Long term seagrass monitoring in Cairns Harbour and Trinity Inlet - December 2006

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EXECUTIVE SUMMARY

This report details results from the December 2006 seagrass monitoring survey for Cairns Harbour and Trinity Inlet conducted as part of an annual long term monitoring program. The monitoring program was established following a baseline survey in December 2001 and examines selected representative seagrass meadows in Cairns Harbour and Trinity Inlet. Total area of each monitoring meadow, species composition and seagrass density (above ground biomass) were measured for comparison with previous surveys.

In 2006 seagrasses in Cairns were generally healthy with total area of seagrass meadows the highest since monitoring began in 2001 and biomass for the largest meadows remaining relatively high. Within the overall area and biomass trends there were differences between intertidal and subtidal meadows and between meadows in Cairns Harbour and Trinity Inlet. There was also a substantial change to seagrasses to the south of Bessie Point resulting in the establishment of a new meadow.

The changes to Cairns Harbour and Trinity Inlet seagrass meadows appear to be strongly linked to local and regional climate conditions and generally reflected similar changes that have occurred to seagrasses in other areas of Queensland over the same time period. The increases in intertidal seagrasses in the harbour and declines in deeper subtidal meadows further up the inlet were consistent with a return to more “normal” rainfall, temperature and light conditions over the past three years.

The increased abundance of seagrass in Cairns Harbour may have flow on effects for fisheries in the area especially tiger and endeavour prawns which utilise these areas as a nursery ground. There was also an increase in seagrass species that are preferred as a food source by dugong and green turtles.

Results of monitoring in 2006, combined with similar monitoring in other north Queensland locations, indicate that seagrass habitats and the marine environment in Cairns Harbour and Trinity Inlet were relatively healthy. The monitoring program has developed our understanding of the relationships between climatic changes, anthropogenic disturbance and seagrass abundance and has shown that there have been minimal impacts associated with current port and urban activities.

INTRODUCTION

Seagrass forms a key habitat of Cairns Harbour and Trinity Inlet and represents a significant component of the regions seagrass resources (Trinity Inlet Management Plan 1999). The seagrass meadows are mostly within the Trinity Inlet Fish Habitat Area, which encompasses 1200 ha of tidal waters with seagrass, mangrove and salt marsh habitats. The State of Trinity Inlet Report and Ecological Overview (1997) recognised seagrass as crucial to maintaining biodiversity and fisheries productivity in the inlet and identified it as a key habitat type for monitoring. The first surveys of seagrass distribution, species diversity and abundance throughout Cairns Harbour were undertaken as part of a broad scale survey in February 1988 (Coles *et al.* 1993). In December 1993 the Cairns Harbour and Trinity Inlet regions were surveyed (Lee Long *et al.* 1996) and subsequent detailed mapping of Ellie Point seagrasses occurred in December 1996 (Rasheed and Roelofs 1996).

In recognition of the value and potential threats to seagrasses in the region the Department of Primary Industries and Fisheries (DPI&F) in partnership with Cairns Port Authority and Trinity Inlet Waterways developed an annual long term seagrass monitoring program. Seagrass meadows show a measurable response to changes in water quality and long term monitoring of selected seagrass meadows in Cairns Harbour provides an indicator of marine environmental health for the region. In December 2001 a baseline survey of all seagrasses in Cairns Harbour and Trinity was conducted (Campbell *et al.* 2002). From this baseline survey five seagrass meadows were identified as suitable for a long term seagrass monitoring program. The five meadows selected were representative of the range of seagrass species and habitat types (intertidal and subtidal) that occur within the Cairns Harbour and Trinity Inlet monitoring area. Annual monitoring conducted from 2002 to 2005 revealed some significant changes in seagrasses from the baseline survey, with the most likely causes of change being regional climatic events combined with local characteristics of the seagrass population and physical characteristics of Cairns Harbour and Trinity Inlet. The first four years of monitoring began to reveal the ranges of natural change for these seagrasses as well as some of the associations between seagrass abundance and changes in climate.

Cairns Port Authority (CPA) in partnership with DPI&F commissioned the continuation of seagrass monitoring in 2006 as part of its commitment to maintaining the health of the marine environment within the port. This report details the results of the sixth annual long term monitoring survey conducted in December 2006. The objectives of this survey were to:

1. Compare results of monitoring with previous seagrass surveys and assess any changes in seagrass distribution and abundance in relation to natural events or anthropogenic port and catchment activities
2. Discuss the implications of monitoring results for the overall health of Cairns Harbour and Trinity Inlet’s marine environment and provide advice to relevant management agencies

METHODOLOGY

Surveys of the monitoring meadows in Cairns Harbour and Trinity Inlet were conducted in November and December 2006. Intertidal areas were surveyed from a helicopter on 2nd November 2006, and subtidal areas were surveyed by boat on the 4th and 5th December 2006. Five meadows from the 2001 baseline and 2002 monitoring surveys (Campbell *et al.* 2002; 2003) were selected for long term monitoring. These meadows represented the range of seagrass community types found in the area and also captured areas of interest and likely impact.

Due to historical information collected at Ellie Point and large changes recorded in the region in previous monitoring surveys, the results for the Ellie Point and Esplanade sections of the entire "Ellie Point to Esplanade" monitoring meadow were also examined separately. This was achieved by partitioning the meadow into two components; the 'Esplanade' meadow (south of Swampy Creek), and the 'Ellie Point' meadow (north of Swampy Creek).

At each survey site within the monitoring meadows, seagrass meadow characteristics, including seagrass species composition, above ground biomass, percent algal cover, depth below mean sea level (MSL) (for subtidal meadows), sediment type, time and position (differential Global Positioning System (dGPS)) fixes (± 5m) were recorded. A detailed description of the methods used to characterise the monitoring meadows is provided in Campbell *et al*. (2002; 2003).

Seagrass community types were determined according to species composition from nomenclature developed for seagrass meadows of the Queensland region (Thomas and Rasheed, 2003) (Table 1). Abundance categories (light, moderate, dense) were assigned to community types according to above ground biomass of the dominant species (Table 2).

Table 1. Nomenclature for seagrass community types in Cairns Harbour and Trinity Inlet, December 2006

Community type	Species composition
Species A	Species A is 90-100% of composition
Species A with Species B	Species A is 60-90% of composition
Species A with Species B/Species C	Species A is 50% of composition
Species A/Species B	Species A is 40-60% of composition

Table 2. Density categories and mean above ground biomass ranges for each species used in determining seagrass community density in Cairns Harbour and Trinity Inlet, December 2006

Density	Mean above ground biomass (g DW m^{-2})				
	H. uninervis (thin)	*H. ovalis/ H. decipiens*	*H. uninervis* (wide)	*C. serrulata C. rotundata*	*Z. capricorni*
Light	< 1	< 1	< 5	< 5	< 20
Moderate	1 - 4	1 - 5	5 - 25	5 - 25	20 - 60
Dense	> 4	> 5	> 25	> 25	> 60

Seagrass meadows were assigned a mapping precision estimate in metres based on mapping methodology for that meadow (Table 3). Mapping precision estimates ranged from ± 2 m for intertidal seagrass meadows mapped from the helicopter to ± 50 m for the larger subtidal meadow at Bessie Point where boundaries were determined by the distance between diver survey sites (Table 3). The mapping precision estimate was used to calculate a range of meadow area for each meadow and was expressed as a meadow reliability estimate (R) in hectares. Other sources of mapping error associated with digitising and rectifying aerial photographs onto base maps and with dGPS fixes for survey sites were assumed to be embedded within the mapping reliability estimates.

Table 3. Mapping precision for seagrass meadow boundaries in Cairns Harbour and Trinity Inlet, December 2006

Mapping precision	Mapping methodology
≤ 5m	Meadow boundaries mapped in detail dGPS from helicopter All meadows intertidal and completely exposed or visible at low tide Relatively high density of mapping and survey sites Recent aerial photography assisted mapping
± 10m	Meadow boundaries determined from helicopter and/or diver/camera surveys Intertidal meadows mostly exposed or visible at low tide Relatively high density of survey sites for subtidal meadows Recent aerial photography assisted mapping
± 50m	Meadow boundaries determined from diver surveys Meadow completely subtidal (Bessie Point) Relatively high density of survey sites Reliability largely based on number and distances between survey sites Recent aerial photography assisted mapping

RESULTS

Seagrass species

Four seagrass species (from three families) were identified in the monitoring meadows (for a complete list of species found in the survey area see Campbell et al. (2002):

Family CYMODOCEACEAE Taylor:

Halodule uninervis
(wide and thin leaf morphology)
(Forsk.) Aschers. in Boissier

Cymodocea serrulata (R. Br.)
Asche *Cymodocea rotundata*
Ehrenb. Et Hempr. Ex Aschers

Family HYDROCHARITACEAE Jussieu:

Halophila ovalis
(R. Br.) Hook. F.

Family ZOSTERACEAE Drummortier:

Zostera capricorni
Aschers.

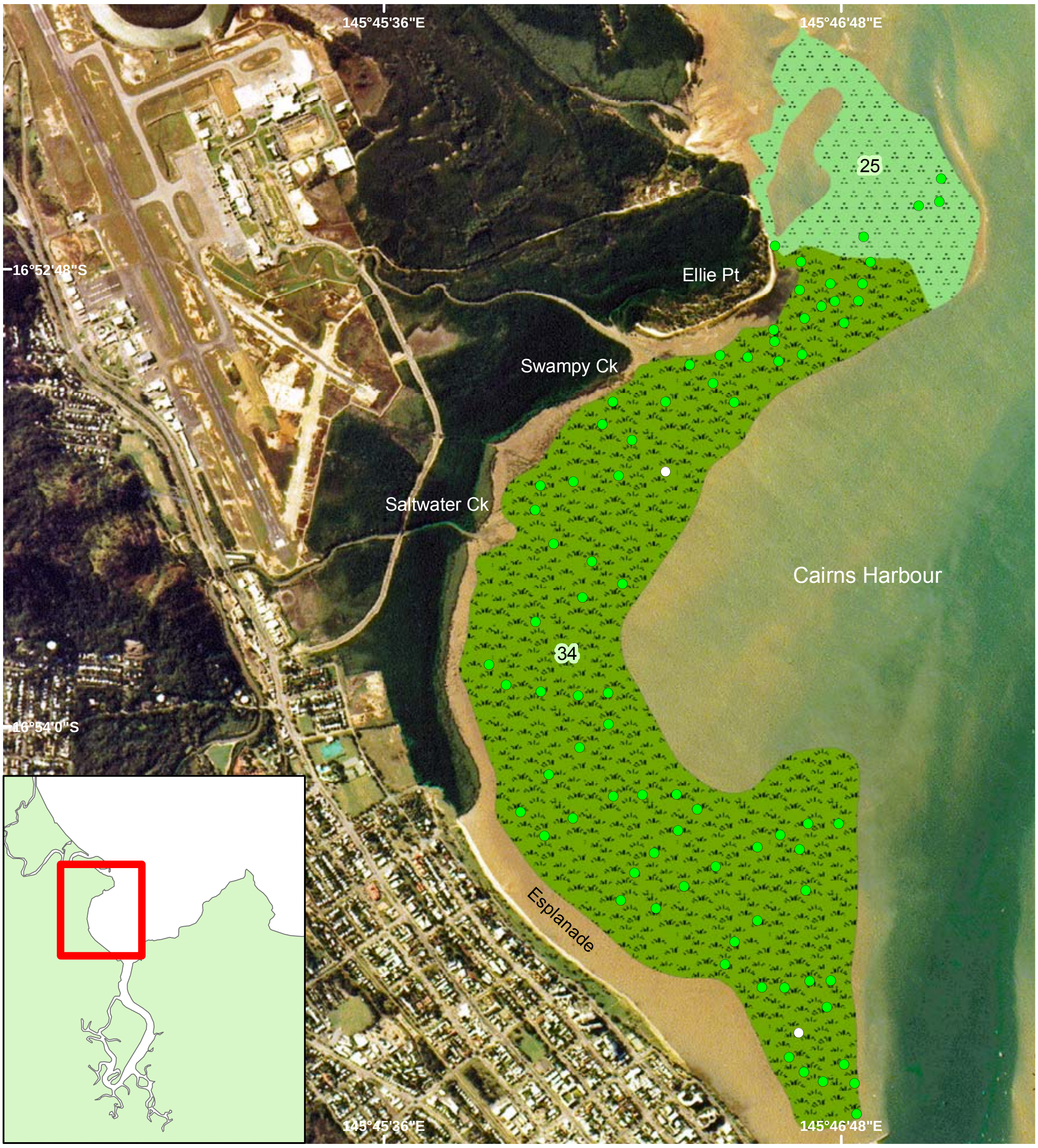
Seagrass distribution and abundance for the monitoring meadows in 2006

A total of 239 sampling sites (not including meadow boundary mapping sites) were surveyed in Cairns Harbour and Trinity Inlet during November and December 2006. Of these, 130 subtidal sites were surveyed from boat using a combination of camera and/or grab, and 109 intertidal sites were surveyed from helicopter. The total area mapped in the five monitoring meadows was 1242.5 ± 90.6 ha (Maps 1, 2 and 3; Table 4). Meadow areas ranged from 0.5 ha to 868.1 ha (Table 4) with the smallest meadows situated in Trinity Inlet (Inlet and Redbank meadows) and the largest meadows located in Cairns Harbour (Esplanade and Bessie Point meadows).

The mean above ground biomass of the five monitoring meadows ranged from 0.1 to 49.3 g DW m^{-2} and was dependent on the mix of species present (Table 4). *Zostera capricorni* and *Halodule uninervis* dominated meadows were higher in above ground biomass than *Halophila ovalis* dominated meadows (Table 4).

Seagrass cover within meadows was continuous for all of the monitoring meadows, although the Esplanade to Ellie Point meadow did contain aggregated patches of seagrass along Cairns Esplanade (Table 5). Based on the mean above ground biomass of the dominant species all three Inlet meadows were classified as being “light”. The remaining two Cairns Harbour meadows were classified as containing “moderate” biomass (Table 5).

Map 1. Cairns Esplanade to Ellie Point seagrass monitoring meadow and survey sites, December 2006



Legend

- Sites without seagrass
- Sites with seagrass

Meadow cover

- Aggregated patches
- Continuous

Monitoring meadow

- Moderate *Zostera capricorni*

Non-monitoring meadow

- Moderate *Cymodocea serrulata* with *Halodule uninervis* (thin)/*Zostera capricorni*

N

0 0.5 1
Kilometres

Source: Rasheed, M.A., Dew, K.R., McKenna, S.A., Sankey, T.L., Taylor, H.A. and Carter, A. (2006). Long term seagrass monitoring in Cairns Harbour and Trinity Inlet - December 2005. DPI&F Publication PR07-2914. (DPI&F, NFC, Cairns).

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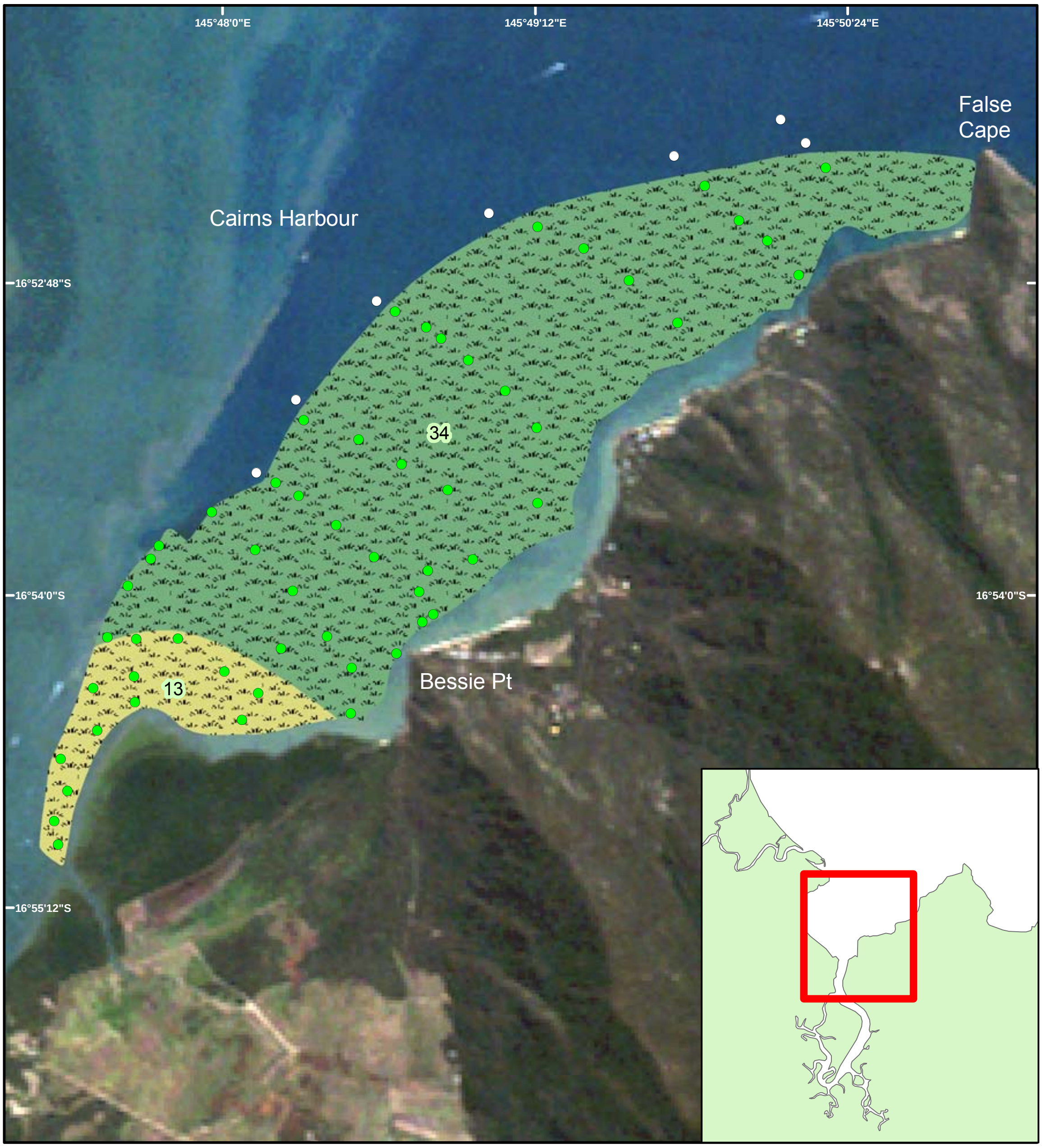
* This is not a complete seagrass distribution, only selected monitoring meadows displayed.
NB: Seagrass meadow boundary mapping sites not shown

Map 2. Bessie Point seagrass monitoring meadow and survey sites, December 2006



Legend

- Sites without seagrass
- Sites with seagrass

Meadow cover

- Aggregated patches
- Continuous

Monitoring meadow

- Moderate *Halodule uninervis* (thin)

Non-monitoring meadow

- Moderate *Zostera capricorni* with *Cymodocea serrulata*

N

0 0.5 1
Kilometres

Source: Rasheed, M.A., Dew, K.R., McKenna, S.A., Sankey, T.L., Taylor, H.A. and Carter, A. (2006). Long term seagrass monitoring in Cairns Harbour and Trinity Inlet - December 2005. DPI&F Publication PR07-2914. (DPI&F, NFC, Cairns).

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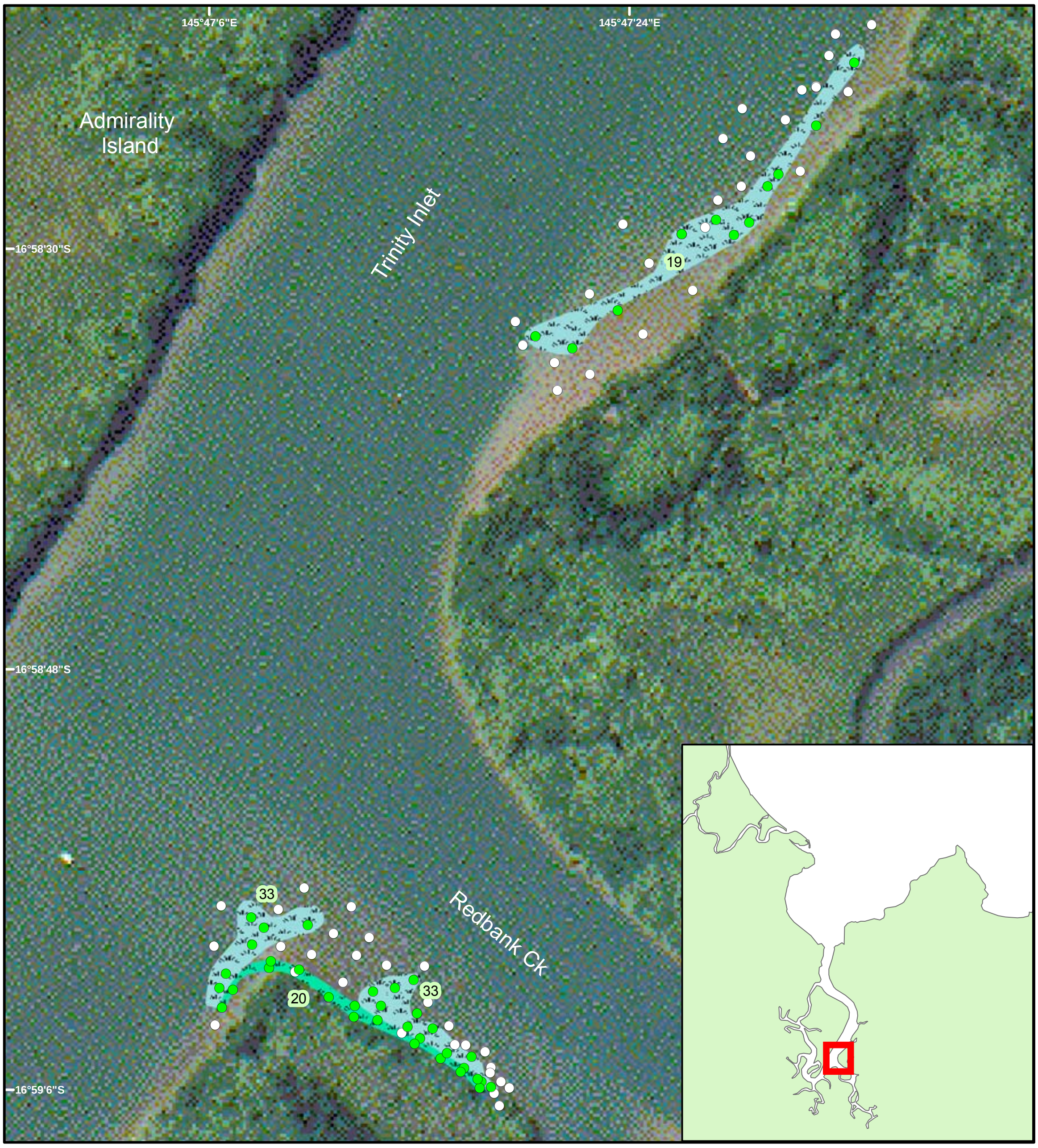
* This is not a complete seagrass distribution, only selected monitoring meadows displayed.
NB: Seagrass meadow boundary mapping sites not shown

Map 3. Trinity Inlet and Redbank Creek seagrass monitoring meadows and survey sites, December 2006



Legend

- ○ Sites without seagrass
- ● Sites with seagrass

Meadow cover

- Aggregated patches
- Continuous

Monitoring meadows

- Light *Halophila ovalis*
- Light *Zostera capricorni*

N

0 140 280
Metres

Source: Rasheed, M.A., Dew, K.R., McKenna, S.A., Sankey, T.L., Taylor, H.A. and Carter, A. (2006). Long term seagrass monitoring in Cairns Harbour and Trinity Inlet - December 2005. DPI&F Publication PR07-2914. (DPI&F, NFC, Cairns).

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* This is not a complete seagrass distribution, only selected monitoring meadows displayed.
NB: Seagrass meadow boundary mapping sites not shown

Table 4. Seagrass monitoring meadow mean above ground biomass (g DW m^{-2}) and area (ha) for monitoring meadows in Cairns Harbour and Trinity Inlet, December 2001 - 2006 (% values indicate change from previous survey) (± R = reliability estimate)

Meadow (see Maps 1-3)	Area (ha) (R)					
	2001	**2002**	**2003**	**2004**	**2005**	**2006**
Esplanade to Ellie Pt. (34)	307.3 ± 10.0	258.5 ± 12.2 (-16%)	280.4 ± 11.7 (+8%)	300.8 ± 12.3 (+7%)	328.91 ± 6.47 (+9%)	370.8 ± 6.5 (+13%)
Bessie Pt. (11)	351.8 ± 133.9	451.2 ± 137.3 (+28%)	473.5 ± 148.8 (+5%)	659.3 ± 158.5 (+39%)	820.4 ± 86.6 (+24%)	868.1 ± 81.6 (+6%)
South Bessie Pt. Meadow (13)# (non-monitoring meadow)	NP	NP	NP	Included in Meadow 11	Included in Meadow 11	73.0 ± 6.3
Inlet (Ho) (19)	1.7 ± 0.6	4.9 ± 1.6 (+195%)	6.9 ± 1.7 (+4%)	5.2 ± 1.5 (-25%)	2.3 ± 1.3 (-56%)	1. 8 ± 1.3 (-23%)
Redbank (Zc) (20)	1.7 ± 1.1	0.1 ± 0.05 (-94%)	0.7 ± 0.4 (+600%)	0.8 ± 0.4 (+14%)	0.4 ± 0.1 (-50%)	0.5 ± 0.2 (+20%)
Redbank (Ho) (33)	np	4.0 ± 1.4+	4.4 ± 1.3 (+9%)	3.9 ± 1.2 (-11%)	2.8 ± 1.0 (-28%)	1.4 ± 1.1 (-50%)
TOTAL (monitoring meadows only)	662.5 ± 145.7	718.9 ± 152.6	765 ±163.9	970 ± 173.9	1154.8 ± 95.5	1242.5 ± 90.6
Esplanade (35)*	278.9 ± 8.0	239.3 ± 10.7 (-14%)	245.8 ± 9.8 (+6%)	267 ± 10.3 (+5%)	282.8 ± 5.0 (+6%)	318.9 ± 5.1 (+13%)
Ellie Pt. (4)*	33.9 ± 3.4	18.7 ± 2.6 (-62%)	25.6 ± 2.9 (+151%)	33.8 ± 3.2 (+184%)	48.1 ± 2.0 (+42%)	51. 9 ± 1.9 (+8%)

Meadow (see Maps 1-3)	Mean biomass ± SE (g DW m^{-2})					
	2001	**2002**	**2003**	**2004**	**2005**	**2006**
Esplanade to Ellie Pt. (34)	36 ± 3.2	18 ± 1.7 (+50%)	46.2 ± 4.1 (+146%)	81.6 ± 6.7 (+76%)	71.6 ± 5.3 (-12%)	47.4 ± 3.4 (-34%)
Bessie Pt. (11)	2.0 ± 0.4	6.4 ± 0.8 (+217%)	4.4 ± 0.4 (-31%)	5.8 ± 0.3^ (+32%)	15.6 ± 1.5 (+169%)	12.7 ± 1.7 (-19%)
South Bessie Pt. Meadow (13)# (non-monitoring meadow)	NP	NP	NP	Included in Meadow 11	Included in Meadow 11	46.3 ± 9.0
Inlet (Ho) (19)	6.6 ± 2.1	0.4 ± 0.1 (-94%)	3 ± 0.5 (+650%)	1.8 ± 0.3 (-39%)	3.6 ± 1.2 (+100%)	0.1 ± 0.0 (-98%)
Redbank (Zc) (20)	4.5 ± 4.1	3.1 ± 0.6 (-31%)	50.1 ± 9.4 (+1516%)	61.5 ± 12.1 (+23%)	15.1 ± 7.4 (-75%)	11.9 ± 2.9 (-21%)
Redbank (Ho) (33)	np	0.8 ± 0.1+	5.2 ± 1.1 (+550%)	1.3 ± 0.2 (-75%)	2.2 ± 0.4 (+69%)	0.3 ± 0.0 (-87%)
Esplanade (35)*	36.2 ± 4.5	18.9 ± 1.9 (-48%)	49.8 ± 4.9 (+163%)	77.4 ± 7.9 (+55%)	72.1 ± 6 (-7%)	46.7 ± 4.0 (-35%)
Ellie Pt. (4)*	35.6 ± 3.9	13.6 ± 3.2 (-62%)	34.1 ± 5.9 (+151%)	96.9 ± 11.7 (+184%)	69.4 ± 3.8 (-28%)	49.3 ± 6.7 (-29%)

+ Percent change not shown because of insufficient biomass samples in 2001 for statistical analyses
^ The one site containing *Cymodocea serrulata* was omitted from Bessie Point biomass analyses
* Split of the Esplanade to Ellie Point meadow
np = meadow not present
(Ho = *Halophila ovalis*; Zc = *Zostera capricorni;* np = meadow not present)

Table 5. Description of Cairns Harbour and Trinity Inlet seagrass monitoring meadows from the November 2006 monitoring survey

	Meadow	Location	Meadow ID	Number of Sites	Habitat Type	Meadow Cover	Meadow Description
Cairns Harbour	**Esplanade-Ellie Pt.**	Cairns Harbour	34	76	Intertidal	Continuous	Moderate *Zostera capricorni*
	Bessie Point	Cairns Harbour	11	41	Subtidal to intertidal	Continuous	Moderate *Halodule uninervis* (thin)
Trinity Inlet	**Inlet (Ho)**	Trinity Inlet	19	11	Subtidal	Continuous	Light *Halophila ovalis*
	Redbank (Zc)	Trinity Inlet	20	16	Intertidal	Continuous	Light *Zostera capricorni*
	Redbank (Ho)	Trinity Inlet	33	19	Subtidal	Continuous	Light *Halophila ovalis*

(Ho = *Halophila ovalis*; Zc = *Zostera capricorni*)

COMPARISON WITH PREVIOUS SURVEYS

In 2006 seagrasses in Cairns were generally healthy with total area of seagrass meadows the highest since monitoring began in 2001 and biomass for the largest meadows remaining relatively high. Within the overall area and biomass trends there were differences between intertidal and subtidal meadows and between meadows in Cairns Harbour and Trinity Inlet (Table 4; Maps 4, 5, 6 and 7; Figure 1). In 2006 there was also a substantial change to seagrasses to the south of Bessie Point resulting in the establishment of a new meadow.

The increase in overall seagrass area was due to the expansion of the two large meadows in Cairns Harbour (13% increase for Esplanade to Ellie Point and 6% for Bessie Point). Both of these meadows were at their largest area for the monitoring program and have been increasing over recent years (Maps 4 & 6; Table 4; figure 1). A majority of the expansion for the Bessie Point *Halodule* meadow occurred at the deeper offshore meadow edge, which in 2006 was at its deepest ever level (maximum 4.3m below MSL) (Table 6).

The small monitoring meadows in Trinity Inlet, however, had either declined in area (subtidal *Halophila* meadows 19 and 33) or remained similar to previous years (intertidal *Zostera* meadow 20) (Map 7; Table 4; figure 1). The two subtidal *Halophila* meadows in Trinity Inlet have been declining in area since 2003 (Figure 1). The declines in area of these subtidal meadows generally occurred at their deepest margins, which has resulted in the depth penetration of the meadows reducing from 2004 (Table 6; Map 7).

Biomass of the intertidal *Zostera* meadow (Esplanade to Ellie Point 34) in Cairns Harbour had significantly decreased from the record highs of 2004 (Appendix 1). In the context of the overall monitoring program, biomass for this meadow was still relatively high and higher than all surveys prior to 2004. Biomass of the other monitoring meadow in Cairns Harbour, the intertidal to subtidal *Halodule* meadow (Bessie Point 11), remained at the record high levels reached in 2005 (Appendix 1). In contrast, biomass of the two subtidal *Halophila* meadows in Trinity Inlet had significantly declined and were at their lowest recorded levels (Table 4; Figure 1; Appendix 1). The intertidal *Zostera* monitoring meadow in Trinity Inlet had a similar biomass to 2005 but remained significantly lower than the high levels reached in 2003 and 2004 (Figure 1; Appendix 1).

Species composition of the southern section of the Bessie Point meadow had changed substantially from 2005 to 2006 resulting in this section of the meadow being separated and reclassified as a new meadow (Table 4; Map 2). Previously the area had been dominated by *Halodule uninervis* (narrow) but had changed in 2006 to be dominated by the higher biomass species *Cymodocea serrulata* and *Zostera capricorni.* These species had first appeared in the meadow in low abundance in 2004 but were excluded from meadow biomass estimations in 2004 and 2005.

In 2005 morphology of *Halodule uninervis* in the Bessie Point monitoring meadow had changed from the “narrow leaf” form to the “wide leaf” variety. In 2006 the meadow had again returned to the narrow leaf variety. The species composition of the other seagrass monitoring meadows had remained very similar between 2005 and 2006 (Figure 1).

Table 6 Maximum depth of monitoring meadows at Cairns Harbour and Trinity Inlet, December 2001 – 2006

Meadow location and ID number	Max. depth (m) 2001	Max. depth (m) 2002	Max. depth (m) 2003	Max. depth (m) 2004	Max. depth (m) 2005	Max. depth (m) 2006
Esplanade to Ellie Pt.	na	na	na	0.9	na	na
Bessie Pt.	3.7	3.7	4.0	4.1	4.0	4.3
Inlet (Ho)	na	3.2	3.4	3.8	2.9	3.3
Redbank (Zc)	1.3	1.1	1.5	1.6	1.2	1.1
Redbank (Ho)	na	3.4	3.2	3.2	2.9	2.4

(na = insufficient depth measurements, or sites were surveyed using helicopter)

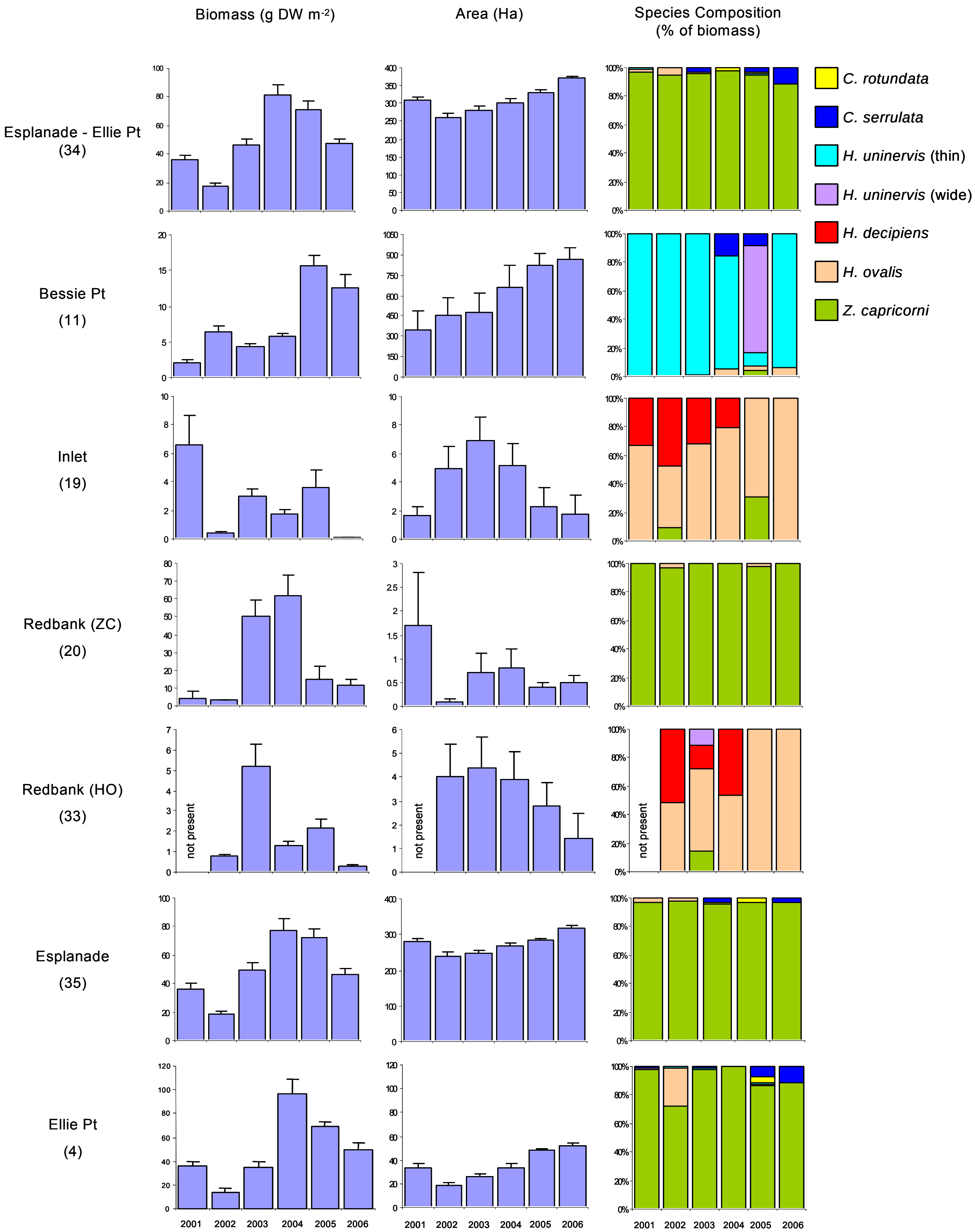
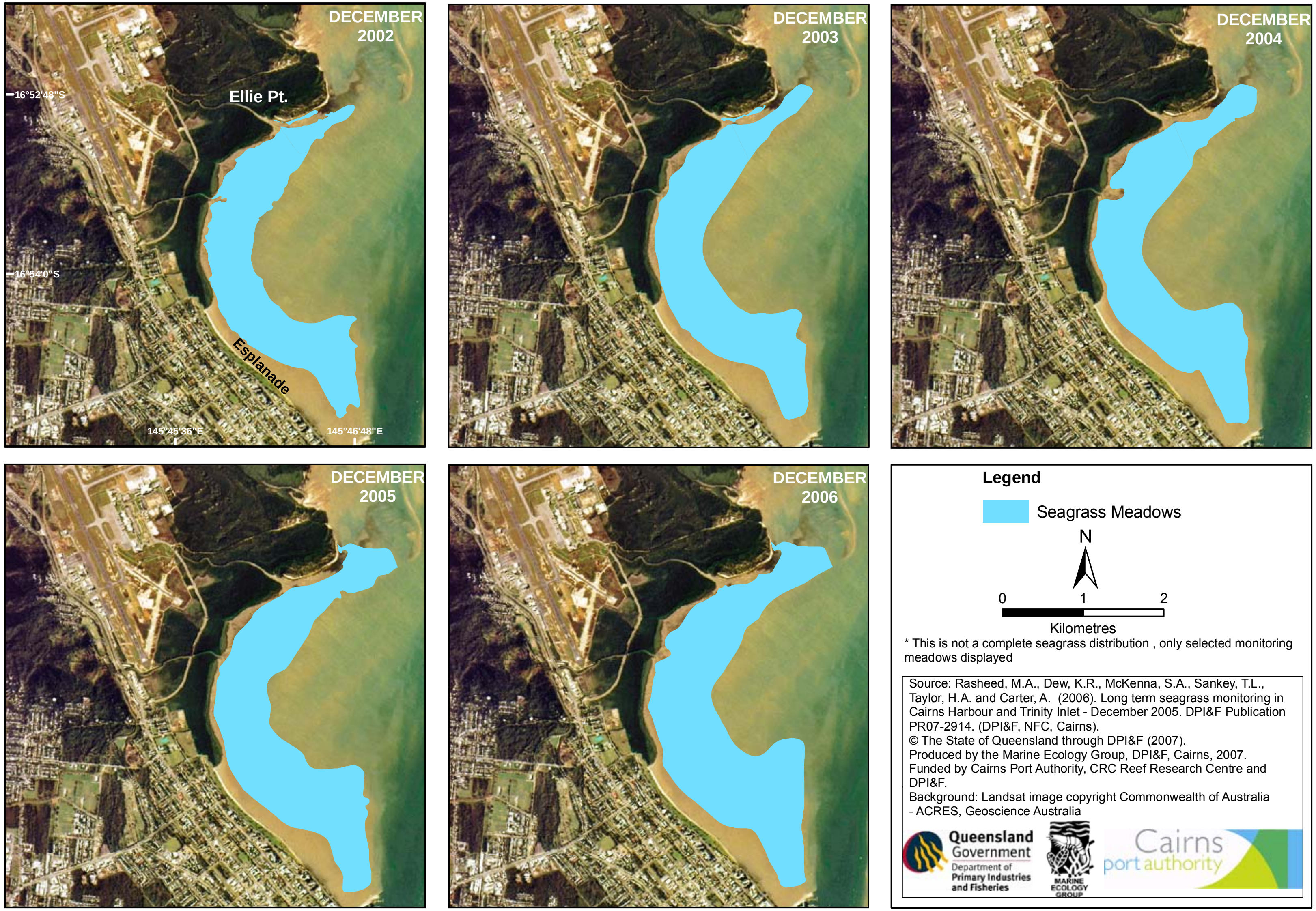
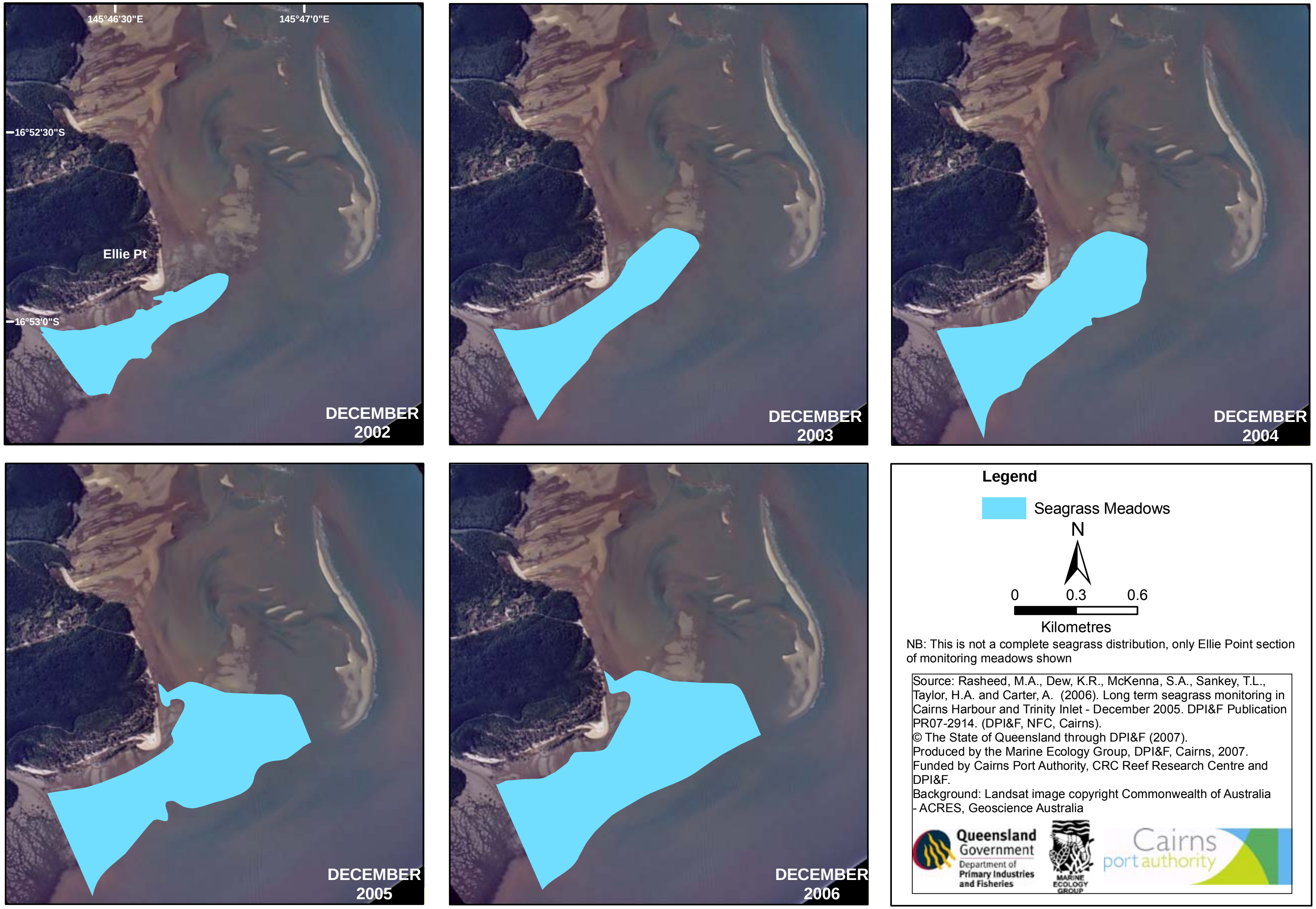


Figure 1 Mean biomass (g DW m^{-2}), area ± R (ha) and species composition (%) of monitoring meadows at Cairns Harbour and Trinity Inlet from 2001 to 2006.

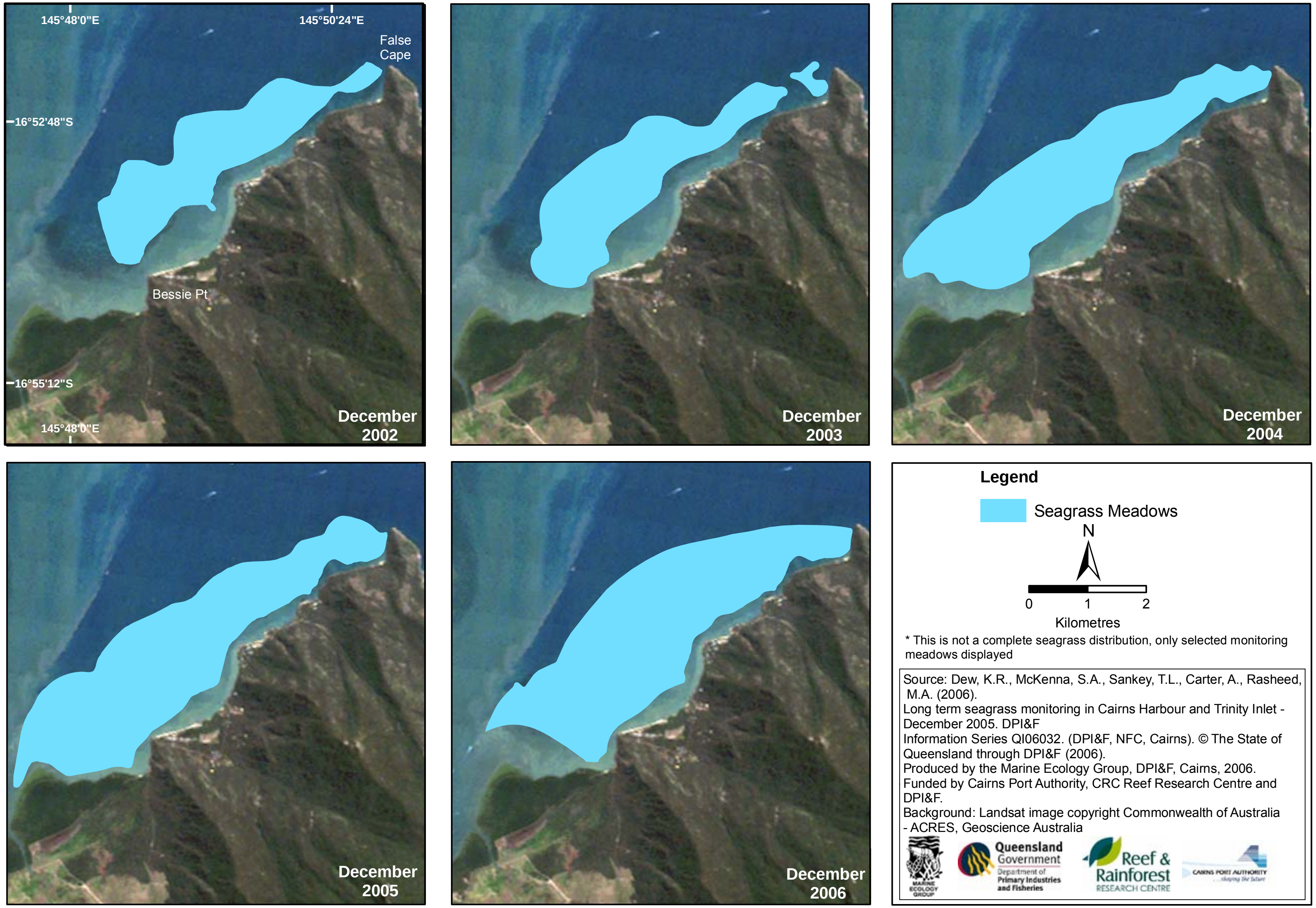
Map 4. Esplanade to Ellie Point seagrass monitoring meadows in December 2002, 2003, 2004, 2005 and 2006



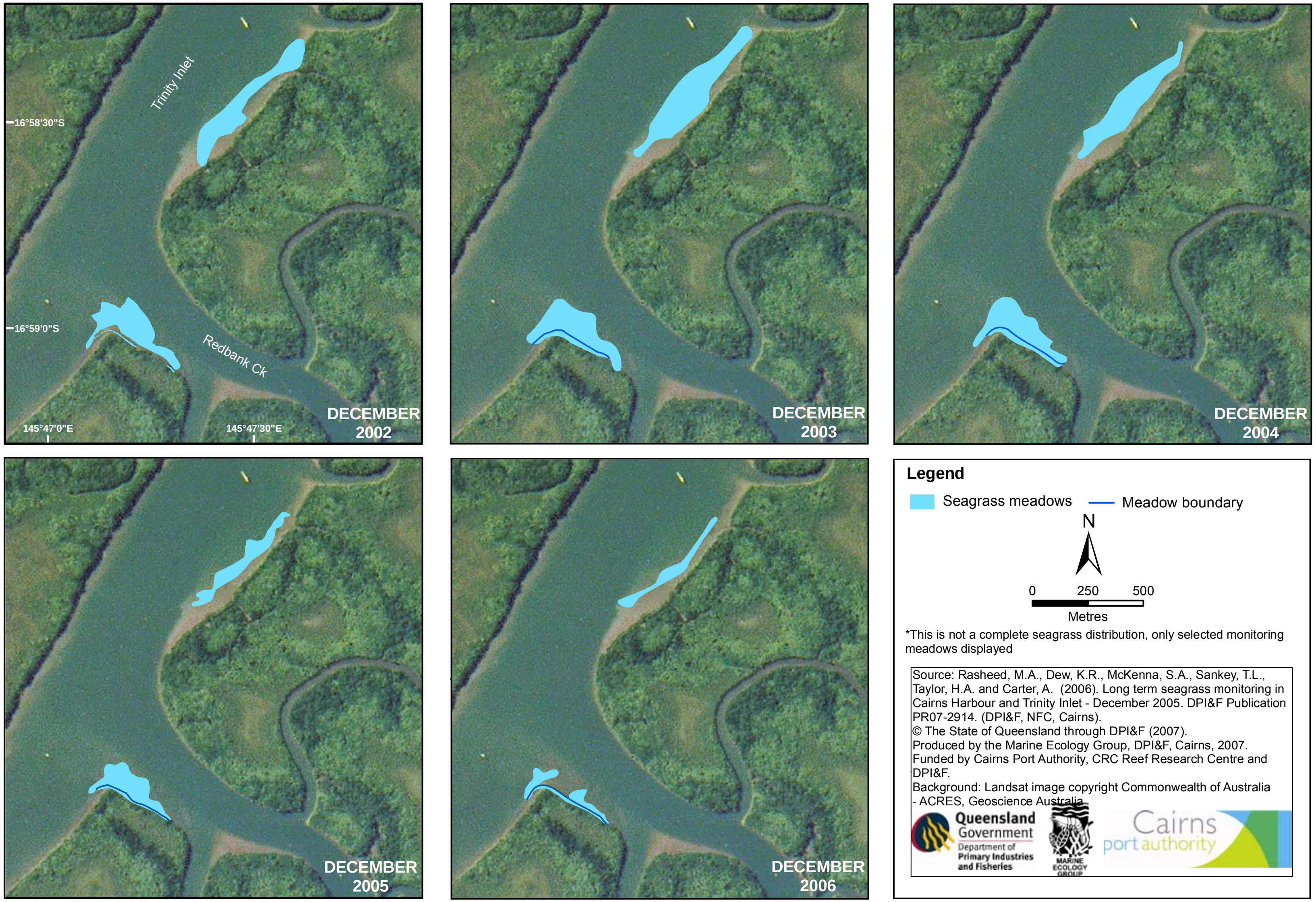
Map 5. Ellie Point seagrass monitoring meadow in December 2002, 2003, 2004, 2005 and 2006



Map 6. Bessie Point seagrass monitoring meadow in December 2002, 2003, 2004, 2005 and 2006



Map 7. Trinity Inlet seagrass monitoring meadows in December 2002, 2003, 2004, 2005 and 2006



DISCUSSION

The 2006 monitoring survey of Cairns Harbour and Trinity Inlet has found seagrasses to be in a healthy condition. The two Cairns Harbour monitoring meadows had increased to the largest area recorded in the monitoring program and had maintained a relatively high density (biomass). In addition a new dense seagrass meadow had developed in the harbour and seagrass area outside of the monitoring meadows had also increased. The opposite was true for the small monitoring meadows within Trinity Inlet where some significant declines in both biomass and area were recorded in 2006. The changes observed for Cairns seagrasses were consistent with the prevailing climate conditions in the area and for other similar seagrass areas monitored in north Queensland.

The decline in Trinity Inlet seagrasses over the past three years appears to be a result of climate and environmental conditions rather than port or other anthropogenic influences. Higher rainfall levels over the past three years (Figure 2) were likely to have caused higher levels of turbidity in Trinity Inlet resulting in reduced light penetration through the water column. The seagrasses in Trinity Inlet, particularly the deeper subtidal meadows, were more vulnerable to runoff related turbidity than meadows in Cairns Harbour. These meadows were growing in deeper water and would also be subjected to longer exposure to turbid water. Hydrodynamic modelling of tidal current flows in Trinity Inlet shows a circulation around Admiralty Island that would confine turbid water in the area for extended periods (Lou Mason (JCU) pers com). Studies in other areas of Queensland have found that reductions in light availability for as little as 30 days can have detrimental affects on seagrass growth (Abal and Dennison 1996; Longstaff *et al*. 1999).

The largely subtidal *Halodule* meadow in eastern Cairns Harbour has not been impacted in the same way as subtidal meadows located in Trinity Inlet. We hypothesise that while runoff related turbidity is a major factor driving change in seagrass growth in the Trinity Inlet meadows, the Cairns Harbour meadows are less affected as they would be regularly exposed to relatively “clear”, oceanic water.

The same climate conditions leading to a decline in subtidal meadows in Trinity Inlet were likely to be beneficial to the large intertidal seagrass meadows of Cairns Harbour. Over the last three years there has been a return to more “normal” climate with higher rainfall and increased number of cloudy days (lower irradiance) (Figure 2). These conditions combined with a decrease in the number of hours intertidal meadows were exposed (Figure 3) were likely to have protected intertidal seagrasses from the effects of thermal stress and desiccation thought to have contributed to their decline during 2002 and 2003 (Rasheed *et al.* 2006).

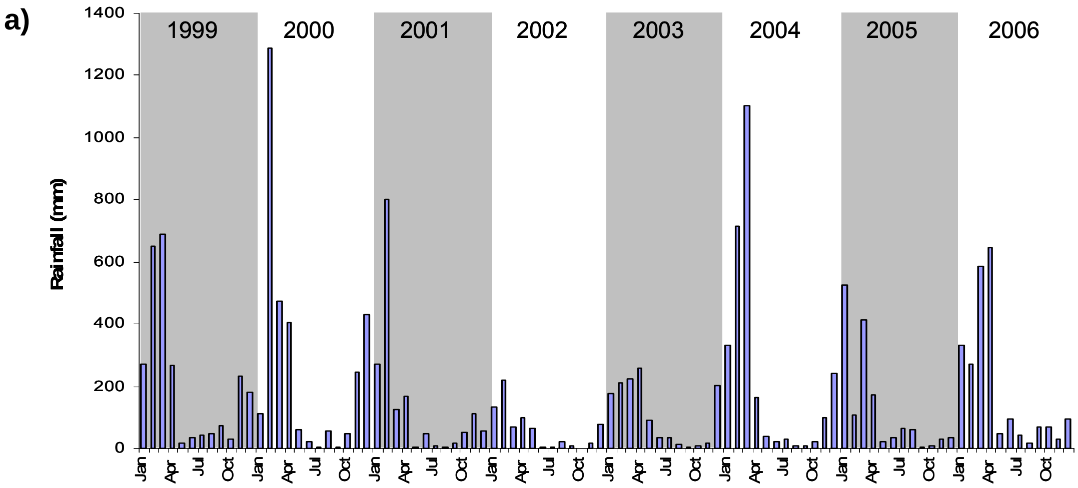
The changes in Cairns seagrass in 2006 were consistent with climate linked changes seen in other areas of north Queensland. Intertidal meadows in Karumba had increased in 2006 associated with similar climatic changes to those recorded in Cairns (increased rainfall, lower temperatures and decreased solar irradiance) (Dew *et al.*2007). In Gladstone intertidal *Zostera* meadows had also increased in 2006 coinciding with reduced temperatures and a reduction in daytime exposure of meadows (Taylor *et al.* 2007). Intertidal to subtidal *Halodule* meadows in Gladstone have also shown similar increasing trends to the Bessie Point meadow in recent years (Taylor *et al.* 2007). Unlike Cairns, the Gladstone region did not have any substantial increases in rainfall leading up to the 2006 survey and consequently the subtidal *Halophila* meadows there had increased substantially in area and biomass unlike the Trinity Inlet meadows of the same species.

The dramatic increase in *Zostera capricorni* and *Cymodocea serrulata* in the southern section of the Bessie Point meadow led to the establishment of a new higher density meadow for the area in 2006. Although *Cymodocea serrulata* has been present in this section of the Bessie Point meadow since 2004 it was previously only a minor component. This area is the shallowest section of the Bessie Point mud/sand bank with observations in the field indicating that the bank had shallowed in recent times. This is also the area of the shipping channel that requires the most regular maintenance dredging due to high siltation rates (Adam Fletcher (CPA) pers com). The shallowing of this bank would likely explain the changes to the meadow, as elsewhere in the harbour *Zostera capricorni* and *Cymodocea serrulata* tend to occur in the shallower sections of the intertidal banks where optimal conditions for *Zostera capricorni* growth are found (Conacher *et al.* 1994).

In 2005 a new area of seagrass at the northern end of Ellie Point was included as part of the Esplanade to Ellie Point monitoring meadow. Due to tidal conditions in 2005 it was not possible to confirm seagrass species composition in this new area. In 2006 the same area of seagrass was again present, but ground truthing revealed a different species composition to the monitoring meadow (dominated by *Cymodocea serrulata* and *Halodule uninervis* rather than *Zostera*). As a consequence it was determined this area formed a separate meadow and the results of the 2005 survey were reworked accordingly for comparison in this latest report.

The continued increase in area of dense *Zostera capricorni* meadows had the potential to positively affect fisheries productivity in the region. *Zostera capricorni* meadows are known to provide a valuable nursery habitat and refuge for juvenile commercial fish and prawn species (McKenzie et al 1996; Watson et al 1993). These meadows are especially important for juvenile tiger prawns (Watson et al. 1993), a fishery that contributed over $27 million Gross Value of Production to Queensland in 2005 (DPI&F, 2007). The expansion of the large *Halodule uninervis* meadow in eastern Cairns Harbour (Bessie Point) may also be of benefit to dugong and turtle using the area. *Halodule* species are the preferred food source of dugong as they are more palatable and easily digested than many other seagrass species (Lanyon 1991; Preen 1995).

Results of monitoring in 2006 indicate that seagrass habitats and the marine environment in Cairns Harbour were relatively healthy. The major changes observed were most likely associated with regional and local climate rather than local port activities. While port and urban activities were unlikely to have had a major influence on seagrass changes, land use in the Trinity Inlet catchment had the potential to be influencing the small subtidal meadows located within the inlet. The increased understanding of seagrass dynamics arising from this monitoring program is assisting our ability to effectively manage seagrass habitats. Information collected in the program is also assisting in the planning and management of port and urban activities that will have minimal impacts on marine habitats in Cairns Harbour and Trinity Inlet.



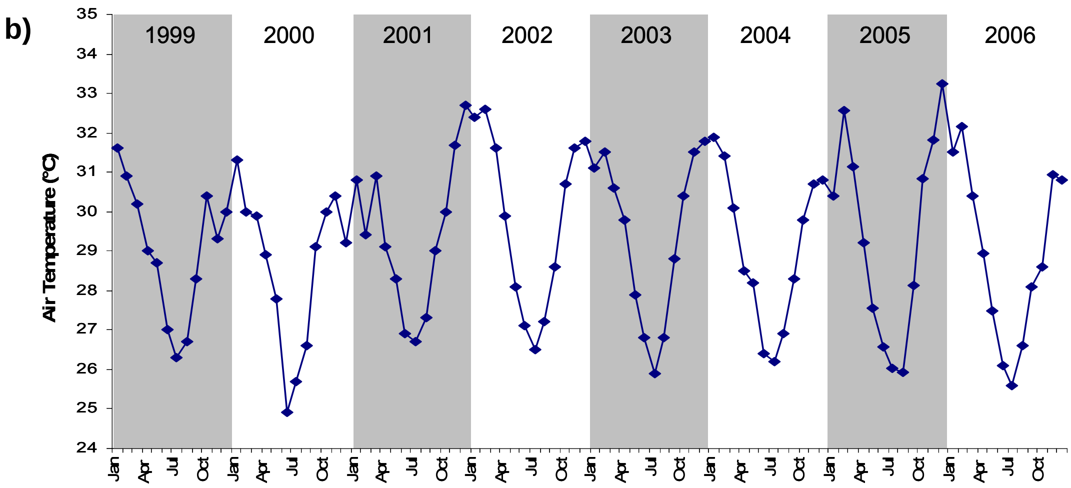


Figure 2 a) Total monthly rainfall (mm) and b) mean monthly maximum air temperature (°C) for Cairns, 1999 to 2006

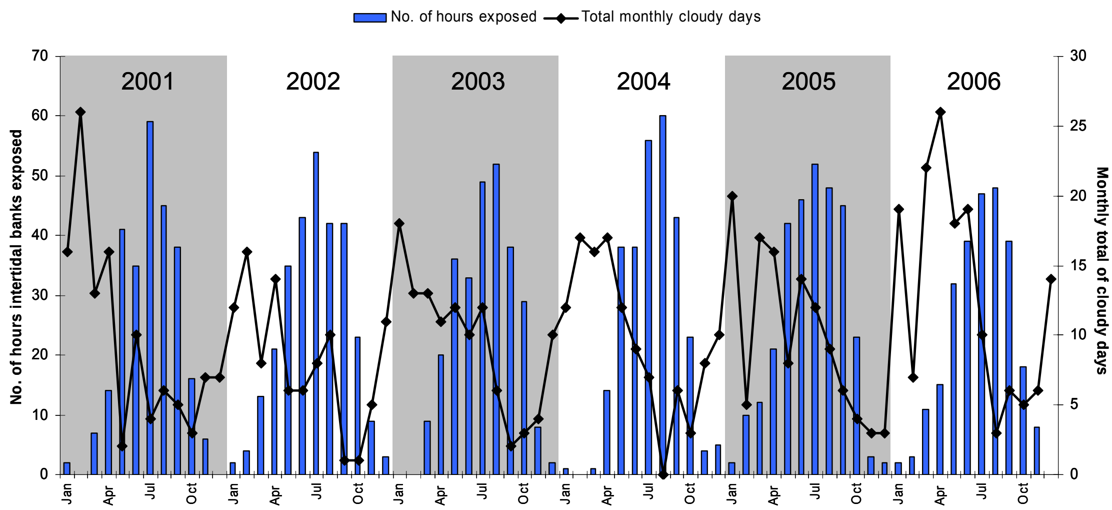


Figure 3 Mean number of daylight hours per month intertidal seagrasses are exposed and number of cloudy days per month for Cairns from 2001 to 2006

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APPENDIX 1

Results of one-way ANOVA for mean above-ground biomass versus year for the Cairns Harbour and Trinity Inlet monitoring meadows 2001 to 2006.

Ellie Point Meadow (4)	DF	MS	F	P
Between Years	5	16000.3	16.02	< 0.0001
Within Years	114	998.916		
Total	119			
Esplanade Meadow (35)	**DF**	**MS**	**F**	**P**
Between Years	5	30881.3	16.24	< 0.0001
Within Years	360	1901.06		
Total	360			
Esplanade to Ellie Pt. Meadow (34)	**DF**	**MS**	**F**	**P**
Between Years	5	44925.8	26.68	< 0.0001
Within Years	480	1684.05		
Total	485			
Redbank (Zc) Meadow (20) ^	**DF**	**MS**	**F**	**P**
Between Years	5	67.6858	9.68	< 0.0001
Within Years	61	6.99295		
Total	66			
Inlet (Ho) Meadow (19) ^	**DF**	**MS**	**F**	**P**
Between Years	5	5.50637	9.70	< 0.0001
Within Years	84	0.56743		
Total	89			
Redbank (Ho) Meadow (33) ^	**DF**	**MS**	**F**	**P**
Between Years	4	1.01	25.70	< 0.0001
Within Years	109	0.03941		
Total	113			
Bessie Pt Meadow (11) ^	**DF**	**MS**	**F**	**P**
Between Years	5	60.2267	29.88	< 0.0001
Within Years	360	2.01579		
Total	365			

*Data was square root transformed ^ Data was log+1 transformed.

Results of Least Significant Difference (LSD) pairwise comparisons of mean above ground biomass (g DW m^{-2}) for the Cairns Harbour and Trinity Inlet monitoring meadows. Means that share the same letter group within each meadow are not significantly different (P<0.05).

Meadow	Year	Mean biomass
Ellie Pt (4)	2001	35.6 c
	2002	136 d
	2003	34.1 cd
	2004	96.9 a
	2005	69.4 b
	2006	49.3 bc
Esplanade (35)	2001	36.2 b
	2002	18.9 c
	2003	49.8 b
	2004	77.4 a
	2005	72.1 a
	2006	46.7 b
Esplanade to Ellie Pt (34)	2001	36 b
	2002	18 c
	2003	46.2 b
	2004	81.6 a
	2005	71.6 a
	2006	47.4 b
Redbank (Zc) (20)	2001	1.2 b
	2002	1.5 b
	2003	6.3 a
	2004	7.1 a
	2005	2.8 b
	2006	2.7 b
Inlet (Ho) (19)	2001	2.3 a
	2002	0.6 c
	2003	1.5 ab
	2004	1.3 b
	2005	1.5 b
	2006	0.2 c
Redbank (Ho) (33)	2001	not sampled
	2002	0.2 c
	2003	0.7 a
	2004	0.3 bc
	2005	0.4 b
	2006	0.1 d
Bessie Point (11)	2001	1.0 d
	2002	2.2 b
	2003	1.9 b
	2004	2.3 b
	2005	3.5 a
	2006	3.8 a