Australian Government

Queensland Government

Ground cover monitoring methods

Reef Water Quality Report Card 2020

Reef 2050 Water Quality Improvement Plan

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Citation

Australian and Queensland governments, 2022, *Ground cover monitoring methods, Reef Water Quality Report Card 2020,* State of Queensland, Brisbane.

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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) (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 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 currently in place or are planned. They include programs which aim to improve management of ground cover levels appropriate to the regional conditions 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
- 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 Queensland Ground Cover Monitoring program. It is based on the measurement of late dry season ground cover using Landsat satellite imagery for historical measurements and Sentinel-2 satellite imagery 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 at local scales, 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 and are of limited use for regional-scale reporting. Access to some of these products is via the interactive online tool VegMachine and the online reporting tool, FORAGE. A decision support tool, the P2R projector has now been released and includes components to inform management practices on grazing lands. The P2R Projector assists land managers and investors to assess the most cost-effective land management strategies for the greatest reduction in sediment loss. Furthermore, there are a number of commercial platforms now providing access to the same ground cover information with additional functionality, such as property infrastructure mapping and estimation of Total Standing Dry Matter. New data 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, where appropriate.

Methods

Ground cover data

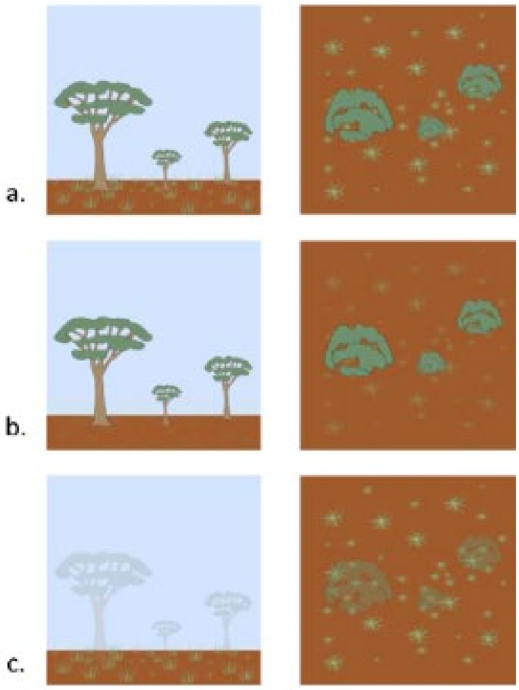
Satellite imagery and fractional ground cover

Measurement of ground cover for reporting is based on fractional ground cover data derived following methods described in Scarth et al (2010), Guerschman et al (2015) and Trevithick et al (2014). 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 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-2A and Sentinel-2B satellites have augmented the Landsat record. These satellite sensors have a higher spatial resolution of 10m and an acquisition frequency of five days. Analyses undertaken by Flood (2017) has shown that fractional cover data produced from the two imagery sources is statistically comparable as the surface reflectance values of the Sentinel-2 products have been adjusted to closely match those from the Landsat satellites. The inclusion of the Sentinel-2 data is expected to improve ground cover estimates, particularly in areas that are cloud affected, due to the more frequent acquisition strategy. For all reporting, the Sentinel-2 data are downscaled (i.e. degraded) to 30m to match the spatial resolution of the Landsat data.

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, called the 'persistent green', to effectively remove the influence of trees and shrubs on the fractional cover data. 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. The assumption with this product is 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 amount of gaps or spaces in the tree and shrub layer(s) when viewed vertically from above (or below). 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'.



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 certain 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 actually 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.

The current version of the fractional ground cover product was developed using around 2,000 field observations across a range of ground cover, tree cover and shrub cover levels within a range of environments (Scarth et al, 2010; Guerschman et al, 2015). It has been assessed using linear regression to have an accuracy of 17% Root Mean Square Error (Figure 2). Due to a collaborative national effort, there are now over 4,000 field observations collected using the same field protocols across Australia, and a re-calibrated and revised fractional cover model is being developed. It is expected that this updated version will help to address some known limitations in the current version (e.g. in bright soil areas) and will be incorporated into reporting in the future, following assessment of the accuracy and degree of difference to the current reporting. Re-processing of previous years will be undertaken to produce reporting statistics which are based on a single, consistent product.

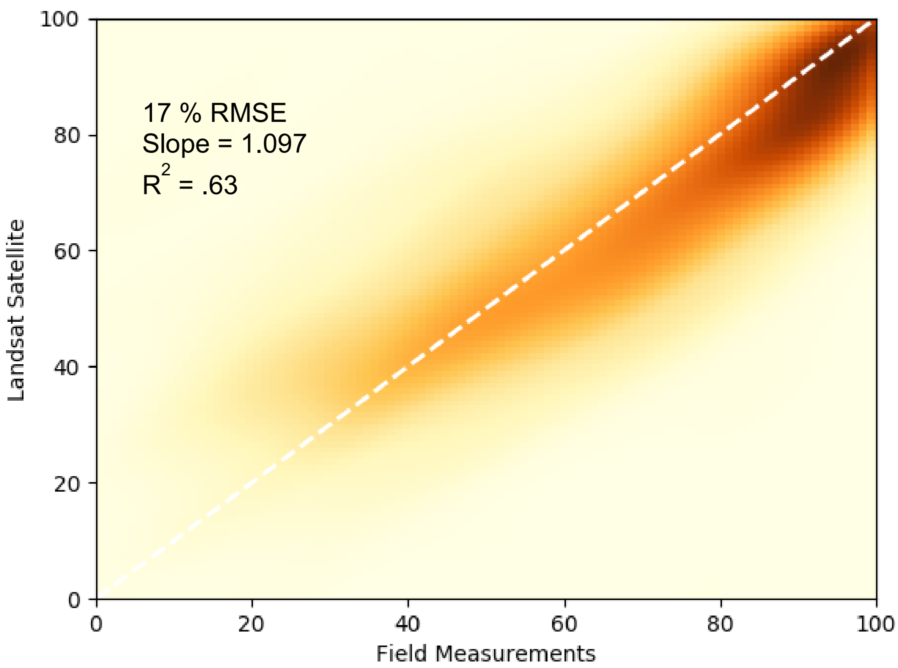


Figure 2: Comparison of field measurements of fractional cover with Landsat derived fractional ground cover for 2047 sites across Australia. The linear regression shows an overall Root Mean Square Error (RMSE) of 17%.

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 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 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.

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 acquisition strategy of the Sentinel-2 satellites typically results in very little missing data once composited.

Reporting regions and grazing lands

Reporting is based on the six natural resource management (NRM) 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 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, with the Fitzroy and Burnett Mary current to 2017. Cape York and the Wet Tropics are current to 2013 and 2015, respectively.

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. spring) 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). Therefore, the mean ground cover reported is 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, and low rainfall results in 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.

Scoring system

A standardised scoring system is used for each of the key indicators in the Reef Water Quality 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% 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 adequate ground cover level	E - Red
Poor ground cover	Between 60-69% of grazing lands meet the adequate ground cover level	D - Orange
Moderate ground cover	Between 70-79% of grazing lands meet the adequate ground cover level	C - Yellow
Good ground cover	Between 80-89% of grazing lands meet the adequate ground cover level	B - Light Green
Very good ground cover – Target met	More than 90% of grazing lands meet the adequate ground cover level	A - Dark Green

Adequate ground cover for 2019 is defined as >70% late dry season ground cover.

Qualitative confidence ranking

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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.

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

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