Marine and Tropical Sciences Research Facility
Milestone and Progress Report #3, 2008-2009 (ARP 3)

Project 1.1.3 ext a Milestone report September 2009

Title:	Task 1.1.3 ext a: Observing change in seagrass habitats of the GBR– Seagrass-Watch monitoring

Project Leaders: Associate Professor Michelle Waycott, Dr Catherine Collier

Institution: James Cook University

Summary of Milestone report

Light loggers have been deployed at four intertidal and subtidal seagrass meadows in the Burdekin (Magnetic Island) and Wet tropics NRMs (Dunk Island, Green Island, Low Isles) since 2008. Total daily light reaching seagrass meadows at all locations was much higher in the intertidal meadows than the subtidal meadows. The annual pattern of total daily light at the seagrass meadow sites does not closely follow annual solar light intensity where light is highest around the summer solstice (December) and lowest at the winter solstice (June). Therefore seagrass responses to light (e.g. percent cover) may also not follow annual changes in solar insolation. Large peaks in light intensity occur during the winter period when spring low tides result in significant periods of time exposed to the air or very shallow water. This can result in a large departure in daily light between subtidal and intertidal seagrasses, particularly for intertidal sites above +0.8m LAT, which is a typical low tide level throughout the year. Daily light was lowest at Low Isles and Magnetic Island, which relates to site depth and may also reflect a poorer water quality at these sites. However, light at canopy height data are not a true indication of water quality as the sites are at different depths (subtidal ranging from -0.9 to -2.5m below LAT, intertidal from +0.6 to +0.9).

Water quality loggers (chlorophyll and turbidity loggers) are being deployed at subtidal seagrass sites (Magnetic Island, Dunk Island and Green Island) starting October 2009. Data from these loggers will help to elucidate the source of changes in light at the seagrass meadows. Light monitoring will continue at the subtidal and intertidal sites until March/April 2010. After this time, there are no plans in place to continue with subtidal monitoring as this is largely undertaken under MTSRF project 1.1.3 which concludes in June 2010. The intertidal component will be retained. Three of the intertidal sites will continue to be monitored, as well as nine additional Reef Rescue intertidal seagrass monitoring sites. Light monitoring at these intertidal sites will be started in October 2009. Future reports will explore the relationship between light intensity and Reef Rescue intertidal seagrass monitoring data (1.1.3 ext a November 2009 Milestone report) and the relationship between light and subtidal and intertidal seagrass responses (MTSRF 1.1.3 December 2009 Milestone report) in an effort to elucidate thresholds and the role of light as a driver in seagrass meadows.

For reference: Milestone extracted from Project Schedule

- Final report on the light availability and water quality parameters (pesticide) at the intertidal and subtidal seagrass meadow locations and potential implications for seagrass meadow health.

Project Results

Description of the results achieved for this milestone

Light availability at intertidal and subtidal seagrass meadow locations

2008 – 2009

Dr Catherine Collier, Assoc Prof Michelle Waycott and Ana Giraldo Ospina

The inclusion in the Reef Rescue monitoring of light levels reaching seagrasses in 2008/2009 provides data for establishing the loss of seagrass habitat due to changes in water quality. Measurement of this parameter requires the deployment of light sensors at the surface of the seagrass canopy. In the GBR, many seagrasses form low height canopies, particularly species that form in coastal locations (Waycott et al. 2004). The establishment of monitoring at both intertidal and subtidal locations during 2008 was completed and initial survey of the data collected at these sites was undertaken. The expansion of sites to additional intertidal sites during 2009 is currently underway.

Light loggers were deployed at four intertidal and subtidal seagrass meadow locations: Magnetic Island (Burdekin NRM), Dunk Island, Green Island and Low Isles (Wet Tropics NRM) (Table 1). These are monitoring locations for MTSRF project 1.1.3 research project part b, Drivers of change in seagrasses of the GBR (Waycott and Collier). All but the Low Isles sites are immediately adjacent to Reef Rescue intertidal seagrass monitoring sites. Establishment of the sites has been staged to evaluate the success of logger deployment and data management. The Magnetic Island site was established first in January 2008 and the Low Isles site was established last in November 2008. Therefore a full year of light data is not yet available for two of the four sites.

Table 1. Light monitoring coordinates, set-up date and depth relative to LAT

Location	Site	Latitude	Longitude	Set-up date	Site depth*
Magnetic Island	Subtidal	19 10.88	146 50.63	29 January 2008	-1.5m
	Intertidal				+1.0m
Dunk Island	Subtidal	17 55.91	146 08.42	25 May 2008	-0.9m
	Intertidal	17 56.75	146 08.45		+0.9m
Green Island	Subtidal	16 45.29	145 58.38	15 Oct 2008	+2.0m
	Intertidal	16 45.53	145 58.38		+0.8m
Low Isles	Subtidal	16 22.97	145 33.85	24 Nov 2008	-2.5m
	Intertidal	16 23.11	145 33.88		+0.6m

*refers to mean tidal exposure depth

Light loggers (2π light loggers; Submersible Odyssey Photosynthetic Irradiance Recording System, Dataflow Systems Pty Ltd, New Zealand) were installed at seagrass canopy height. Each light logger has a wiper unit to keep the sensor clean. This can increase the deployment period and improve the quality of light data. Light loggers are checked and or changed every 4 – 8 weeks at the Magnetic Island and Dunk Island sites and every 6 – 12 weeks at the Green Island and Low Isles sites. Some fouling of the sensors can occur, despite the wiper units and regular exchange of loggers. Algae can over time attach to the light sensor and the wiper is not 100% effective at keeping the sensor clean. This is the most relevant to subtidal meadows where the loggers are always submersed, and so a redundant system of deploying duplicate light loggers (i.e. two at each site) are deployed at canopy height in subtidal meadows allowing verification of local conditions. If the cleaning unit fails on one of these loggers, data from the other logger can be used. At intertidal sites, regular exposure to the air tends to inhibit the establishment of algae on the sensors and the wiper unit is typically highly effective at removing any settled particles such as sediment.

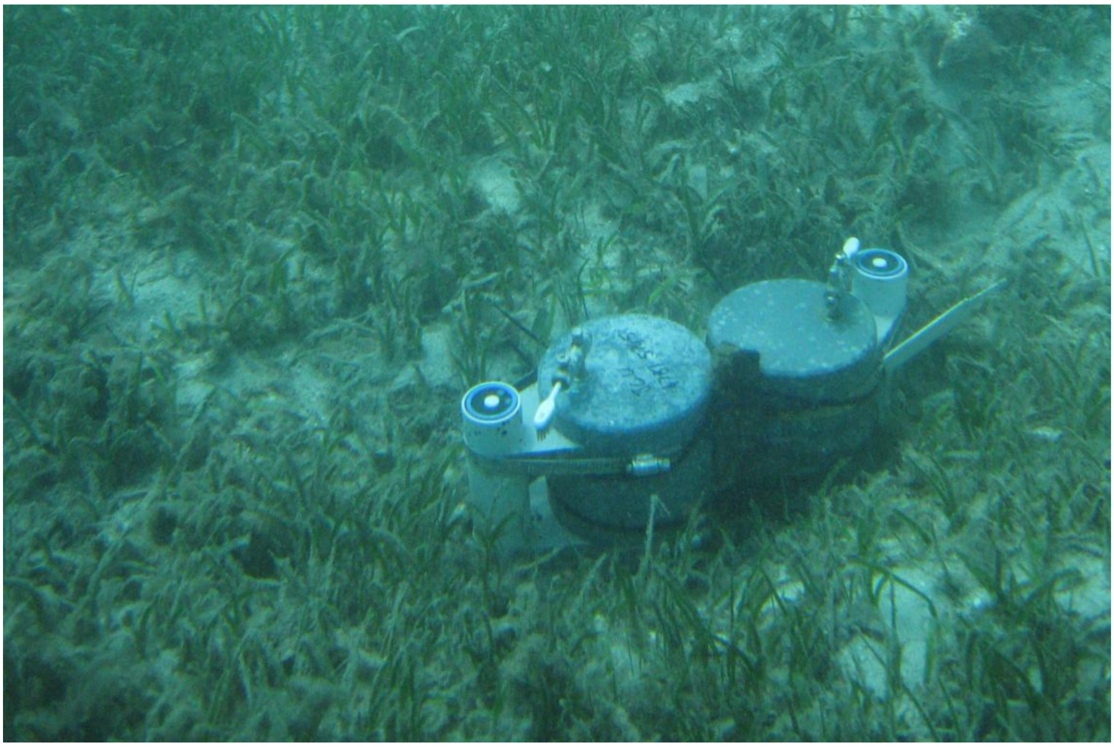

Figure 1. The light logger and wiper unit device at Green Island. Duplicate light loggers are deployed at subtidal meadows as the wipers are not always 100% effective at removing epiphytes.

The light loggers were calibrated in air in midday sunlight against a LiCor light sensor, however, recently under 1.1.3 ext a an in-laboratory calibration device has been built. This will improve the quality and efficiency of light calibration and therefore light measurements. Light data collected from the field sites is multiplied by 1.33 to allow for the differences in light absorption properties between air (calibration medium) and water (deployment media) (Kirk 1994) but only for loggers deployed at subtidal locations. At intertidal locations, application of the factor depended on whether the loggers were submersed. Observed sea level data provided by Maritime Safety Queensland was used to determine whether the logger was covered in water or exposed to air for each data point. The loggers record for 30 mins, so sea level data were averaged for the same 30 min period as the light data. If average sea level was above logger height (i.e. submersed in water), the multiplication factor was applied, but it was not applied for loggers when emersed. The data were also corrected for epiphyte cover of the sensor. If, at the time of logger retrieval there was epiphytes on the logger (0 – 25% cover), a linear back-calculation was applied to the data to compensate for the light absorbing properties of the sensor. A linear calculation was applied, as opposed to an exponential calibration, as the wiper seriously retards the rate of epiphyte growth. If epiphyte cover was greater than 25%, the data were not included in the analysis as there is a reduced confidence in its quality and our ability to make appropriate adjustments. The light data were then added for the day to derive a value for daily light (mol photons.$m^{-2}.d^{-1}$). A full year of data have not yet been collected for all sites so it is not possible to determine annual patterns in light availability, nor meaningful statistical comparisons between sites at this stage. Data are therefore presented as daily light, with an average for each for the period only when all loggers have been deployed. In the future, after more data are collected, more thorough analysis will be completed.

Results

Total daily light reaching seagrass meadows at all locations was much higher in the intertidal meadows than the subtidal meadows (Table 2, Figures 2 – 5). Total daily light is highly variable and is affected by solar intensity, tides, cloudiness and water quality. This makes it difficult to elucidate significant patterns without more analysis (which will

occur as a larger data set is obtained), though some general trends are worth noting. The annual pattern of daily total daily light at the seagrass meadow sites does not closely follow annual solar light intensity where light is highest around the summer solstice (December) and lowest at the winter solstice (June). Therefore seagrass responses to light (e.g. percent cover) may not follow annual changes in solar insolation. Large peaks in light intensity occur during the winter period when spring low tides result in significant periods of time exposed to the air or very shallow water. This can result in a large departure in daily light between subtidal and intertidal seagrasses, particularly for intertidal sites sitting above +0.8m (Magnetic Island and Dunk Island, +0.9m). At Green Island and Low Isles, the slightly deeper intertidal meadows (+0.8 and +0.6m) have dampened intertidal peaks in light intensity and the light at the subtidal and intertidal meadows follow a more similar pattern to eachother.

Daily light for the period November 2008 to July 2009, the period when all sites have been established, is presented in Table 2. Daily light was lowest at Low Isles and Magnetic Island, which relates to site depth and may also reflect a poorer water quality at these sites. This is not a true indication of water quality as the sites are at different depths. Light is reduced through the water column at an exponential rate, so that in a turbid site, a small increase in depth can result in a large reduction in light (Collier & Waycott 2009). However, the difference between depths is not very large (0.9 to 2.5m, for subtidal sites, Table 1) and the data can be used as a guide to water quality. Future collection of automated water quality data (turbidity and chlorophyll loggers) will help to elucidate the source of low light conditions at these sites. There was a prolonged low light period in February to March 2009 at Magnetic Island, and a slightly shorter low light period at Dunk Island (Figures 2 and 3). There was also a low light period at Magnetic Island from May to July 2009.

Table 2. Average daily light reaching seagrass canopies, November 2008 to July 2009 at the four monitoring GBR locations.

Location	Subtidal ($mol.m^{-2}.d^{-1}$)	Intertidal ($mol.m^{-2}.d^{-1}$)
Magnetic Island	5.0	11.0
Dunk Island	7.4	15.2
Green Island	8.7	14.7
Low Isles	4.7	10.5

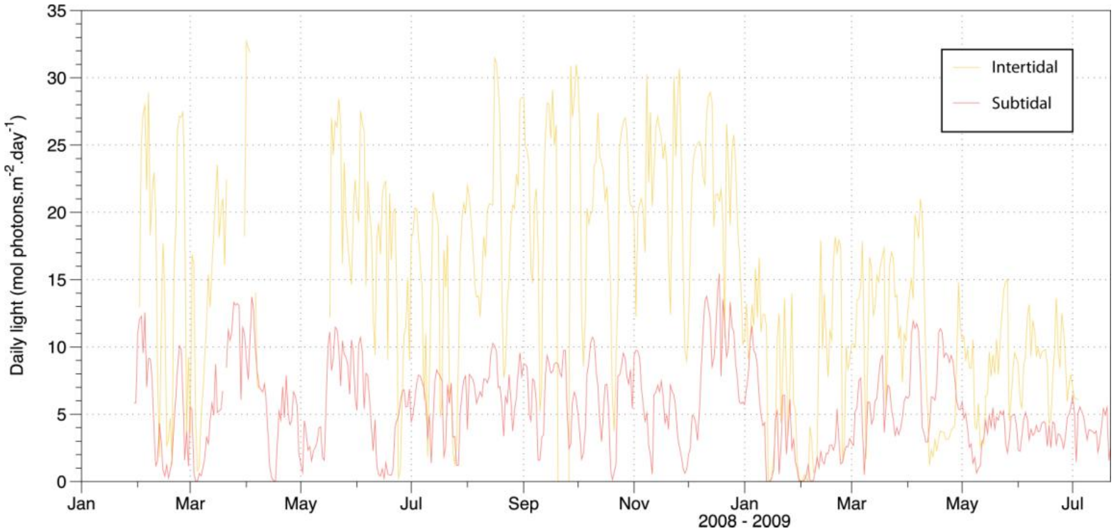

Figure 2. Daily light at Magnetic Island from January 2008 to July 2009

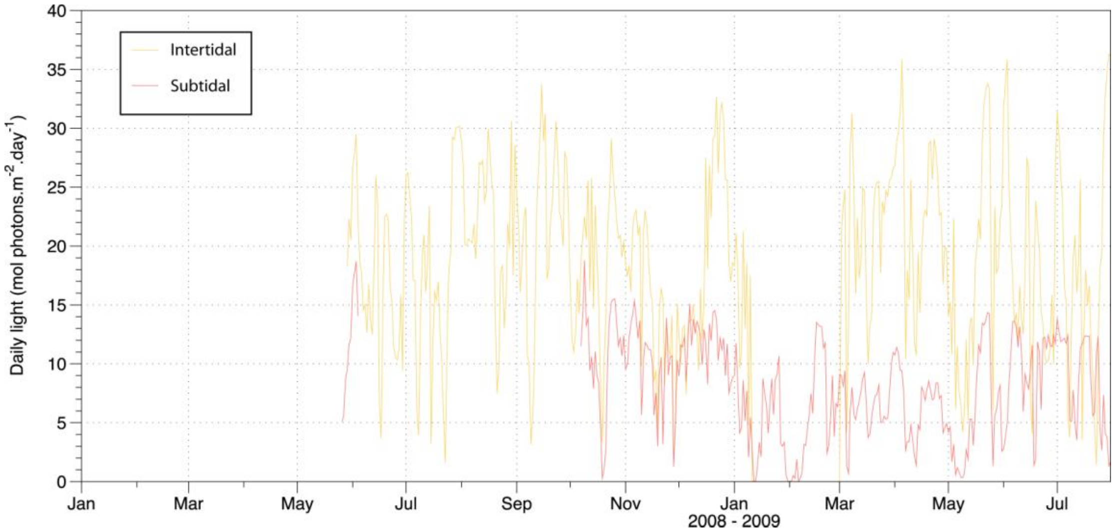

Figure 3. Daily light at Dunk Island from May 2008 to July 2009

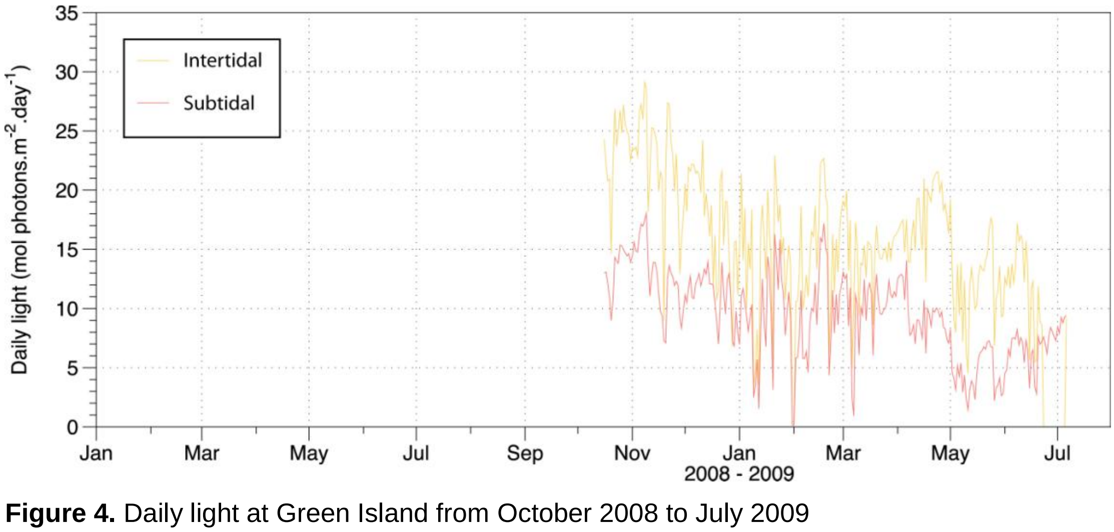

Figure 4. Daily light at Green Island from October 2008 to July 2009

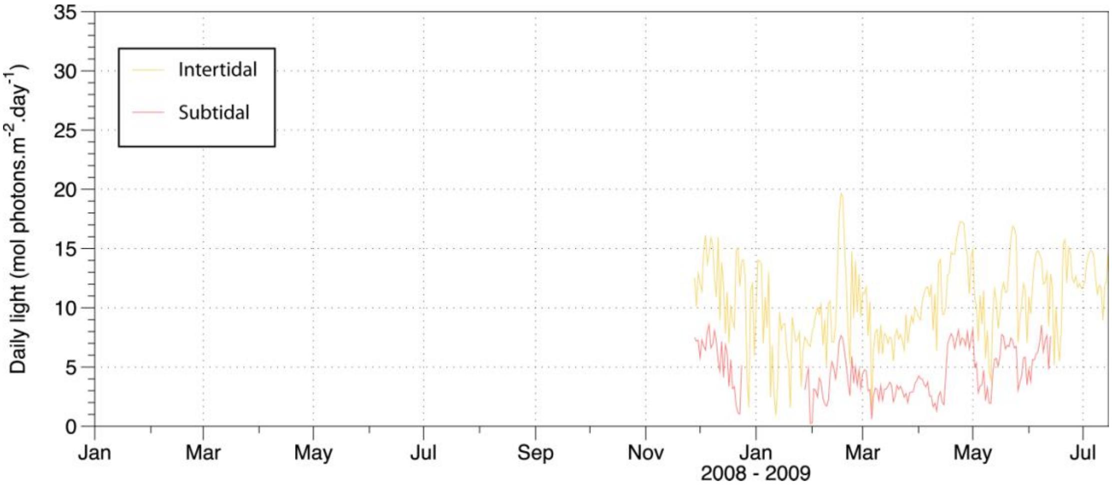

Figure 5. Daily light at Low Isles from November 2008 to July 2009

Seagrasses respond to changes in light at a range of time-scales from seconds through to months. Many of the physical expressions of seagrass health (e.g. percent cover) take weeks to months to occur, therefore, it is useful to consider the light environment of the seagrass meadows on these scales. Light data will be presented in future reports relating light intensity to seagrass response variables at these relevant time scales (see MTSRF 1.1.3b attachment 2 June 2009 report where light was related to seagrass percent cover). This will be explored further in project 1.1.3 ext a November 2009 Milestone report integrating the Reef Rescue intertidal seagrass monitoring results with the light data presented here.

Light monitoring will continue at these four locations until March/April 2010. The subtidal monitoring will cease after that time as will the monitoring at the Low Isles site as these were established under MTSRF project 1.1.3. Light measurements will continue at Magnetic Island, Dunk Island and Green Island under the 1.1.3 ext a Reef Rescue intertidal seagrass monitoring program. In addition, to these three sites, light will be monitored at nine other Reef Rescue intertidal monitoring sites from Gladstone to Cooktown.

References

Collier C, Waycott M (2009) Drivers of change to seagrass distributions and communities on the Great Barrier Reef: Literature review and gaps analysis, Reef and Rainforest Research Centre Limited, Cairns

Kirk JTO (1994) Light and photosynthesis in aquatic ecosystems, Vol. Cambridge University Press, Cambridge

Waycott M, McMahon M, Mellors J, Calladine A, Kleine D. 2004. A guide to the tropical seagrasses of the Indo-West Pacific. Townsville: James Cook University.

Explanation of Activity changes

Nil

Problems and opportunities

nil

Other issues

Nil

Communications, major activities or events

Field deployment of light loggers expanding to Marine Monitoring Program (Reef Rescue) SeagrassWatch sites during sampling periods for 2009/2010.

Database development for inclusion of light data.

Forecast variations to planned milestones

Nil