Development of Wet Tropics WQIP elements - seagrass monitoring

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**EXECUTIVE SUMMARY**

Seagrass meadows are a key component of the Wet Tropics NRM region marine ecosystem, supporting dugong, endangered green turtle and valuable fisheries resources. Seagrasses of the Wet Tropics are highly diverse (14 species), highly productive and highly dynamic, fluctuating in extent and abundance. Approximately 20% of the seagrass area mapped in the Great Barrier Reef (GBR) occurs within the Wet Tropics. However, the Wet Tropics also includes some of the most poorly mapped areas in the GBR.

The distribution of seagrass was examined in the Frankland Islands on 17 March 2014, to assess the current seagrass status and identify a possible location to establish a long-term monitoring site for inclusion in the MMP. Seagrass was limited to a few locations within the Frankland Islands, however a seagrass site suitable for inclusion in the MMP was identified at Normanby Island. This is an ideal site to complete a cluster of MMP components, supporting the formation of a "SuperSite" to illustrate success of water quality improvements through the Paddock to Reef (P2R) reporting. To ensure data gaps in other MMP components (i.e. pesticides) are minimised, support for regular maintenance of the existing MMP pesticide site at Normanby Island is recommended. A proposal has been prepared to support monitoring of the new Normanby Island seagrass site for inclusion in the MMP.

An assessment of the status of seagrass on the intertidal banks adjacent to Lucinda was conducted on 31 March 2014. The intertidal banks were barren and seagrass has failed to recover across the area or within the existing long-term monitoring site. Seagrass recolonisation may be slowed due to the excessive sediment movement across the intertidal banks or lack of viable seagrass propagules (seeds and/or vegetative fragments). It is recommended that support be provided to investigate the presence of seed banks and to conduct a detailed survey of seagrass meadows in the region (Hinchinbrook Channel to Cleveland Bay) to provide insight to whether recovery of seagrass at Lucinda is possible in the near future.

An assessment of the long-term monitoring site at Goold Island was conducted on the 12 June 2014 with the assistance of Girringun rangers. The absence of seagrass across the site showed no significant recovery over the last 24 months since it was last monitored. Only isolated patches of low cover *Halophila ovalis* and few shoots of *Enhalus acoroides* and *Halodule uninervis* were observed in the near vicinity. These findings are in agreement with other monitoring sites in the southern Wet Tropics which indicate that meadows remain in a vulnerable condition, with weak resistance and a lower capacity to recover from major disturbances.

Seagrass was absent from the estuaries of the Hull and Tully Rivers on the 17 June 2014. This equates to a loss of approximately 7ha of seagrass over the last 25 years. A combination of a relatively closed estuarine system with no remaining plants and severe declines in nearby systems limits the availability of donor meadows to contribute seeds or vegetative propagules via dispersal for the meadows to recover naturally.

The loss of seagrass in the southern section of the Wet Tropics may indicate a deterioration of water quality in the estuaries and inshore areas. The lack of recovery may likely be due to a lack of seagrass propagules (depleted seed banks and deficient donor meadows). Assisted recovery through restoration efforts has been considered.

It is critical for any potential recolonisation and recovery that favourable conditions for seagrass growth are restored and maintained. Future activities and development in the rivers and their catchments in the southern Wet Tropics should consider the current poor state of seagrass resilience and their vulnerability to future impacts.
**Objective:**

Investigate establishment of seagrass monitoring site in the Frankland Islands and reassess MMP inshore seagrass monitoring sites to improve measures for end of catchment impacts from the Russell-Mulgrave, Tully and Herbert Rivers, and also strengthen links with Traditional Owners in the region.

**Introduction & Background**

Chronic declines in inshore water quality in the Great Barrier Reef (GBR) since European settlement have resulted in ecological shifts in GBR marine ecosystems (De’ath and Fabricius, 2010; Roff et al., 2013). Multiple pressures are the cause of this decline, including intensive use of the GBR catchments for agriculture and grazing, and coastal development for urban centres and commercial ports (Brodie et al., 2013b). Flood plumes, in particular, disperse terrestrially sourced pollutants over sensitive inshore GBR ecosystems including seagrass meadows summarised in Schaffelke et al., summarised in (2013). Degraded water quality from agricultural runoff has been identified as the largest anthropogenic threat to GBR seagrasses and 40% of seagrass meadows along the urban coast of the GBR are identified as being at a moderate-high risk to anthropogenic threats (Grech et al., 2011). Hinchinbrook Island (including Lucinda and Tully/Murray/Hull River mouths), Cassowary coast (including the Frankland Islands) and Cairns Harbour coastal seagrass have been identified at highest exposure to threats in the Wet Tropics NRM region (hereafter referred to as the Wet Tropics) (Grech et al., 2011).

Healthy seagrass meadows in the GBR are important resources as the primary food for dugong, green turtles, numerous commercially important fish species and as habitat for large number of invertebrates, fish and algal species (Carruthers et al., 2002). Much of the connectivity in reef ecosystems depends on intact and healthy non-reef habitats, such as seagrass meadows (Waycott et al., 2011). These non-reef habitats are particularly important to the maintenance and regeneration of populations, e.g., reef fish. Seagrass are also considered coastal canaries or coastal sentinels that integrate environmental stressors and can be monitored to provide insight into the status of the surrounding environment (Dennison et al., 1997; Orth et al., 2006; Heck et al., 2008).

Seagrass in the Wet Tropics was first mapped as part of broad scale surveys of the Queensland coast in 1984 (Wujula Wujal to Trinity Inlet) and 1987 (Cairns Harbour to Halifax Bay). The survey included only nearshore seagrass to a depth of approx 15m. Since the 1980s, mapping has been issue focused at local scales (e.g. Cairns Port, Mourilyan Harbour, Green Island, Low Isles, Port Hinchinbrook (Oyster Point) and Dunk Island to Halifax (including the Hinchinbrook Dugong Protection Area) (Lee Long et al., 1996; McKenzie et al., 1996; Lee Long et al., 1998; McKenzie et al., 1998; Udy et al., 1999; Lee Long et al., 2001; McKenzie et al., 2001). Unfortunately, seagrass mapping across the Wet Tropics includes some of the poorest mapped areas in Queensland. One of the most data poor areas is Wujula Wujal to Ellie Point (Trinity Inlet), as many locations were missed during the broadscale surveys. Another location is the Frankland Islands. Apart from anecdotal reports (e.g. fishers, divers), there have been no detailed examinations of either of these areas for seagrass.

Approximately 6.5% of the maximum habitable area of seagrass mapped in the shallow waters (<15m) of the GBR occurs in the Wet Tropics (McKenzie et al., 2010, 2014b). The most extensive areas of seagrass in this region occur around Low Isles, Cairns Harbour, Green Island, Mourilyan Harbour and Hinchinbrook Island (between Dunk Island and Lucinda) (Coles et al., 2007). Thirteen seagrass species have been recognised for this region (Lee Long et al., 1993). Nearshore seagrass meadows are situated on sand and mud banks and mostly dominated by Halodule uninaervis with some Halophila in the northern and southern areas. Intertidal meadows in Cairns Harbour and
southern Hinchinbrook channel are dominated by *Zostera muelleri*. Shallow subtidal coastal meadows consist of *Halodule uninevis* and *Halophila* communities mostly along sheltered coasts and harbours (e.g. Cairns Harbour and Mourilyan Harbour). *Cymodocea* spp., *Thalassia* and a suite of *Halophila* species tend to dominate island habitats in the region (e.g. Dunk Island and northern Hinchinbrook Island).

Information on seagrass status in the Wet Tropics is provided by Ports North's annual monitoring in the ports of Cairns and Mourilyan Harbour, and as part of the Great Barrier Reef Marine Park Authorities (GBRMPA) Marine Monitoring Program (MMP) (Low Isles, Yule Point, Green Island, Dunk Island and Lugger Bay) (Figure 1). Ports North monitoring is conducted to identify impacts associated with port activities (e.g. maintenance dredging) (Jarvis et al., 2014; York et al., 2014), while the MMP is focused primarily on agricultural runoff (McKenzie et al., 2014a). Current indications from the MMP are that inshore water quality, largely driven by fluctuations in total suspended sediment, and seagrass state across the Wet Tropics are in a poor to very poor state (Brodie et al., 2013a). Although seagrass abundance has increased over the last 12 months at some locations, seagrass in the overall Wet Tropics has been in a poor state since 2009 and remains in a vulnerable condition, with weaker resistance and a lower capacity to recover from major disturbances (McKenzie et al., 2014a). Unprecedented declines in biomass and distribution of estuarine meadows have also been reported since 2009 in the Ports of Cairns and Mourilyan Harbour, and there has been limited recovery since (Jarvis et al., 2014; York et al., 2014).

![Figure 1. Location of existing MMP sites for each monitoring component and major river catchments in the Wet Tropics. Dashed boxes show existing seagrass assessment areas.](image)

Nine river catchments lie within the Wet Tropics which support a population of over 250,000. Land use practices include primary production such as cane and banana farming, dairy, beef, cropping and tropical horticulture (Commonwealth of Australia, 2013). The largest is the Herbert (9,842km²), followed by the Johnstone (2,326km²). In regard to relative catchment size and pollutant loads (suspended sediment, dissolved inorganic nitrogen and phosphorus, particulate nitrogen and phosphorus and photosystem II inhibiting herbicides), the catchments Johnstone, Tully, and Russell-Mulgrave are of greatest concern (Turner et al., 2013). The catchments which posed the greatest risk for seagrass from poor water quality, with regards to agricultural runoff, were the Tully-Murray and Herbert followed by the Johnstone and Russell-Mulgrave (Devlin and Schaffelke, 2009; Waterhouse et al., 2014). This includes the coastal areas around Hinchinbrook Island, extending north to the Tully River mouth and south to the regional boundary at the southern part of the Herbert basin (Waterhouse et al., 2014). A number of long-term seagrass monitoring sites have been established within these areas, however, most have not been revisited in over 2 years to determine if they have
recovered from the losses experienced in 2011 as a consequence of several years of above average river discharge and TC Yasi (McKenzie et al., 2012a; McKenzie et al., 2012b).

To demonstrate whether improved land practices are improving inshore water quality, it has been recommended that apart from monitoring locations across a region, where possible, the MMP should include "SuperSites" where components of MMP (coral, seagrass, water quality, pesticides, remote sensing) are clustered. One location identified where MMP sites are clustered was the Frankland Islands.

To provide information to assist with the development of the Water Quality Improvement Plan (WQIP) for the Wet Tropics, and identify areas of concern and to prioritise investment, the following tasks were undertaken:

1. Conduct reconnaissance of seagrass in the Frankland Island Islands, and if possible, establish long-term monitoring sites and conduct post-wet monitoring in 2014 using MMP protocols;
2. Conduct post-wet monitoring in 2014 at established site on Goold Island (in collaboration with Traditional Owners if possible) and reconnaissance of seagrass in the mouths of Tully, Murray and Hull Rivers;
3. Conduct post-wet monitoring at established site at Lucinda;
4. Provide recommendations and protocols for inshore seagrass monitoring off the central and southern Wet Tropics.
METHODOLOGY

Reconnaissance survey strategy

The Frankland Islands survey focused on the main islands, including: High, Normanby, Mabel, and Russell (Figure 2). An aerial reconnaissance was first conducted on the 02 March 2014 during the low spring tide to identify shallow reefs and reef flats to focus the ground survey. The ground survey was conducted on the 17 March 2014 and primarily focused on identifying the presence of seagrass and any meadows which would be suitable for long-term monitoring (McKenzie et al., 2014a). Intertidal and shallow subtidal areas were surveyed using a boat, based on the aerial reconnaissance, aerial photographs and local bathymetry. Benthos was examined at haphazardly selected points across shallow banks which extended from the upper intertidal to depths of approximately 10m. In submerged areas, benthos was examined using a bathyscope and van Veen sediment grabs.

At Lucinda, the intertidal sand-banks were first assessed from aerial photographs to identify any apparent meadows or positions to focus the ground survey. The existing long-term monitoring site (HX1) and the intertidal banks in the near vicinity were examined by foot on 31 March 2014. The presence of seagrass and benthos was examined at haphazardly selected points across the intertidal banks.

The estuaries of the Tully and Hull Rivers were examined on 17 June 2014. The survey originally focused on re-examining the positions of the ground truth sites in 1996 (Figure 3, Lee Long et al., 1998) and then at haphazardly selected points across the shallow banks which extended from the upper intertidal to depths of approximately 5m. Benthos was examined from shallow drafted vessel using van Veen sediment grabs as it was too turbid (20cm visibility) for a bathyscope.
Figure 3. Location of points (●) examined 08 October 1996 and seagrass meadows mapped (green polygons) in the Hull (a), Tully (b) and Murray River (c) estuaries. Large meadow in Hull River estuary mapped October 1987 and smaller meadow was mapped in October 1996. Green points identify seagrass present, 08 October 1996. NB: positional accuracy in 1996 was ±5m.

Data Collection

Mapping

Seagrass habitat characteristics including visual estimates of above-ground percentage cover (of a 0.25 m² quadrat), species composition, % algae cover, sediment type were recorded at each point according to the standard methodologies (McKenzie et al., 2001; McKenzie et al. 2003). A Global Positioning System (GPS) was used to accurately determine geographic location of sampling points (±5 m). Seagrass species were identified where possible according to Waycott et al., (2004) and voucher specimens were collected for taxonomic verification. Depths of survey sites were measured using a depth sounder and field descriptions of sediment composition from hand or grab samples were recorded for each site using a visual/tactile assessment of sediment grain size: gravel (>2mm); coarse sand (>500 μm); sand (>250 μm); fine sand (>63 μm); and mud (<63 μm) (McKenzie, 2007).

Monitoring

Field survey methodology followed standardised protocols (McKenzie et al., 2003). Sites were defined as a 50m x 50m area within a relatively homogenous section of a representative seagrass community/meadow (McKenzie et al., 2000). At each site, observers recorded the percent seagrass cover within a 50 cm × 50 cm quadrat every 5 m along three 50m transects, placed 25m apart. A total of 33 quadrats were sampled per site. Seagrass abundance was visually estimated as the fraction of the seafloor (substrate) obscured by the seagrass species when submerged and viewed from above. This method was used because the technique has wider application and is very quick, requiring only minutes at each quadrat; yet it is robust and highly repeatable, thereby minimising among-observer differences. Quadrat percent cover measurements have also been found to be far more efficient in detecting differences in seagrass abundance than seagrass blade counts or measures of above or below-ground biomass (Heidelbaugh and Nelson, 1996). To improve resolution and allow greater differentiation at very low percentage covers (e.g. <3%), shoot counts
based on global species density maxima were used. For example: 1 pair of *Halophila ovalis* leaves in a quadrat = 0.1%; 1 shoot/ramet of *Zostera* in a quadrat = 0.2%. Additional information was collected at the quadrat level, including: seagrass canopy height of the dominant strap leaved species; macrofaunal abundance; abundance of burrows, as an measure of bioturbation; presence of herbivory (e.g. dugong and sea turtle); a visual/tactile assessment of sediment composition (see McKenzie, 2007); and observations on the presence of superficial sediment structures such as ripples and sand waves to provide evidence of physical processes in the area (see Koch, 2001).

A criteria to determine the suitability of a sites inclusion to the MMP is that the Minimum Detectable Difference (MDD) be less than 20% (at the 5% level of significance with 80% power). The MDD is the minimum difference between the largest and smallest means, and is based upon differences in precision of the mean Standard Error for each sample number. From the method of Bros and Cowell, (1987), using the degrees of freedom at a particular sample number, critical t-values were selected from t-value tables for both 0.05 (α set at 5%) and 0.20 (β set at 80% power), using 2-tailed tests. These t-values were entered into the following formula (eq. 1) in order to determine the minimum detectable difference:

$$MDD = \sqrt{2} S_{T} (t_{(0.05),\nu} + t_{(0.2),\nu})$$

(equation 1)

where $S_{T}$ = SE for sample size, $\nu$ = 2 (number of replicates -1) and all t-values are 2-tailed.
RESULTS & DISCUSSION

Frankland Islands seagrass assessment, 17 March 2014

Aerial reconnaissance of the Frankland Islands conducted on the 2 March 2014 (at a height of ~150m) (Figure 4) identified a number of areas requiring closer inspection for seagrass presence, including: the fringing reef-flat on the western side of High Island; the shallow subtidal area to the north of Normanby Island (where tourist vessels moor); the sheltered reef flat on the western side of Normanby Island; and the sheltered reef flat at Russell Island.

Figure 4. Flight path (02 March 2014) and ground survey points around the Frankland Islands (17 March 2014). 128 survey points were examined around the Frankland Islands (Figure 4) on the 17 March 2014. Three seagrass species were recorded/colllected from the shallow waters (<10m) surrounding High, Normanby and Russell Islands:

Family CYMODOCEACEAE Taylor

*Halophila ovalis* (R. Brown) Hooker f.

*Halodule uninervis* (Forsskål) Ascherson

Family HYDROCHARITACEAE Jussieu

*Thalassia hemprichii* (Ehrenberg) Ascherson
**High Island**

Isolated patches (<5m diameter) of *Thalassia hemprichii* were found on the shallow reef flat, located on the western side of High Island (Figure 5, Figure 6). The shallow areas surrounding the remainder of the island were unsuitable for seagrass, being predominately gravel/coral and rubble/coarse sand substrates or sharp drop-offs.

![Figure 5. Location of ground survey points and dominant benthos around High Island.](image)

![Figure 6. Thalassia hemprichii shoots on the fringing reef located along the western shores of High Island.](image)
**Russell Island**

10 points were examined in the shallow waters surrounding Russell Island. The eastern and western portions of the shallows were predominately substrates of coral/rubble/coarse sand, unsuitable for seagrass. Isolated patches of *Halophila ovalis* were present in the shallow waters (1.5 - 2m depth) between Russell Island and Round Island, sheltered from the south-easterly trade winds. No meadows of seagrass were observed in the shallows.

![Figure 7. Location of ground survey points and dominant benthos around Russell Island.](image)

![Figure 8. Russell Island reef flat.](image)
**Normanby Island**

77 points were examined in the shallow waters surrounding Normanby Island. The eastern section of the shallows was predominately coral bommies (stand-alone mounds of coral or rubble) or substrates of coral/rubble/coarse sand. The northern section was sheltered from the south-easterly trade winds and tourist vessels anchor in the area. A semi submersible mooring/pontoon was also moored in the vicinity. A near continuous meadow of *Halophila ovalis* and *Halodule uninervis* on coarse sand/gravel sediment was located in the north western section adjacent to the tourist vessel area. The meadow was subtidal, between 0.5m and 1m below LAT. The meadow covered approximately 0.6 ha.

![Figure 9. Location of ground survey points, dominant benthos and seagrass meadows around Normanby and Mabel Islands.](image)

![Figure 10. *Halophila ovalis* and *Halodule uninervis* meadow in the north western section of Normanby Is.](image)
A monitoring site was established within this meadow and surveyed using standard protocols. Seagrass abundance averaged 14.5 ±2.1% (median=17) (Figure 11), which was rated as poor relative to the seagrass guideline for the Wet Tropics reef habitats (McKenzie et al., 2013). Seagrass is seasonally abundant, higher during the growing season (late August to November), but lower during the post-monsoon senescent season (May to August) (McKenzie, 1994; Coles et al., 2007). The low abundance observed at Normanby Island may be natural, a consequence of the post-monsoon as seagrass move toward the senescent season, or anthropogenic, in response to catchment runoff.

![Figure 11. Percentage cover of seagrass (all species pooled), epiphytes and macro-algae at the new long-term monitoring site, Normanby Island, 17 March 2014. The heavy line in the box marks the average. The box represents the interquartile range of values, where the boundary of the box closest to zero indicates the 25th percentile, a line within the box marks the median, and the boundary of the box farthest from zero indicates the 75th percentile. Whiskers (error bars) above and below the box indicate the 90th and 10th percentiles, and the black dots represent outlying points.]

Seagrass within the site were dominated by *Halophila ovalis*, an opportunistic colonising species, which may indicate some level of disturbance (e.g. sediment movement, grazing), but also included *Halodule uninervis*. The species composition is representative of seagrass communities on reef habitats in the southern Wet Tropics (Coles et al., 2007; McKenzie et al., 2013). The abundance of macro-algae was 4.6 ±2.3 (at the GBR long-term average for subtidal reef habitats) and epiphytic cover on the seagrass blades was 5.8 ±0.9 (below the GBR long-term average for subtidal reef habitats) (Figure 11). No reproductive structures (flower or fruits) and no seed bank were present, however, this is not unexpected as flowering and seed set mainly occurs in the late growing season. There was also no evidence of dugong grazing or turtle cropping.

The MDD for the site (calculated using eq. 1) was 10.4%, which supports the sites suitability for monitoring, i.e., monitoring can detect a statistically significant change of 10.4% with a 5% chance of reporting a change when none actually exists and a 20% chance of reporting no change when actually there was one.

Reefs in the Frankland Islands are regularly subjected to outflows from the Johnstone and the Russell-Mulgrave rivers. Unlike the majority of reefs in the Wet Tropics, sediments in the Frankland Islands have higher than average levels of clay and silt, organic carbon and nitrogen indicating high residence or accumulation of sediment components derived from these rivers (Thompson et al., 2011). Coral status has declined (Thompson, 2014) and pesticide exposure appears high (Kennedy et al., 2011), although pesticide results are less clear due to data gaps in recent years (Chris Paxman, National Research Centre for Environmental Toxicology, UQ. Pers. Comm.). The Normanby Island pesticide site is one of the longest datasets in the WT, but the reliance on volunteers and infrequent collections are of concern. The suitability of the seagrass site and the presence of other MMP component monitoring sites, supports the formation of a cluster in the Frankland Islands to illustrate success of water quality improvements through the Paddock to Reef (P2R) reporting.
**Lucinda seagrass assessment, 31 March 2014**

**Long-term monitoring site**

A long-term monitoring site (HX1) was established within the meadow adjacent to Lucinda township on 26 September 2004 as part of the Seagrass-Watch scientific monitoring program. The seagrass was near equally composed of the opportunistic species *Halophila ovalis* and the relatively persistent species *Halodule uninervis* (Figure 12). In July 2005, only *H. uninervis* was present, suggesting the meadow was stabilising and possibly more enduring in character. However, in 2011 following TC Yasi, seagrass was lost from the site and no seagrass was found across the entire intertidal banks. The resurvey of the site in March 2014, found seagrass had not recovered and the substrate across the site was predominately bare sand with occasional sand dollars, worm tubes and hermit crabs.

![Figure 12. Seagrass abundance and species composition at Lucinda long-term monitoring site (HX1) from September 2004 to March 2014.](image1)

**Meadow reconnaissance**

Although no seagrass meadows were obvious from recent aerial photography (19 August 2013), an area of intertidal banks sheltered by a large sand bar/ridge, immediately seaward of Lucinda township, intimated closer inspection. 71 ground truth points were examined across the intertidal banks adjacent to Lucinda township on 31 March 2014 (Figure 13), however, no seagrass was observed. The sediments were predominately sand, with some mud component in the area west of the sand bar/ridge. The linear to undulatory ripples across the banks indicated a high-energy habitat with excessive sediment movement, unlikely to support seagrass settlement (Koch, 2001) (Figure 14).

![Figure 13. Location of long-term monitoring site (HX1) and ground truth positions examined 31 March 2014. Aerial photograph 19 August 2013.](image2)
Figure 14. *Images of the intertidal banks adjacent to Lucinda township showing: bare sand with ripples (a); worm tubes and moon snail (Polinices sp.) egg mass (b); and fine sand with ray pits (c, d).*

The findings from 31 March 2014 illustrate the lack of recovery since 20 March 2011 when the intertidal banks were last examined post TC Yasi (Figure 15, Collier et al., 2012). Between March 2007 and March 2011, approximately 2,350 ha of seagrass was lost (Figure 15) (Rasheed et al., 2007).

Historically, the seagrass meadows adjacent to Lucinda township have fluctuated in extent since first mapped in 1987 (Figure 16). The absence of seagrass plants for at least 3 years suggests either the seed bank (if any) has depleted, that no suitable donor meadows remain in the near vicinity to supply propagules (seeds or vegetative fragments), or that sediment movement across the banks is too excessive for seagrass settlement. To provide insight to whether recovery is possible will require closer investigation to determine the presence of seed banks and a more detailed survey of seagrass meadows in the region (Dunk Island to Cleveland Bay).
Figure 15. Seagrass meadows on the intertidal banks adjacent to Lucinda, 31 March 2014, 20 March 2011 (from Collier et al., 2012) and 18 March 2007 (from Rasheed et al., 2007).

Figure 16. Seagrass meadow extent on the intertidal banks adjacent to Lucinda, 1987 - 2014.
**Tully inshore area seagrass assessment, June 2014**

**Goold Island survey 12 June 2014**

Goold Island is a small (8.3km²) continental island located 17 km offshore from Cardwell. The Island is a national park within the Great Barrier Reef World Heritage Area. The Bandjin and Girramay Aboriginal people are the Traditional Owners of Goold Island (traditionally know as Marrajumban).

Intertidal seagrass meadows are found on the fringing reef flats on the south western and southern shores of the island. A monitoring site was established on the 4 June 2008 in as part of the turtle and dugong monitoring plan for Girringun Sea Country.

When established, the site (GO1) was predominantly *Cymodocea serrulata* with some *Halodule uninervis*. *Enhalus acoroides* is also found within the meadow. As a consequence of 3 successive years of above median flows from both the Tully and Murray Rivers, and the highest rainfall in over a decade in early 2009, the meadow at Goold Island severely declined with only isolated *Cymodocea serrulata* shoots remaining (Johns and McKenzie, 2010). Since 2009, seagrass has shown little recovery, a result similar to other seagrass meadows within the region (McKenzie et al., 2013). In September 2010, the meadow species mix changed, becoming dominated by the colonising *Halophila ovalis*. The meadow has remained in this state with a recent appearance of a few isolated *Cymodocea serrulata* seedlings in 2011. When last examined in 2012, Goold Island seagrass and abundance remained in a poor state, although dugong grazing trails were observed (seagrasswatch.org).

With the assistance of the Girringun Rangers, the long-term monitoring site at Goold Island was monitored on 12 June 2014. A detailed assessment (full monitoring) of the site was not possible due to a low pressure system keeping the tidal height 30cm above predicted (Figure 17). A partial assessment (haphazard sampling of 20 spots within the site and 20 spots adjacent to the site) failed to locate any seagrass on the monitoring site (Figure 18, Figure 19). Isolated patches of low cover (<3%) *Halophila ovalis* and isolated shoots of *Halodule uninervis* and *Enhalus acoroides* were observed in the near vicinity of the site on the shallow banks. The *H. ovalis* and *E. acoroides* was shoreward of the site, approximately 15m off the sandy beach, and the *H. uninervis* shoots were in an area immediately north of the site.

![Figure 17. View looking west across the shallow banks with water remaining over long-term monitoring site (GO1), above predicted spring tide, at Goold Island, 12 June 2014.](image-url)
The lack of recovery within the site suggests the seed bank observed in 2011 has been depleted and recovery will most likely rely on vegetative growth from adjacent plants. The finding that seagrass across the site had changed little since 30 August 2012, with no significant recovery over the last 21 months, is in agreement with other monitoring sites in the southern Wet Tropics which indicate that meadows remain in a vulnerable condition, with weak resistance and a lower capacity to recover from major disturbances (McKenzie et al., 2013).

**Tully and Hull River estuary surveys 17 June 2014**

There is very little information available on seagrass within the estuaries of the Hull, Tully and Murray Rivers. There have been only two surveys of the region to date which have included the river estuaries. A meadow of 6.3ha with 10 - 50% cover of undescribed seagrass was mapped in October 1987 in the Hull estuary (Coles et al., 1989; Coles et al., 2001), but was absent in October 1996 (Lee Long et al., 1998). In October 1996, however, a *Zostera/Halodule uninervis* meadow (0.7ha) was mapped in the North Hull River, on the mud banks near the branch of the Hull River, within the Hull River Fish Habitat Area (Lee Long et al., 1998).

39 spots were examined in the small estuaries immediately within the mouths of the Hull and Tully Rivers on 17 June 2014 (Figure 20, Figure 21). Sampling was conducted only by grab as water clarity was poor (approx 20cm). The Murray River was unable to be assessed via the river mouth due to poor weather / sea state or Barrets-Lagoon Road due to poor state of the road and boat ramp. The intertidal banks near the mouth and in the northern branch of the Hull river were thoroughly examined for the presence of the meadows observed in 1996.

Mapping on the 17 June 2014 found no evidence of recovery in the meadow mapped in 1987 and the loss of the meadow mapped in 1996. This equates to at least 7 hectares of seagrass which has been lost over the past 25 years in the estuaries. The benthos was bare and sediments were predominately coarse sand with gravel and mud (Figure 22). The mud (<63μm grain size) was
composed mainly of what appeared to be fine silt (possibly 2 - 10μm grain size), which was noncohesive (unlike clay) and dispersive in nature, i.e. easily suspended to elevate turbidity.

Figure 20. Location of spots examined for the presence of seagrass in the Hull River estuary, 17 June 2014.

Figure 21. Location of spots examined for the presence of seagrass in the Tully River estuary, 17 June 2014.

Figure 22. Sediment grab sample from Hull River showing coarse sand/gravel with fine mud, 17 June 2014.
The loss of seagrass may indicate a deterioration of water quality in the estuaries, similar to the nearest estuary where long-term monitoring occurs in the Wet Tropics; Mourilyan Harbour (45km north). Recent monitoring for Ports North reported that seagrass meadows in Mourilyan Harbour estuary were in a poor condition with a significant decline in biomass since 2008 (York et al., 2014). The authors attributed this decline to climate impacts, including extreme rainfall events in 1999, 2000, TC Larry in 2006 and La Niña conditions that lead to heavy wet seasons from 2009-11 culminating in TC Yasi in 2011 (York et al., 2014). Similar declines have also been reported in Cairns Harbour estuary where meadows dominated by Z. muelleri and H. uninervis have reduced to isolated patches since 2009 (Jarvis et al., 2014).

In the Hull River estuary, as with Mourilyan, the lack of recovery may likely be due to a lack of seagrass propagules. Surveys of the seed banks in Mourilyan Harbour sediments in 2012 and 2013 reported very low densities of Z. muelleri seeds, which were also likely to have very low levels of viability given their age (York et al., 2014). This would be similar for the Hull River estuary. It remains uncertain how these meadows will recover naturally as a combination of a relatively closed estuarine system with no remaining plants and severe declines in nearby systems limits the availability of donor meadows to contribute seeds or vegetative propagules via dispersal. Assisted recovery through a restoration project has been suggested for Mourilyan Harbour (York et al., 2014).

It will be critical for any potential recolonisation and recovery that favourable conditions for seagrass growth are restored and maintained. Future activities and development in the rivers and their catchments in the southern Wet Tropics should consider the current poor state of seagrass resilience and their vulnerability to future impacts.

**RECOMMENDATIONS**

Support of monitoring the seagrass site identified at Normanby Island be provided to complete the cluster of MMP components in the Frankland Islands and formation of a "SuperSite" to illustrate success of water quality improvements through the Paddock to Reef (P2R) reporting.

Support for regular maintenance of the existing MMP pesticide site at Normanby Island be provided to ensure data gaps are minimised, to assist with interpretation of seagrass monitoring at the "SuperSite"

Support to fill a significant knowledge gap in Wet Tropic seagrass ecosystems by conducting baseline mapping of inshore seagrass meadows between Wujula Wujal and Ellie Point (Trinity Inlet).

Support to investigate the presence of seed banks and a more detailed survey of seagrass meadows in the region (Dunk Island to Lucinda) be granted to provide insight on the recovery of seagrass at Goold Island, the Hull River estuary and Lucinda is possible in the near future.
REFERENCES


McKenzie et al 2014 - Wet Tropics WQIP seagrass –TropWATER 14/37


APPENDIX 1

Communications

www.seagrasswatch.org for regular updates of monitoring and sampling activities, e.g. gallery page


Indigenous engagement

As part of this project, 4 Girringun indigenous rangers assisted with monitoring at Goold Island on the 12 June 2014 and 2 Girringun indigenous rangers assisted with the assessment of seagrass in the estuaries of the Tully and Hull Rivers on the 17 June 2014. The Girringun Aboriginal Corporation vessel (Wulgu, 4.5m) were also hired for the assessment of the Tully and Hull Rivers.

Figure 23. Girringum rangers Penny Ivey (above left) and Cindy Lou Togo (above right) assisting with the survey of the Hull and Tully river estuaries, 17 June 2014.
APPENDIX 2

Proposal to FNQ NRM Ltd trading as Terrain Natural Resource Management ("Terrain NRM") for
"Enhancing linkages between Wet Tropics catchment improvements and GBR ecosystem status -
seagrass health in the Russell-Mulgrave and Tully inshore areas."