Australian Government

Queensland Government

Marine Modelling

Results

Reef Water Quality Report Card 2017 and 2018

Reef 2050 Water Quality Improvement Plan

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MARINE CONDITION – GREAT BARRIER REEF WATER QUALITY

The Marine Monitoring Program (Waterhouse et al., 2018) supports the 2050 outcome sought by the Reef 2050 Water Quality Improvement Plan (Reef 2050 WQIP) (Australian and Queensland governments 2018), which is:

"Good water quality sustains the outstanding universal value of the Great Barrier Reef, builds resilience, improves ecosystem health and benefits communities."

Given the scale of the Great Barrier Reef, it would be impractical to measure and report water quality throughout the entire domain at a reasonable frequency using *in situ* monitoring data alone. Historically satellite imaging has been used by the Marine Monitoring Program to cover this wide spatial domain but the coverage is seasonally affected by cloud cover and the interpretative models used for water quality assessment have lowest accuracy in complex coastal waters. As a result, the eReefs marine modelling component (Herzfeld et al., 2016) of the Marine Monitoring Program was launched in 2016 to:

- Assess trends in ecosystem health for the Great Barrier Reef in relation to water quality and its linkages to end-of-catchment loads by predicting, assessing and reporting trends in inshore water clarity and concentrations of chlorophyll *a*.
- Predict physical and biogeochemical properties of Great Barrier Reef waters under a range of scenarios to assess the impact of management practices and contribute to the establishment or review of catchment-level water quality targets.
- Support regional and whole-of-Great Barrier Reef water quality risk assessments by predicting the impact of rivers on the Great Barrier Reef waters under a range of conditions.

The eReefs deterministic modelling framework is used in conjunction with *in situ* information collected by the Marine Monitoring Program and satellite observations to extrapolate water quality across the entire Great Barrier Reef (Skerratt et al., 2019a). It was used to generate the marine water quality metric in the Great Barrier Reef report cards 2015 and 2016.

This report describes results for the marine water quality metric for regional and global scales for the 2016-2017 and 2017-2018 water years (1 October to 30 September) along with trends estimated by consistent application of the eReefs models over a five year period (2013-2018).

EREEFS MARINE MODELLING - RESULTS

Marine water quality condition

Table 1 summarises the results of the eReefs modelling of marine water quality condition for open coastal water bodies of the Great Barrier Reef lagoon across two recent water years (1 October to 30 September). Each score is based on averaging scores for chlorophyll *a* and Secchi depth.

Table 1. Report Card marine water quality metric results for 2016-2017 and 2017-2018 within the open coastal water body, across the whole Great Barrier Reef and individual regions. Values are indexed scores scaled from 0-100; ■ = very good (81-100), ■ = good (61-80), ■ = moderate (41-60), ■ = poor (21-40), ■ = very poor (0-20).

Region (inshore)	Year	Water quality index	Chlorophyll-a	Secchi depth
Great Barrier Reef	2016-17	42	47	38
	2017-18	37	38	35
Cape York	2016-17	63	87	38
	2017-18	61	86	37
Wet Tropics	2016-17	54	68	39
	2017-18	50	63	36
Burdekin	2016-17	54	62	46
	2017-18	49	56	42
Mackay Whitsunday	2016-17	30	30	30
	2017-18	21	15	26
Fitzroy	2016-17	32	22	41
	2017-18	28	15	41
Burnett Mary	2016-17	58	55	61
	2017-18	48	42	54

The main points for noting are as follows:

- Inshore water quality across the Reef was assessed as moderate in 2016-2017 and poor in 2017-2018, with a north-south gradient of declining water quality from Cape York (good) to Mackay Whitsunday and Fitzroy (poor).
- For the individual indicators, chlorophyll *a* was rated as moderate in 2016-2017 and poor in 2017-2018; Secchi depth was rated as poor overall across both years. Chlorophyll *a* was variable across the regions with a north-south gradient from very good in Cape York to poor and very poor in the Mackay Whitsunday and Fitzroy in 2016-2017 and 2017-2018, respectively.
- Inshore water quality was assessed as moderate in the Burnett Mary across both years.

Marine water quality trends

While the eReefs model was first used to report water quality in the Great Barrier Reef report cards 2015 and 2016, the model was also run in the same assimilating mode for two earlier years (Figure 1). These values differ from previously published report cards but are included here as the best estimate of recent trends. For the reporting period, both the model and the data assimilation scheme were significantly improved. The different approaches are identified by different symbols in Figure 1 but they are considered to have minor impact on the trends (Skerratt et al., 2019b).

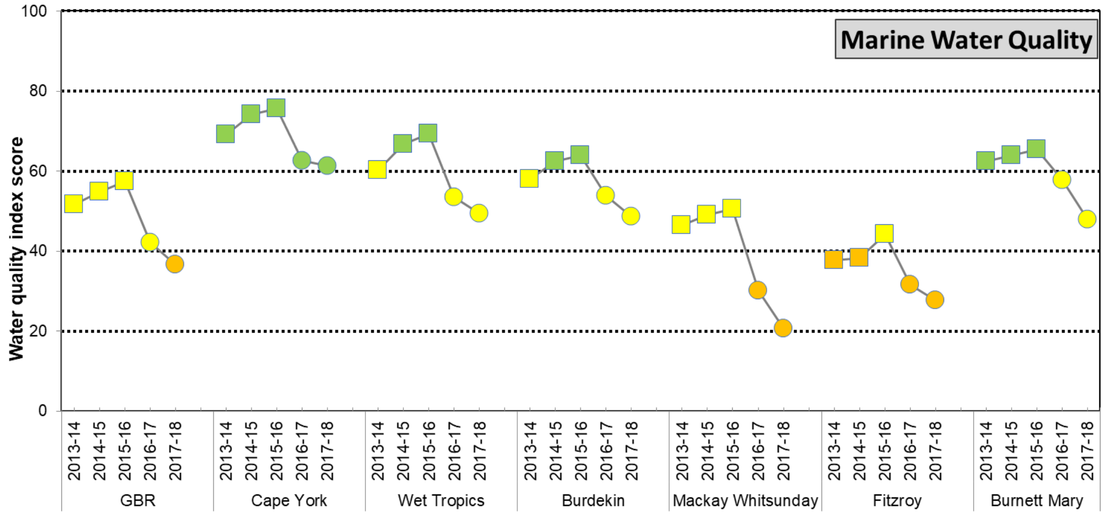

Figure 1. Trends in marine water quality index, as modelled by eReefs for the period 1 October 2013 to 30 September 2018 (biogeochemical model version 2.0 as squares and 3.0 as circles), for the open coastal water body, across the whole GBR and individual regions. Values are indexed scores scaled from 0-100; ■ = very good (81-100), ■ = good (61-80), ■ = moderate (41-60), ■ = poor (21-40), ■ = very poor (0-20).

The main points for noting are as follows:

- While Great Barrier Reef water quality improved in all regions between 2013 and 2016, the two years following saw a decrease in water quality, with the greatest change taking place in 2016-2017 in all regions except Burnett Mary.
- The decline in water quality for the years 2016-2017 and 2017-2018 was observed in all regions but with regional differences in condition. Despite annual variation, water quality in the Cape York region remained good over the five years. Three other regions (Wet Tropics, Burdekin, Burnett Mary) changed from good to moderate. Two southern regions (Mackay Whitsunday, and Fitzroy) changed from moderate to poor.

Since the 2015 and 2016 report cards, the Great Barrier Reef water quality Index has been calculated as the average of separate scores for chlorophyll *a* and Secchi depth (Figure 2). The main points for noting are as follows:

- The two indicators of water quality showed consistent temporal changes (among years) in all regions except Burdekin but different spatial patterns.
- Chlorophyll *a* scores showed the greatest change over five years, as well as greater regional differentiation. Chlorophyll *a* levels declined from north to south unlike Secchi depth and clearly had dominant influence on the pooled scores for the water quality index.
- Chlorophyll *a* levels should reflect nutrient availability. There is either a steep gradient in nutrient availability from Cape York to Fitzroy or a more subtle and nuanced one from Cape York to Burnett Mary with additional factors boosting chlorophyll *a* production in the Mackay Whitsunday and Fitzroy regions. The latter are both impacted by large flood plumes from the Fitzroy River as well as being coastal regions with very strong tidal mixing.
- The chlorophyll *a* scores observed over the five water years are generally consistent with recorded patterns of recent and historical river runoff in the different regions (Figure 3).

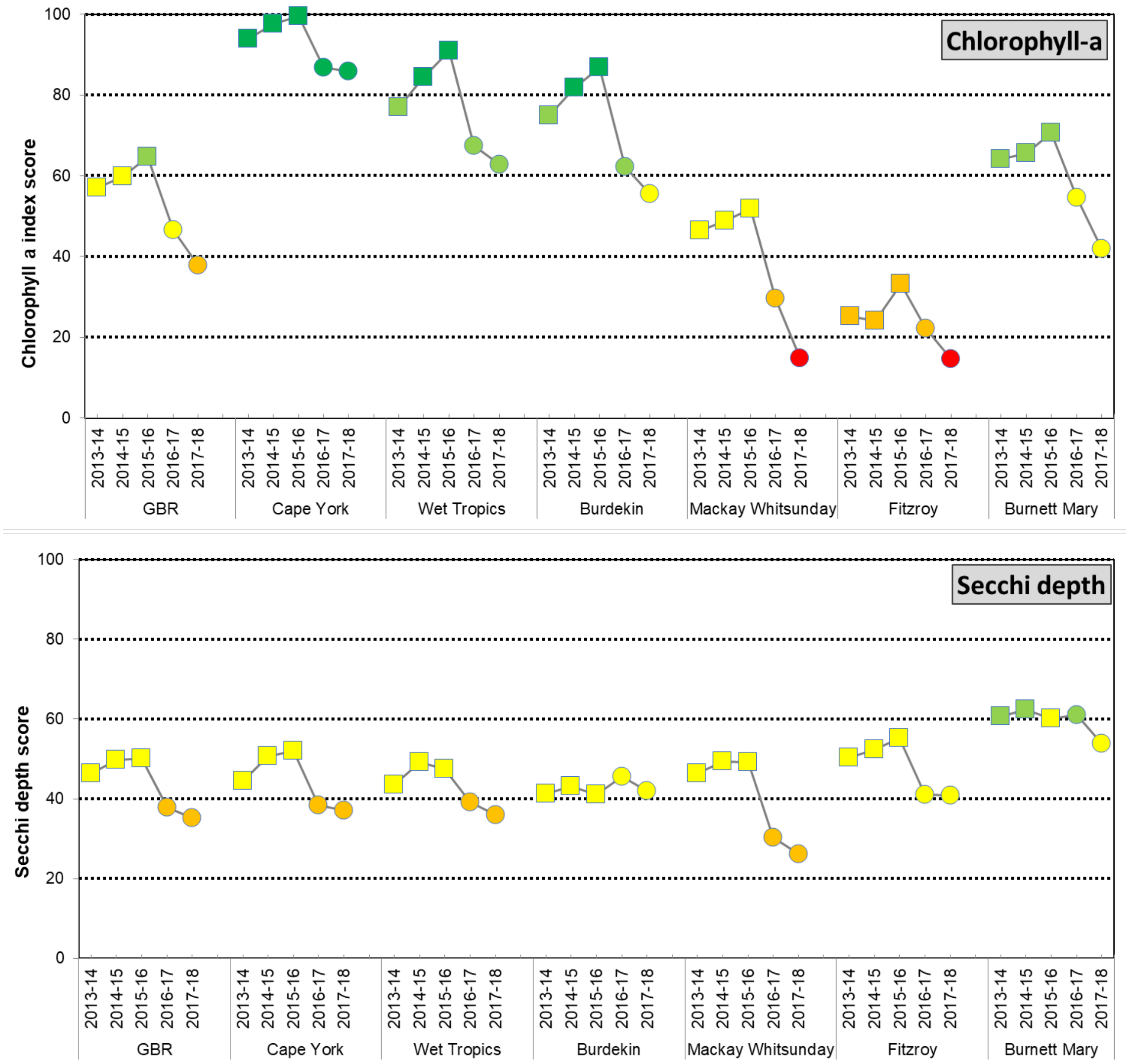

Figure 2. Trends in marine water quality measures chlorophyll *a* and Secchi depth, as modelled by eReefs for the period 1 October 2013 to 30 September 2018 (biogeochemical model version 2.0 as squares and 3.0 as circles), for the open coastal water body, across the whole Great Barrier Reef and individual regions. Values in Table 1.

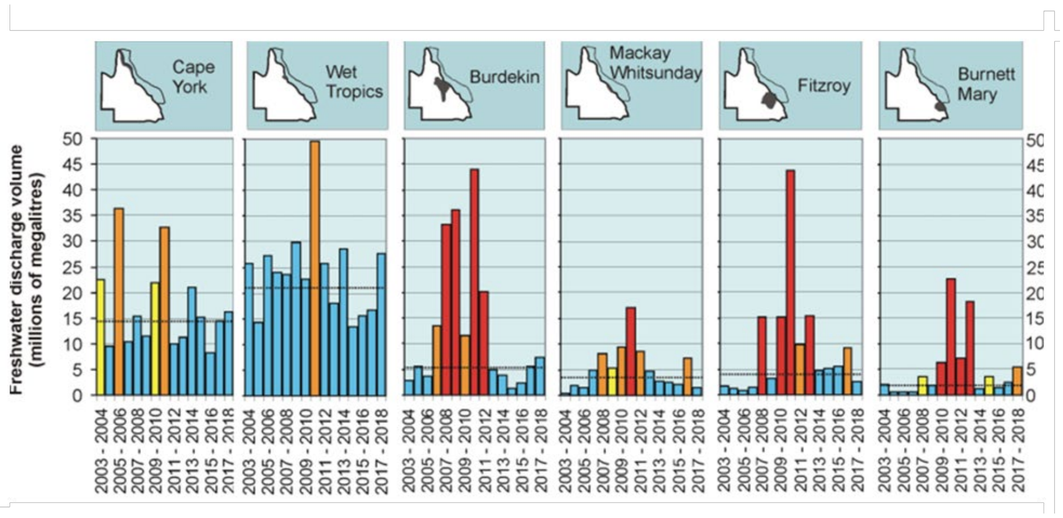

Figure 3. Annual freshwater discharge from Great Barrer Reef rivers (2003-2018) in millions of megalitres (ML) per water year. Bar colours: Bar colours: ■ = >3 times long term median flow, ■ = 2-3 times, ■ = 1.5-2 times, ■ = <1.5. Black line indicates long-term median for each natural resource management region. Source:Gruber et al., 2019.

- Unlike chlorophyll *a*, eReefs did not predict regional differences in Secchi depth scores with the possible exception of clearer water in the Burnett Mary region (Figure 2). The latter should not be unexpected given that this region lies south of the Great Barrier Reef Marine Park in a region more exposed to ocean swell and waves.

- As a proxy for water clarity, Secchi depth scores will be impacted by the prevalence of sediment resuspension in shallow waters. In the Great Barrier Reef Marine Park, the major forcing near the coast is wind-driven resuspension because ocean swell is blocked by the reef matrix to the East. The effectiveness of the prevailing south-east wind field at resuspending fine sediments along the coast will increase from south to north because of a shallowing of the bathymetry. This will counteract the effect of chlorophyll *a* on water clarity.

- Despite little regional variation, Secchi depth scores showed similar temporal changes to those shown by the chlorophyll *a* indicator. While consistent with the effect of river discharge on both variables, the strong change observed in the Mackay Whitsunday region in 2016-2017 is most likely a response to Tropical Cyclone Debbie which led to anomalous river discharges (Figure 3) and strong sediment resuspension in the Mackay Whitsunday and Fitzroy regions.

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