Australian Government

Queensland Government

Ground Cover Monitoring

Methods

Reef Water Quality Report Card 2017 and 2018

Reef 2050 Water Quality Improvement Plan

#31897 | 0619

CONTENTS

CATCHMENT CONDITION – GROUND COVER MONITORING METHODS

This report summarises the data and methods used for reporting progress towards the Reef 2050 Water Quality Improvement Plan (Reef 2050 WQIP) 2025 land and catchment management target for ground cover.

The target for ground cover is as follows (Australian and Queensland governments, 2018):

- 90% of grazing lands will have greater than 70% ground cover in the late dry season.

"The ground cover target focusses on late dry season ground cover levels across grazing lands, recognising that water quality risk is generally highest at the onset of the wet season. The target incorporates an area-based component (i.e. 90% of grazing lands will have achieved the ground cover target), while providing for natural variability in ground cover levels. Research supports a ground cover target of 70% to minimise erosion."(Reef 2050 WQIP)

Background

Why measure ground cover?

Ground cover is defined as the vegetation (living and dead) and biological crusts and rocks that are in contact with the soil surface and is a key indicator of catchment condition. Ground cover is a key component of many soil processes, including infiltration, run-off and surface erosion. In the Great Barrier Reef catchments, low ground cover can lead to soil erosion which contributes to increased sediment loads reaching the Great Barrier Reef lagoon and loss of productivity for grazing enterprises.

It is particularly important to maintain ground cover during dry periods, or periods of unreliable rainfall, to minimise loss of water, soil and nutrients when rainfall eventually occurs. This practice will also maximise the pasture growth response to rainfall. Implementing appropriate and sustainable land management practices, particularly careful management of grazing pressure, can help to maintain or improve ground cover, reducing erosion and improving the stability and resilience of the grazing system.

Factors that influence ground cover

Ground cover levels are the result of complex interactions between landscape function (soil type, topography and vegetation dynamics), climate and land management. Some areas maintain naturally higher levels of ground cover due to factors such as high soil fertility and consistently high annual rainfall. The impacts of grazing land management practices on ground cover levels in these areas can be minimal due to the resilience of the land in responding to pressures. In areas where rainfall is less reliable and soils are less fertile, ground cover levels can vary greatly and the influence of grazing land management practices on ground cover levels and on the species composition of the ground cover can be more pronounced.

A number of initiatives aimed at improving grazing land management in Great Barrier Reef regions are in place or are planned. They include programs which are improving management of ground cover levels appropriate to the regional conditions, such as:

- the industry-led Grazing Best Management Practice program
- infrastructure projects such as fencing key areas and better distribution of watering points for stock
- trials of different grazing strategies
- a range of extension and education activities including development of online, interactive and reporting tools for accessing and viewing ground cover information.

Reporting ground cover levels for the Reef 2050 Water Quality Improvement Plan

Progress towards the 2025 land and catchment management ground cover target is assessed by the Ground cover monitoring program and is based on the measurement of late dry season ground cover using Landsat satellite imagery for historical measurements, and Sentinel-2 imagery when available in more recent years (post-2015). All imagery has been processed to produce fractional ground cover estimates, using field data for calibration. While a range of factors influence ground cover levels, reporting is focused only on information that describes regional ground-cover levels in the current and historical context. Rainfall data is provided for context only, as it is the primary driver of ground cover levels at a regional scale.

A range of products have been developed by the Queensland Ground Cover Monitoring Program that account for the influence of climate, land management and soil type. These products are more appropriate for monitoring local-scale variability and differences in ground cover levels, but are of limited use for the regional-scale reporting required here. Access to some of these products is via the interactive online tool VegMachine and the online reporting tool, FORAGE. Products that prove useful for describing ground cover levels at the regional scale will help to revise future ecologically-relevant and regionally-focused targets, and will be incorporated into future reporting.

Methods

The following is a brief overview of the data and methods used for reporting regional ground cover in the Great Barrier Reef Report Card 2017-2018. For further detail about data processing, refer to the ground cover technical report (DES, 2019).

Ground cover data

Reporting is based on the measurement of late dry season ground cover using Landsat satellite imagery for historical measurements, and Sentinel-2 imagery when available in more recent years (post-2015). All imagery has been processed to produce fractional ground cover estimates, using field data for calibration.

Ground cover satellite imagery and fractional ground cover

Measurement of ground cover for reporting is based on data derived following the method described in Trevithick et al. (2014). The underlying fractional ground cover data will be updated using a machine learning (support vector regression) algorithm, still in development. This is a new method using additional field data to train and calibrate a machine learning approach (support vector machines). The newer method produces results very similar to the previous method, allowing for comparison of results with earlier report cards, but with much greater information on the known accuracy of the product and some improvements in areas of known error such as scalded locations.

The fractional ground cover method measures the proportion of green cover, non-green cover and bare ground using reflectance information from late dry season from several sources of satellite imagery. These include the longer-term dataset of Landsat imagery (1987 to present; several versions) with a spatial resolution of approximately 30m and an acquisition frequency of 16 days, and the European Space Agency's Sentinel-2A and Sentinel-2B satellites (mid-2015 to present) with a higher spatial resolution of 10m and a more frequent acquisition of every five days. Fractional cover data produced between the two sources is statistically comparable. The switch to using Sentinel-2 data is expected to improve ground cover estimates, particularly in areas that are cloud affected.

It is important to note that the fractional cover data measures all cover as viewed from above by the satellite, including the trees and shrubs as well as the ground cover and bare ground. It is then further corrected to effectively remove the influence of trees and shrubs, providing individual estimates of the level of green ground cover, non-green ground cover and bare ground at ground level (Figure 1). This method works in areas of tree cover up to 60% persistent green (i.e. woody vegetation) cover, at which point the canopy becomes too dense to reliably achieve an estimate of the ground. This means that fractional ground cover can be reported for the majority (>90%) of the grazing lands of the Great Barrier Reef catchment areas. As a final step, the green and the non-green ground cover fractions are summed to produce a total ground cover estimate (erosion and run-off are influenced by all ground cover). This estimate of total ground cover is what is used for reporting and is hereafter referred to simply as 'ground cover'.

The current fractional ground cover product was developed using approximately 1,800 field observations across a range of ground cover, tree cover and shrub cover levels, within a range of environments. This product is used in the 2017-2018 reporting period. A newer fractional ground cover algorithm has been developed using machine learning techiques and calibrated using over 4,000 field observations. This new product will be used for the remaining reporting years and while it is believed to be more accurate, it will not effect overall results at a catchment scale. The current fractional ground cover product has been assessed using linear regression to have a an accuracy of 17% RMSE (Figure 2).

Late dry season ground cover

Late dry season ground cover is defined using seasonal composites of images for spring (September–November) (for the period 1987 to present). It is estimated using a seasonal composite of fractional ground cover data images (Landsat prior to 2015 and Sentinel-2 post-2015) acquired throughout the season (requiring at least three observations per pixel). The data is then corrected for tree cover to produce a seasonal ground cover dataset for all areas with up to 60% tree canopy cover. This approach has the advantage of removing errors and outliers in the data (e.g. due to cloud or cloud shadow artefacts), and providing the most spatially comprehensive coverage as there is generally very little missing data due to cloud, cloud shadow or satellite sensor issues. For areas where there is still missing data, further infilling can be undertaken using what are referred to as seasonal ground cover 'patches'. These are pixel values generated in areas where less than three valid observations were made in a season. This process is only undertaken for the Landsat imagery, as the more frequent Sentinel-2 data typically has very little missing data once composited.

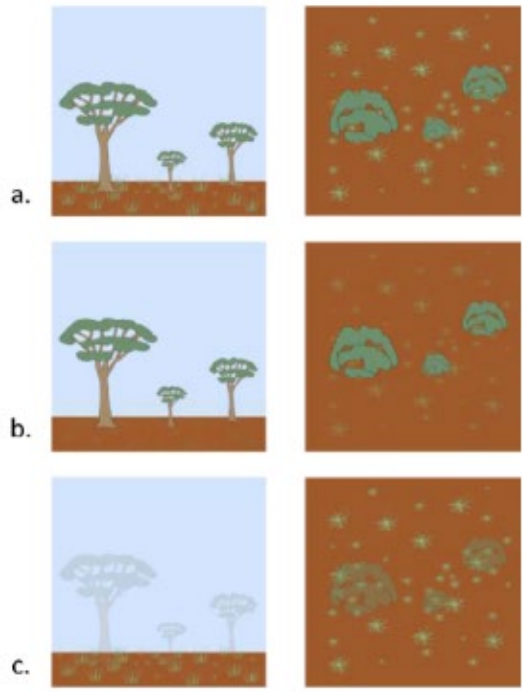

Figure 1. Schematic representation of the correction of the fractional cover data to estimate the fractional ground cover (Trevithick et al., 2014), used for reporting. (a) Fractional cover measures all vegetation cover including trees, shrubs and ground cover, as well as bare ground. The ground cover and bare ground are partially obscured by the trees and shrubs. (b) Next, a time-series approach is used to estimate the percentage of 'persistent' cover in the tree and shrub layers. (c) Finally, a correction factor is applied, based on field data, to effectively remove the 'persistent' cover in the tree and shrub layers, thus providing an estimate of the green cover, non-green cover and bare ground, all at the ground level – the fractional ground cover.

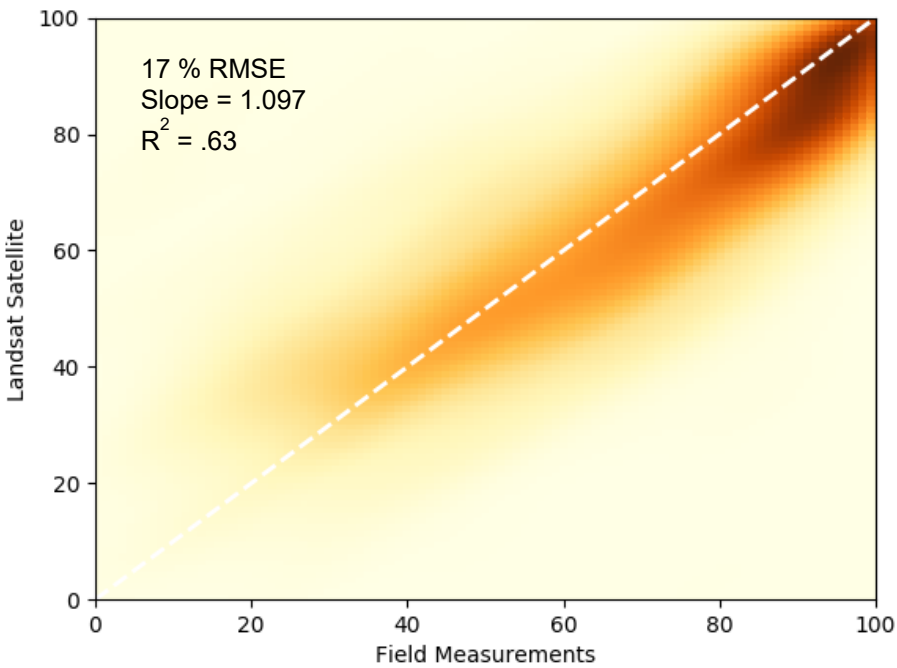

Figure 2. Comparison of field measurements of fractional cover with Landsat derived fractional ground cover for 2,047 sites across Australia. The linear regression shows a RMSE of 17%, within the specified guidelines for Reef reporting.

Reporting regions and grazing lands

Reporting is based on the six natural resource management regions of the Great Barrier Reef region:

- Cape York region
- Wet Tropics region
- Burdekin region
- Mackay Whitsunday region
- Fitzroy region
- Burnett Mary region.

Grazing lands in the reporting regions were spatially-defined based on the most recent land use data provided by the Queensland Land Use Mapping Program (DSITIA, 2012). The most recent version of the mapping for Burdekin and Wet Tropics is 2016, while Cape York, the Wet Tropics and Burnett Mary are current to 2013, 2015 and 2017 respectively.

A *reporting region* is defined as that part of an NRM region which is grazing land and has less than 60% persistent green (i.e. woody vegetation) cover.

Reporting ground cover

This report provides a regional overview of late dry season ground cover levels in the Great Barrier Reef catchments based on analysis of seasonal (spring) total ground cover data. The statistics are calculated for each pixel (i.e. 30m x 30m area) and then summarised (i.e. averaged) for each of the 35 catchments.

Statistics reported for each region include:

- mean late dry season ground cover
- mean long term late dry season ground cover (1987 to reporting season)
- the percentage of the region's reporting area with late dry season ground cover greater than 70% in the reporting year
- the percentage of the region's reporting area with mean late dry season ground cover greater than 70% for the Landsat historical record (1987 to the reporting year).

Graphs show the distribution of ground cover for each region across the range of ground cover levels. Maps of ground cover percentages are provided for the entire Great Barrier Reef region, and for each reporting region, as a visual representation of the statistics listed above. A map comparing ground cover decile rankings for the reporting year with long-term mean levels is also produced.

It is important to note that averaging ground cover across whole regions can mask localised areas of lower cover, particularly in large catchments with a strong rainfall gradient (e.g. the Burdekin and Fitzroy). The mean ground cover reported is therefore indicative of general levels of ground cover within the reporting region. For additional level of reporting, the reporting regions are further divided into catchments (and sub-catchments for larger catchments) in the ground cover technical report (DES, 2019).

Rainfall data

Rainfall data is provided for current and historical context as rainfall is the primary driver of ground cover levels at the regional scale. In general, high rainfall in the preceding seasons results in higher ground cover levels and low rainfall in preceding seasons results in lower ground cover levels. Rainfall data is obtained from SILO as a 5km grid. For each reporting region. The mean annual rainfall is then calculated from September to August for each year from 1986, to align the mean annual rainfall with the late dry season reporting period.

Scoring system

A standardised scoring system is used for each of the key indicators in the reef report card. The scoring system is used to assess and communicate the status of the indicator against the Reef 2050 WQIP 2025 targets.

Ground cover target

- 90% of grazing lands will have greater than 70 per cent ground cover in the late dry season.

Table 1: The colour-coded ground cover scoring system

Status	Criteria	Grade and colour code
Very poor ground cover	Less than 60% of grazing lands meet the optimal cover level	E - Red
Poor ground cover	Between 60-69% of grazing lands meet the optimal cover level	D - Orange
Moderate ground cover	Between 70-79% of grazing lands meet the optimal cover level	C - Yellow
Good ground cover	Between 80-89% of grazing lands meet the optimal cover level	B - Light Green
Very good ground cover – Target met	More than 90% of grazing lands meet the optimal cover level	A - Dark Green

Optimal cover level for 2018 is > 70 % ground cover.

Qualitative confidence ranking

A multi-criteria analysis is used to qualitatively score the confidence in each indicator used in the Reef report card from low to high. The approach combined the use of expert opinion and direct measures of error for program components where available. Ground cover has received a four-bar confidence ranking.

Groundcover

Maturity of methodology (weighting 0.5)	Validation	Representativeness	Directness	Measured error
New or experimental methodology	Remote sensed data with no or limited ground truthing	1:1,000,000	Measurement of data that have conceptual relationship to reported indicator	Error not measured or >25% error
Peer reviewed method	Remote sensed data with regular ground truthing (not comprehensive)	1:100,000	Measurement of data that have a quantifiable relationship to reported indicators	10-25% error
Established methodology in published paper	Remote sensed data with comprehensive validation program supporting (statistical error measured)	1:10,000	Direct measurement of reported indicator with error	Less than 10% error
3 x0.5 = 1.5	3	3	2	2

Bolded cells indicate assessment ranking

Total score = 11.5, equates to **four bars**.

References

Australian and Queensland governments 2018, *Reef 2050 Water Quality Improvement Plan 2017-2022*, State of Queensland, Brisbane

Department of Environment and Science, 2019, *Ground cover technical report 2016-17: Great Barrier Reef catchments*, Queensland Department of Environment and Science, Brisbane.

Department of Science, Information Technology, Innovation and the Arts 2012, *Land use summary 1999-2009: Great Barrier Reef catchments*, Queensland Department of Science, Information Technology, Innovation and the Arts, Brisbane.

Flood, N 2013, 'Seasonal composite Landsat TM/ETM+ images using the medoid (a multi-dimensional median)', *Remote Sensing*, vol. 5, no. 12, pp. 6481–6500.

Guerschman J, Scarth P, McVicar T, Renzullo L, Malthus T, Stewart J, Rickards J & Trevithick R 2015, 'Assessing the effects of site heterogeneity and soil properties when unmixing photosynthetic vegetation, non-photosynthetic vegetation and bare soil fractions from Landsat and MODIS data', *Remote Sensing of Environment*, vol. 161, pp. 12–26.

Scarth P, Roder A & Schmidt M 2010, 'Tracking grazing pressure and climate interaction – the role of Landsat fractional cover in time series analysis' in *Proceedings of the 15th Australasian Remote Sensing and Photogrammetry Conference,* Alice Springs, Australia, pp. 13–17.

Trevithick, R, Scarth, P, Tindall, D, Denham, R & Flood, N 2014, *Cover under trees: RP64G Synthesis Report*, Queensland Department of Science, Information Technology, Innovation and the Arts, Brisbane. <https://publications.qld.gov.au/dataset/ground-cover-fire-grazing>