Great Barrier Reef

Report Card 2011

Reef Water Quality Protection Plan

Methods

Australian Government

Queensland Government

Methods

This report details how the key indicators were measured for Report Card 2011. Ongoing improvements will be made to the methods and data sources to improve the accuracy and precision of reporting over time.

Management practices

This section presents the per cent of landholders who have improved practices between 2009 and 2011. The status of each industry under the ABCD management practice reporting framework as at 2011 is also presented.

Management practice frameworks

ABCD management practice frameworks (rated from A to D for reporting purposes) describe a continuum of practices that are recommended to maintain and/or improve water quality and land resource condition. A group of specific management practices together describe a management system.

For cropping systems, the ABCD framework details management practices and systems for managing nutrients, herbicides and soils. For grazing systems, the framework describes practices impacting upon land condition, soil erosion and water quality.

Management practice system ABCD classes and definitions for sugarcane, horticulture and grains (Source: Drewy J, et al., 2008)

Class	Description of practice	Farm management plan	Community and industry standard	Effect on resource condition	Effect on profitability
A	Cutting-edge practices that require further validation of environmental, social and economic costs/benefits	Yes, develops and tests innovative technology.	When validated is an acceptable practice for the long term. (May not be universally endorsed as feasible by industry and community.)	When validated, practice likely to achieve long term resource condition goals if widely adopted.	When validated, improves profitability in the medium to long term. (May reduce profitability during the transition.)
B	Currently promoted practices often referred to as 'Best Management Practices'.	Yes, and utilises common technology.	Acceptable practice for the medium term.	Practice likely to achieve medium term resource condition goals if widely adopted.	Improves profitability in the short to medium term.
C	Common practices. Often referred to as 'Code of Practice'.	Basic.	Acceptable practice today but may not be acceptable in medium term.	Practice unlikely to achieve acceptable resource condition goals if widely adopted.	Decline of profitability in the medium to long term.
D	Practices that are superseded or unacceptable by industry and community standards.	None.	Superseded or unacceptable practice today.	Practice likely to degrade resource condition if widely adopted.	Decline of profitability in the short to medium term.

Management practice system ABCD classes and definitions for grazing

	A	B	C	D
Management practice category	Practices are highly likely to maintain land in good (A) condition and/or improve land in lesser condition	Practices are likely to maintain land in good or fair (A/B) condition and/or improve land in lesser condition	Practices are likely to degrade some land to poor (C) condition or very poor (D) condition	Practices are highly likely to degrade land to poor (C) or very poor (D) condition
Soil erosion and water quality risk associated with grazing land management	Very low risk	Low risk	Low to moderate risk	Moderate to high risk

It is important to note that not all improved management practices result in a change in management practice system (rated from A to D for reporting purposes). This means that the number of landholders estimated to have improved management practices will typically be greater than the number estimated to have improved management systems.

Grazing

The ABCD management practice framework for the grazing industry describes management practices based on their likely impacts upon land condition, soil erosion and water quality.

Data collection and synthesis

Collated datasets were reviewed by expert panels at the regional level. These expert panels identified data gaps and errors, and provided advice on the appropriate interpretation of management change resulting from the various drivers of management practice change. This review developed a small suite of change drivers which contributed to management practice improvements, and a further subset which are credited with achieving overall management system improvements.

Management system improvements are restricted to:

- completed Reef Rescue Water Quality grants projects (generally including training plus hard infrastructure improvements)
- a smaller group of highly intensive training/consultancy courses
- a small selection of Natural Resource Management body and/or State Government extension projects with documented impacts of management system change.

Any management changes which graziers have implemented without direct influence or assistance from recognised service providers has not been captured. As such, the results are likely to be a conservative estimate of the degree of management practice improvement.

Sugarcane

Management practice framework

The ABCD management practice framework for the sugarcane industry includes practices relating specifically to nutrients, herbicides, soils, on-farm water management (irrigation and drainage), record keeping and planning.

Data collection and synthesis

There were no consistent industry wide systems in place for collecting data on improved land management practices in the sugarcane industry between 2008 and 2010. As such, the only reliable source of data is the Reef Rescue Water Quality Grants program. Management system changes identified in this Third Report Card are restricted to those identified by regional Natural Resource Management bodies as an outcome of completed Reef Rescue Water Quality Grants projects, which generally include planning and/or training plus hard equipment or infrastructure improvements.

Any management changes which sugarcane growers have implemented without direct influence or assistance from regional Natural Resource Management bodies and the Reef Rescue initiative were not captured. Therefore, the degree of change reported in Report Card 2011 is likely to be a conservative estimate. Similarly, regional Natural Resource Management bodies, through the Reef Rescue program, have in several instances directed funding toward projects which are likely to have industry-wide benefits. These are meritorious investments for which no evaluation information exists.

Horticulture

Improved land management practices are described within the Growcom Farm Management System (FMS) - the accepted industry best practice program - and Natural Resource Management body ABCD management practice frameworks.

Management practice frameworks

Practical application of ABCD management practice frameworks in an industry as diverse as horticulture means there are variations in the practices described for different crops or climatic zones. The Burnett Mary, Fitzroy, Mackay Whitsunday and Cape York regions share a common ABCD management practice framework for horticulture. In the Burdekin region, the ABCD framework developed and used by NQ Dry Tropics specifically serves the regional production system, while remaining similar to other frameworks. In the Wet Tropics, Terrain Natural Resource Management uses separate management practice frameworks to describe practices in bananas, pawpaws and a combined 'multicrop' category.

Data collection and synthesis

Data on management practice adoption within the horticultural sector is collected through Growcom's FMS. The Water Quality module within the FMS allows detailed assessment of water quality risks and key actions to reduce those risks. These assessments involve one-on-one interaction between growers and Growcom or Natural Resource Management body field officers. Results of these assessments are aligned with regional and industry ABCD frameworks to estimate ABCD proportions within the grower population, on a year-by-year basis.

The number of growers adopting improved practices is limited to those that successfully implemented Reef Rescue Water Quality Grants, as an outcome of their engagement with Growcom FMS completed from 2008 to 2011. This is likely to provide a conservative estimate of the number of growers implementing improved practices.

Industry-wide management practice adoption is estimated using the proportions established through the Growcom FMS in each region.

Coverage of Growcom FMS as at 30 June 2011*							
Region	**Burnett Mary**	**Fitzroy**	**Mackay Whitsunday**	**Burdekin**	**Wet Tropics**		
					Banana	**Pawpaw**	**Multicrop**
Industry coverage (% of total area)	>70%	40%	33%	>70%	57%	80%	64%

** Coverage estimates are based on the actual area of production represented in the FMS (as reported by participant growers) expressed as a percentage of the estimates of total horticulture area as reported in the First Report Card. These First Report Card values now appear to underestimate the horticulture production area in several regions.*

Grains

Improved management practices are described within the industry-endorsed farm management system, Grains Best Management Practices (BMP).

Management practice frameworks

The ABCD management practice framework for the grains industry is derived from the Grains BMP program:

- nutrient management practices are described in the Crop Nutrition and Soil Fertility module
- chemical management practices are described in the Pesticide Application module
- soil management practices are described in the Property Design and Layout and Making Best Use of Rainfall modules.

The Grains BMP modules articulate three levels of practice for each key area – Below BMP Standard, Minimum BMP Standard and Above BMP Standard - which correspond to C/D, B and A, respectively.

Data collection and synthesis

Data on management practice status within the grains sector is collected through the Grains BMP program. Growers typically engage with the program through facilitated workshops where they complete self-assessments with process and technical support available. Management practice data is then able to be accurately reported on the bases of area impacted, or number of growers.
Grains industry reporting for Report Card 2011 is relevant to the Fitzroy region only (which includes the majority of the grains industry in Great Barrier Reef catchments).

Increase in grower participation and area impacted by the Grains BMP Program						
Year	**2008-09**		**2009-10**		**2010-11**	
Fitzroy NRM Region	**Growers**	**Area (ha)**	**Growers**	**Area (ha)**	**Growers**	**Area (ha)**
	66	90,178	111	150,370	134	179,384

Increasing program engagement can mean that overall management practice status appears to be static or regressing over time (e.g. if the proportion of growers with A or B level management practice in the sample reduces over time). This is not the case, and is an artefact of early program participants generally being relatively advanced farmers. It is, therefore, appropriate that the most recent data is used as the best estimate of management practices, meaning that the baseline status is hindcast from the most recent data.

The number of growers adopting improved practices is the number of growers that completed specific intensive training or consultancy and/or implemented infrastructure and equipment changes on-farm as a result of their engagement with Grains BMP and the Reef Rescue Water Quality Grants program (through the field network of the Fitzroy Basin Association). This is likely to provide a conservative estimate of the number of growers implementing improved practices.

Dairy

Improved land management practices are described in the dairy industry's accepted best practice program, Dairying Better 'n Better for the Reef (DBnBR). The program is funded through the Australian Government's Reef Rescue program and is driven by the industry peak body, the Queensland Dairyfarmer's Organisation Ltd (QDO), the Burnett Mary Regional Group (BMRG) and Terrain Natural Resource Management.

Evidence of dairy producers adopting improved management practices is limited to the number of producers that completed soil and water management plans and Reef Rescue Water Quality Grants projects through the DBnBR program during 2008-2009, 2009-2010, and 2010-2011. Therefore, the number of producers adopting improved practices is likely to be a conservative estimate.

Management practice frameworks

The DBnBR program includes detailed soil and nutrient management planning processes including benchmarking current practices, identifying risks and planning priorities for action. DBnBR assesses management practices against three categories:

- above acceptable industry practice
- acceptable industry practice
- unacceptable industry practice.

Data collection and synthesis

Data is provided through the DBnBR program. Reporting of regional or industry-wide management system status is not possible. However, there is reliable evidence of the adoption of improved management practices as described by:

- the number of producers that have completed professional risk analyses and soil and nutrient management plans
- the number of producers that have implemented on-ground works with the support of Reef Rescue Water Quality Grants, as an outcome of their engagement with the soil and nutrient management planning process

Estimates of the proportion of producers adopting improved management practices are presented at the Great Barrier Reef-wide scale only.

Catchment indicators

This section presents information on catchment attributes (wetlands, riparian areas and groundcover) that play a role in water quality entering the reef.

Progress for wetlands and riparian areas is not provided in Report Card 2011 as they are only monitored every four years (see Report Card 2010 for latest data).

The Groundcover section reports on mean late dry season groundcover for 2011, the 24-year mean groundcover for the period 1988 to 2011 and the area of land with mean groundcover below 50 per cent.

Groundcover

Groundcover consists of the non-woody plant cover near the soil surface and all litter including woody litter. It affects soil processes including infiltration, runoff and surface erosion. In the Great Barrier Reef catchments, low groundcover can contribute to increased sediment loads reaching the reef lagoon (Queensland Government, 2009).

Reporting regions

Groundcover is not reported for the Cape York region and the Wet Tropics region, with the exception of the Herbert catchment. These areas are generally considered to have low grazing pressure and the tree cover is too high for groundcover monitoring derived from satellite imagery.

Grazing lands

Grazing lands in the reporting regions were spatially defined based on the most recent version of land use data provided by the Queensland Land Use Mapping Program (Department of Science, Information Technology, Innovation and the Arts, 2012).

Groundcover data

Reporting is based on the fractional vegetation cover method described by Scarth et al. (2010). The method measures the proportion of green vegetation, non-green vegetation and bare ground using reflectance information from Landsat 5 Thematic Mapper (TM) and Landsat 7 Enhanced Thematic Mapper (ETM+) satellite imagery. The spatial resolution of Landsat imagery is approximately 30 metres.

The Ground Cover Index (Scarth *et al*., 2006) uses image data from satellites at approximately 30 metre pixel resolution to estimate groundcover levels based on the reflectance of bare ground. This data is calibrated using field observations.

For the purposes of reporting on groundcover, it is necessary to only provide estimates where tree cover is low. This is because higher tree cover obstructs the view of the ground and can contribute to reflectance measurements when viewed from the satellite thus affecting the accuracy of groundcover estimates. Reporting is therefore limited to grazing areas of less than 15 per cent. Foliage projective cover is a measure of the density of woody vegetation and is defined as the percentage of ground area occupied by the vertical projection of foliage (Specht *et al*., 1981).

The fractional vegetative cover method differs to the approach used for the previous two report cards which was based on the Ground Cover Index (Scarth *et al*., 2006). The fractional vegetative cover method is more accurate because it uses a larger sample of field data and has a lower model error for prediction of groundcover. Using the fractional cover method has changed the distribution of groundcover levels significantly in some cases, but this is considered to be more representative of the true level of groundcover. When averaged across large catchments, the statistics for mean late dry season groundcover and the 24-year median groundcover can be considered to be

nominally the same as for previous reporting and can therefore be readily compared. However, the statistics for area of mean groundcover less than 50 per cent is not comparable with previous reporting. This is due to the change in distribution of groundcover at the extremes, leading to a significant reduction in the amount of groundcover that is less than 50 per cent, relative to previous estimates derived from the Ground Cover Index.

2011 mean late dry season groundcover

The 2011 mean late dry season groundcover was calculated by averaging the per pixel amount across the reporting area for each region.

24-year mean groundcover

The 24-year mean groundcover was calculated by estimating, per pixel, the mean annual late dry season groundcover for the period 1988 to 2011 inclusive and averaging for the reporting area of each catchment. This is the period for which Landsat TM/ETM+ satellite imagery is available.

For more information on the methods, please contact the Reef Plan Secretariat.

References

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.

Scarth P, Byrne M, Danaher T, Henry B, Hassett R, Carter J and Timmers P,(2006). `State of the paddock: monitoring condition and trend in groundcover across Queensland' in *Proceedings of the 13th Australasian Remote Sensing and Photogrammetry Conference,* Canberra, Australia, November 2006.

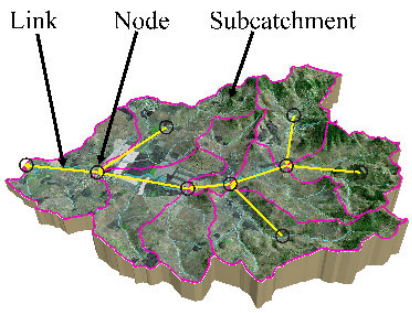
Scarth P, Roder A and Schmidt M (2010). 'Tracking grazing pressure and climate interaction – the role of Landsat fractional cover in time series analysis' in *Proceedings of the 15th Australasian Remote Sensing and Photogrammetry Conference,* Alice Springs, Australia, September 2010.

Specht RL and Morgan DG (1981). The balance between the foliage projective covers of overstorey and understorey strata in Australian vegetation. *Australian Journal of Ecology*, 6, 193-202.

Catchment pollutant loads

Catchment modelling

The Source Catchments modelling framework (eWater 2010) is used to report pollutant loads for the 35 catchments in the Great Barrier Reef region. It is a catchment scale water quantity and quality model which uses a node link network to represent the stream. The model generates runoff and pollutant loads for each landuse within a sub-catchment, and runoff and pollutants are transported through the node link stream network to the end of the catchment.



Example of a node link network generated in Source Catchments to represent a catchment and stream network.

Source Catchments runs at a daily time step which allows exploration of the interactions of climate and management at a range of time-steps. However, for the report card, average annual catchment loads are reported.

Modelled loads were generated for the fixed climate period using 2008-2009 (baseline), 2009-2010 (Second Report Card) and 2010-2011 (Report Card 2011) landuse/land management following the adoption of improved management practices. A total of 17 pollutants were modelled including fine and course sediments, various nutrients and eight pesticides. Key land uses were modelled for the baseline scenario including open and timbered grazing, cane, cropping, horticulture and forestry.

Management practice change

An ABCD management system framework was used to describe and categorise farming practices according to recognised water quality improvements at a paddock scale. Improvements in water quality as a result of adopting improved management practices are determined by linking paddock model time series outputs to catchment models.

Management practice change has been modelled for the sugarcane and grazing areas of the Great Barrier Reef catchments. Changes in riparian management, which weren't modelled in the Second Report Card 2010, have now also been modelled for most areas.

Limitations

Water quality improvements from the baseline were not modelled for the horticulture, dairy and cotton industries. Modelling was not undertaken for these industries due to a lack of management practice data and/or limited experimental data on which to base load reductions. Dissolved inorganic nitrogen reductions have not been modelled in the grains system as there is no dissolved inorganic nitrogen model in HowLeaky?

There may also be some over estimate of load reductions as pesticide, nutrient and soil management practices were modelled as a whole system rather than representing the individual practices in which investments were

made. Any over estimates may be offset by the fact that some pollutants and industries could not be modelled, as outlined above.

Linking paddock and catchment models

Two constituent generation approaches were used in Great Barrier Reef modelling. Firstly, the constituent time-series (e.g. load per day per unit area) for any spatial unit in the Source Catchments model was replaced with an output time-series from a paddock model. In the second approach, a scaling approach, GRASP model groundcover time-series outputs were used to relate changes in grazing system management to changes in the groundcover time-series (or Revised Universal Soil Loss Equation (RUSLE) C-factors). These were modelled and applied to a range of climates and pasture productivity levels and land types.

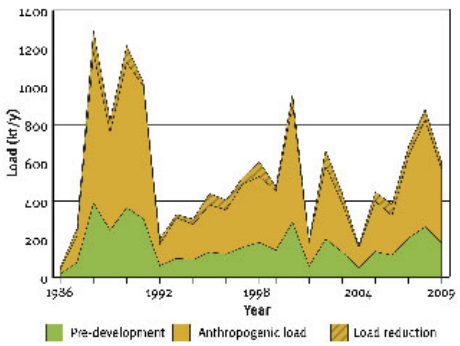
The outputs from each of the modelled land management practices were accumulated into a single landuse time-series for a sub-catchment. All loads were then aggregated at a sub-catchment scale and routed through the stream network.

Total load

The total load was the load modelled as at 2008-2009 land use/land management within each Great Barrier Reef catchment. A pre-development land use map was also developed and modelled. The model was then run for a 23-year period to establish the total load over this period. Thus, the anthropogenic load was the total load less the pre-development load.

Load reductions

The model was then re-run for the same climate period using updated proportions of A, B, C and D areas to reflect investment in improved management practices since 2008-09. The relative change in pollutant loads from the anthropogenic baseline after investment reflects the load reduction due to changes in management practices.



Example of modelled loads for pre-development, anthropogenic baseline and the load reduction following investment in improved practices.

How the information is reported

Progress towards Reef Plan targets is measured by how much the pollutant load has reduced from the average annual anthropogenic baseline (total load less the pre-development load). This is calculated as a percentage reduction in average annual load.

Total suspended sediment, nitrogen, phosphorus and pesticides loads at the end of the catchment are reported for the total Great Barrier Reef region, six regions and the 35 catchments.

The average annual percentage reduction in load is calculated from:

$$\text{Reduction in load (\%)} = \frac{\text{(Anthropogenic baseline load less anthropogenic change)} \times 100}{\text{Anthropogenic baseline load}}$$

Where, anthropogenic baseline load = total load less pre-development load.

Catchment modelling is not informed by a spatially explicit management practice change dataset for all areas which means some assumptions are made when spatially distributing management change data in some areas. Depending on the availability of useful investment data, there may be instances where a load reduction is reported for a particular region or sub-catchment that in reality has had no investment in land management improvement. For this reason, load reductions are presented at the Great Barrier Reef and regional scales only in Report Card 2011. Processes are being established to report catchment scale load reductions for future report cards through the capture and reporting of spatially explicit management change data.

References

Argent, R.M, Perraud, J.M, Rahman, J.M, Grayson, R.B, Podger, G.M. (2009) A new approach to water quality modelling and environmental decision support systems. Environmental Modelling & Software 24 pp. 809–818

Department of Environment and Resource Management (2009). Monitoring and Sampling Manual 2009, Version 2. ISBN 978-0-9806986-1-9

eWater Cooperative Research Centre, (2010). Source Catchments User Guide, eWater Cooperative Research Centre, Canberra. ISBN 978-1-921543-29-6.

Marine

Marine Monitoring Program

The water quality issues affecting the inshore waters of the Great Barrier Reef are significant, and most assessment and monitoring information relates to this area. The Reef Rescue Marine Monitoring Program monitors the water quality in the inshore reef lagoon and the long-term health of key marine ecosystems (inshore coral reefs and seagrasses). The four sub-programs are outlined below.

More information about the Marine Monitoring Program is available from the Great Barrier Reef Marine Park Authority website (www.gbrmpa.gov.au).

The marine environment in the Cape York region is relatively pristine compared to other regions. However, increasing pressure from development and the associated impacts on water quality in the region mean that Cape York is a high priority for intensifying monitoring efforts. No coral monitoring occurs in the Cape York region in the Marine Monitoring Program, though some sites are monitored in the southern section as part of the Long Term (Reef) Monitoring Program by the Australian Institute of Marine Science.

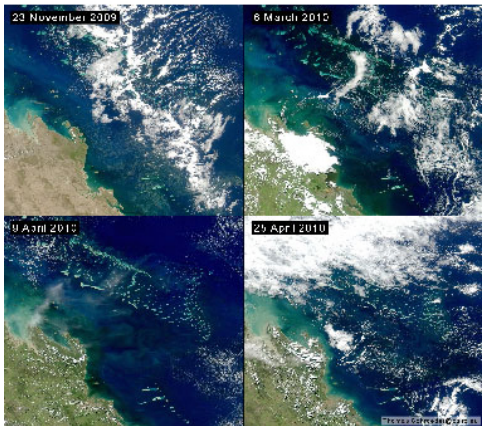
Inshore water quality

Monitoring includes the measurement of concentrations of nutrients (nitrogen and phosphorus), chlorophyll, suspended solids (water turbidity) and pesticides. Techniques used to monitor water quality include satellite remote sensing, automated data loggers, and collection of water samples from research vessels for standard laboratory analysis. Passive samplers are used to measure the concentration of pesticides in the water column integrated over time. (Booij et al., 2007; Shaw & Mueller, 2009).

Flood plume dynamics

The majority of the annual pollutant load to the reef is delivered by flood events in the wet season (Devlin et al. 2001).

Monitoring of water quality during flood events and the wet season includes measuring salinity, concentrations of nutrients, chlorophyll, suspended solids (water turbidity) and pesticides. The movement of the flood plume across inshore waters of the reef is assessed using images from aerial flyovers and remote sensing.



Satellite images (MODIS-Aqua) of the Fitzroy Region of the Great Barrier Reef during normal (low) flow conditions in November 2009 (a) and flood conditions in March and April (b, c, d). The discharge from the Fitzroy River was more than four times the annual median flow and images b-d show large plumes of dissolved and suspended material in the coastal waters.

Seagrass status

Monitoring temporal and spatial variation in the status of intertidal seagrass meadows in relation to changes in local water quality is essential in evaluating long-term ecosystem health.

Monitoring includes assessing the abundance of seagrass species and seagrass reproductive effort, which provide an indication of the capacity of meadows to regenerate following disturbances. Tissue nutrient composition is assessed in the laboratory as an indicator of potential nutrient enrichment.

Seagrass monitoring along the Queensland Coast (Image: L. McKenzie, Queensland Government)

Coral reef status

In evaluating long-term ecosystem health, it is essential to monitor temporal and spatial variation in the status of inshore coral reef communities in relation to changes in local water quality.

Monitoring covers a comprehensive set of community attributes including the assessment of hard and soft coral cover, the density of hard coral juvenile colonies, macroalgae cover, and the rate of change in coral cover as an indication of the recovery potential of the reef following a disturbance (Thompson and Dolman, 2010). Comprehensive water quality measurements are also collected at many of the coral reef sites.

Coral reefs being monitored on the Great Barrier Reef. (Image: Australian Institute of Marine Science)

Synthesis and integration of data and information

A sub-set of indicators was selected to calculate the water quality, seagrass and coral scores. These scores were expressed on a five-point scale and integrated into an overall score that describes the status of the Great Barrier Reef and each region.

An overview of the methods used to calculate the Great Barrier Reef wide and regional scores is available from the Marine Monitoring Program Quality Assurance Manual.

Great Barrier Reef wide and regional assessments

Water quality
Near-surface concentrations of chlorophyll *a* and total suspended solids from remotely sensed images were used to evaluate inshore water quality. Chlorophyll *a* is a measure of phytoplankton biomass that is related to the amount of available nutrients in the water column and therefore the productivity of the system. Total suspended solids is a measure of all other particulate matter in the water column. It should be recognised that the accuracy of these estimates from satellites is limited in some regions by the amount of on-ground data for validation.

Seagrass
Abundance, reproductive effort and nutrient status were used to evaluate inshore seagrass condition. Seagrass abundance includes assessment of percent cover determined in reference to the Seagrass Abundance Guidelines (McKenzie 2009). Reproductive effort is based on the average number of reproductive structures on an area basis and provides an indication of the capacity for recovery following disturbances. The nutrient status of seagrass is based on the ratio of carbon to nitrogen in leaf tissue and reflects the level of nutrients in the surrounding waters.

Corals
Coral cover, coral cover change, juvenile density and macroalgae cover were used to evaluate inshore coral reef condition. Coral cover is a measure of the abundance of hard and soft corals, and indicates the capacity of coral to persist under the current environmental conditions and to recover from disturbances by estimating the availability of adult broodstock. Coral change is a measure of the change in hard coral cover from the preceding three years and is an indicator of the balance between disturbance and recovery. Juvenile density is a measure of the abundance of hard coral juveniles and is an indicator of the potential of the community to recover from disturbances or stress. Macroalgal cover is a measure of the abundance of large, fleshy algae. High abundance of algae is an indicator of poor water quality and once established algal communities reduce the recovery of corals by denying them space and the ability to produce chemical deterrents.

Site specific assessments

Water quality
To complement the water quality scores derived from remotely sensed images, site-specific water quality data are reported using an interim Water Quality Index based on the monitoring data and expert opinion.

The Water Quality Index aggregates the scores for four indicators of water quality relative to the Great Barrier Reef Water Quality Guidelines (GBRMPA 2009) to give an overall rating for each of the 20 fixed sampling sites. The four indicators that comprise the Water Quality Index are an integrated assessment of turbidity, chlorophyll, and concentrations of particulate nitrogen and phosphorus. Decision rules for the Water Quality Index are outlined in more detail in Schaffelke *et al.* 2011 (http://www.gbrmpa.gov.au/resources-and-publications/publications/annual-reef-rescue-marine-monitoring-science-report).

The Water Quality Index may be refined with future research and data analysis.

Pesticides

The most frequently detected pesticides in inshore waters include those that inhibit the photosynthetic pathway (PSII) of plants in an additive manner: the PSII herbicides diuron, atrazine, hexazinone, simazine and tebuthiuron (Haynes et al., 2000; Mitchell et al. 2005; Kapernick et al. 2006; Lewis et al. 2009; Packett et al. 2009). These PSII herbicides may also have a negative impact on non-target organisms such as algae, corals and seagrass (Magnusson et al., 2008; Jones and Kerswell, 2003; Haynes et al., 2000).

Passive samplers are used to measure the concentration of pesticides in the water column integrated over time. (Booij et al., 2007; Shaw & Mueller, 2009). For reporting purposes, five categories of the PSII Herbicide Equivalent Index were developed with reference to the Great Barrier Reef Water Quality Guidelines.

For more information on the methods, please contact the Reef Plan Secretariat.

References

Booij, K., Vrana, B. & Huckins, J.N. 2007, "Theory, modelling and calibration of passive samplers used in water monitoring" in *Passive sampling techniques in environmental monitoring*, eds. R. Greenwood, G. Mills & B. Vrana, Elsevier, Amsterdam, pp. 141-169.

Furnas, M. & Brodie, J. 1996, "Current status of nutrient levels and other water quality parameters in the Great Barrier Reef" in *Downstream effects of landuse*, eds. H.M. Hunter, A.G. Eyles & G.E. Rayment, Department of Natural Resources, Brisbane, pp. 9-21.

Great Barrier Reef Marine Park Authority 2010, *Water quality guidelines for the Great Barrier Reef Marine Park,* Rev edn, Great Barrier Reef Marine Park Authority, Townsville.

Great Barrier Reef Marine Park Authority 2009, *Water quality guidelines for the Great Barrier Reef Marine Park*, Great Barrier Reef Marine Park Authority, Townsville.

Haynes, D., Mueller, J. & Carter, S. 2000, "Pesticide and herbicide residues in sediments and seagrasses from the Great Barrier Reef World Heritage Area and Queensland coast", *Marine pollution bulletin,* vol. 41, no. 7-12, pp. 279-287.

Haynes, D., Ralph, P., Muller, J., Prange, J., MichalekWagner, K. & Waterhouse, J. 2000, "The occurrence and impact of herbicides in the Great Barrier Reef, Australia", *Reef Research,* vol. 10, no. 2-4, pp. 3-5.

Haynes, D., Ralph, P., Prange, J. & Dennison, W. 2000, "The impact of the herbicide diuron on photosynthesis in three species of tropical seagrass", *Marine pollution bulletin,* vol. 41, no. 7-12, pp. 288-293.

Jones, R.J. & Kerswell, A.P. 2003, "Phytotoxicity of Photosystem II (PSII) herbicides to coral", *Marine Ecology Progress Series,* vol. 261, pp. 149-159.

Kapernick, A., Shaw, M., Dunn, A., Komarova, T., Mueller, J., Carter, S., Eaglesham, G., Schaffelke, B., Bass, D., Haynes, D., 2006. "River pesticide loads and GBR lagoon pesticide data", *Attachment A, Task 2.6. Report to the Great Barrier Reef Marine Park Authority (Marine Monitoring Programme),* National Research Centre for Environmental Toxicology (EnTox).

Lewis, S.E., Brodie, J.E., Bainbridge, Z.T., Rohde, K.W., Davis, A.M., Masters, B.L., Maughan, M., Devlin, M.J., Mueller, J.F. & Schaffelke, B. 2009b, "Herbicides: A new threat to the Great Barrier Reef", *Environmental Pollution,* vol. 157, no. 8-9, pp. 2470-2484.

Magnusson, M., Heimann, K. & Negri, A.P. 2008, "Comparative effects of herbicides on photosynthesis and growth of tropical estuarine microalgae", *Marine pollution bulletin,* vol. 56, pp. 1545-1552.

McKenzie, L. *, MTSRF Milestone report for June 2009: Seagrass indicators, distribution and thresholds of potential concern*. Available: http://www.rrrc.org.au/publications/downloads/113-QDPIF-McKenzie-L-2009-June-Milestone-Report.pdf [2010, 1/4/2010].

Mitchell, C., Brodie, J.E. & White, I. 2005, "Sediments, nutrients and pesticide residues in event flow conditions in streams of the Mackay Whitsunday Region, Australia", *Marine pollution bulletin,* vol. 51, no. 1-4, pp. 23-36.
Packett, R., Dougall, C., Rohde, K. & Noble, R. 2009, "Agricultural lands are hot-spots for annual runoff polluting the southern Great Barrier Reef lagoon", *Marine pollution bulletin,* vol. 58, no. 976, pp. 986.

Shaw, M., Negri, A., Fabricius, K. & Mueller, J.F. 2009, "Predicting water toxicity: Pairing passive sampling with bioassays on the Great Barrier Reef", *Aquatic Toxicology,* vol. 95, no. 2, pp. 108-116.

Thompson, A.A. & Dolman, A.M. 2010, "Coral bleaching: one disturbance too many for near-shore reefs of the Great Barrier Reef", *Coral Reefs,* vol. 29, pp. 637-648.

Scoring system

A standardised scoring system was developed for each of the key indicators in the report card. The scoring system is used to assess and communicate the progress towards the goals and targets. The Reef Plan targets are considered ambitious. Therefore, progress that is equal to or exceeds the target is considered very good.

Management practice adoption – sugarcane, horticulture and grains
Target: 80 per cent of landholders adopt improved practices by 2013.

Score	Criteria for June 2011	Colour
Very poor progress towards target	0 – 9% adoption of improved management practices	Red
Poor progress towards target	10 – 19% adoption of improved management practices	Orange
Moderate progress towards target	20 - 29% adoption of improved management practices	Yellow
Good progress towards target	30 - 40% adoption of improved management practices	Light green
Very good progress towards target	Greater than 40% adoption	Dark green

Management Practice adoption – grazing
Target: 50 per cent of landholders adopt improved practices by 2013.

Score	Criteria for June 2011	Colour
Very poor progress towards target	0 – 6% adoption of improved management practices	Red
Poor progress towards target	7 – 12% adoption of improved management practices	Orange
Moderate progress towards target	13 - 18% adoption of improved management practices	Yellow
Good progress towards target	19 - 25% adoption of improved management practices	Light green
Very good progress towards target	Greater than 25% adoption	Dark green

Groundcover
Target: minimum 50 per cent late dry season groundcover by 2013.

Score	Criteria for June 2011	Colour
Very poor groundcover – “Well below the target”	Less than 30% groundcover	Red
Poor groundcover - “Below the target”	Between 30-39% average groundcover	Orange
Moderate groundcover – “Just below the target”	Between 40-49% average groundcover	Yellow
Good groundcover – “Above the target”	Between 50-69% average groundcover	Light green
Very good groundcover – “Well above the target”	Greater than 70% average groundcover	Dark green

Catchment pollutant loads – pesticides, nitrogen and phosphorus
Target: 50 per cent reduction in load by 2013.

Score	Criteria for June 2011	Colour
Very poor progress towards target – “Increase in the catchment load”	No reduction in load	Red
Poor progress towards target – “No or small increase in the catchment load”	0-5% reduction in load	Orange
Moderate progress towards target – “A small reduction in catchment load”	5-12.5% reduction in load	Yellow

Score	Criteria for June 2011	Colour
Good progress towards target – "A significant reduction in catchment load"	12.5-25% reduction in load	Light green
Very good progress towards target – "A high reduction in catchment load"	Greater than 25% reduction in load	Dark green

Catchment pollutant loads – sediment
Target: 20 per cent reduction in load by 2020.

Score	Criteria for June 2011	Colour
Very poor progress towards target – "Increase in the catchment load"	No reduction in load	Red
Poor progress towards target – "No or small increase in the catchment load"	0-1% reduction in load	Orange
Moderate progress towards target – "A small reduction in catchment load"	1-3% reduction in load	Yellow
Good progress towards target – "A significant reduction in catchment load"	3-4% reduction in load	Light green
Very good progress towards target – "A high reduction in catchment load"	Greater than 4% reduction in load	Dark green

Marine

Score	Marine Indicators				
	Corals	Water quality	Seagrass	Overall	
Very poor condition	Standardised scale (1-100)	Standardised scale (1-100)	Standardised scale (1-100)	Standardised scale (1-100)	Red
Poor condition					Orange
Moderate condition					Yellow
Good condition					Light green
Very good condition					Dark green