GLADSTONE WESTERN BASIN

BPAR MONITORING UPDATE:
February – May 2016

Davies JN, Shepherd LJ, Bryant CV & Rasheed MA

Report No. 16/32

June 2016

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A Report for Gladstone Ports Corporation (GPC)

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INTRODUCTION

The dredging projects associated with port expansion in the Western Basin were identified as potentially posing a high level of environmental risk to the marine habitats of the area, particularly to seagrass meadows. A detailed seagrass and light assessment program was established for the Western Basin Dredging and Disposal Project (WBDDP) to assist in management of the project during and after dredging. This program includes a requirement for continued assessment of seagrasses and Benthic Photosynthetically Active Radiation (BPAR) or benthic light following the end of dredging activities to assess seagrass recovery. These post-dredge seagrass and light monitoring requirements are outlined in several conditions and plans connected with the WBDDP and a strategy to meet them was developed and endorsed by the Dredge Technical Reference Panel.

In May 2014, benthic light monitoring equipment was also established at additional sites (Colosseum Inlet, South Trees and Quoin Island) to expand the seagrass and light assessment program to areas most likely to be impacted by dredging associated with the proposed Channel Duplication project. These sites were decommissioned in August 2015. For more information, see Davies et al (2015a).

METHODS

Benthic light monitoring equipment was initially deployed in December 2013 at the seven locations identified for WBDDP monitoring (Map 1). Equipment was deployed at the existing benthic light compliance sites where possible to maintain consistency with the historical dataset. At Fisherman's Landing, loggers were deployed adjacent to the permanent seagrass monitoring site to improve our ability to interpret changes in seagrass in response to changes in light.

Submersible Odyssey™ photosynthetic irradiance autonomous loggers (light loggers) were deployed with automatic wiper units which clean the optical surface of the sensor every 15 minutes to prevent marine organisms fouling the sensors (Figure 1A & B). At each location, two independent light loggers and wiper units were deployed on the seabed approximately 5 to 10 m apart and affixed to a metal stake. The presence of dual loggers reduces the risk of data loss through unit malfunction, fouling or disturbance during the three months between equipment exchange and download. During the initial three months of the program, light loggers were replaced and downloaded every month to provide confidence in the equipment and to ensure no loss of data. From March 2013, equipment has been changed out and downloaded approximately every three months.

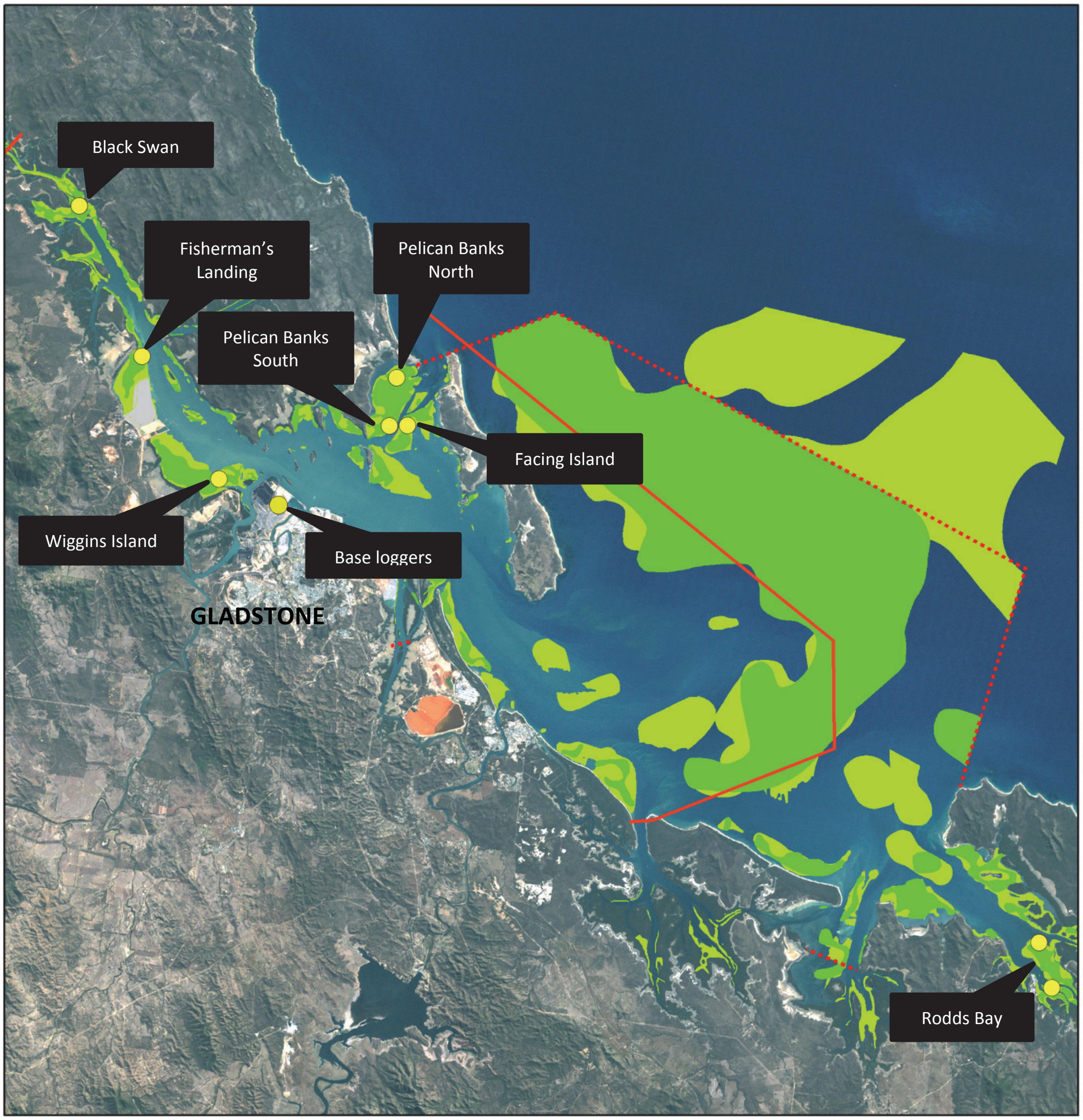
At Black Swan and Wiggins Island, where the sediment is extremely soft mud, repeated visits on ground may compromise the site. At this location, two independent light loggers and wiper units were deployed on two separate deployment cradles connected to a surface float (Figure 1C & D) to allow loggers to be exchanged at high tide.

A reference logger and wiper unit was also deployed outdoors at the Queensland Boating and Fisheries Patrol office at the Gladstone Marina to assess trends in surface irradiance and assist QA/QC procedures. In September 2014 a second reference logger and wiper unit was deployed outdoors at AB Marine at the Gladstone Marina to further aid in the assessment of surface irradiance trends. Base data for part of the monitoring period has been excluded in the following figures due to suspected shading. Base loggers have been relocated to rectify shading issues. Base data for the period from 14th June to 31st July 2014 is sourced from Vision Environment Queensland (2014).

Odyssey loggers log a cumulative reading at 15 minute intervals, which is calibrated and summed to gain total daily benthic light (mol m^{-2} day^{-1}). The raw data captured by the loggers requires calibrating to a known light value. Sensors were calibrated against a certified reference irradiance sensor (LI-CORTM LI-192SB Underwater Quantum Sensor) in controlled laboratory conditions. A custom built calibration device held the light loggers a consistent distance from the source light and excluded all external light. To allow for the differences in light absorption properties between air (calibration medium) and water (deployment media), a multiplication factor of 1.33 was applied to data during submersion periods based on the tide record supplied by Maritime Safety Queensland (MSQ) and the depth of each logger.

Total daily rainfall is sourced from the Bureau of Meteorology (station 039123).

Map 1. Seagrass Permanent Transect and BPAR monitoring locations.



- Western Basin coastal seagrass and BPAR monitoring sites
- Port limits
- November 2014 seagrass baseline survey boundary
- Fisherman's Landing reclamation
- Seagrass distribution November 2014
- Gladstone seagrass distribution 2002 to 2014

N

0 5 10 15
Kilometres

Davies et al. 2016. 'Gladstone Western Basin BPAR Monitoring Update: February - May 2016', TropWATER Publication, JCU, Cairns.

Figure 1. Dual Odyssey BPAR loggers and wiper units deployed on stakes in the sediment (A & B) and on deployment cradles connected to surface floats (C & D).

DATA PROCESSING AND QA/QC PROCEDURES

Benthic light monitoring equipment utilised for this work was not set up for reactive management of a dredge operation where real-time data is required to ensure day-to-day compliance. Rather, it is intended to track the relationship between light and seagrass change and to interpret seasonal dynamics and/or extreme changes to the light climate which may affect seagrass success.

Following retrieval from the field, a report on the condition and appearance of each data logger was made to identify any fouling of the sensor or issues with the wiping apparatus. After downloading, the data was adjusted using the most recent calibration factor for each logger and adjusted for periods of submersion (see methods above). The adjusted data was used to calculate a total daily benthic light value for each logger.

At each site and for the control bases at the Gladstone Marina, loggers A & B were compared to determine if there were any significant differences (>20%) in total daily light value. This comparison was initially undertaken for 15 minute increments however, for some sites the distance between loggers meant that differences in excess of 20% were common. Even a distance of 10 m can cause loggers to differ substantially during exposure and submersion events. It was therefore considered more accurate to consider the total daily light when discerning differences between loggers.

Where failures of one unit were obvious, data was removed from the record (e.g. where a logger failed to record data or where there were exceptionally high readings outside of possible light levels). Data was also removed from the record when the condition report indicated that fouling had occurred. Where there was no obvious cause for the difference between units, the total daily light value for that site was compared to the data at the other nearby sites and to the reference site to assist in identification of the errant logger.

If both loggers were deemed to be recording accurately and loggers agreed (difference <20%), a mean total daily light value was calculated. Where there were no obvious malfunctions and units disagreed by more than 20% in one day, the data for the unit recording the higher value was used as it is more likely to be reading within the 5% error margin for that logger. The lower of the two is considered more likely to have been affected by physical disturbances such as shading by floating debris.

During this phase of the post-dredge monitoring program where a continuous dataset is not as critical, if there is no compelling evidence as to which of the two loggers was functioning correctly, then the data may be quarantined from use in any future compliance situations.

RESULTS

Interpretation of any changes in the condition of seagrasses in relation to benthic light at permanent monitoring sites is provided in an annual report detailing results of seagrass and benthic light monitoring at sensitive receptor sites (Bryant et al. In prep). Figures 2 to 9 represent a 14 day rolling average of the total daily benthic light value at each of the monitoring sites since monitoring began in December 2013 (WBDDP sites).

Studies conducted in Gladstone by Chartrand et al. (2012) found that the dominant species *Zostera muelleri* subsp. *capricorni* requires between 4.5 and 12 mol quanta m^{-2} day^{-1} over a minimum period of two weeks to survive during the growing season, typically from July to January. From these studies, a working light threshold value of 6 mol m^{-2} day^{-1} over a two week period had been successfully used as a management threshold in Port Curtis during GPC operations (Chartrand et al. 2012). At this level there is sufficient light to maintain growth of *Z. muelleri* subsp. *capricorni*. In the following figures, light levels in *Z. muelleri* subsp. *capricorni* dominated meadows fall below this threshold value periodically as expected with the natural variation in the light environment, with the majority occuring during the senescent season. Periods of time below this threshold value are part of expected background conditions, particularly during the seagrass senescent season (Chartrand et al. 2012).

Light levels can vary substantially between sites, as light is recorded at the seagrass canopy level for this study rather than at a standard depth. This is because the goal of the light monitoring was to determine associations between seagrass changes and changes in light that the various monitoring meadows experience.

This report accompanies data sets provided to Gladstone Ports Corporation. The data presented here updates data presented in previous reports where more accurate tidal exposure information has been obtained.

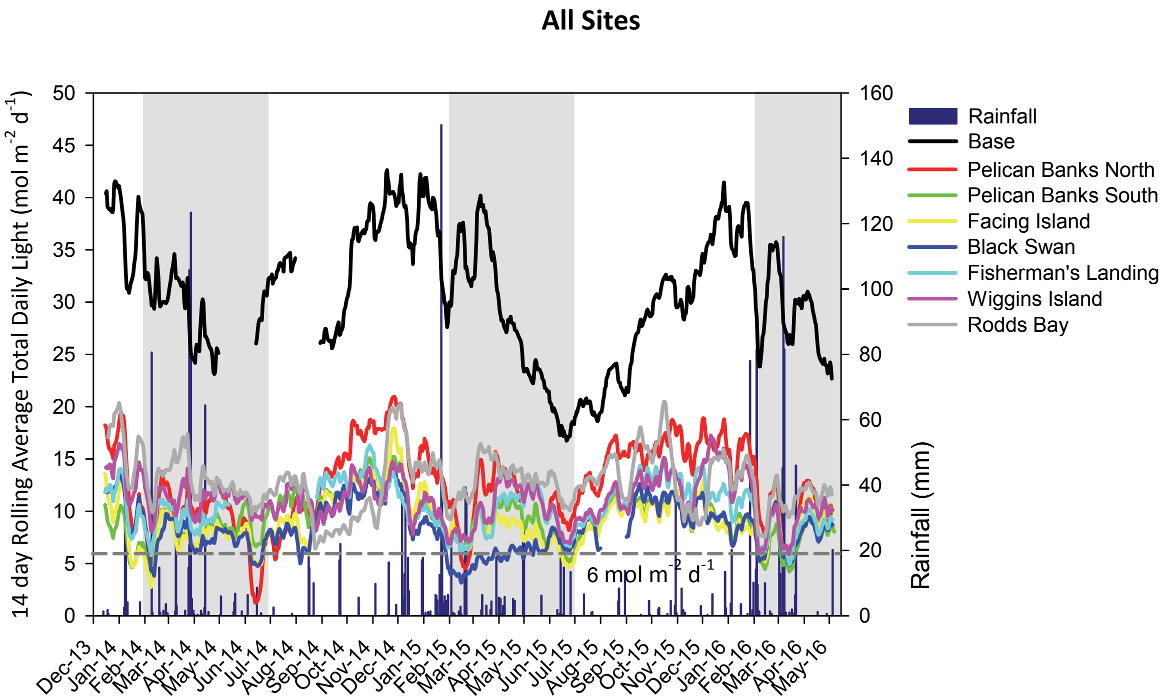


Figure 2. Average total daily benthic light (presented as a 14 day rolling average) at seagrass permanent transect sites in Port Curtis and Rodds Bay, and daily surface light from Base loggers.

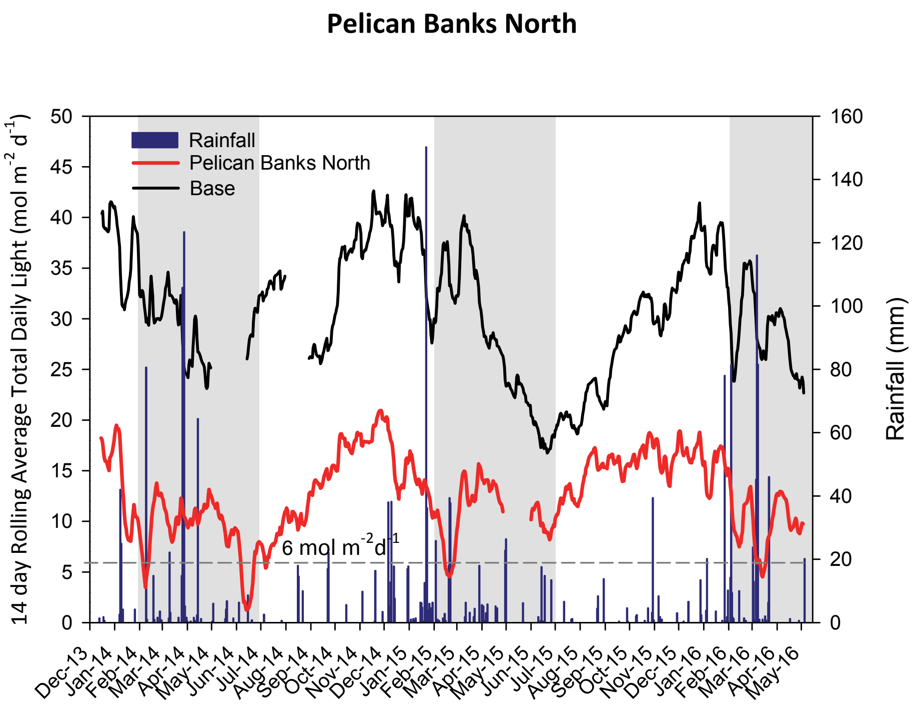


Figure 3. Average total daily benthic light (presented as a 14 day rolling average) at the Pelican Banks North seagrass monitoring site and daily surface light from Base loggers. Shading represents the seagrass senescent season in Port Curtis (February through June).

Pelican Banks South

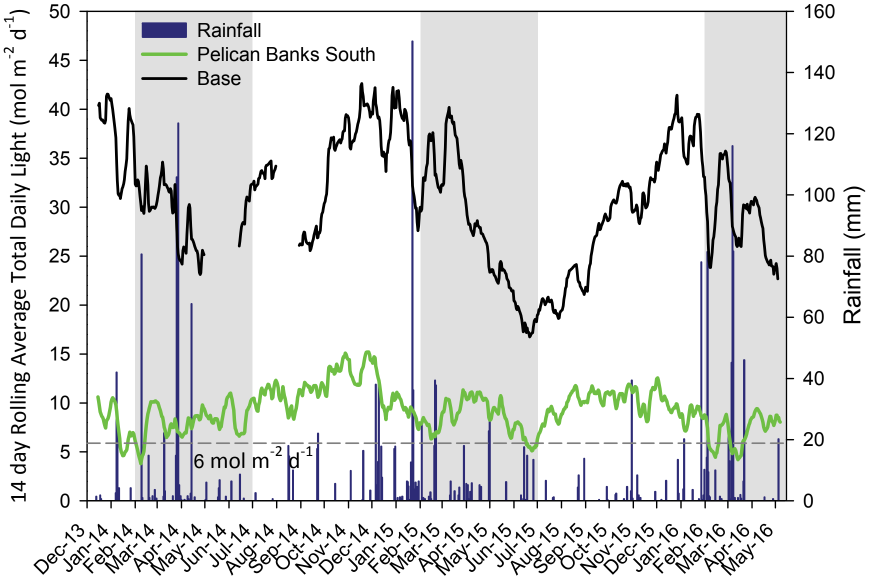


Figure 4. Average total daily benthic light (presented as a 14 day rolling average) at the Pelican Banks South seagrass monitoring site and daily surface light from Base loggers. Shading represents the seagrass senescent season in Port Curtis (February through June).

Facing Island

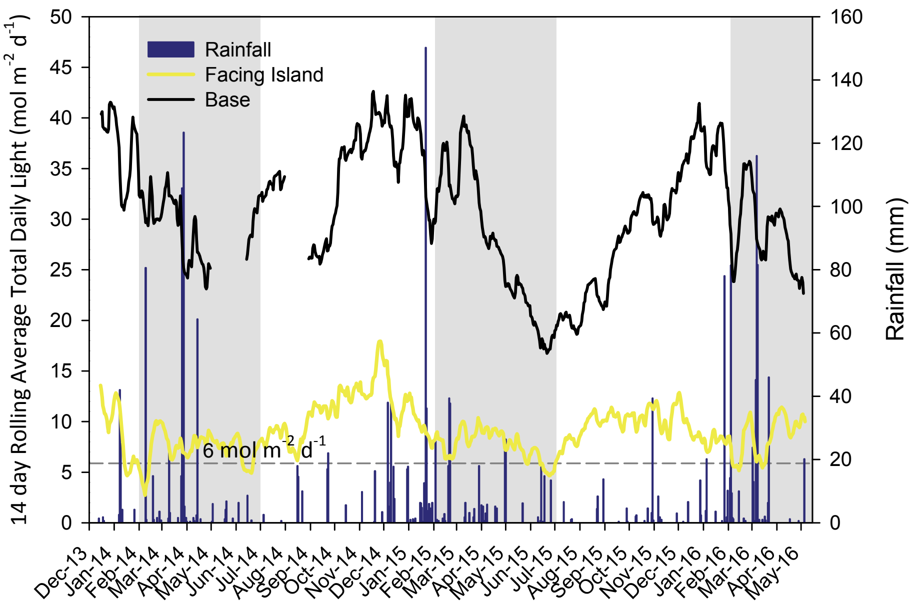


Figure 5. Average total daily benthic light (presented as a 14 day rolling average) at the Facing Island seagrass monitoring site and daily surface light from Base loggers. Shading represents the seagrass senescent season in Port Curtis (February through June).

Black Swan

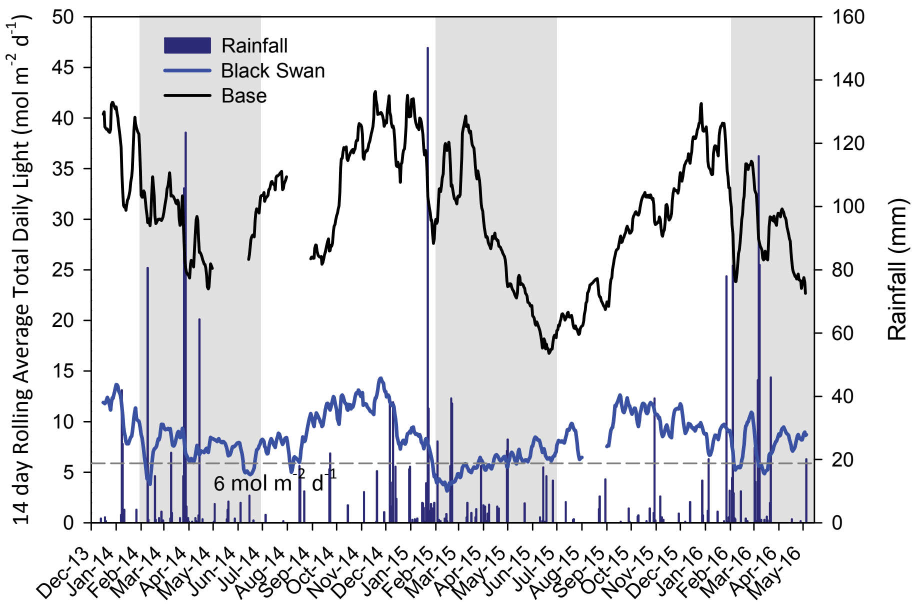


Figure 6. Average total daily benthic light (presented as a 14 day rolling average) at the Black Swan seagrass monitoring site and daily surface light from Base loggers. Shading represents the seagrass senescent season in Port Curtis (February through June).

Wiggins Island

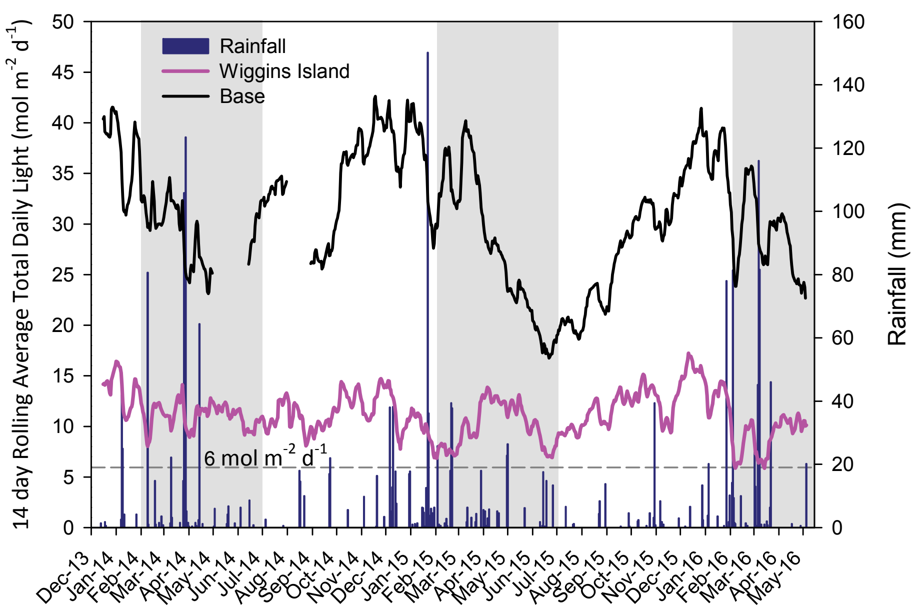


Figure 7. Average total daily benthic light (presented as a 14 day rolling average) at the Wiggins Island seagrass monitoring site and daily surface light from Base loggers. Shading represents the seagrass senescent season in Port Curtis (February through June).

Fisherman's Landing

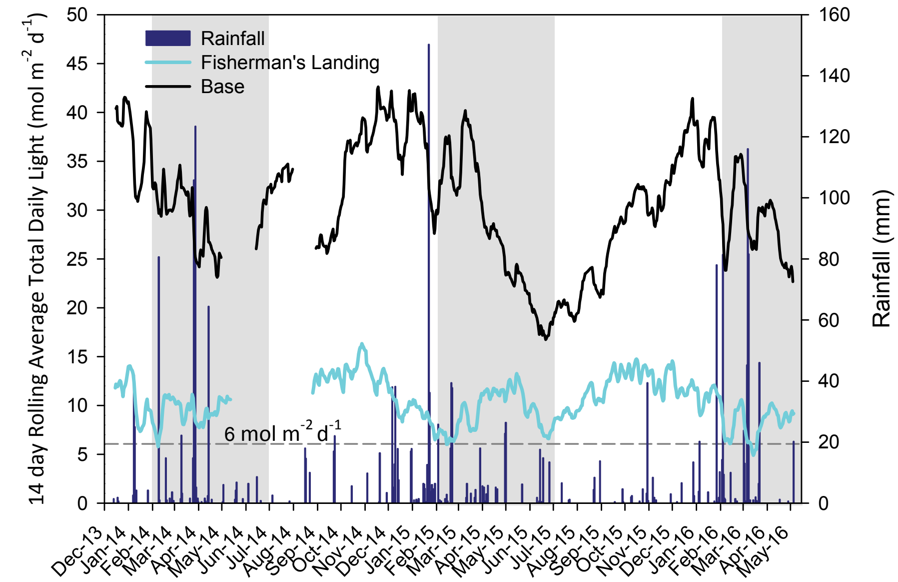


Figure 8. Average total daily benthic light (presented as a 14 day rolling average) at the Fisherman's Landing seagrass monitoring site and daily surface light from Base loggers. There was damage to equipment shortly after the May 2014 deployment and there are no data available for this period. Shading represents the seagrass senescent season in Port Curtis (February through June).

Rodds Bay

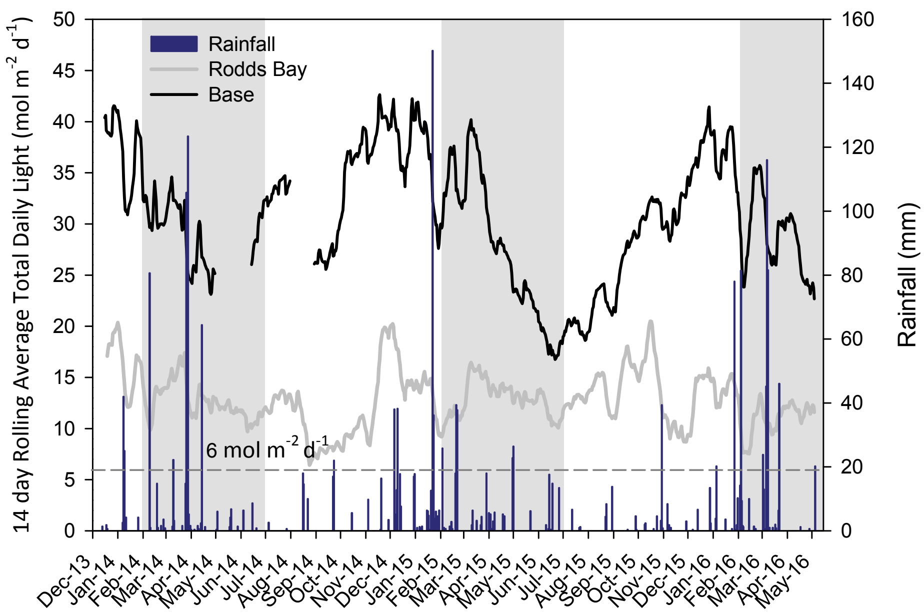


Figure 9. Average total daily benthic light (presented as a 14 day rolling average) at the Rodds Bay seagrass monitoring site and daily surface light from Base loggers. Shading represents the seagrass senescent season in Port Curtis (February through June).

REFERENCES

Bryant, C., J. Davies, T. Sankey, and M. Rasheed. In prep. Long term seagrass monitoring in Port Curtis: Quarterly permanent transect monitoring progress report 2009 to 2015. Centre for Tropical Water & Aquatic Ecosystem Research (TropWATER) Publication 15/05, James Cook University, Cairns.

Chartrand, K. M., Ralph, P. J., Petrou, K. and Rasheed, M. A. 2012. Development of a light-based seagrass management approach for the Gladstone Western Basin dredging program. DEEDI Publication, Fisheries Queensland, Cairns, 92 pp.

Davies JN, Scott EL, Bryant CV & Rasheed MA 2015a. Gladstone Western Basin & Channel Duplication BPAR Monitoring, May – August 2015, Centre for Tropical Water & Aquatic Ecosystem Research Publication 15/51 James Cook University, Cairns, 14pp.

Vision Environment QLD (2014). EIS for Port of Gladstone Gatcombe and Golding Cutting Channel Duplication Project Water Quality Monitoring – July 2014. Vision Environment QLD, Gladstone, Australia.