Ground cover monitoring methods

Reef Water Quality Report Card 2023–2025

Reef 2050 Water Quality Improvement Plan

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This report summarises the data and methods used for reporting progress towards the Reef 2050 Water Quality Improvement Plan (Australian and Queensland governments 2018) 2025 land and catchment management target for ground cover.

The target for ground cover is:

- 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 Water Quality Improvement Plan).

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. It is an important indicator of catchment condition, as ground cover is a key component of many soil processes including infiltration, run-off and surface erosion. In particular, low ground cover can lead to soil erosion which contributes to increased sediment loads reaching the Great Barrier Reef lagoon as well as loss of productivity for grazing enterprises.

Maintaining ground cover through periods of low or unreliable rainfall will help minimise loss of water, soil and nutrients when rainfall eventually occurs, as well as maximising pasture growth. Implementing appropriate and sustainable land management practices, particularly careful management of grazing pressure, can help to maintain or improve ground cover.

Factors that influence ground cover

The amount of ground cover is the result of complex interactions between landscape aspects such as soil type, topography and vegetation dynamics, as well as 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. The influence of grazing land management practices on ground cover levels and species composition can be more pronounced in these areas. For example, overstocking, especially during dry periods, can result in bare areas and average ground cover levels decreasing to less than 30%.

There are multiple initiatives aimed at improving grazing land management in Great Barrier Reef regions, such as:

- the Grazing Resilience and Sustainable Solutions (GRASS) program, which provides one-on-one support to help graziers improve poor and degraded land
- infrastructure projects such as fencing key areas and better distribution of watering points for stock
- trials of different grazing strategies.

The Queensland Ground Cover Monitoring Program has developed a range of products suitable for monitoring local-scale variability and differences in ground cover levels. These products can be used for extension and education, and viewed via tools such as:

- VegMachine, an online tool to summarise decades of satellite data over Australia quickly and easily. By making these datasets freely available, it can help people looking after the land to understand and communicate patterns in the landscape, and the outcomes of management decisions
- FORAGE, an online system to distribute property-scale reports on land management matters such as ground cover, pasture growth and erodible soils
- MyFORAGE, an extension of FORAGE, that allows users to adjust/modify input information which helps to achieve better estimation of pasture growth, ground cover and long-term carry capacity at both property- and paddock-scales
- p2r projector, a decision support tool to assist land managers and investors to assess the most cost-effective land management strategies for the greatest reduction in sediment loss.

Further, there are a number of commercial platforms that also provide access to the same ground cover information with additional functionality, such as property infrastructure mapping and estimation of Total Standing Dry Matter.

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 Queensland Ground Cover Monitoring Program. It is based on the measurement of late dry season ground cover using Landsat satellite imagery (Department of the Environment & Joint Remote Sensing Research Program, 2022). Rainfall data is provided for context, as it is the primary driver of ground cover levels at a regional scale.

Methods

Ground cover data

Satellite imagery and fractional ground cover

Measurement of ground cover for reporting is based on fractional ground cover data, version 3 (Queensland Department of Environment and Science & Joint Remote Sensing Research Program, 2022). 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. This includes the longer-term dataset of Landsat imagery (1987 to present): Landsat 5 Thematic Mapper, Landsat 7 Enhanced Thematic Mapper and Landsat 8 and 9 Operational Land Imager satellites with a spatial resolution of approximately 30m and an acquisition frequency of 16 days. In more recent years (mid-2015 to present), the European Space Agency's Sentinel-2 satellites have provided a complementary dataset to the Landsat record. These satellite sensors have a spatial resolution of 10m and an acquisition frequency of five days. Previous Reef water quality report cards (2017-2022) used Sentinel-2 products from 2016-2022, and Landsat products prior to 2016. The inclusion of the Sentinel-2 data was expected to improve ground cover estimates due to more frequent image acquisition, particularly in areas that were often cloudy. However, recent quality control investigations have shown there are some issues with the cross calibration used to align reflectance values between Landsat and Sentinel-2 imagery, leading to differences in cover predictions between the two datasets. To maintain consistency across the time series, this report uses Landsat datasets only for the entire analysis period. Previously reported values for 2016-2022 may therefore be different from those reported here.

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. To derive a ground cover estimate, a further step is applied following Trevithick et al. (2014) which uses another remote sensing product, 'persistent green', to effectively remove the influence of trees and shrubs on the fractional cover estimates. The persistent green product is based on a time series of imagery and an analysis of the behaviour of the green

cover fraction over that time series. It is assumed that the minimum of the time series represents the less seasonally-variable woody vegetation, effectively providing an estimate of the level of woody cover at any given (pixel) location. This estimate is then converted to a measure of the gap fraction of the woody vegetation, which is essentially a measure of the gaps or spaces in the tree and shrub layer(s) when viewed vertically from above. A relationship is then defined, based on quantitative field data estimates of overstorey and ground cover data and gap fractions, which estimates the amount of ground cover and bare ground that is expected given a particular overstorey gap fraction estimate. An adjustment is then made to the fractional cover to provide individual (i.e. pixel-level) estimates of the level of green ground cover, non-green ground cover and bare ground at ground level, thus producing a fractional *ground* cover estimate (Figure 1). As a final step, the green and the non-green ground cover fractions are summed to produce a total ground cover estimate, as erosion and run-off are influenced by all ground cover. This estimate of total ground cover is used for reporting and is hereafter referred to simply as 'ground cover'.

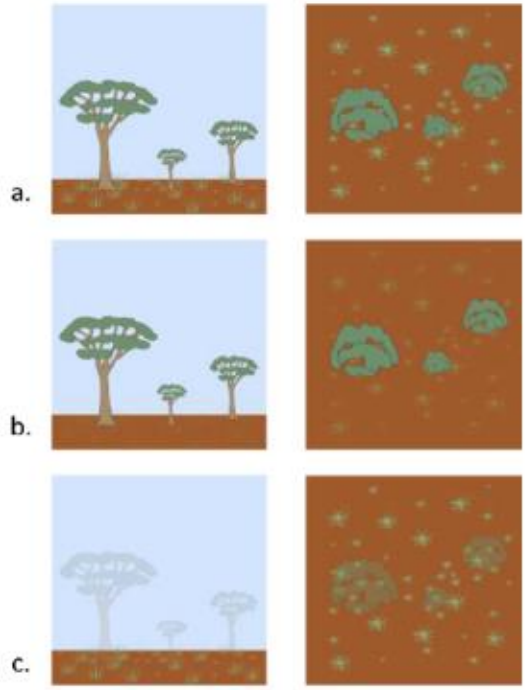

Figure 1: Schematic representation of the correction of the fractional cover data to estimate the fractional ground cover used for reporting (Trevithick et al., 2014). (a) Fractional cover measures all vegetation cover including trees, shrubs and ground cover, as well as bare ground. The ground cover 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 green' cover in the tree and shrub layers. (c) Finally, a correction factor is applied, based on field data, to effectively remove the 'persistent green' 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 or simply 'ground cover'.

The method for deriving ground cover can be applied in areas of woody vegetation cover up to approximately 60% persistent green cover, at which point the canopy becomes too dense to reliably achieve an estimate of the ground cover. Given the lower levels of woody vegetation cover in the Great Barrier Reef catchment areas, this means that generally, ground cover can be reported for the majority (i.e. >90%) of the grazing lands.

The use of the persistent green product to derive ground cover does have some limitations. Given it is an estimate of green cover behaviour over time, some non-woody areas which are persistently green (e.g. in high rainfall areas), can have very high persistent green cover values (i.e. >60%), resulting in them not being included in the areas for analysis and reporting. Further, due to the way the persistent green product is derived using time series approaches, it can only be calculated up to a date which is two years prior to the current (reporting) season. As a result of these limitations, ground cover reporting statistics calculated in one reporting period may vary slightly when re-calculated and updated in the next reporting period, as will the area of the grazing lands analysed and reported. In general, the reporting of mean cover helps to account for these

differences. Future work will consider ways to further limit the impact these issues have on the ongoing consistency of the ground cover reporting.

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 Landsat fractional ground cover data images acquired throughout the season, following Flood (2013). This approach has the advantage of removing errors and outliers in the data (e.g. due to cloud or cloud shadow artefacts) and produces a composite image for the season which is based on the selection, per pixel, of the most representative value (medoid) for that season. Each pixel is a real estimate selected from the set of images available for that season; it is not a modelled or synthesised value. The method requires at least three valid observations in any given season before a pixel is selected for inclusion in the composite image. It provides the most spatially comprehensive coverage as there is generally very little missing data due to cloud, cloud shadow or satellite sensor issues.

Reporting regions and grazing lands

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

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

Grazing lands in the reporting regions are spatially-defined based on land use data provided by the Queensland Land Use Mapping Program (2019 version), to maintain consistency with previous reporting periods.

A *reporting region* is defined as that part of a region which is grazing land and has less than approximately 60% persistent green cover. Any reporting region with less than 10% area reported as grazing lands, or less than 10% ground cover data within the grazing lands, is excluded from the results.

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 (i.e. September - November) 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 include mean late dry season ground cover from 1987 to the current reporting period, and the percentage of the region's reported grazing area with late dry season ground cover greater than 70% in the current reporting year. Graphs show the mean ground cover levels over time, with rainfall included to provide context. Maps of ground cover percentages are also provided for the entire Great Barrier Reef region, and for each reporting region, to show where in each region the ground cover levels were higher or lower.

It is important to note that averaging ground cover across whole regions can mask localised areas of lower or higher 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. Reporting is further divided into catchments (and sub-catchments for larger catchments). For more detailed or localised ground cover information and to visualise ground cover data products, refer to VegMachine or FORAGE.

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 while low rainfall leads to lower ground cover levels. Rainfall data is obtained from SILO as a 5km grid. The mean annual rainfall is then calculated for each reporting region from September to August for each year from 1986, to align the mean annual rainfall with the late dry season reporting period. It should be noted that rainfall statistics are constantly updated by the Bureau of Meteorology as more data becomes available, thus reported mean annual rainfall may change slightly between reporting periods.

Assessing progress towards the target

The report card shows 'target met' for catchments and sub-catchments where 90% of grazing lands have greater than 70% ground cover in the late dry season in 2025. Where the target has not been met, the results are also compared with the previous results for 2024. The trend indicator shows either:

- 'improving', if the proportion of grazing lands with greater than 70% cover has increased
- 'declining', if the proportion of grazing lands with greater than 70% cover has decreasedor
- 'no change'.

The trends should be interpreted cautiously with reference to relative rainfall amounts in the catchment, as this provides a strong influence on inter-annual variability.

Semiquantitative confidence ranking

Data confidence ●●●●○

A multi-criteria analysis is used to score the confidence in each indicator used in the 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 dot confidence ranking.

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 x 0.5 = 1.5	3	3	2	2

Bolded cells indicate assessment ranking

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

References

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