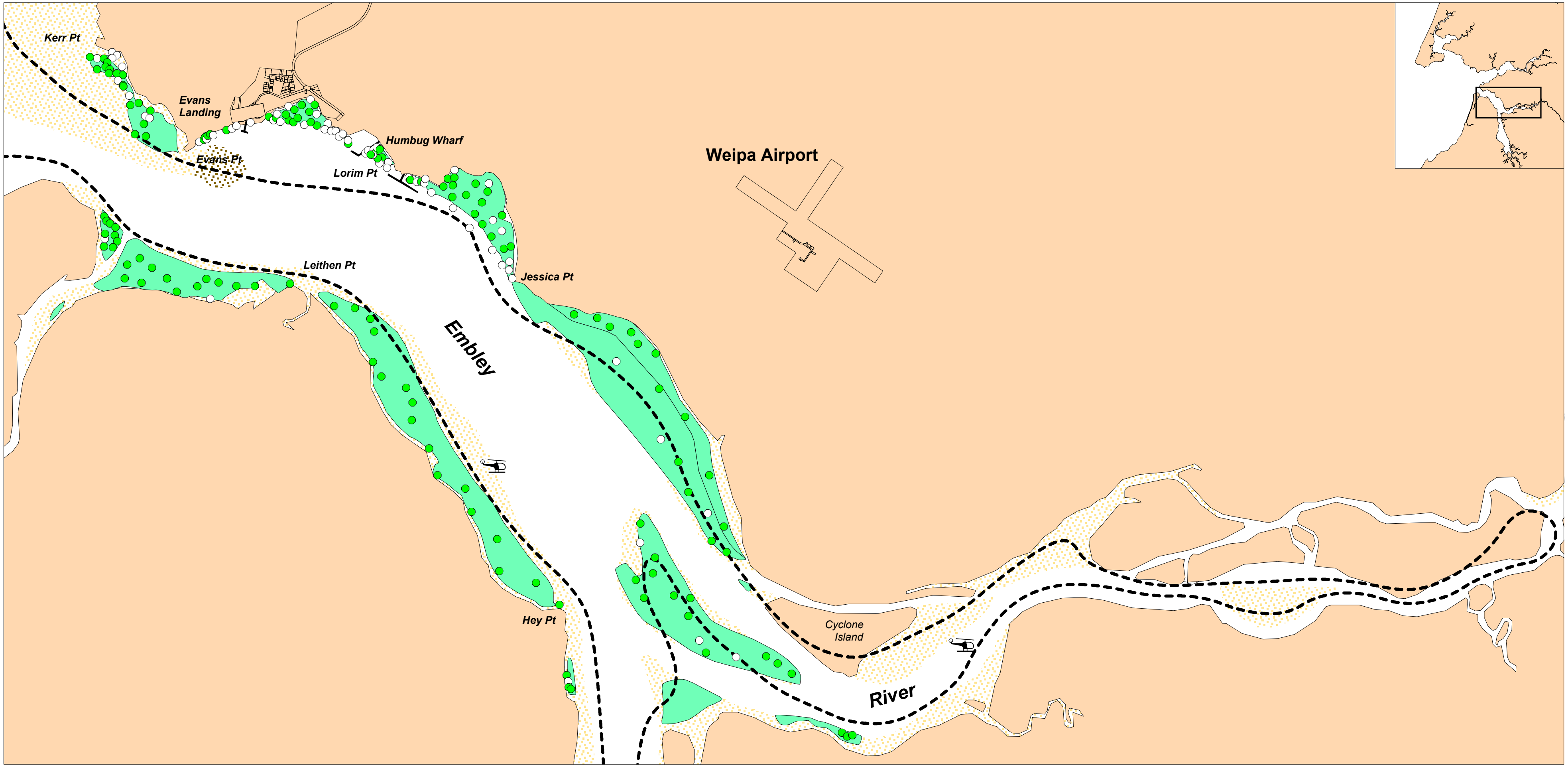
MAP 6. Seagrass meadows, biomass sampling sites and helicopter flight path in the Embley River, September 2000.



LEGEND

- Approximate helicopter flight path
- Sampling site with no seagrass
- Sampling site with seagrass
- Seagrass meadow
- Sand and mud banks
- Intertidal reefs

0 2 4

Kilometres

N

Source:
Roelofs, A.J., Rasheed, M.A. and Thomas, R. (2001). Port of Weipa Seagrass Monitoring Baseline Surveys, April & September 2000. *Ecoports Monograph Series No. 21.* (Ports Corporation of Queensland, Brisbane) 38 pp.

Sampling dates: 8 - 14th April; 20 - 25th September 2000.

Funded by the Ports Corporation of Queensland and the Queensland Fisheries Service (QFS).

Produced by the Marine Plant Ecology Group, QFS,
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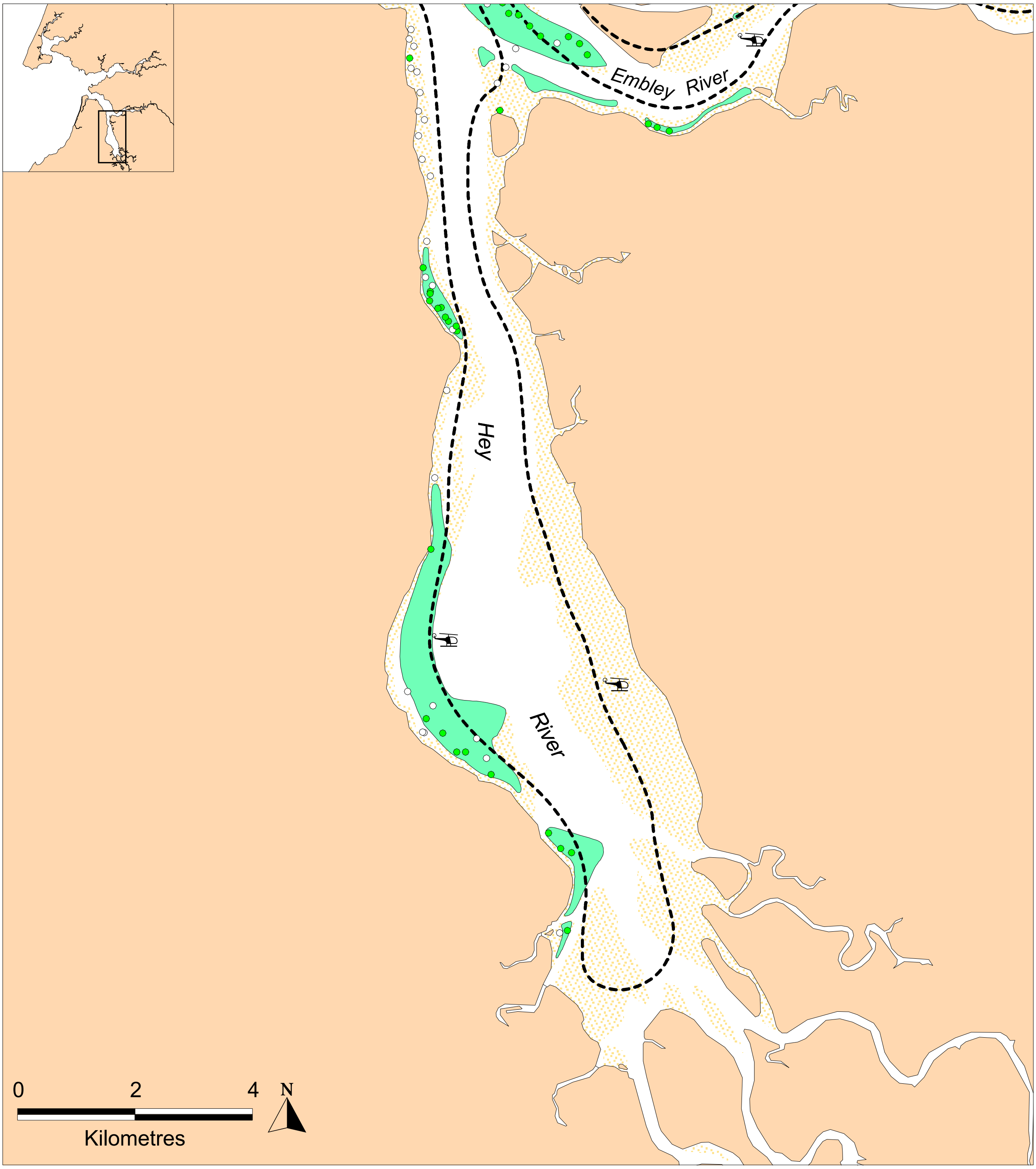
MAP 7. Seagrass meadows, biomass sampling sites and helicopter flight path in the Hey River, April 2000.



LEGEND

- Approximate helicopter flight path
- Sampling site with no seagrass
- Sampling site with seagrass
- Seagrass meadow
- Sand and mud banks

Source:
Roelofs, A.J., Rasheed, M.A. and Thomas, R. (2001). Port of Weipa Seagrass Monitoring Baseline Surveys, April & September 2000. *Ecoports Monograph Series No. 21*. (Ports Corporation of Queensland, Brisbane). 38 pp.

Sampling dates: 8 - 14th April 2000:
20 - 25th September 2000.

Funded by the Ports Corporation of Queensland and the Queensland Fisheries Service (QFS).

Produced by the Marine Plant Ecology Group, QFS, Northern Fisheries Centre, Cairns, 2001.

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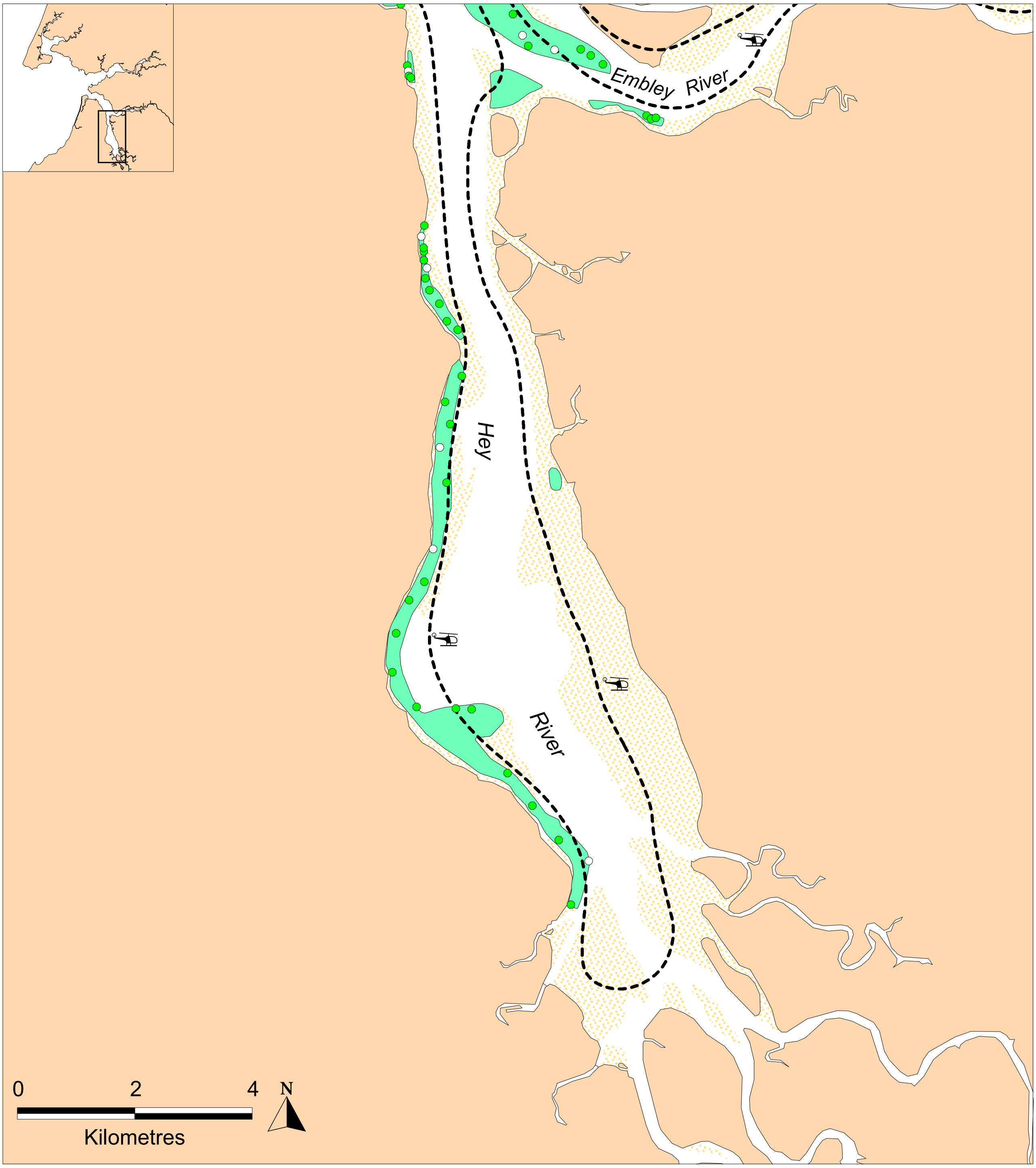
MAP 8. Seagrass meadows, biomass sampling sites and helicopter flight path in the Hey River, September 2000.



LEGEND

- Approximate helicopter flight path
- Sampling site with no seagrass
- Sampling site with seagrass
- Seagrass meadow
- Sand and mud banks

Source:
Roelofs, A.J., Rasheed, M.A. and Thomas, R. (2001). Port of Weipa Seagrass Monitoring Baseline Surveys, April & September 2000. *Ecoports Monograph Series No. 21*, (Ports Corporation of Queensland, Brisbane). 38 pp.

Sampling dates: 8 - 14th April 2000:
20 - 25th September 2000.

Funded by the Ports Corporation of Queensland and the Queensland Fisheries Service (QFS).

Produced by the Marine Plant Ecology Group, QFS, Northern Fisheries Centre, Cairns, 2001.

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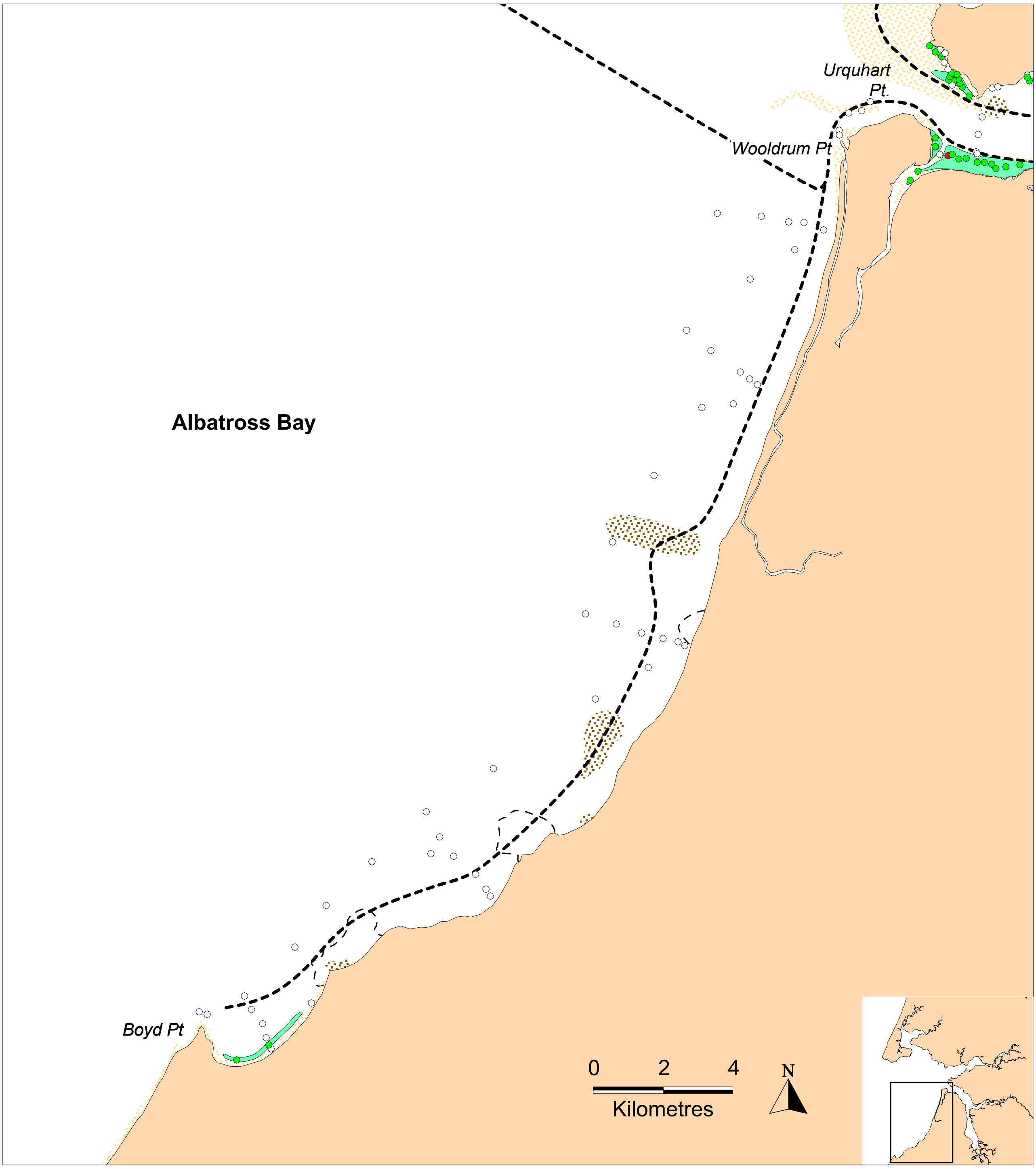
MAP 9. Seagrass meadows, biomass sampling sites and helicopter flight path in southern Albatross Bay, April 2000.



LEGEND

Approximate helicopter flight path
Sampling site with no seagrass
Sampling site with seagrass
Seagrass meadow
Sand and mud banks
Intertidal reefs
Submerged reefs

Source:
Roelofs, A.J., Rasheed, M.A. and Thomas, R. (2001). Port of Weipa Seagrass Monitoring Baseline Surveys, April & September 2000. *Ecoports Monograph Series No. 21*. (Ports Corporation of Queensland, Brisbane). 38 pp.

Sampling dates: 8 - 14th April 2000:
20 - 25th September 2000.

Funded by the Ports Corporation of Queensland and the Queensland Fisheries Service (QFS).

Produced by the Marine Plant Ecology Group, QFS, Northern Fisheries Centre, Cairns, 2001.

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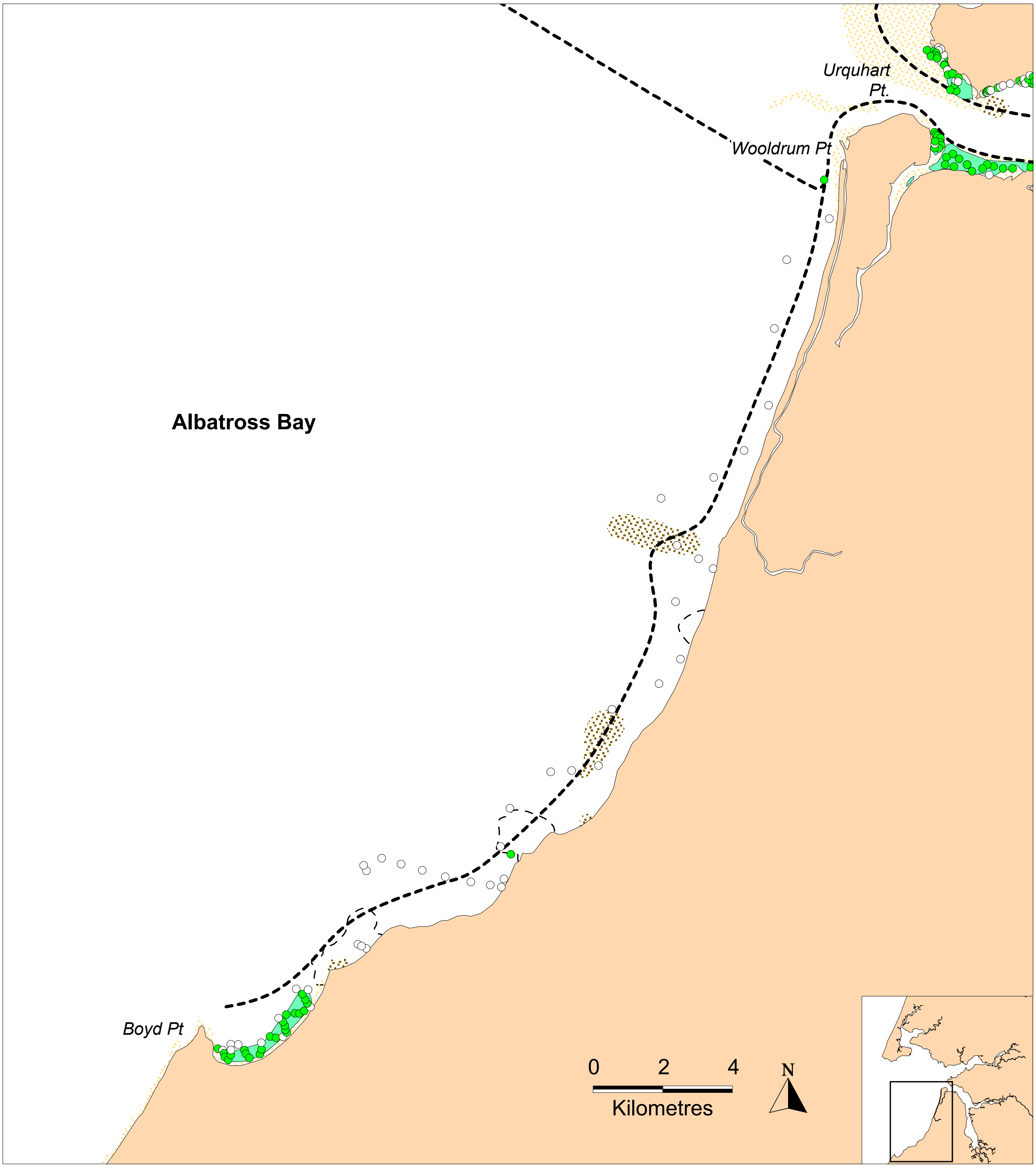
MAP 10. Seagrass meadows, biomass sampling sites and helicopter flight path in southern Albatross Bay, September 2000.



LEGEND

Approximate helicopter flight path

Sampling site with no seagrass

Sampling site with seagrass

Seagrass meadow

Sand and mud banks

Intertidal reefs

Submerged reefs

Source:
Roelofs, A.J., Rasheed, M.A. and Thomas, R. (2001). Port of Weipa Seagrass Monitoring Baseline Surveys, April & September 2000. *Ecoports Monograph Series No. 21*, (Ports Corporation of Queensland, Brisbane). 38 pp.

Sampling dates: 8 - 14th April 2000:
20 - 25th September 2000.

Funded by the Ports Corporation of Queensland and the Queensland Fisheries Service (QFS).

Produced by the Marine Plant Ecology Group, QFS, Northern Fisheries Centre, Cairns, 2001.

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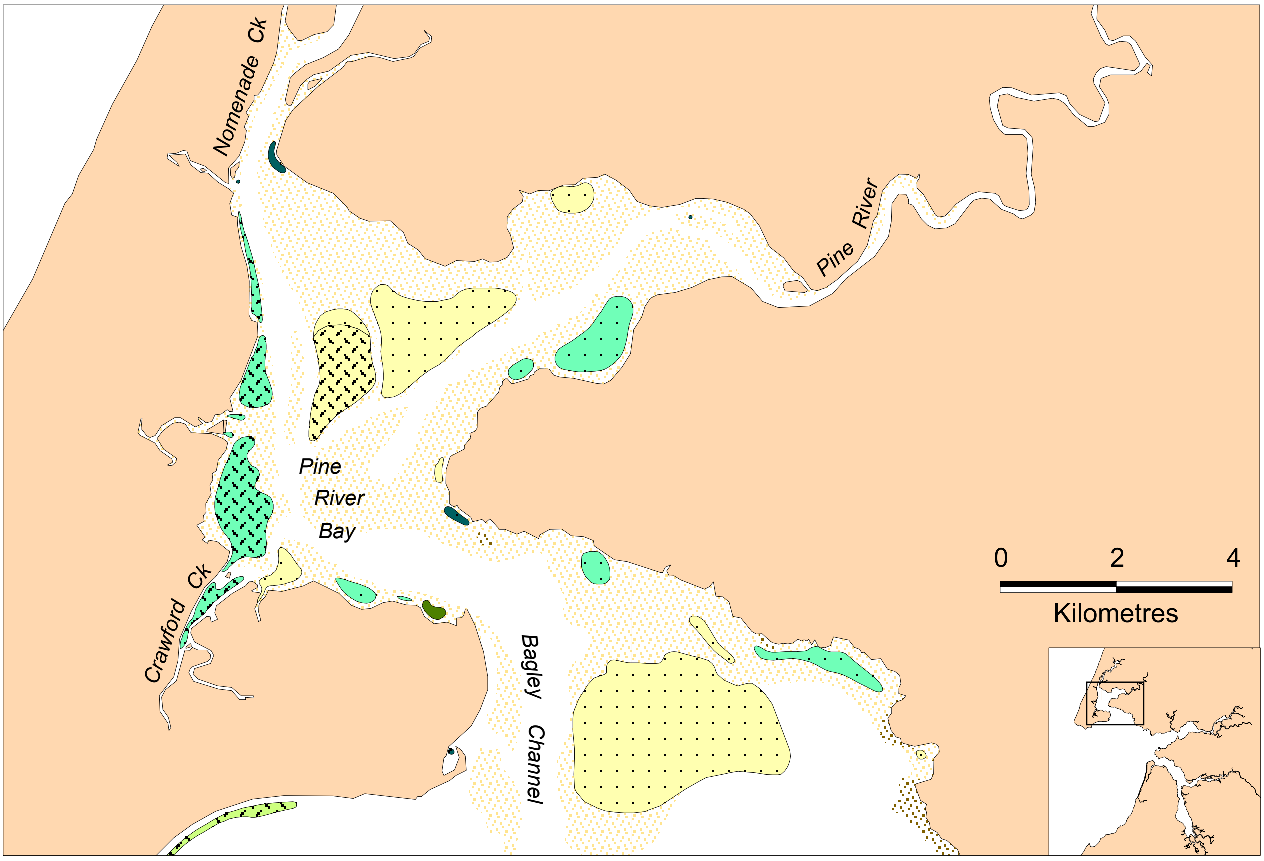
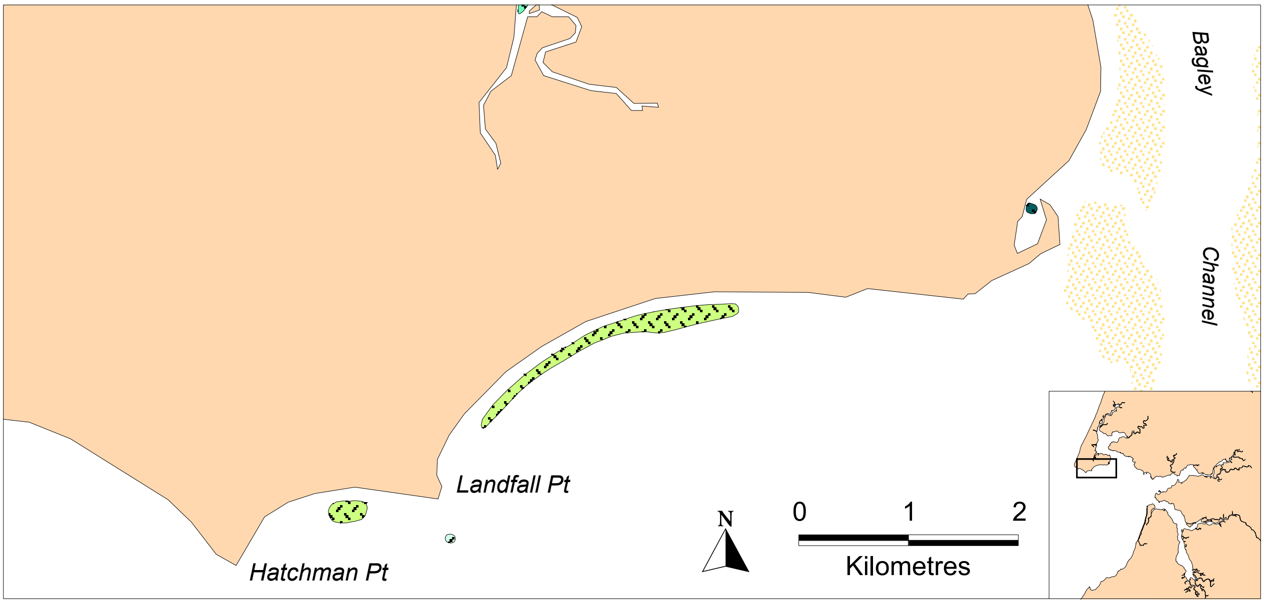
MAP 11. Seagrass meadows in Pine River Bay, April 2000.





LEGEND

Meadow Type	Meadow Density
Halophila ovalis dominated	Continuous seagrass meadow (few gaps)
Halodule pinifolia dominated	Aggregated seagrass patches
H. ovalis/H. pinifolia dominated	Isolated seagrass patches
Thalassia hemprichii dominated	
Halophila decipiens dominated	Sand and mud banks
Enhalus acoroides dominated	Intertidal reefs

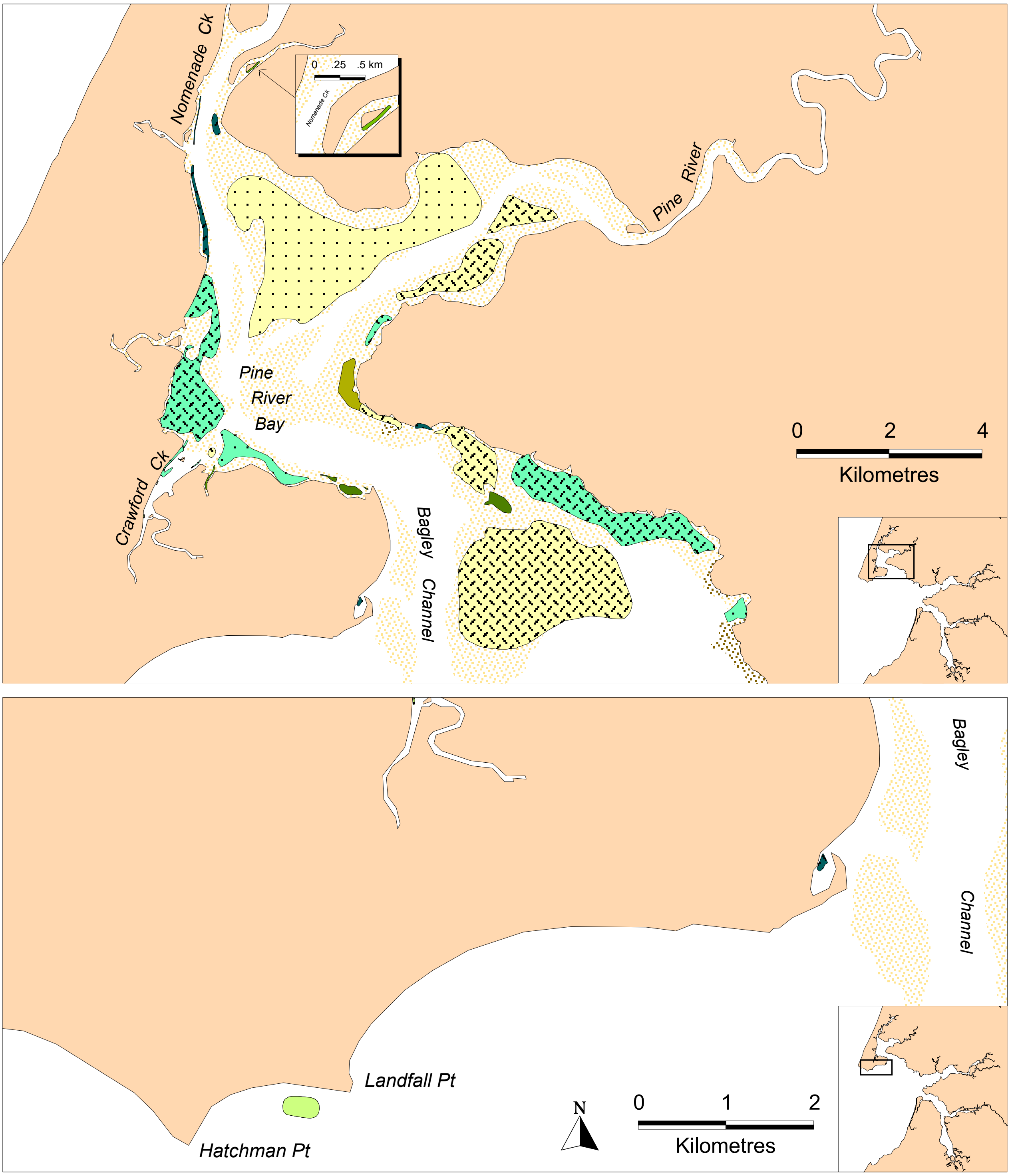
Source:
Roelofs, A.J., Rasheed, M.A. and Thomas, R. (2001). Port of Weipa Seagrass Monitoring Baseline Surveys, April & September 2000. *Ecoports Monograph Series No. 21*, (Ports Corporation of Queensland) 38 pp.

Sampling dates: 8 - 14th April 2000; 20 - 25th September 2000.

Funded by the Ports Corporation of Queensland and the Queensland Fisheries Service (QFS).

Produced by the Marine Plant Ecology Group, QFS, Northern Fisheries Centre, Cairns, 2001.

MAP 12. Seagrass meadows in Pine River Bay, September 2000.



LEGEND

Meadow Type

- *Halophila ovalis* dominated
- *Halodule pinifolia* dominated
- *H. ovalis/H. pinifolia* dominated
- *Syringodium isoetifolium* dominated
- *Thalassia hemprichii* dominated
- *Halodule uninervis* (wide) dominated
- *Enhalus acoroides* dominated

Meadow Density

- Continuous seagrass meadow (few gaps)
- Aggregated seagrass patches
- Isolated seagrass patches
- Sand and mud banks
- Intertidal reefs

Source:
Roelofs, A.J., Rasheed, M.A. and Thomas, R. (2001).
Port of Weipa Seagrass Monitoring Baseline Surveys, April & September 2000. *Ecoports Monograph Series No. 21*, (Ports Corporation of Queensland) 38 pp.

Sampling dates: 8 - 14th April 2000; 20 - 25th September 2000.

Funded by the Ports Corporation of Queensland and the Queensland Fisheries Service (QFS).

Produced by the Marine Plant Ecology Group, QFS, Northern Fisheries Centre, Cairns, 2001.

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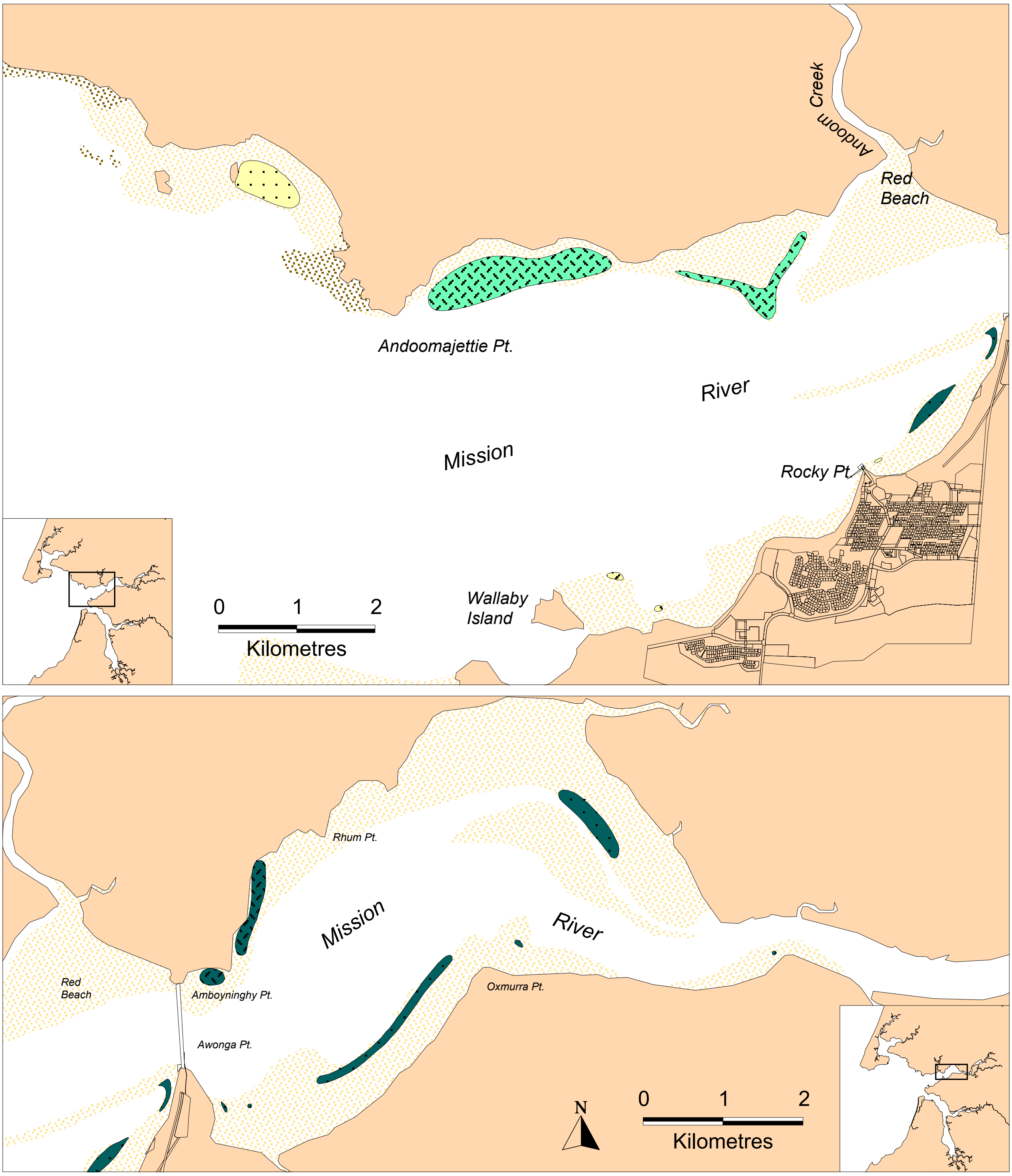
MAP 13. Seagrass meadows in the Mission River, April 2000.



LEGEND

Meadow Type

- *Halophila ovalis* dominated
- *Halodule pinifolia* dominated
- *H. ovalis/H. pinifolia* dominated
- *Enhalus acoroides* dominated

Meadow Density

- Continuous seagrass meadow (few gaps)
- Aggregated seagrass patches
- Isolated seagrass patches
- Sand and mud banks
- Intertidal reefs

Source:
Roelofs, A.J., Rasheed, M.A. and Thomas, R. (2001). Port of Weipa Seagrass Monitoring Baseline Surveys, April & September 2000. *Ecoports Monograph Series No. 21*, (Ports Corporation of Queensland) 38 pp.

Sampling dates: 8 - 14th April 2000; 20 - 25th September 2000.

Funded by the Ports Corporation of Queensland and the Queensland Fisheries Service (QFS).

Produced by the Marine Plant Ecology Group, QFS, Northern Fisheries Centre, Cairns, 2001.

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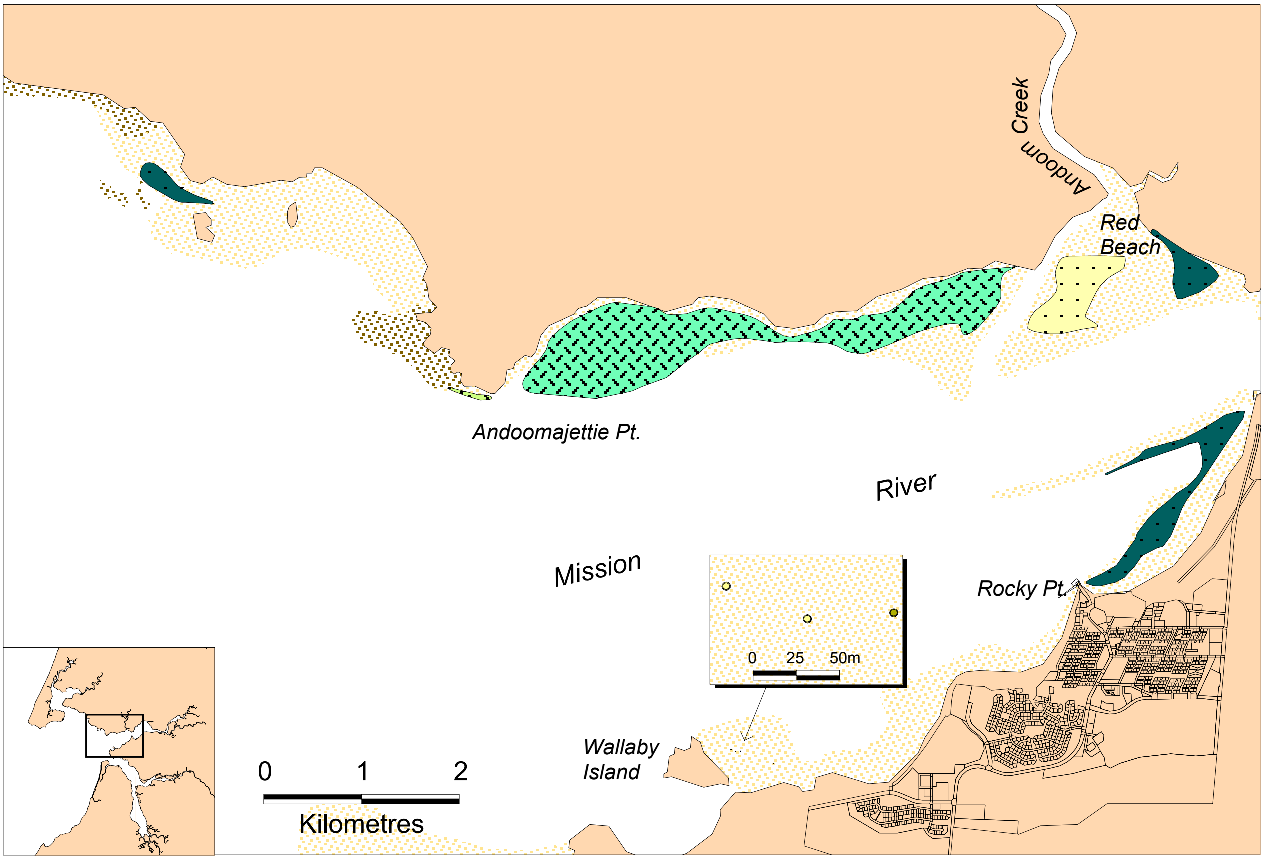
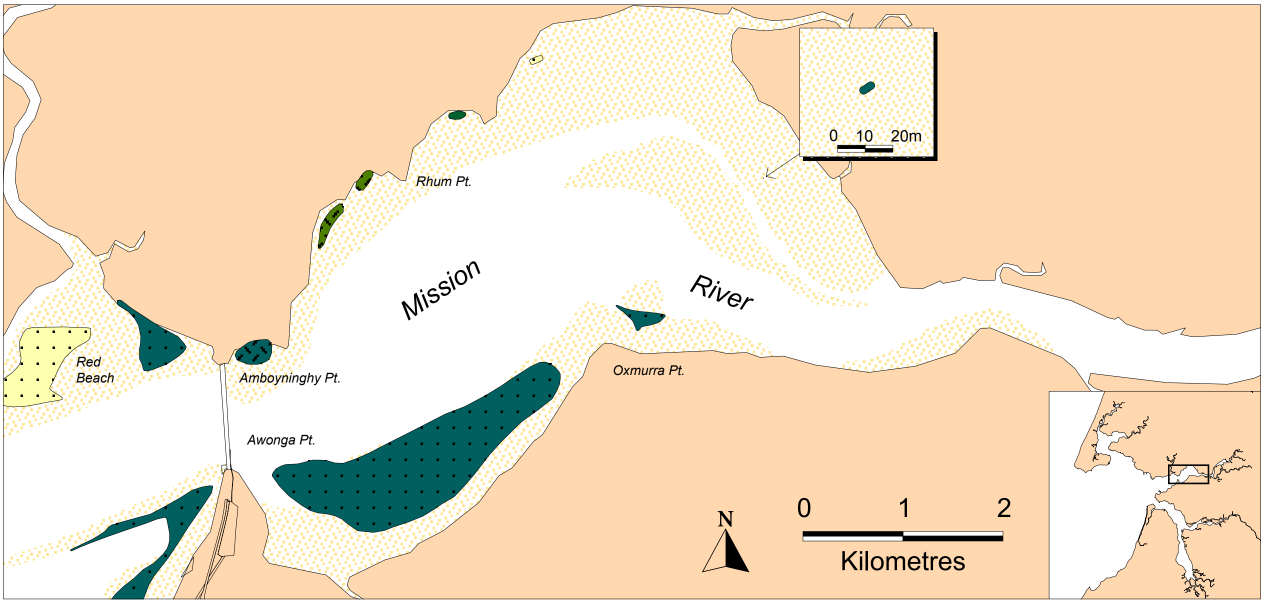
MAP 14. Seagrass meadows in the Mision River, September 2000.





LEGEND

Meadow Type

- *Halophila ovalis* dominated
- *Halodule pinifolia* dominated
- *H. ovalis/H. pinifolia* dominated
- *Thalassia hemprichii* dominated
- *Enhalus acoroides* dominated

Meadow Density

- Continuous seagrass meadow (few gaps)
- Aggregated seagrass patches
- Isolated seagrass patches
- Sand and mud banks
- Intertidal reefs

Source:
Roelofs, A.J., Rasheed, M.A. and Thomas, R. (2001).
Port of Weipa Seagrass Monitoring Baseline Surveys, April & September 2000. *Ecoports Monograph Series No. 21*, (Ports Corporation of Queensland) 38 pp.

Sampling dates: 8 - 14th April 2000; 20 - 25th September 2000.

Funded by the Ports Corporation of Queensland and the Queensland Fisheries Service (QFS).

Produced by the Marine Plant Ecology Group, QFS, Northern Fisheries Centre, Cairns, 2001.

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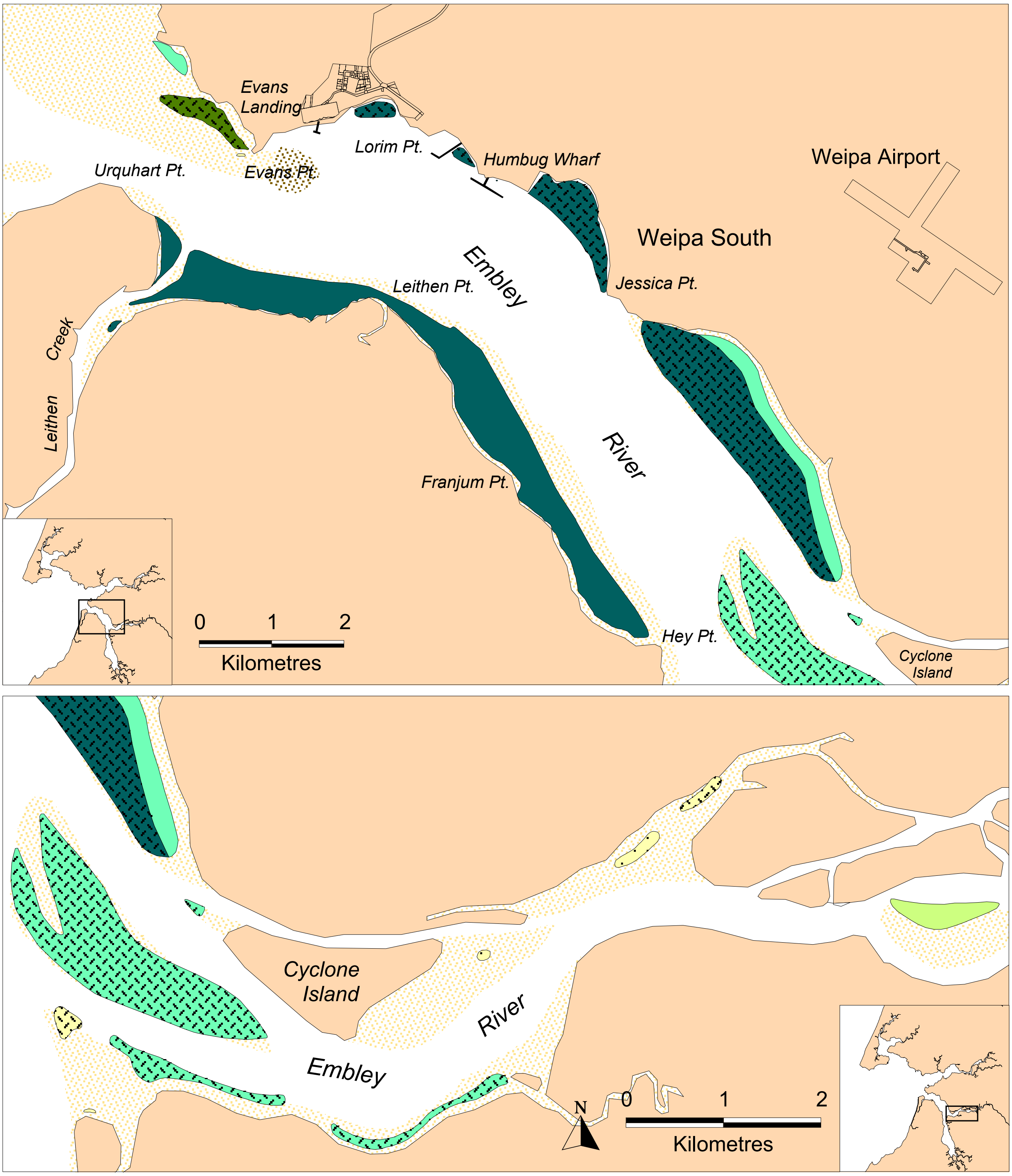
MAP 15. Seagrass meadows in the Embley River, April 2000.



LEGEND

Meadow Type

- *Halophila ovalis* dominated
- *Halodule pinifolia* dominated
- *H. ovalis/H. pinifolia* dominated
- *Thalassia hemprichii* dominated
- *Enhalus acoroides* dominated

Meadow Density

- Continuous seagrass meadow (few gaps)
- Aggregated seagrass patches
- Isolated seagrass patches
- Sand and mud banks
- Intertidal reefs

Source:
Roelofs, A.J., Rasheed, M.A. and Thomas, R. (2001). Port of Weipa Seagrass Monitoring Baseline Surveys, April & September 2000. *Ecoports Monograph Series No. 21*, (Ports Corporation of Queensland) 38 pp.

Sampling dates: 8 - 14th April 2000; 20 - 25th September 2000.

Funded by the Ports Corporation of Queensland and the Queensland Fisheries Service (QFS).

Produced by the Marine Plant Ecology Group, QFS, Northern Fisheries Centre, Cairns, 2001.

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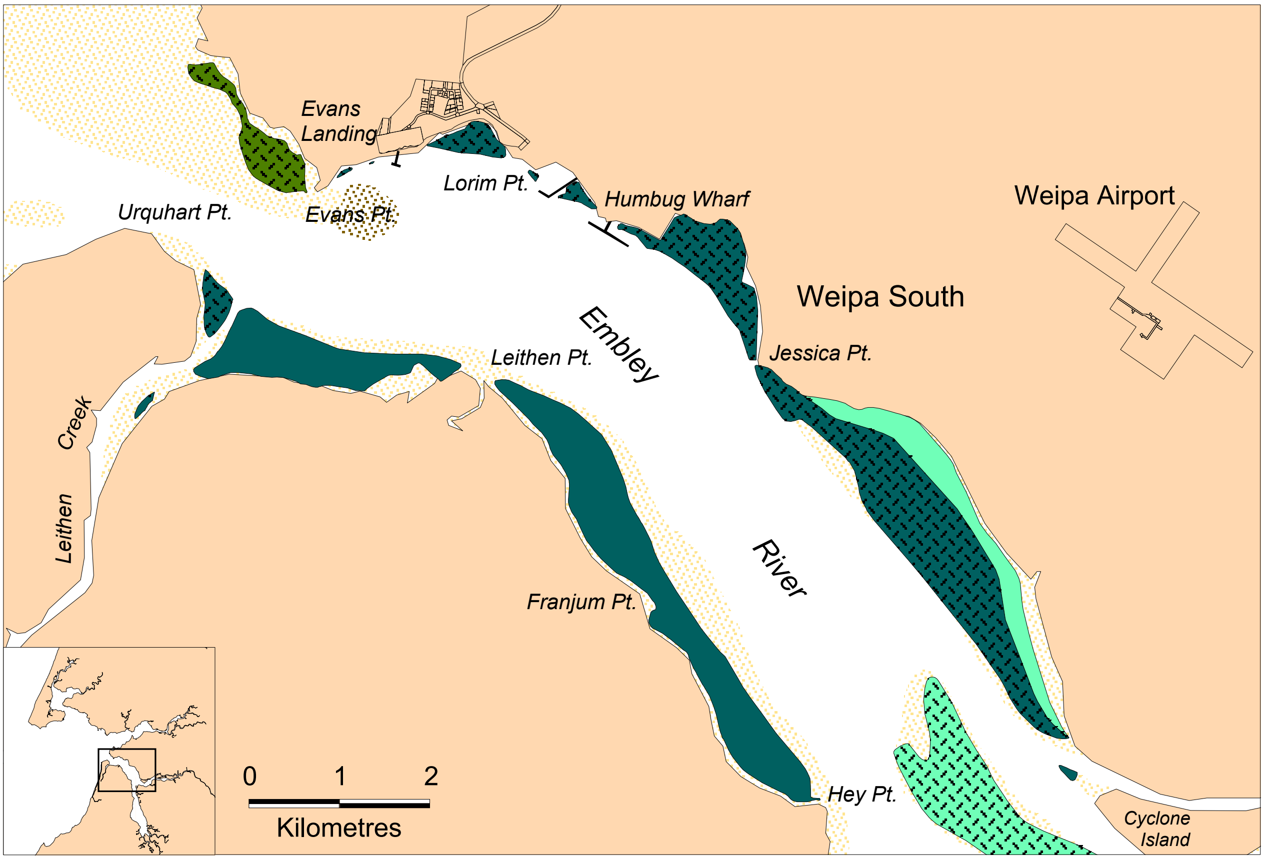
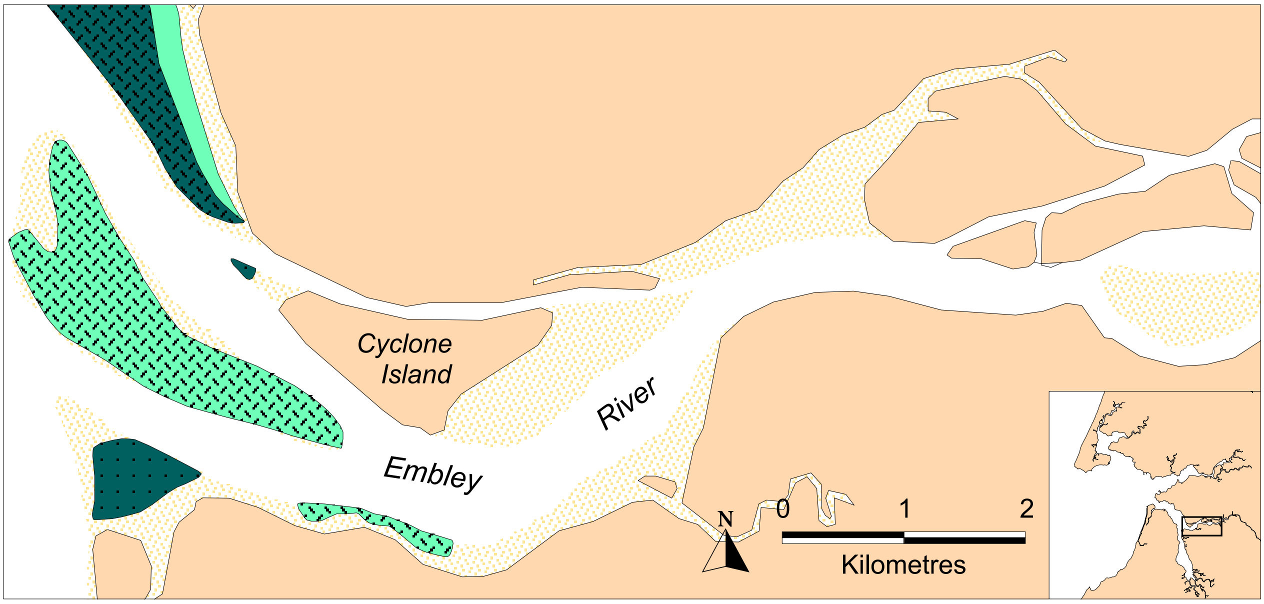
MAP 16. Seagrass meadows in the Embley River, September 2000.





LEGEND

Meadow Type

- *Halophila ovalis* dominated
- *Halodule pinifolia* dominated
- *H. ovalis/H. pinifolia* dominated
- *Thalassia hemprichii* dominated
- *Enhalus acoroides* dominated

Meadow Density

- Continuous seagrass cover (few gaps)
- Many seagrass patches
- Few seagrass patches
- Sand and mud banks
- Intertidal reefs

Source:
Roelofs, A.J., Rasheed, M.A. and Thomas, R. (2001).
Port of Weipa Seagrass Monitoring Baseline Surveys, April & September 2000. *Ecoports Monograph Series No. 21*, (Ports Corporation of Queensland) 38 pp.

Sampling dates: 8 - 14th April 2000; 20 - 25th September 2000.

Funded by the Ports Corporation of Queensland and the Queensland Fisheries Service (QFS).

Produced by the Marine Plant Ecology Group, QFS, Northern Fisheries Centre, Cairns, 2001.

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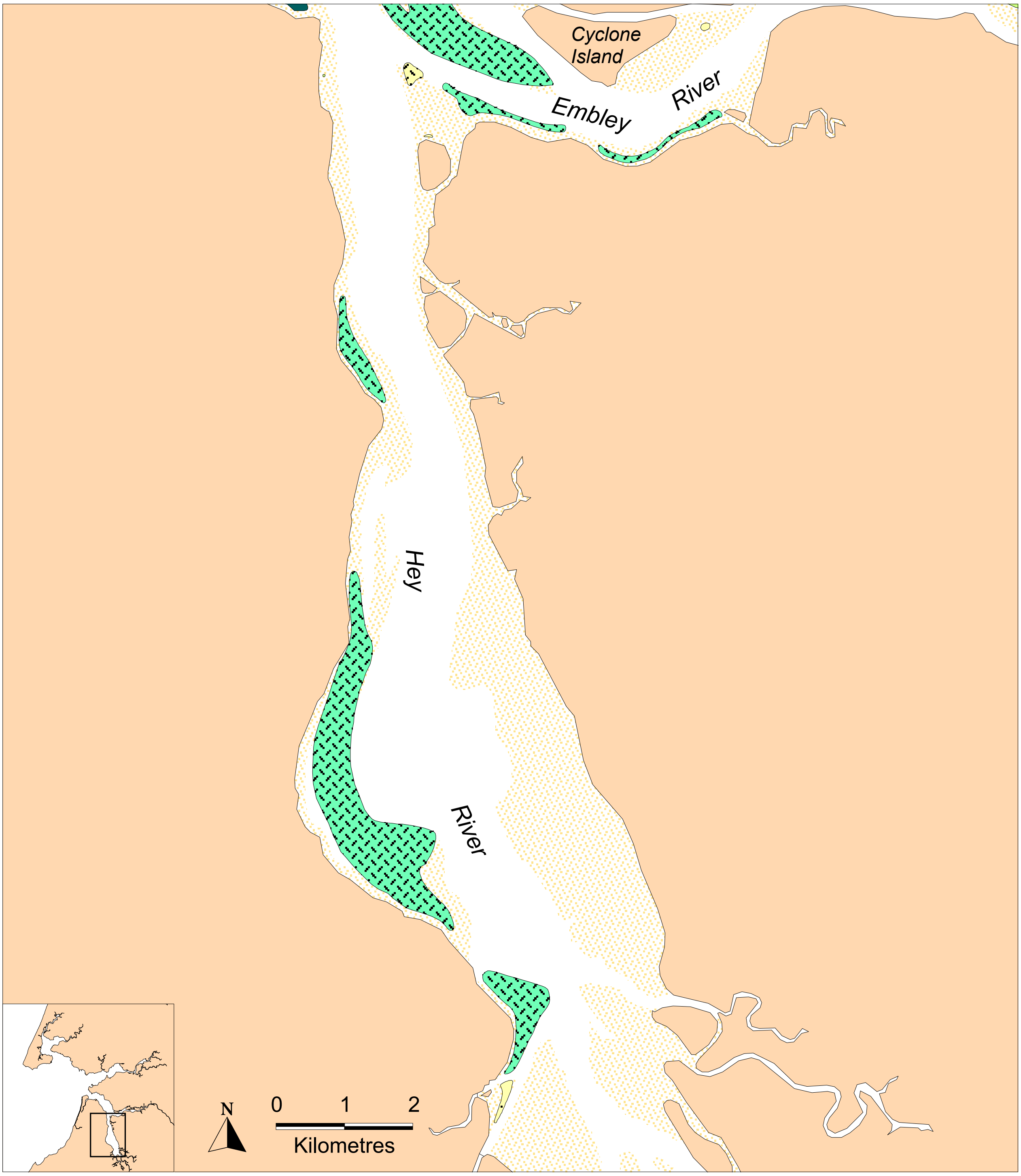
MAP 17. Seagrass meadows in the Hey River, April 2000.



LEGEND

Meadow Type

- *Halophila ovalis* dominated
- *H. ovalis/H. pinifolia* dominated

Meadow Density

- Continuous seagrass meadow (few gaps)
- Aggregated seagrass patches
- Isolated seagrass patches
- Sand and mud banks

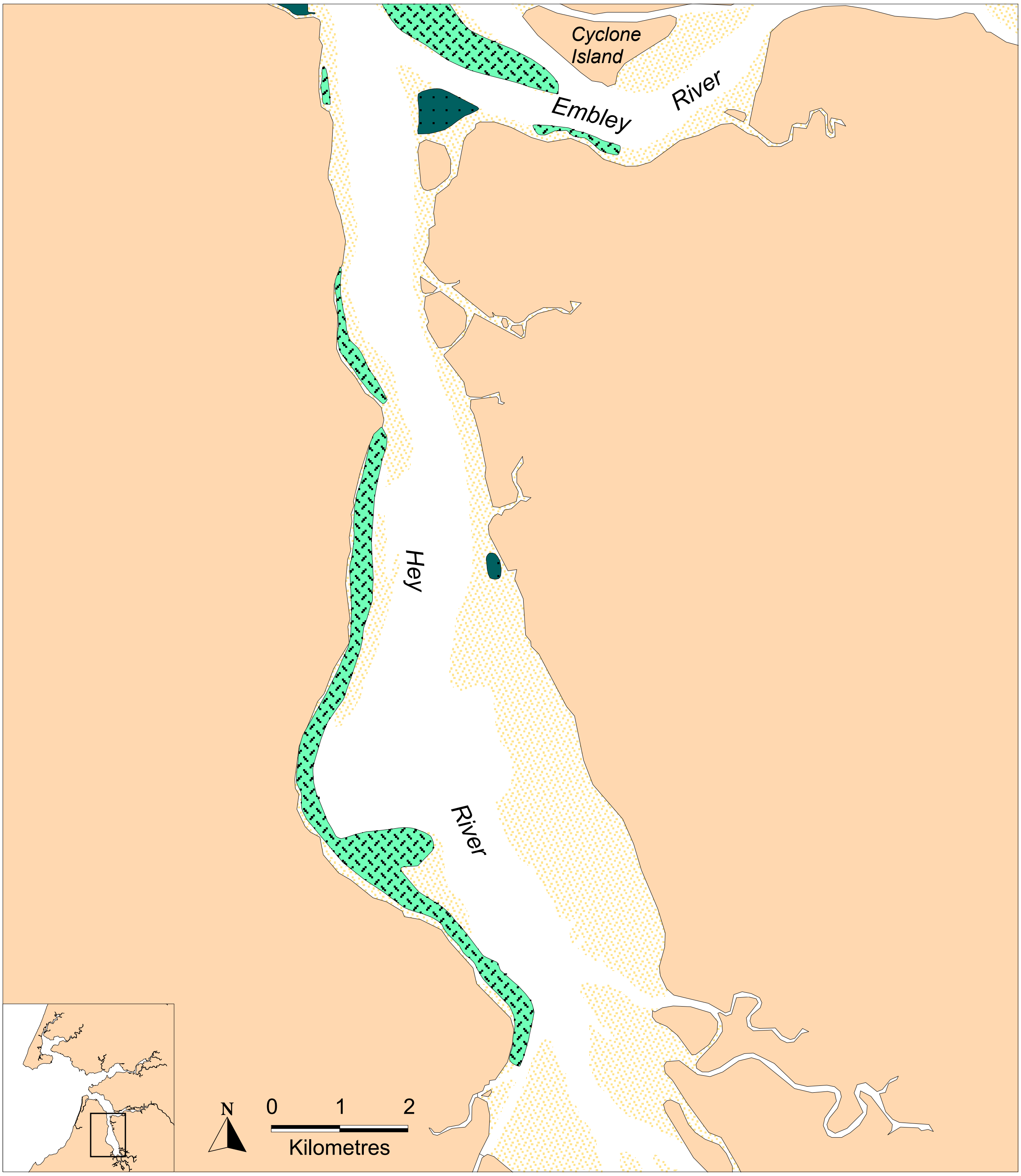
Source:
Roelofs, A.J., Rasheed, M.A. and Thomas, R. (2001). Port of Weipa Seagrass Monitoring Baseline Surveys, April & September 2000. *Ecoports Monograph Series No. 21*, (Ports Corporation of Queensland) 38 pp.

Sampling dates: 8 - 14th April 2000; 20 - 25th September 2000.

Funded by the Ports Corporation of Queensland and the Queensland Fisheries Service (QFS).

Produced by the Marine Plant Ecology Group, QFS, Northern Fisheries Centre, Cairns, 2001.

MAP 18. Seagrass meadows in the Hey River, September 2000.



LEGEND

Meadow Type

Thalassia hemprichii dominated

Enhalus acoroides dominated

Meadow Density

Continuous seagrass meadow (few gaps)

Aggregated seagrass patches

Isolated seagrass patches

Sand and mud banks

Source:
Roelofs, A.J., Rasheed, M.A. and Thomas, R. (2001). Port of Weipa Seagrass Monitoring Baseline Surveys, April & September 2000. *Ecoports Monograph Series No. 21*. (Ports Corporation of Queensland) 38 pp.

Sampling dates: 8 - 14th April 2000; 20 - 25th September 2000.

Funded by the Ports Corporation of Queensland and the Queensland Fisheries Service (QFS).

Produced by the Marine Plant Ecology Group, QFS, Northern Fisheries Centre, Cairns, 2001.

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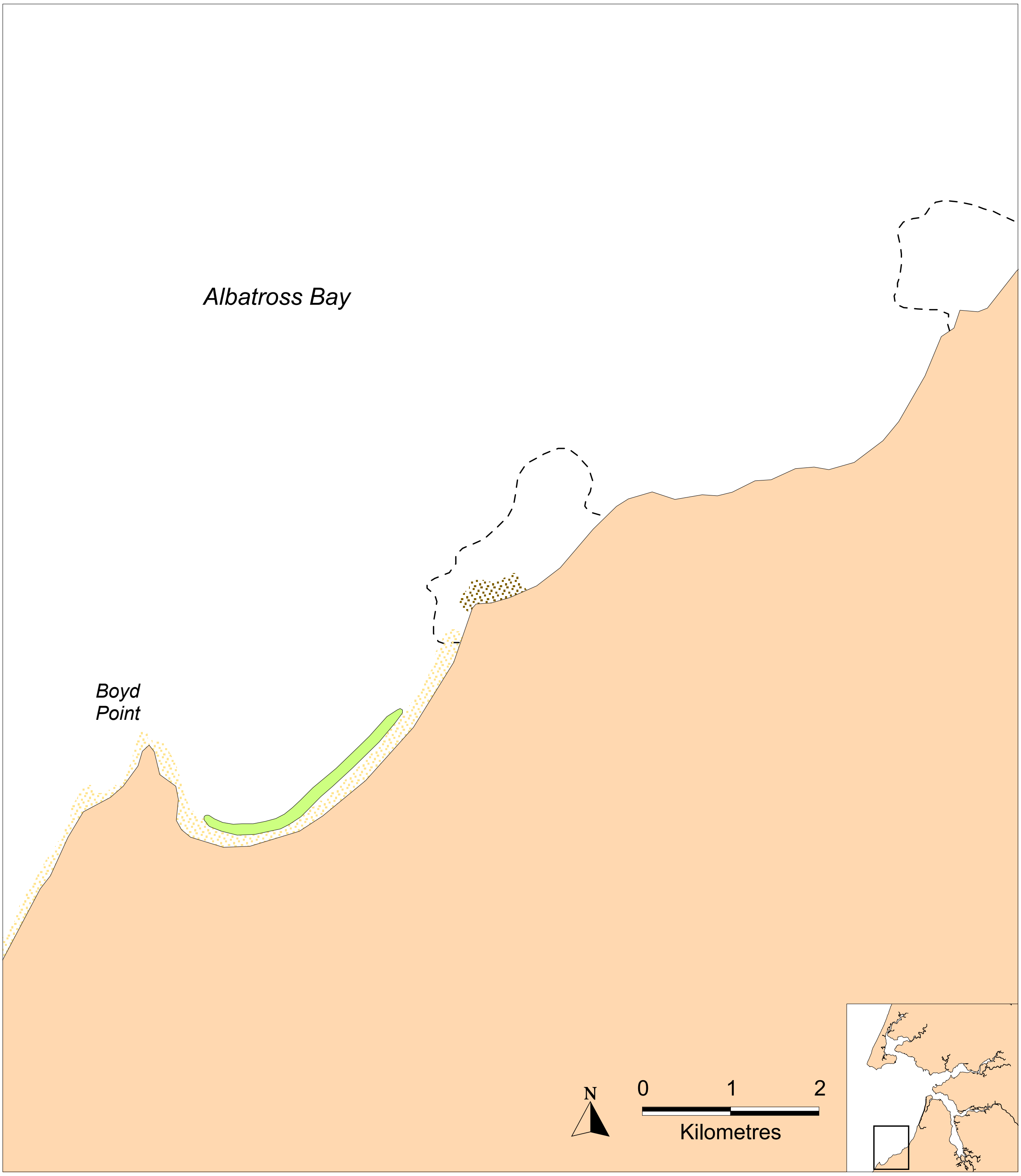
MAP 19. Seagrass meadows north of Boyd Point, April 2000.



LEGEND

Meadow Type

Halodule pinifolia dominated

Meadow Density

Continuous seagrass meadow (few gaps)

Aggregated seagrass patches

Isolated seagrass patches

Sand and mud banks

Intertidal reefs

Submerged reefs

Source:
Roelofs, A.J., Rasheed, M.A. and Thomas, R. (2001). Port of Weipa Seagrass Monitoring Baseline Surveys, April & September 2000. *Ecoports Monograph Series No. 21*, (Ports Corporation of Queensland) 38 pp.

Sampling dates: 8 - 14th April 2000; 20 - 25th September 2000.

Funded by the Ports Corporation of Queensland and the Queensland Fisheries Service (QFS).

Produced by the Marine Plant Ecology Group, QFS, Northern Fisheries Centre, Cairns, 2001.

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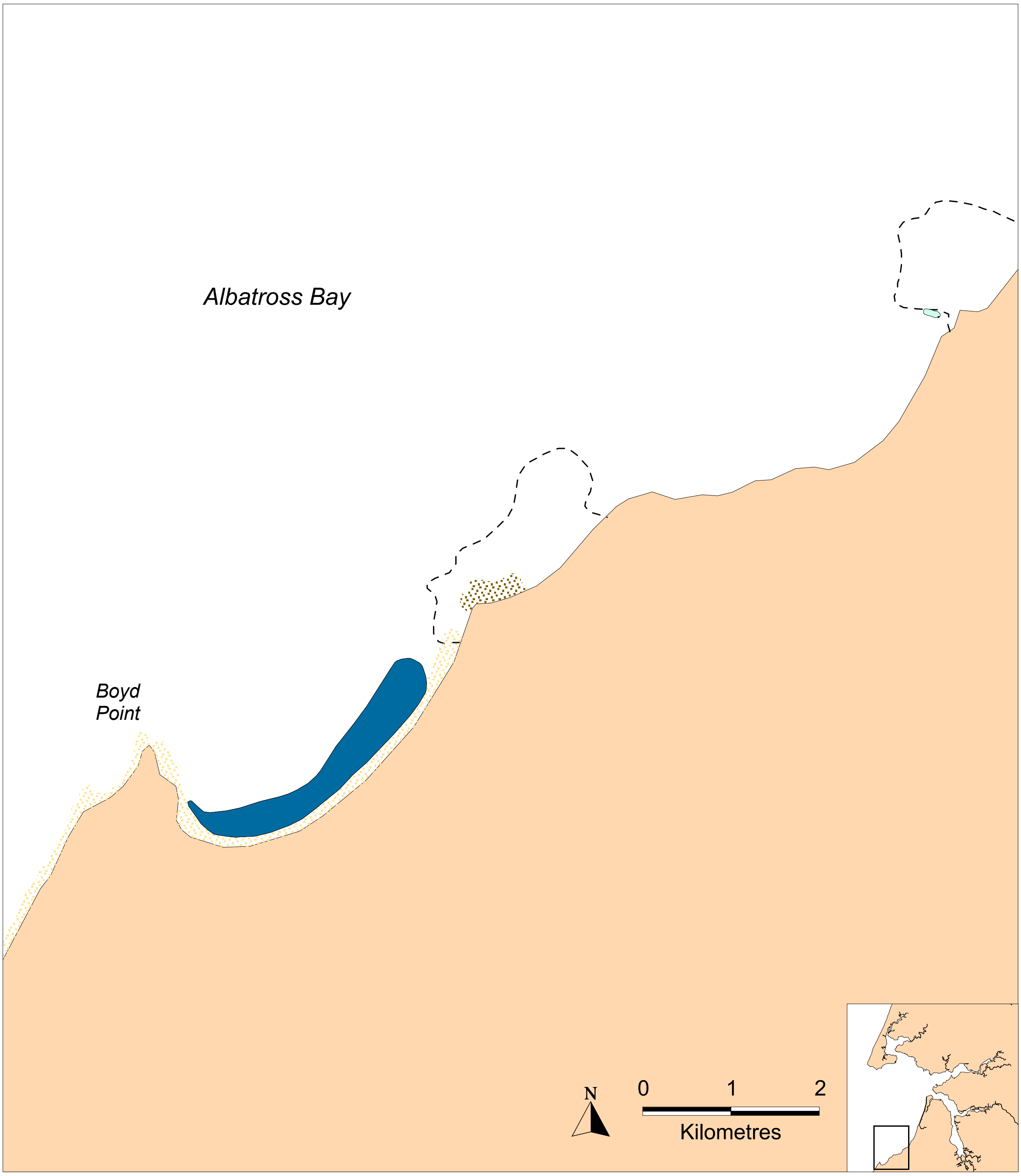
MAP 20. Seagrass meadows north of Boyd Point, September 2000.



LEGEND

Meadow Type

Halodule pinifolia/Halophila decipiens dominated

Halophila decipiens dominated

Meadow Density

Continuous seagrass meadow (few gaps)

Aggregated seagrass patches

Isolated seagrass patches

Sand and mud banks

Intertidal reefs

Submerged reefs

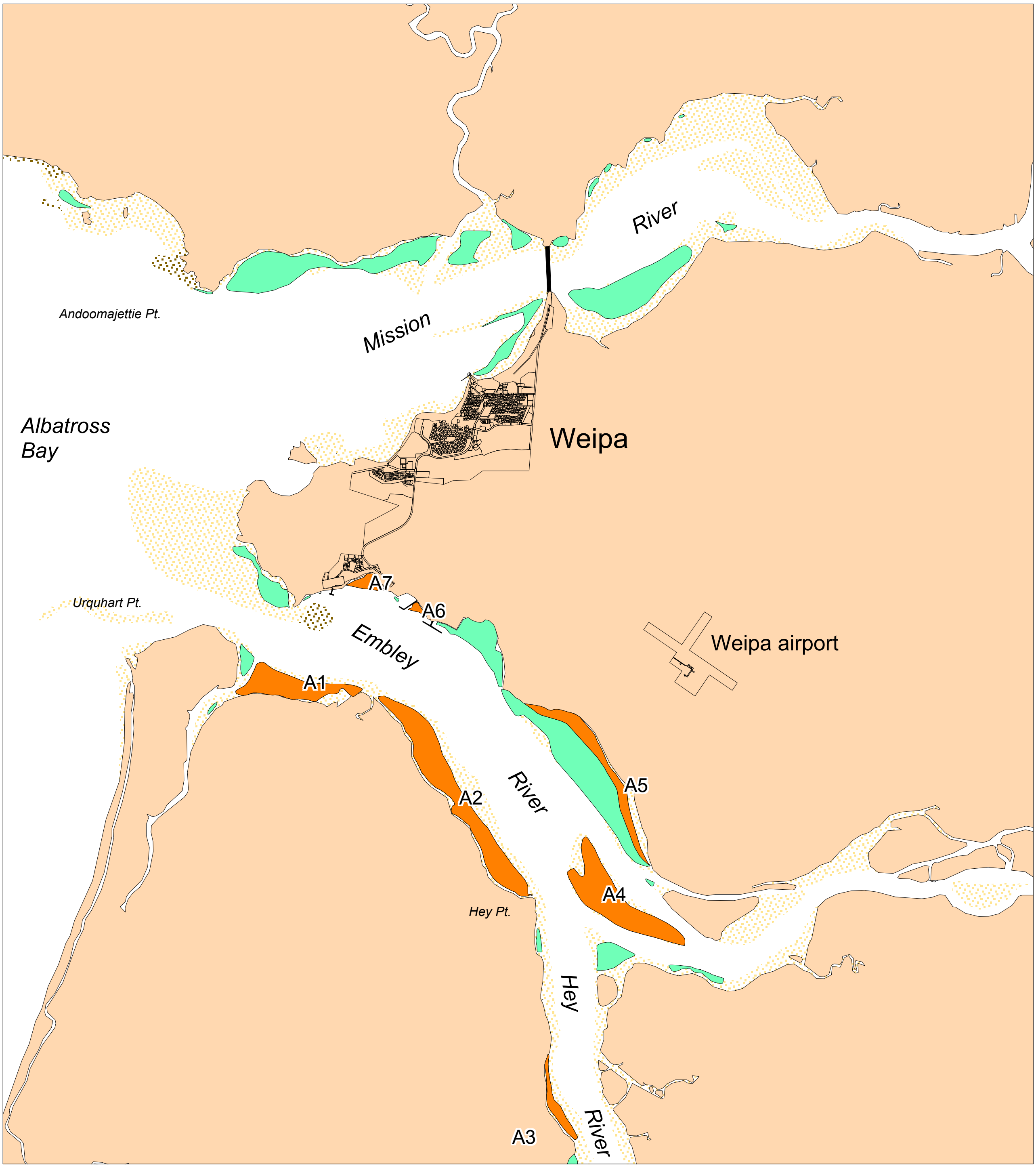
Source:
Roelofs, A.J., Rasheed, M.A. and Thomas, R. (2001). Port of Weipa Seagrass Monitoring Baseline Surveys, April & September 2000. *Ecoports Monograph Series No. 21*, (Ports Corporation of Queensland) 38 pp.

Sampling dates: 8 - 14th April 2000; 20 - 25th September 2000.

Funded by the Ports Corporation of Queensland and the Queensland Fisheries Service (QFS).

Produced by the Marine Plant Ecology Group, QFS, Northern Fisheries Centre, Cairns, 2001.

MAP 21. Intensive Monitoring Area for the Port of Weipa.



LEGEND

- Seagrass meadow monitored for distribution, abundance & species composition
- Seagrass meadow monitored for distribution & species composition
- Sand and mud banks
- Intertidal reefs

0 2 4
Kilometres

N

Source:
Roelofs, A.J., Rasheed, M.A. and Thomas, R. (2001).
Port of Weipa Seagrass Monitoring Baseline Surveys, April & September 2000. *Ecoports Monograph Series No. 21*, (Ports Corporation of Queensland) 38 pp.

Sampling dates: 8 - 14th April 2000; 20 - 25th September 2000.

Funded by the Ports Corporation of Queensland and the Queensland Fisheries Service (QFS).

Produced by the Marine Plant Ecology Group, QFS, Northern Fisheries Centre, Cairns, 2001.

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Discussion

Extensive seagrass meadows were found within the Port of Weipa on shallow mud or sand banks throughout the Hey, Embley and Mission Rivers, Pine River Bay and Albatross Bay. The total seagrass area mapped in April and September surveys (3511 ±528 & 4688 ±418 ha respectively) was larger than in previous surveys of the Port of Weipa (680 ha by Poiner *et al.* 1987; 2225 ha by QDPI unpublished data). An additional species of seagrass was found in the baseline surveys, *Halophila decipiens*, which was not recorded in any previous surveys. The baseline surveys were more comprehensive and utilised a greater range of methodology and more accurate mapping techniques than previous surveys. Information from the current mapping exercise is likely to produce higher estimates of seagrass coverage than previous surveys. Several previously undescribed seagrass meadows were mapped in the baseline surveys, particularly in Pine River Bay and the southern section of the Hey River.

Halophila ovalis and *Halodule pinifolia* meadows in the Port of Weipa were highly variable in location, shape and abundance between surveys. Overall distribution and abundance of these species was higher in September than in April. Seasonal and year to year changes in the distribution and abundance in *Halophila* and *Halodule* occurs in other Queensland locations (Shoalwater Bay – Lee Long *et al.* 1997; Mourilyan Harbour – McKenzie *et al.* 1998; Port Newry – Roelofs and Roder 2001; Ince & Llewellyn Bays – Roder and Roelofs 2001; Upstart Bay - Rasheed and Thomas 2001; Green Island – Rasheed 2000; Karumba – Rasheed *et al.* 2001). Variability in meadow distribution of these species may be due to their rapid colonisation strategies and spatial variability in seed banks. *Halodule uninervis* produces single seeded fruits that may remain viable in sediments for several years (McMillan 1991). *Halodule* seed production can lead to the formation of high density seed banks (up to 10 000 seeds m^{-2}) (Inglis 2000) from which meadow development can occur. *Halophila* spp. in other locations also rapidly colonises areas through sexual reproduction (Rasheed 2000). Seasonal cues such as wet season rainfall may trigger the rapid germination of dormant seed banks. A reduction in salinity is known to stimulate germination in other *Halodule* and *Halophila* species (McMillan 1981, 1988). Seagrass seed banks and below-ground biomass were not sampled in the baseline surveys and this report presents meadows mapped based on above-ground seagrass evidence only.

The distribution of *Enhalus acoroides* dominated meadows increased from April to September, however biomass declined slightly. This contrasts with other high biomass seagrass species in the tropics (eg. *Zostera capricorni*) where above-ground biomass is generally higher in spring/early summer than autumn (McKenzie 1994; McKenzie *et al.* 1998). Seagrass distribution and abundance can vary significantly both seasonally and between years in other locations of tropical Queensland (McKenzie *et al.* 1998, Rasheed *et al*. 1996), however little seasonal information on abundance and distribution exists for *Enhalus acoroides* in Queensland. Continued monitoring of seagrasses in the Port of Weipa will add valuable information to our understanding of the biology of this seagrass species.

The Embley River had the densest and largest continuous *Enhalus acoroides* meadows in the Port of Weipa survey area. The highest density meadows occurred on the western side of the river opposite the main port. *Enhalus acoroides* only occurs in relatively shallow water as flowers and fruits are produced on the surface (McConchie and Knox 1989). The western side of the Embley River has a larger area of shallow mud and sand banks than the eastern side. The extensive western mud banks are more protected than the eastern banks from strong south easterly trade winds and have a shallower depth gradient making them more suitable for *Enhalus* growth.

High biomass *Enhalus acoroides* meadows were located adjacent to port infrastructure and facilities between Evans and Jessica Points and on banks adjacent to dredged channels in the Embley River. Future developments and maintenance programs have the potential to impact on these habitats, given their proximity to port infrastructure. The presence of these meadows suggests that current port activities are maintaining suitable conditions for seagrass growth in these areas. Continued monitoring of these meadows is likely to provide a good indication of the port's environmental health given their proximity to likely sources of impact.

The ecologically important *Enhalus acoroides* meadows found in the Embley River are known to support juveniles of major commercial prawn (*Penaeus esculentus, Penaeus semisulcatus, Metapenaeus endeavouri* and *Metapenaeus ensis*) (Staples *et al.* 1985, Haywood *et al.* 1995) and fish species (Blaber *et al.* 1989). Large barramundi (*Lates calcarifer*) were observed in these meadows during the present surveys.

Seven species of seagrass have previously been described within the survey area (Poiner *et al.* 1987). Two of the species identified by Poiner, *Halodule uninervis* (narrow leaf morph) and *Halodule pinifolia*, are similar in morphology and are difficult to distinguish in the field. Recent studies from the Queensland east coast indicate there may be no genetic distinctions between the two currently recognised species (M. Waycott. pers. comm.). In the present surveys they are considered as one species and are referred to only as *Halodule pinifolia*.

Halophila decipiens was found in April and September but was not reported in previous Weipa seagrass surveys. This species was found in isolated meadows south of Landmark Point and in southern Albatross Bay, near Boyd Point. *Halophila decipiens* is an ephemeral species with large natural fluctuations in distribution and abundance seasonally and between years (McKenzie *et al.* 1996, 1998; Lee Long *et al.* 2000) and this may explain why it was not detected in previous surveys. *Halophila decipiens* meadows may have been missed in previous surveys as the species had small leaves, was low in biomass and occurred in isolated subtidal patches in Weipa.

No seagrass was found deeper than 3.7m below MSL in April and 5.3m below MSL in September. The deepest occurring species in both surveys was *Halophila decipiens*. Increased water clarity and higher light intensities in spring/early summer most likely contribute to *Halophila decipiens* existing at greater depths in September than April.

Future Monitoring

The results of the baseline surveys were used to develop a monitoring program that will survey seagrass abundance, distribution and species composition in April and September 2001 for the Port of Weipa. The methodology and sample design employed will be a modified form of that developed for seagrass monitoring programs at Mourilyan Harbour (McKenzie *et al.* 1996) and Karumba (Rasheed *et al.* 1996). The monitoring program is designed to detect changes in seagrass distribution and abundance at levels of significance and assurance determined from results of the baseline surveys, and with consideration of what can be realistically conducted. A stratified approach to the design will allow the collection of fine scale information to measure seagrass condition within the greater Weipa Port area. Intensive fine scale monitoring will focus on seagrass meadows adjacent to port facilities and the community of Weipa. This will allow for the detection of fine scale changes in seagrass meadows in areas where human activity and coastal developments occur. The Intensive Monitoring Area is shown in map 21.

The monitoring plan will have three components:

1. Monitor seagrass distribution, species composition and abundance in seven primary meadows (A1 – A7) within the Intensive Monitoring Area (map 21). The meadows selected represent a range of different seagrass habitats found at Weipa. Monitoring of these meadows will identify effects of potential disturbances on seagrasses within the main harbour area of Weipa. The number of sites and replicates required to monitor

changes within these meadows will be determined from the results of the baseline seagrass surveys (See McKenzie *et al.* 1996 and Rasheed *et al.* 1996).

2. Map seagrass distribution and confirm species composition in other seagrass meadows within the Intensive Monitoring Area (map 21).

3. Confirm presence by helicopter reconnaissance at low tide of other seagrass meadows within the Weipa Port limits (including Pine River Bay). No measurements of seagrass abundance and distribution will be taken.

PCQ has agreed to fund a further year of monitoring with the first of these surveys to be conducted in April 2000.

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