Guidance on seagrass monitoring

1 Purpose and scope

This document provides background information on seagrass monitoring and where to get advice on monitoring approach and relevant techniques.

2 Associated documents

Biological assessment: Guidance on using Photosynthetically Active Radiation (PAR) as a method to measure light availability for photosynthetic organisms facing acute impacts.

3 Introduction

Seagrasses can be an excellent indicator of environmental change and impact, as well as being an incredibly valuable coastal habitat performing a range of critical ecosystem functions, such as stabilising bottom sediments, and providing fisheries habitat and food for dugong and turtles (Seagrass-Watch HQ, 2006-2015). However, deciding how and what to monitor is not straight forward. In Queensland, seagrasses include a variety of species, occur in a range of landscapes from sparse through to continuous cover, and across a broad range of depth gradients from shallow intertidal (Figure 1) through to depths greater than 60m in the Great Barrier Reef lagoon. As a consequence not all areas of “seagrass” behave the same, even under natural conditions; some meadows remaining relatively stable through to those that are naturally highly variable. There are also 15 different species of seagrass in Queensland waters, all of which have different lifecycles and ecological requirements. Taking a “one size fits all” approach to monitoring is unlikely to yield desired outcomes and any seagrass monitoring program should be designed with careful consideration of the nature and location of the meadow, the species involved and the questions that needs to be answered.

Figure 1: A seagrass meadow found on tidal flats

4 Scale of monitoring

A critical consideration is the scale at which monitoring should be conducted. For example, small-scale permanent transect approaches are most suited to answering questions related to local issues, such as assessments of impacts from point sources or assessments of discrete impacts to specific sensitive receptor sites. However, many seagrass landscapes are highly dynamic and present a shifting mosaic of biomass hot spots within their boundaries, as well as substantial shifts in the spatial footprints of the meadows (Seagrass-Watch HQ, 2006-2015). Therefore, questions regarding the overall state of seagrasses in a particular bay or region are best addressed using methods that integrate much greater areas that are considered representative; e.g. using multiple sites within a meadow and multiple meadows within a bay or region. In Queensland, there are excellent examples of both kinds of approaches that have been conducted over long time-frames (Coles et al. 2015). These programs present standardised approaches and adopting these methods at new sites has the distinct advantage of allowing for easy regional and state-wide comparisons to be made, thereby contextualising the changes observed locally.

5 Variables to be measured

Another important consideration is the variables that should be assessed. There are a large number of different seagrass condition variables that could be collected, ranging from the molecular scale all the way through to whole plant and landscape changes. Again, the questions being asked of the monitoring program should dictate the most suitable variables for monitoring. However, if tracking the change in seagrass is the overarching goal, then there are some fundamental variables that should be incorporated:

- Change in seagrass meadow area
- Change in biomass or cover within those areas
- Significant shifts in species composition
- Changes in sediment characteristics and topography
- Light (measured as photosynthetically active radiation (PAR[1])).

In addition to these, there are an enormous range of other important factors that could be included in monitoring, including measurements of seed-banks and reproductive output, assessment of nutrient status, plant carbohydrate stores, herbivory, epiphyte cover, changes in gene expression indicating stress and assessment of key controlling variables such as light and temperature. The final mix of monitoring variables will depend on the resources available, logistical constraints and what the monitoring is trying to achieve.

6 Frequency of monitoring

Seagrasses in Queensland are highly seasonal, so the timing of monitoring is critically important. In part the frequency of monitoring will depend on what the monitoring objectives are. An annual assessment of seagrass condition could reasonably be performed with one sampling event conducted during the peak season for seagrass abundance (typically between September and December). This is important as some species are annuals and present only as a seed bank through winter. However, if tracking seasonal change is important to the program, then more frequent (ideally at least quarterly) sampling is required. An even higher frequency of sampling may be needed if the monitoring is intended to assess compliance or impacts associated with a particular development or discharge event. The variables selected for measurement in the monitoring program will also affect the timing and frequency of sampling. For example, flowering and sexual reproduction for some species can be highly variable and occur over relatively short timeframes, and reliable data may require multiple sampling events during the reproductive seasons to ensure they are adequately assessed.

[1] Light requirements (specified as PAR) have been added as a WQO for some coastal waters containing seagrasses under the Environmental Protection Policy (Water).

7 Establishing appropriate baselines

Monitoring programs will generally be required to assess change from some baseline or reference condition. The highly seasonal nature and potentially large inter-annual changes that can occur in Queensland's seagrasses mean that the longer the baseline period of data collection is, the better. Often this is not possible with programs triggered by a specific event, but a minimum of three to five years is likely to provide a useful context and allow some level of assessment of the degree of inter or intra-annual change, and thereby place future monitoring results in context. Recent work has suggested that even longer timeframes may be required to set baseline conditions for detailed seagrass condition reporting (see Gladstone Healthy Harbour Program[2] report card for example).

8 How to decide what monitoring approach to take

To decide on the best monitoring approach for a given situation it is recommended that one of the specialist seagrass monitoring groups in Queensland is consulted. Some links are provided below. The two major ongoing seagrass monitoring programs for Queensland are based out of James Cook University:

1. Monitoring in high risk areas of the state as part of the James Cook University ports seagrass monitoring. See: www.jcu.edu.au/portseagrassqld
2. Seagrass-Watch. See: http://www.seagrasswatch.org/home.html

Some monitoring techniques are provided within these links. The Great Barrier Reef (GBR) Marine Monitoring Program is also a valuable source of information for Queensland waters (www.gbrmpa.gov.au/managing-the-reef/how-the-reefs-managed/reef-2050-marine-monitoring-program) and global programs such as SeagrassNet (http://www.seagrassnet.org/global-monitoring) have comprehensive manuals to download for monitoring that can be used as guidance.

Other useful web pages for seagrass monitoring in Queensland

- James Cook University Seagrass Ecology Group: www.seagrassecology.com
- Griffith University Australian Rivers Institute: https://www.griffith.edu.au/environment-planning-architecture/australian-rivers-institute
- University of Queensland Remote Sensing Research Centre: https://www.gpem.uq.edu.au/rsrc

9 References and additional reading

Coles, RG, Rasheed, MA, McKenzie, LJ, Grech A, York, PH, Sheaves, MJ, McKenna, S and Bryant, CV 2015, 'The Great Barrier Reef World Heritage Area seagrasses: managing this iconic Australian ecosystem resource for the future.' *Estuarine, Coastal and Shelf Science* 153. pp. A1-A12

EHMP, 2008, *Ecosystem Health Monitoring Program 2006-7: Annual Technical Report*. Brisbane: South East Qld Healthy Waterways Partnership.

Carter, AB, Jarvis, JC, Bryant, CV and Rasheed, MA 2015, *Development of seagrass indicators for the Gladstone Healthy Harbour Partnership Report Card,* ISP011: Seagrass. Centre for Tropical Water and Aquatic Ecosystem Research Publication 15/29, James Cook University, Cairns. Available from: https://dims.ghhp.org.au/repo/data/public/d3be7a

Chartrand KM, Ralph PJ, Petrou K and Rasheed MA 2012, *Development of a Light-Based Seagrass Management Approach for the Gladstone Western Basin Dredging Program*. DAFF Publication. Fisheries Queensland, Cairns 126 pp.

Collier, CJ, Chartrand K, Honchin C, Fletcher A and Rasheed, M 2016, *Light thresholds for seagrasses of the GBR: a synthesis and guiding document. Including knowledge gaps and future priorities*. Report to the National Environmental Science Programme. Reef and Rainforest Research Centre Limited, Cairns (41pp.).

[2] http://ghhp.org.au/

McKenzie, LJ, Collier, CJ, Langlois, LA, Yoshida, RL, Smith, N, Takahashi, M, and Waycott, M 2015, *Marine Monitoring Program - Inshore Seagrass, Annual Report for the sampling period 1st June 2013 – 31st May 2014*. TropWATER, James Cook University, Cairns. 25pp. Available from: http://hdl.handle.net/11017/2976

McKenna, S, Jarvis, JC, Sankey, T, Reason, CL, Coles, RG, and Rasheed, MA 2015, 'Declines of seagrasses in a tropical harbour, North Queensland, Australia, are not the result of a single event.' *Journal of Biosciences*, 40 (2), 389-398

Rasheed, MA, McKenna, S, Carter, A and Coles, RG 2014, 'Contrasting recovery of shallow and deep water seagrass communities following climate associated losses in tropical north Queensland, Australia' *Marine Pollution Bulletin*, 83, 491-499

Roelfsema, CM, Lyons, M, Kovacs, E, Maxwell, P, Saunders, MI, Samper-Villarreal, J, Phinn, SR 2014, 'Multi-temporal mapping of seagrass cover, species and biomass: A semi-automated object based image analysis approach', *Remote Sensing of the Environment*, 150, July 2014, 172-187

Seagrass-Watch HQ, 2006-2015. James Cook University, Queensland, Australia.

Short, F and Coles, RG, 2001, *Global seagrass research methods*. Elsevier Science B.V., Amsterdam. 473pp.