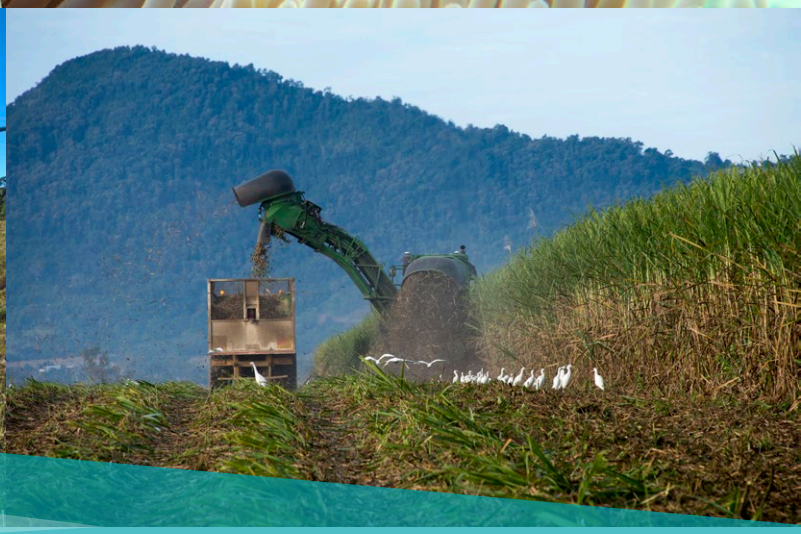

Mackay-Whitsunday Report Card

Program Design

2017 - 2022

Mackay-Whitsunday Healthy Rivers to Reef Partnership
December 2018

HEALTHY RIVERS TO REEF PARTNERSHIP
MACKAY-WHITSUNDAY

Authorship statement

The Mackay-Whitsunday Healthy Rivers to Reef Healthy Partnership (Partnership) Report Card Program Design for 2017 – 2022 was compiled by the Partnership's Technical Officers, Emma Maxwell and Alysha Sozou.

Substantial content was also drawn from the program design documents relevant to earlier Mackay-Whitsunday report cards.

Acknowledgements

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Executive Summary

Report cards have become an increasingly utilised communication tool for aquatic ecosystem health monitoring programs in Australia and around the world, enabling complex, systematically collected scientific information from multiple sources to be summarised and communicated in a way that enables broad understanding and encourages discussion. In Queensland, many report cards are developed through partnership arrangements which involve collaborations between government, research, industry, and community organisations.

The Mackay-Whitsunday Healthy Rivers to Reef Partnership (the Partnership) was established to develop an annual report card for the Mackay-Whitsunday Region. The Region covers from Home Hill in the north to Flaggy Rock Creek in the south, including the freshwater and marine environment (to the eastern boundary of the Great Barrier Reef Marine Park). The report card provides an holistic picture of the ecosystem health in the Region, informs a long-term approach to management, and aims to be consistent with other report card programs across Queensland. Currently there are a multitude of different programs and projects collecting and reporting on data from the Mackay-Whitsunday Region. The Partnership and the associated annual report card work to integrate this data.

The 2014 - 2016 report cards established the foundations of the report card program design, determining the reporting zones, scoring methods and overarching indicators, indicator categories and indices for reporting on the environmental condition of freshwater basins, estuaries, inshore and offshore marine environments. Human dimensions reporting was also determined for social, economic, and cultural heritage components relevant to the Region, with understanding best practice management activities (stewardship reporting) undertaken across a range of sectors (horticulture, grazing, sugarcane, ports, industry, aquaculture, tourism, and urban). This process identified robust programs and data available for reporting, but also identified data and knowledge gaps throughout the Region.

This report card program design outlines the framework that will be used to develop the report cards between 2017 and 2022. It outlines the framework that was established in previous report cards, as well as the plan for improving report cards over the 2017 – 2022 timeframe. Improvements include improving the time-lag between data reported and report card release, filling data gaps identified in earlier report cards, increasing confidence in current reporting and ensuring alignment of reporting within and outside of the Region. Improvements for the 2017 – 2022 report cards will particularly focus on filling the data gap in the southern inshore marine zone, increasing confidence in water quality reporting in freshwater basins and estuaries, establishing reporting for estuarine and marine fish and enhancing human dimensions reporting. The program design also outlines a procedure for introducing stability in reporting, by restricting methodology and scoring changes to a five-year cycle.

While report cards are released annually, this document will be reviewed again with the release of the 2022 report card.

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Terms and Acronyms

AIMS	Australian Institute of Marine Science
CLMP	Catchment Loads Monitoring Program
DES	Queensland Department of Environment and Science
DNRME	Queensland Department of Natural Resources, Mines and Energy
DPSIR framework	Drivers-Pressures-State-Impact-Responses framework
GBR	Great Barrier Reef
GBRMPA	Great Barrier Reef Marine Park Authority
GBRCLMP	Great Barrier Reef Catchment Loads Monitoring Program
GHHP	Gladstone Healthy Harbour Partnership
ISP	Independent Science Panel
JCU	James Cook University
LGA	Local Government Area
MMP	Marine Monitoring Program
NERP	National Environmental Research Program
NQ	North Queensland
NQBP	North Queensland Bulk Ports
NRM	Natural Resource Management
RCL	Reef Catchments Limited
Reef 2050 Plan	Reef 2050 Long-Term Sustainability Plan
RIMReP	Reef Integrated Monitoring and Reporting Program
SELTMP	Social and Economic Long-Term Monitoring Program
SEQ	South-East Queensland
SKIP	Science Knowledge and Information Provision
SSIMR	Spatial and Scientific Information Management for Reef
TORG	Mackay-Whitsunday-Isaac Traditional Owner Reference Group
TWG	Regional report cards Technical Working Group
WQIP	Water Quality Improvement Plan

1. Introduction

1.1. Purpose of this Document

The Report Card Program Design document has been produced as a framework to guide the development of the Mackay-Whitsunday Healthy Rivers to Reef Report Card and its future scope (2017 - 2022). This document will be reviewed again after the release of the 2022 report card. Separate technical reports provide further support with detailed methodologies and results for the report card.

1.2. Defining healthy waterways

For the purposes of the Partnership and the report card, the term "waterways" refers to freshwater creeks and rivers, estuarine environments and wetlands within the five nominated basins (see section 1.8), and the inshore and offshore marine waters and habitats (including reefs).

For the report card, an ecosystem is defined as healthy "…if it is stable and sustainable- that is, if it is active and maintains its organisation and autonomy over time and is resilient to stress"[1].

1.3. The Mackay-Whitsunday Healthy Rivers to Reef Partnership

The Mackay-Whitsunday Healthy Rivers to Reef Partnership (the Partnership) was launched in 2014. It is a collaboration between community, Traditional Owners, farmers, fishers, industry, science, tourism, natural resource management (NRM) groups and government, who recognise that more can be delivered by working together.

The Partnership provides the platform for the development of the annual Mackay-Whitsunday report card for waterway health, which reports on the condition of the Region's freshwaters through to the offshore marine waters and Reef. The report card uses the best available science and integrates a range of Great Barrier Reef (GBR) wide and regional monitoring programs to measure waterway health in an environmental, social, economic and cultural context. By drawing on information from existing monitoring programs, duplications and gaps can be identified, and information easily communicated to the community in a cost-effective way.

The Partnership has released three report cards, the 2014 pilot report card, 2015 and 2016 report cards. The 2017 - 2022 Report Card Program Design is intended to guide the development of the 2017 - 2022 annual report cards.

[1] Costanza (1992). Toward an operational definition of ecosystem health. Chapter 14 in *Ecosystem Health: New goals for environmental management*. Ed. Costanza R., Norton BG, and Haskell BD. Island Press.

1.4. Vision and objectives of the Partnership

The Partnership's vision is for:

"Healthy rivers and Reef contributing to a prosperous Region where people visit, live, work, and play".

The primary objectives identified by the Partnership in June 2018 are:

- Communicate information effectively and at a relevant scale to the broader community on waterway health issues with scientific integrity, independence and transparency;
- Be specific to the Mackay-Whitsunday region and consistent with other regional waterway report cards including the Wet Tropics, Townsville, Gladstone and Fitzroy;
- Provide effective, coordinated, strategic and transparent investment to ensure cost effective development of an annual report card;
- Consolidate and integrate outputs from ambient and event monitoring programs as well as different modelling platforms;
- Provide scientific information that may assist in improving or maintaining the environmental, social and economic values of our Region;
- Deliver more innovative approaches to understanding catchment wide cumulative impacts and communicating that more effectively to the broader community;
- Inform planning and delivery activities of the Partners in response to the findings of the report card;
- Utilise the stewardship assessments in the report cards to promote Partners' activities, while drawing on the findings of the report card to identify enhanced or additional management actions;
- Communicate our understanding of catchment-wide cumulative impacts;
- Build upon, complement and enhance existing efforts of members;
- Foster a culture of collaboration between Partners for the benefit of our Region's waterways and communities;
- Develop community education initiatives; and
- Act as advocates for priority regional outcomes consistent with the Partnership's objectives.

The Partnership aims to ensure local community and heritage values (e.g. recreational use and Indigenous Cultural Heritage values) of the Region, relevant to the waterways and marine environment, are recognised and incorporated in the report card. By collaboratively producing and releasing a report card for the Region that incorporates ecological, social, economic, cultural, and stewardship reporting, local communities are provided with a tool that enables a broad understanding of the current condition of their waterways and ecosystem health and the linkages with management practices.

Additionally, the Partnership aims to continue to use the report card process to engage meaningfully with Traditional Owners regarding the protection of culturally significant sites associated with waterways in the Mackay-Whitsunday Region.

1.5. Linkages with other programs

The Mackay-Whitsunday report card is relevant to both GBR-wide and regional plans, and links with state, regional and local programs and reporting. Some of the key plans and strategies and how they are linked to the Mackay-Whitsunday report card are outlined below (Figure 1).

1.6. Roles and responsibilities

Overall, the Mackay-Whitsunday report card program is managed through the Partnership (25 organisations at October 2018) and the Management Committee. The Executive Officer, Technical Officer and Project Officer progress the day-to-day operation of the Partnership and the report card development.

The development of the report card is guided by the Regional Report Card's technical working group (TWG) and all aspects of the methodology and scoring approach is reviewed by the Reef Independent Science Panel (ISP).

Refer to the Governance Charter for explanations of the relationship and responsibilities of the different groups.

1.6.1. Technical Working Group

The TWG review and provide technical monitoring, modelling and reporting advice on environmental condition indicators for the Mackay-Whitsunday Healthy Rivers to Reef Partnership, Wet Tropics Healthy Waterways Partnership, and the Dry Tropics Partnership for Healthy Waters. The TWG members are skills based and experts in their field.

1.6.2. Independent Science panel

To ensure robustness of data and scientific rigour for the Mackay-Whitsunday report card, the ISP is utilised. The ISP fulfil an independent review function at key points along the report card development. The ISP operate within the scope of a specifically established Terms of Reference.

The ISP are involved in review of the report card program design, indicator development, methodology and scoring, and annual review of data synthesis, results, interpretation and technical reports.

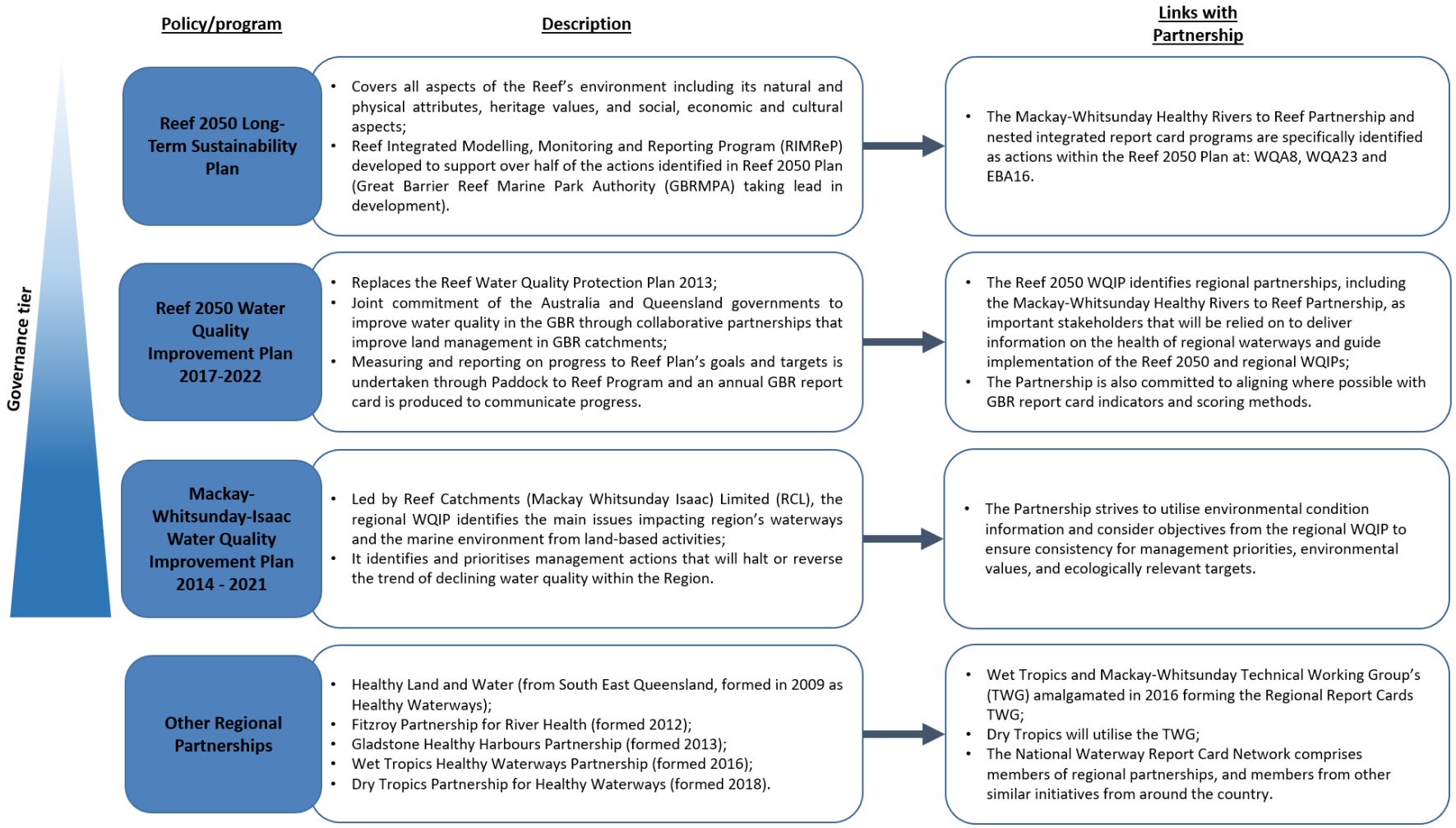

Figure 1. Linkages with other programs.

1.7. The Mackay-Whitsunday Region

Geographically the Region covered by the Partnership and the report card is from Home Hill in the north to Flaggy Rock Creek in the south, including the freshwater and marine environment (Figure 2). Three local government areas (LGAs) are covered in the geographic scope of the Region: Mackay Regional Council, Whitsunday Regional Council and a portion of the Isaac Regional Council. There are currently two natural resource management (NRM) bodies which cover this Region, North Queensland (NQ) Dry Tropics and Reef Catchments (Mackay Whitsunday Isaac) Limited (RCL). The area is rich in natural resources, which underpin community lifestyles and a range of industries.

1.8. Geographic scope of the report card

The area included within the scope of the Partnership and the report card includes the Don, Proserpine, O'Connell, Pioneer and Plane basins, eight estuaries and the coastal and marine area to the eastern boundary of the GBR Marine Park (Figure 2) including both the freshwater and marine environments.

The NRM body that covers the northern most section of the report card is NQ Dry Tropics, which covers from Home Hill to Edgecumbe Bay (covering the Don Basin). RCL covers from the south of Edgecumbe Bay to St Lawrence (covering the Proserpine, O'Connell, Pioneer and Plane Basins) (Figure 2).

Both NRM bodies have split their regions into workable sub-catchments for the purposes of assessing and implementing land management change. RCL differentiated their region into 33 catchment management areas (or sub-catchments) in the 2008 and 2014 Water Quality Improvement Plans (WQIPs), based on hydrological boundaries, land use and management. The Don Basin includes three sub-catchments and is the southern-most area covered by NQ Dry Tropics (the entire NQ Dry Tropics NRM region is comprised of 52 sub-catchments).

Waterways in the Don Basin are ephemeral, flowing for short periods of time during intense periods of rainfall from December to March, but remain dry for most of the year. In contrast, the larger creek systems in the other four basins to the south, receive higher annual rainfall and usually flow year-round. The coastal freshwater wetlands within the Don Basin are also mostly ephemeral or seasonal.

For the purposes of the report card, the freshwater and marine environments were differentiated into areas that, as far as practicable, align with how other initiatives (such as Reef 2050 WQIP and NRM WQIPs) report and present information.

The marine environment for the report card includes the receiving waters identified in the 2014 - 2021 Mackay-Whitsunday-Isaac (MWI) WQIP and the marine environment from the NQ Dry Tropics region that is relevant to the Don Basin. Inshore areas are more influenced by river discharges and run-off than the offshore area, so the inshore and the offshore area are reported on separately. The division between inshore and offshore reporting zones is directed by the State jurisdiction boundary; therefore mid-shelf waters are part of both the inshore and offshore reporting zones.

The waterways in the Region are separated into individual reporting areas based on natural ecosystem boundaries/differences or based on relevant jurisdictional boundaries (Table 1). The freshwater component (including wetlands) of the report card includes the five basins. In subsequent years, it may be possible to split the freshwater environment into the sub-catchment management areas as determined by the two NRM bodies. Additionally, data is collected for eight estuaries across the report card area. The inshore zone is broken into four separate areas from the north to the south of the Region, while the offshore area is reported as one zone (Figure 2).

Table 1. Reporting zones and justification for boundaries.

Zone	Environment	Determination of zones
Don Basin	Freshwater	All freshwater zones are based on the boundaries of the corresponding basins, as determined by the Queensland Department of Natural Resources, Mines and Energy (DNRME).
Proserpine Basin	Freshwater	
O'Connell Basin	Freshwater	
Pioneer Basin	Freshwater	
Plane Basin	Freshwater	
Inshore zones		Inshore zones include enclosed coastal, open coastal and mid-shelf waters
Northern	Inshore Marine	Including enclosed coastal, open coastal and a small area of mid-shelf waters, the Northern zone extends as far north as Cape Upstart. It does not include Upstart Bay as this bay is heavily influenced by the event outputs from the Burdekin River and the Burdekin River basin is outside of the scope of this report card.
Whitsunday	Inshore Marine	Including enclosed coastal, open coastal and mid-shelf waters, the Whitsunday zone encompasses the Whitsunday Coast from Hideaway Bay, south to Cape Conway and includes the islands referred to as the 'Whitsunday Islands', down to, and including, Thomas Island. Repulse Bay was excluded from this zone due to the heavy influence from the Proserpine River, with the sediment in Repulse Bay tending to stay within Repulse Bay and only flowing north during significant event conditions. While regional advice was that Repulse Bay should be included in this zone as residents consider it part of the 'Whitsunday region', its inclusion would likely have confounded water quality results/scores when aggregated, due to the differences between the hydrodynamics/mixing of the Proserpine River and the rest of the Whitsunday region to the north.
Central	Inshore Marine	Including enclosed coastal, open coastal and mid-shelf waters, the Central zone extends from Cape Conway in the north down to Cape Palmerston. This area does not have any distinct patterns to separate it further and is similar ecologically.
Southern	Inshore Marine	Including enclosed coastal, open coastal and mid-shelf waters, the Southern zone extends from Cape Palmerston down to the southern part of the Plane basin, at St Lawrence. This zone captures the influence from the adjacent land and the influences from the more southern Broadsound area. Historical aerial imagery shows that the influences from Broadsound repeatedly track north, but then track out toward the mid-shelf from Cape Palmerston.
Offshore	Offshore Marine	The offshore zone extends from the State jurisdiction boundary to the eastern boundary of the GBR Marine Park and includes offshore and mid-shelf waters. The offshore zone is separated from the inshore zone by the State jurisdiction boundary, but there is no variation to justify a split north to south.

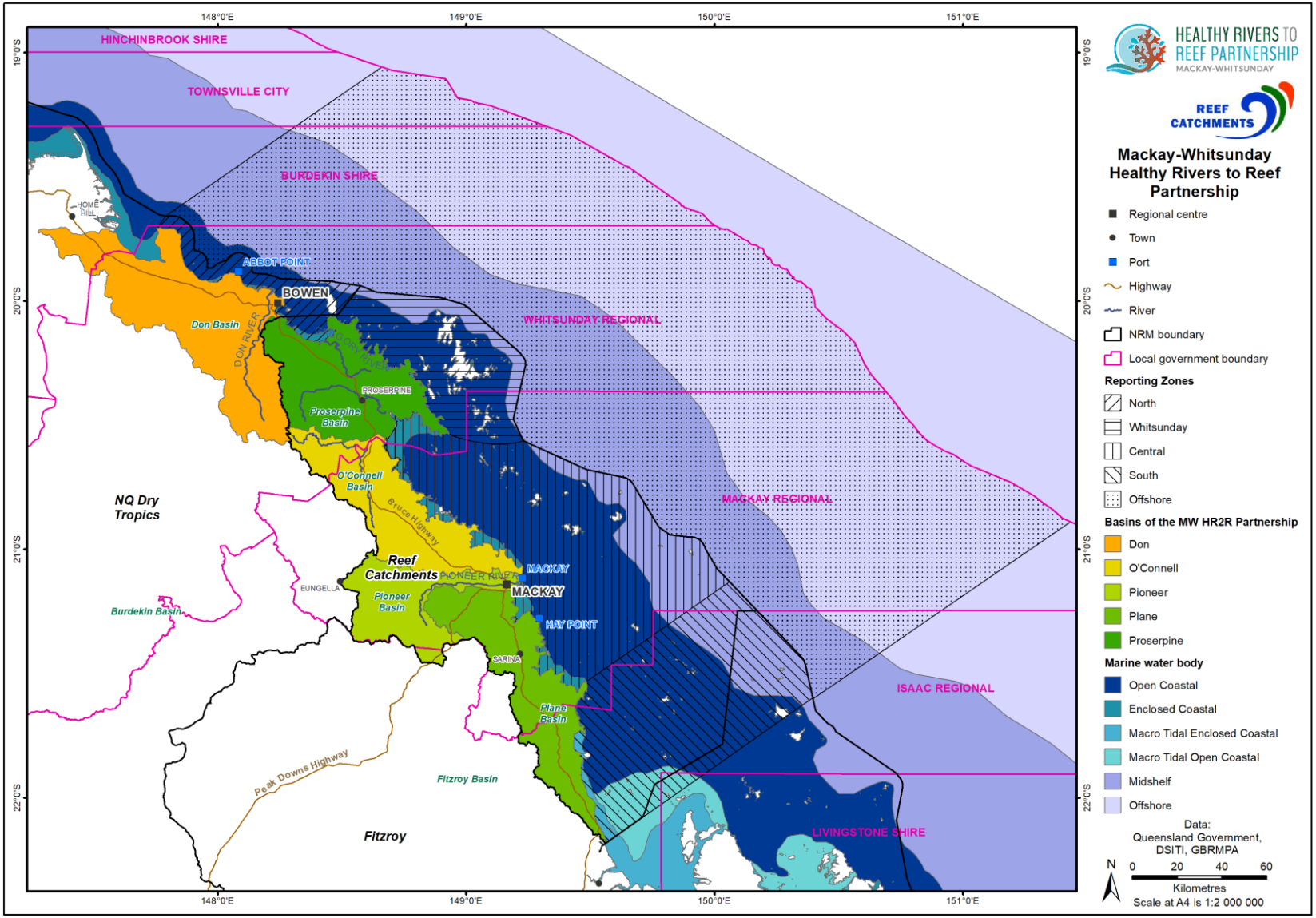

Figure 2. Geographic extent of the Mackay-Whitsunday Healthy Rivers to Reef Partnership and the reporting zones of the report card.

2. Annual report card development

2.1. Report cards

Report cards have become an increasingly utilised communication tool for aquatic ecosystem health monitoring programs in Australia and around the world. Report cards enable complex, systematically collected scientific information from multiple sources to be summarised and communicated in a way that enables broad understanding and encourages discussion. They also enable a broad understanding of the complexity and range of influences on catchment condition and aquatic health from a range of activities.

In Queensland, a well-established annual report card for aquatic ecosystem monitoring exists in South-East Queensland (SEQ) and, more recently, for the Fitzroy Basin, Gladstone Harbour, Wet Tropics and Dry Tropics waterways. These report cards have been developed through partnership arrangements which involve collaborations between government, research, industry, and community organisations. There is also a GBR-wide report card program (referred to in this document as the GBR report card) specifically designed to report on changes in reef health and progress towards targets as a result of efforts to reduce agricultural runoff.

2.2. Report card objectives

In supporting the Partnership's vision, the main purpose of the report card is to bring together the best available information for the evaluation of the condition of the Region's waterways in terms of their environmental, social, cultural, and economic values. An assessment of the Region's ecosystem health and how this is reflected in the Region's prosperity is achieved by assessing a range of key indicators representative of these values.

The over-arching objectives for the report card from the Partnership's Memorandum of Understanding are:

- Report on the state of ecosystem health and values of the Region's waterways;
- Inform a long-term approach to the management of the Region's waterways in an holistic manner;
- Communicate information effectively and at a relevant scale to the broader community on waterway health issues with scientific integrity, independence and transparency;
- Provide data and information to support decision making for management activities, interventions, model outcomes and management effectiveness;
- Be specific to the Mackay-Whitsunday Region and consistent with other regional waterway report cards including, the GBR report card, Wet Tropics and Dry Tropics report cards, Reef Integrated Monitoring and Reporting Program (RIMReP) and where feasible, SEQ, Gladstone and Fitzroy;
- Investigate the assessment and reporting of ecosystem services in the next major review of the program; and
- Provide contextual information on drivers of waterway health in the Region.

To meet these objectives, the Partnership aims to assess and report regularly on environmental condition and human dimensions relevant to the waterways within the Mackay-Whitsunday Region. This report card will provide local communities with the latest available information about the current condition of their waterways and ecosystem health and help to leverage on-ground management practices.

The specific report card objectives (Table 2) are focused around assessing specific pressures in the Region and the current state of specific environmental values within the Region. All objectives of the report card are linked to the natural environment. Further, the objectives were chosen so that the report card (and selected indicators) assess and address factors affecting the values of the community as they relate to the health of the waterways. Over the 2017 - 2022 timeframe**,** the Partnership will be able to use the annual report cards to provide insight into the trends in water quality and ecosystem health along with social, cultural, and economic changes.

It should be noted that the objectives listed for human dimensions reflect objectives outlined in the RIMReP program design for human dimensions and achieving them is highly dependent on the scale of investment by RIMReP. Objectives relating to Indigenous cultural heritage are reliant on the continued operation of the Mackay-Whitsunday-Isaac Traditional Owner Reference Group (TORG). For these reasons human dimensions objectives will be reviewed in 2019.

Table 2. Specific objectives of the report card.

Environmental Objectives
▪ Report on the state of ecosystem health and values of the Region's waterways by: □ Reporting on the state of the quality of water within freshwater, estuaries, and marine waters against agreed benchmarks to track changes over time; □ Assess indicators of freshwater, estuarine, and marine aquatic and associated biodiversity, ecosystem structure, function, and resilience; and ▪ Report on progress to targets that are directed at maintaining or improving ecosystem health of our Region's waterways.
Human dimensions
Cultural objectives
▪ Report on trends in Indigenous cultural heritage sites and values; ▪ Where possible, report on pathways to improve the condition of indigenous cultural heritage sites as well as Partners' management efforts. ▪ Report on trends in non-indigenous cultural heritage sites and values; ▪ Report on trends in Indigenous and non-Indigenous connection to the Region's coastal lands or waterways.
Social objectives
▪ Gauge the level of environmental best practice of key industries and communities in the Region, as they relate to waterways and the marine environment; ▪ Monitor trends in aspiration, capacity and stewardship within Regional communities; ▪ Monitor trends in community vitality (community health, satisfaction, wellbeing, relationship with GBR and resource use) within Regional communities; ▪ Monitor trends in culture and heritage (values) within Regional communities; ▪ Monitor trends in how the community values coastal land and adjacent waterways in the Region and the level of importance placed upon the Region's waterways; ▪ Assess and monitor the local community's perception of the health of the waterways in the Region; and ▪ Report on contextual issues of key community importance examples may include marine debris and recreational fishing.
Economic objectives
▪ Report on the direct economic benefits of industries that depend upon the presence of healthy waterways in the Region (i.e. commercial fishers and marine tourism operators).
Governance objectives
▪ Monitor trends in Governance (confidence in management, equity issues, support for management, trust in networks, sources of information and demographic information) within Regional communities.

2.3. Guiding framework

The Drivers-Pressures-State-Impact-Responses (DPSIR) framework [2] guided the development of the report card. The DPSIR model now forms the basis of the RIMReP, currently under development, and is used in other similar regional report cards such as the Fitzroy Basin report card. In 2018, members of the TWG commenced a review the DPSIR framework, with a focus on better incorporating impacts of pressures and state on ecosystem services, which will help to better direct management responses. Until the review is finalised, the framework in Figure 3 will be retained.

Figure 3 shows the DPSIR model and relationships between regional drivers (such as human-induced economic and population growth, as well as climate), human-exerted pressures, the state of the environment that is a by-product of the pressures exerted upon it and the impacts of this state. Additionally, the framework indicates the levels and aspects that can be influenced by management activities (responses) undertaken in response to pressures and the state of the environment. Such management responses are undertaken with the intent to prevent, reduce, or mitigate pressures and/or environmental damage.

2.4. Data

When the report card was established, it was recognised that there was a range of existing programs operating throughout the Region. Incorporating data collected by these programs, where relevant, was considered a high priority. The report card incorporates data from the Paddock to Reef Program, the Long-Term Monitoring Program (LTMP), marine ambient monitoring programs at Abbot Point and, Mackay and Hay Point, the Bureau of Meteorology, Seagrass Watch, RCL and Catchment Solutions Pty Ltd (and a regional environmental consultancy). The Partnership also co-funds monitoring programs put in place specifically to fill data gaps in the report card and will continue to improve the report card by facilitating and/or co-investing in further monitoring, where possible.

[2] European Environment Agency 1999. *Environmental indicators: Typology and overview*. Technical report No 25.

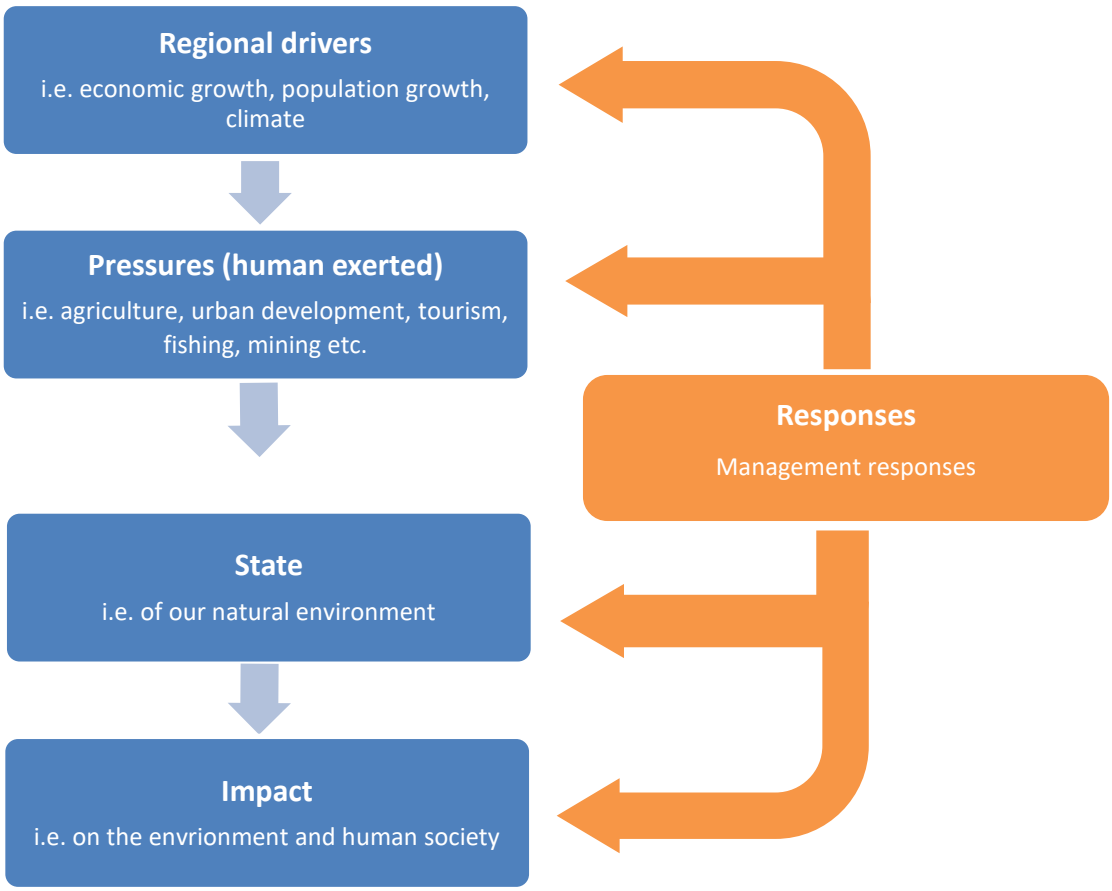

Figure 3. Drivers, pressures, state, impact and responses (DPSIR) framework used to guide the indicator selection for the Mackay-Whitsunday Region.

2.5. Development process

The general process that was undertaken by the Partnership to develop the annual report card is shown in Figure 4. After the Partnership established its vision for the program, the Partnership and report card objectives were defined. Guided by the Partnership's objectives, report card objectives and the guiding Drivers-Pressures-State-Impact-Response (DPSIR) framework, appropriate indicators were identified to report on the state of ecosystem health for the Region's waterways.

Following the production of the 2015 and 2016 report cards the Partnership undertook subsequent workshops to discuss a management response to the report card results. While the Partnership intends to set regional targets in subsequent years such that progress toward long-term targets will be reported, during the management response workshop that followed the release of the 2016 report card, it was identified that there is a need to first review available regional targets.

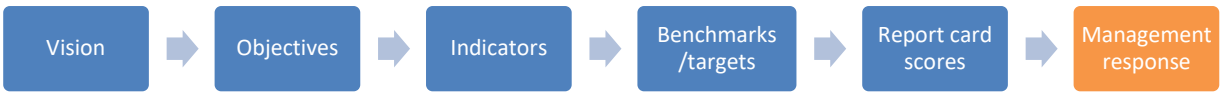

Figure 4. Process of the report card development, from the guiding vision to the production of a report card with scores, including using scores to inform a management response.

2.6. Report card frequency and reporting period

The Partnership aims to undertake an annual assessment and production of a regional report card. The naming protocol for the report card is such that it is dated to reflect the main environmental data that report card scores are derived from. Environmental data is reported on a financial year basis, such that the 2017 report card will include available and relevant water quality data from July 1st 2016 to June 30th 2017. There will always be a lag period between when the data is collected and when the data can be used, due to validation and confirmation processes to ensure the data is of high quality and reliability.

The 2014, 2015 and 2016 report cards were published annually in October 2015, 2016 and 2017 respectively. This represented a time lag of 18 months between the completion of data collection and the release of the report card. In 2017, the Partnership committed to reducing the time-lag between reported data and report card release. The release of 2018 – 2022 report cards is expected to occur in the first half (likely June) of the calendar year, instead of the second half of the calendar year (i.e. in October), reducing the time lag by four months.

To transition into this schedule:

- The 2017 report card will be released online only, when it is complete in 2018 (month unspecified). No official launch will occur.
- The 2018 report card will be released in the first half of 2019 as a hard copy (which will include 2017 scores) and online. An official launch will occur.
- The 2019 report card and those thereafter, will be released in the first half of the next calendar year to the report card name (Table 3).

The schedule for release of the report card in the first half of the calendar relies on data from existing programs being made available at an earlier time than this data has historically been available.

Table 3. Schedule for reporting previous and future report cards and associated data. *Primary data reported refers to the majority of data that is reported annually in the report card, some data is not reported at an annual frequency and this is not reflected in this table.

Report card name	2014	2015	2016	2017	2018	2019	2020	2021	2022
Release year	2015	2016	2017	2018	2019	2020	2021	2022	2023
Release month	October	October	October	December	TBC	TBC	TBC	TBC	TBC
Primary data reported*	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22

3. Framework for the Mackay-Whitsunday report card

3.1. Conceptual diagram

Following the development of the Partnership vision and objectives for the Partnership and report card, existing conceptual diagrams were reviewed to assist in identifying pressures in the Region and prioritise potential indicators. A new conceptual diagram for the Mackay-Whitsunday Region was then developed for the Partnership utilising and adapting existing conceptual diagrams to accurately show the drivers, pressures, impacts, and responses in the Mackay-Whitsunday Region (Figure 5).

Figure 5. The conceptual diagram of the key drivers, pressures, and ecological processes in the Mackay-Whitsunday Region.

3.2. Conceptual framework review

A review of the DPSIR framework commenced in 2018, with a focus on better incorporating impacts of pressures and state on ecosystem services, which will also help to better direct management responses. The review of the framework may result in the need for changes and/or new indicators in the report card. The components of DPSIR, as defined in 2014, 2015 and 2016 report cards will be retained until the review is finalised.

3.3. Drivers and pressures in the Region

The three high level regional drivers in the Mackay-Whitsunday Region are:

- Climate (including climate change and variability);
- Population growth; and
- Economic growth.

The current pressures in the Mackay-Whitsunday Region range from those occurring on an international level, to Reef-wide, to localised regional pressures. Such pressures include:

- Urban, coastal, and industrial development;
- Cyclones and episodic events (including drought and flood events);
- Port development and shipping;
- Agricultural development;
- Fishing and hunting (recreational, commercial, and traditional);
- Tourism and recreational use;
- Litter;
- Water quality:
  - Diffuse sources (agriculture and urban)
  - Point source (urban and industrial);
- Changes to natural freshwater flow regimes; and
- Invasive species (flora and fauna) associated with waterway, wetland, and marine health.

3.4. State of the natural environment

The state of the natural environment, due to the existing pressures (relevant to the waterways) in the Region, are varied. It should be noted that a time-lag often exists between the time of the pressure and the time the effect is seen on the state of the environment and these are not always linear relationships. Additionally, in many environmental situations there is what is referred to as a 'tipping point', whereby an environment can cope with (or adapt to an alternative state) pressures, until the tipping point is passed. Pressures, therefore, are also heavily influenced by the historical situation. The state resulting from current pressures in the Region include:

- Poor water quality in freshwater environments (increased concentration of nutrients, pesticides and sediment);
- Poor water quality in the marine environment (increased concentrations of nutrients, pesticides and sediment);
- Decreased vegetation and habitat in the freshwater, wetland and estuarine environments
- Reduced stability of stream banks and coastal dunes;
- Reduced connectivity throughout the waterways system, including barriers for aquatic species;
- Increased occurrence and extent of terrestrial and marine litter; and
- Reduction or reduced function of marine habitats.

3.5. Impacts and response

Impacts (to both the environment and human society) are considered as changes in the state of the environment, and include:

- Increased erosion, sedimentation and runoff in waterways;
- Increased occurrence and extent of pest and weeds;
- Declines in populations of key fauna species, seagrass and coral communities;
- Reduction in community satisfaction of local waterways;
- Impacts on businesses such as tourism and commercial fishing; and,
- Changes to spiritual value of cultural sites.

A range of responses to impacts in the Region have currently been undertaken or are planned to be undertaken. As with the effects of the pressures, the responses do not necessarily have a linear result and will have time-lag impacts. Responses can be targeted at different points in the causal sequence. Such responses include:

- Land use and management practice change. The 2015 GBR report card provides information on the number of landholders (for grazing, sugarcane, and horticulture) that have adopted improved land management practices for each NRM area;
- Targeted reduction in nitrogen, sediment, and pesticides entering the GBR for each NRM area;
- Development of stewardship frameworks for different industries, by region and GBR-wide (including grazing, sugarcane, horticulture, urban, etc.);
- Development of Reef and regional WQIPs, their review, and all associated management responses; and,
- NRM body works including systems repair works (creek and wetlands, fishways, revegetation, coastal/dune repair projects), Landcare works, working with Traditional Owners, and community involvement and education projects.

4. Environmental indicators

4.1. Determining report card indicators

After the vision and objectives for the program were identified and the current pressures in the Region listed, a range of potential indicators that could be used to assess the pressures while also supporting the objectives of the program were identified. Additionally, the selected indicators needed to consider the community values in the Region.

Each indicator was then prioritised based on whether:

- It was clearly linked to an objective of the report card;
- It could easily be used to provide a report card score; and
- Other programs and report cards used this indicator (this meets a Partnership objective).

Selection of indicators was guided by the SMART principles[3], which are commonly applied in monitoring and evaluation practices. The SMART principles for indicator selection are defined [4&5] as:

- Specific: the indicator is precisely defined, not vague;
- Measurable: it is feasible to quantify the indicator;
- Achievable: the required data and information can actually be collected;
- Relevant: the indicator is valid and describes the underlying issue; and
- Time-bound: a temporal reference is given.

Table 4 lists the criteria used for indicator selection and their relevant SMART principle. A review of indicators used in the Gladstone Healthy Harbour Partnership, Fitzroy Basin Partnership, Healthy Waterways (now Healthy Land and Water) and the GBR report card was also conducted to determine which parameters could be aligned with other report cards.

During indicator selection consideration was given to maintaining consistency of indicators where appropriate across waterway environments (freshwater, estuary, inshore marine and offshore marine) to provide continuity and allow comparison between environments. This could only be achieved for assessments of waterway health that had similar attributes (i.e. water quality), where similar waterway impacts occurred, and where existing monitoring programs collected equivalent data.

[3] Doran, G.T. 1981. There's a S.M.A.R.T. way to write management's goals and objectives. Management Review 70. 11: 35-36.

[4] Olivier, J., T. Leiter, and J. Linke. 2012. Adaptation made to measure: A guidebook to the design and results-based monitoring of climate change adaptation projects. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Eschborn, Germany

[5] Schulte-Herbrüggen,B., Mapendembe, A., Booth, H., Jaques, M. & Smith, J. 2012. The UNCCD Impact Indicators Pilot Tracking Exercise: Results and Conclusions. NEP - WCMC, Cambridge

Table 4. Criteria used for indicator selection and relevant SMART principle.

SMART Principle	Relevant criteria used in indicator selection
Specific	▪ Linked to important regional pressures and impacts on waterway health as identified through the report card conceptual framework and diagram; ▪ Established scientific and conceptual basis, i.e. indicators based on well-defined or validated cause-and-effect linking of human-related pressures to ecosystem response; and, ▪ Represent community environmental values.
Measurable	▪ Availability of appropriate benchmarks (e.g. water quality guideline values) which allow for the generation of report card scores; and, ▪ Sensitive to change.
Achievable	▪ Availability of data (currently and likely in future); and, ▪ Cost effective and able to be resourced.
Relevant	▪ Linked to an objective of the report card; ▪ Align with indicators that are currently monitored as part of ongoing waterway monitoring programs and report cards particularly relating to the GBR regions; ▪ Use the minimum indicators required to represent the targeted pressure and waterway impact, and thereby reduce possible redundancy and doubling up of indicators; and, ▪ Able to be effectively communicated and understood by stakeholders and/or the target audience.
Time-bound	▪ Sensitive to change; and, ▪ Linked to specific management objectives and responsive to related management actions.

4.2. Indicator terminology and aggregation

Indicators from a range of aspects of ecosystem health are combined to produce individual report card scores for each of the reporting areas in the report card. Indicators are assessed and scored individually, before these scores are aggregated into appropriate groups to provide an overall score for a zone. The terminology used in this document for defining the level of aggregation of environmental indicators is as follows:

- An 'indicator' is a measured variable (e.g. concentration of dissolved inorganic nitrogen) or feature in an ecosystem (e.g. fish barrier density);
- Where relevant, scores for related indicators are aggregated to produce an 'indicator category' score (e.g. a nutrients indicator category can be made up of the indicators dissolved inorganic nitrogen and filterable reactive phosphorus);
- An 'index' is generated by aggregating (taking the average) scores from indicators and/or indicator categories (e.g. a water quality index can be made up of the nutrients indicator category, the sediment indicator category, the chlorophyll-a indicator and the pesticides indicator category); and
- An overall score for a reporting zone is generated by aggregating (taking the average) scores for one or more index (e.g. water quality, coral, seagrass and fish indices can make up an inshore marine zone score).

For presentation, indicators, indicator categories and indices are displayed in a colour coded 'coaster' (Figure 6) to demonstrate the scores of indicator and/or indicator categories before they were aggregated to produce index and overall zone scores.

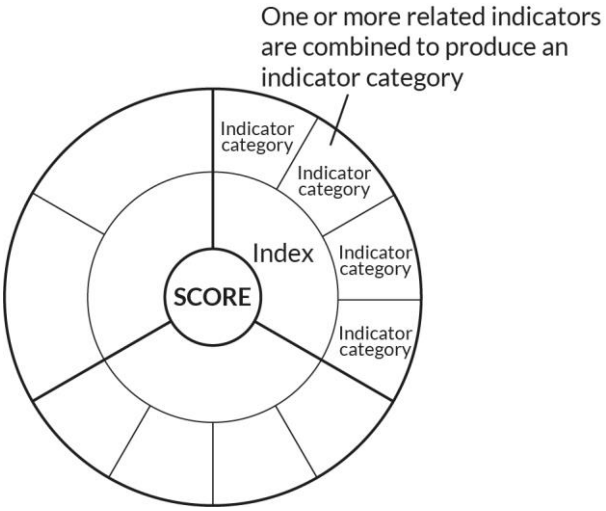

Figure 6. Example of terminology used for defining the level of aggregation of indicators and how they are displayed in the coasters in the report card. Importantly, for presentation not all the rings of the coaster need to be displayed.

4.3. Indicator selection

The sections below provide the rationale for the selection of indicators used for environmental assessments in the report card. Mutual over-arching themes are used to create indices for each reporting area across the freshwater, estuaries and marine waters. These are water quality, habitat (which are specifically identified in each environment) and fish.

4.3.1. Water quality

Sediment, nutrient and pesticide run-off are recognised in the Reef 2050 Long-Term Sustainability Plan[6] as the key threats to water quality resulting from anthropogenic activities, and which impact upon the health of the Great Barrier Reef (GBR). They are also known to impact on the health of freshwater and estuary environments in the Mackay-Whitsunday Region. Consequently, sediment, nutrients and pesticides (or effective proxy indicators) within waterway environments were determined as the most important indicators of water quality throughout the Region. Additional water quality indicators specific to particular waterway environments were also selected.

To assist with the selection of water quality indicators, some of the selection criteria listed earlier have been re-worded to specifically address requirements for water quality indicators. The water quality-specific criteria for selecting indicators were as follows:

- Water quality parameters are currently monitored as part of ongoing monitoring programs within each waterway environment;
- Water quality parameters within each waterway environment are linked to potential impacts on water quality and ecosystem health arising from land management practices in the Mackay-Whitsunday Region;
- Water quality parameters are used for other report cards in GBR regions;
- Water quality parameters have scheduled guideline values to enable scoring; and,

[6] http://www.environment.gov.au/marine/gbr/publications/reef-2050-long-term-sustainability-plan

- Water quality parameters are monitored at a frequency sufficient to detect change in the measured indicator.

Availability of possible water quality indicators was determined through an analysis of current ongoing monitoring programs that collect water quality data in each of the waterway environments. The primary water quality monitoring programs in the Region were:

- The Catchment Loads Monitoring Program (CLMP), led by the Department of Environment and Science (DES) that predominantly monitors freshwater water quality at the end of catchments;
- The DES led program established for the Mackay-Whitsunday report card that monitors water quality in estuaries;
- The Marine Monitoring Program (MMP) conducted by Australian Institute of Marine Science (AIMS) and James Cook University (JCU) on behalf of the Great Barrier Reef Management Authority (GBMRPA) for inshore marine waters;
- The ambient water quality monitoring programs for Abbot Point and, Mackay and Hay Point, both commissioned by North Queensland Bulk Ports (NQBP), also for inshore marine waters; and,
- Remote sensing data sourced from the Bureau of Meteorology for offshore waters.

For the report card, preference was given to parameters collected *in situ*, however for the offshore environment the water quality indicators for chlorophyll-*a* and sediment were only available from remote sensing data sourced from the Bureau of Meteorology. The selected indicators for each waterway environment are presented in Table 5.

Table 5. Water quality indicators (with abbreviations and units) selected for the four waterway environments: freshwater, estuary, inshore marine and offshore marine.

Indicator	Indicator Abbreviation	Indicator Unit	Fresh-water	Estuary	Inshore marine	Offshore marine
Total suspended solids	TSS	mg/L	●		●	●*
Turbidity	Turb	NTU		●	●	
Secchi depth	Secchi	m			●	
Dissolved oxygen	DO	% Saturation		●		
Dissolved Inorganic nitrogen	DIN	µg/L	●	●		
Filterable reactive phosphorus	FRP	µg/L	●	●		
Particulate nitrogen	PN	µg/L			●	
Particulate phosphorus	PP	µg/L			●	
Nitrogen oxides	NO_x	µg/L			●	
Chlorophyll-*a*	Chl-*a*	µg/L		●	●	●*
Pesticides – multi substances potentially affected fraction	ms-PAF	N/A	●	●		
Pesticides PSII herbicide equivalent concentrations	PSII-HEq	Ng/L			●	

*indicates remote sensed data.

Sediment and water clarity

Total suspended solids (TSS) is a measure of particulate matter in the water column, which influences water clarity and sedimentation regimes. This indicator is a common representative of sediment levels in aquatic systems and is very strongly linked to land management practices and erosion. In marine environments concentrations of suspended solids are controlled by sediment inputs from rivers and oceanographic factors such as wind, waves and tides.

Turbidity is a measure of the scattering and absorption of light through water which results from suspended material and soluble coloured organic compounds. Turbidity can be a cost-effective indicator for impacts from sediment run-off in the water column and also allows for continuous logging of measurements.

Secchi depth is a measure of how clear water is, and thus a proxy for the amount of particles (including sediment) that is in water. This is a low cost, fast, easy to measure and easy to understand indicator.

TSS was selected to represent sediment in the freshwater environment. The concentration of TSS is used to estimate sediment loads delivered to the GBR and relates to the MWI WQIP and the Reef 2050 Plan sediment load targets. Turbidity was also investigated (it is used in the estuary and inshore marine environments), but in the freshwater system the availability of data for turbidity was more limited than for TSS. The preferred indicator was therefore TSS, as a guideline value exists for TSS in freshwater systems and there is a volume of data on TSS as it is currently included in existing monitoring programs.

Turbidity was selected as an indicator for sediment in the estuary environment and is linked to sediment loads entering estuaries as a result of land use management practices. Turbidity is measured as part of the current ongoing monitoring program for estuaries in the Mackay-Whitsunday Region. Unlike turbidity, TSS is not sampled as part of this monitoring program, primarily due to analysis costs. Additionally, site-specific relationships between sediment and turbidity can often be derived if necessary when funds can be sourced for periodic analysis of total suspended solids (TSS).

For the inshore marine environment both turbidity, TSS were selected as indicators for sediment and secchi depth was combined with these indicators to produce an overall water clarity category. These indicators are all monitored as part of the MMP. Whilst TSS is sampled using grab samples during manual monitoring activities, turbidity is measured by loggers which provide much higher frequency data collection. It was considered important to retain all three measures in the inshore environment not only to ensure close alignment with MMP indicators but also, to assist in communication associated with the report card; easily understood measures make results more relatable to the public.

Water quality monitoring in the offshore marine environment is from the remote sensed water quality indicators sourced from the Bureau of Meteorology. The data set includes remote-sensed annual exceedances of TSS which was selected as the sediment indicator for the offshore marine environment.

Dissolved oxygen

Dissolved oxygen (DO) is an effective indicator to include for estuarine environments as it is affected by the organic matter load entering estuaries as a result of land use management practices and other anthropogenic activities. Low concentrations of DO are often linked to fish kills, and such events often result in community concern. Very high DO (supersaturation) values can be toxic to some fish as they cause gas bubble disease.

Nutrients

A range of possible nutrient forms that are associated with the major agricultural land uses (sugarcane and grazing throughout the Region and horticulture in the Don basin) were considered as indicators for each waterway environment. Two key nutrients identified as impacting on waterways in the MWI WQIP are nitrogen and phosphorus.

For both freshwater and estuary waterways, dissolved inorganic nitrogen (DIN) and filterable reactive phosphorus (FRP) were selected as the most representative of the pressures and impacts. For both environments, single indicators for each of the key nutrients were chosen to avoid potential duplication in reporting.

DIN is readily available for uptake by aquatic plants such as phytoplankton, macroalgae and algal symbionts and presents risks to freshwater and estuarine ecosystems, as well as being recognised as the largest risk of all the nutrients constituents to the GBR ecosystems[7].

DIN is comprised of oxidised nitrogen (NO_x) and ammonia nitrogen (NH_3) forms. NO_x is the sum of the nitrate (NO_3) and nitrite (NO_2). Nitrite is an intermediate form of nitrogen and is generally short-lived as it is rapidly oxidised to nitrate. Nitrate is essential to plants, is naturally at low levels in waterways, and excessive amounts of nitrate can cause eutrophication. NH_3 is also rapidly taken up by plants, bacteria and animals. At exceptionally high concentrations NH_3 is toxic to aquatic fauna, particularly to fish[8]. However, it is the bioavailability of NH_3 and NO_x to aquatic plants that makes it important to report both forms collectively as DIN.

Water quality objectives for NO_x and NH_3, but not for DIN, are specified for the Region's estuaries in the "draft environmental values and water quality guidelines: Don and Haughton River basins, Mackay-Whitsunday estuaries, and coastal/marine waters", which outlines updated guidelines for mid-estuarine waters in Proserpine, O'Connell, Pioneer and Plane Creek basins[9]. To use DIN (DIN-N) as an indicator for the report card, the WQO concentration values for NO_x (NO_x-N) and NH_3 (NH_3-N) were summed for each water type, creating a DIN guideline. This approach was determined appropriate based upon the following:

- The high rate of exceedance of both NO_x and NH_3 demonstrates that both forms of bioavailable nitrogen are important to assess;
- There is a precedent for creating the DIN guideline value from NO_x and NH_3 in the '2013 scheduled water quality objectives for the Proserpine River, Whitsunday Island and O'Connell River Basins'[10] for which the DIN guideline values are the sum of the NO_x and NH_3 guideline values; and
- Assessing DIN from the summed WQOs is a more stringent approach than from assessing NO_x and NH_3 separately and averaging the scores.

For the inshore marine environment, the nutrient indicators selected were oxidised nitrogen (nitrite and nitrate), particulate nitrogen, and particulate phosphorus. These nutrient forms were selected due to

[7] Schaffelke, B., Collier, C., Kroon, F., Lough, J., McKenzie, L., Ronan, M., Uthicke, S., Brodie, J., 2017. Scientific Consensus Statement 2017. Scientific Consensus Statement 2017: A synthesis of the science of land-based water quality impacts on the Great Barrier Reef, Chapter 1: The condition of coastal and marine ecosystems of the Great Barrier Reef and their responses to water quality and disturbances. State of Queensland, 2017.

[8] Guidelines for NH_3 for freshwater aquaculture are 100 times higher than NH_3 guidelines for aquatic ecosystem health protection for moderately disturbed mid-estuarine waters in the Mackay-Whitsunday Region[10].

[9] Newham, M., Moss, A., Moulton, D., Honchin, C., Thames, D., Southwell, B. Department of Science, Information Technology and Innovation, Queensland (2017). Draft environmental values and water quality guidelines: Don and Haughton River basins, Mackay-Whitsunday estuaries, and coastal/marine waters (draft, March, 2017).

[10] https://environment.des.qld.gov.au/water/policy/pdf/plans/proserpine-river-ev-wqo.pdf

their relevance as indicators of nutrient impacts in the inshore marine environment and, as such, they are used as the nutrient indicators for the MMP water quality index for inshore waters. The selection of these nutrient indicators for the inshore marine environment allows for close alignment of reporting with the MMP.

Nutrients were not selected as indicators for the offshore marine environment due to the distance from land and consequently a lower impact from land based nutrient run-off, compared to waterway environments situated closer to the source of nutrient inputs.

Chlorophyll-*a*

Chlorophyll-*a* concentration provides an estimate of phytoplankton biomass and is also widely considered as a useful proxy for nutrient availability and the productivity of a system. However, due to its links to measures of turbidity, TSS and secchi depth, it has not been combined into the nutrients category. Chlorophyll-*a* was selected as indicator for estuaries particularly because high concentrations can provide an indicator of eutrophication in estuary environments. Chlorophyll-*a* was also selected as an indicator for the inshore and offshore waterways due to its effectiveness as an indicator of nutrient availability in marine ecosystems. Chlorophyll-*a* is an indicator included in the MMP water quality index for inshore waters.

Pesticides

Up to 56 pesticides with different modes of action are detected from the GBR catchments. In the freshwater and estuary environments pesticides are monitored by the Catchment Loads Monitoring Program (CLMP). Pesticide reporting from the CLMP has expanded since the 2004 pilot and 2015 report cards, from five photosystem II (PSII) inhibiting herbicides (ametryn, atrazine, diuron, hexazinone and tebuthiuron) previously identified as the pesticides of greatest concern to the health and the resilience of the Great Barrier Reef[11], to thirteen PSII herbicides detected in the GBR in the 2016 report card (ametryn, atrazine, diuron, hexazinone, tebuthiuron, bromacil, fluometuron, metribuzin, prometryn, propazine, simazine, terbuthylazine, terbutryn). Looking ahead, the toxicity data required for reporting pesticides with other modes of action is expanding, meaning that the range of pesticides included in pesticide reporting will progressively increase in future reporting.

The report card uses the ms-PAF metric to report on pesticide risk in freshwater and estuary environments. The ms-PAF method[12] estimates the impact (i.e. the percentage of species in an ecosystem likely to be affected) of mixtures of pesticides with multiple modes of action. The ms-PAF estimate is limited to pesticides with guideline values; currently 28 pesticides have guideline values. The ms-PAF method will progressively expand to report on up to 28 different pesticides with a range of modes of action (i.e. herbicides, insecticides and fungicides).

[11] DPC (Department of the Premier and Cabinet). 2013. *Reef Water Quality Protection Plan 2013, Securing the health and resilience of the Great Barrier Reef World Heritage Area and adjacent catchments.* Reef Water Quality Protection Plan Secretariat, Brisbane.

[12] Traas, T.P., Van de Meent, D., Posthuma, L., Hamers, T., Kater, B.J., De Zwart, D., Aldenberg, T. 2002. The potentially affected fraction as a measure of ecological risk. In: Posthuma, L., Suter, II G.W., Traas, T.P., editors. Species Sensitivity Distributions in Ecotoxicology. Boca Raton (FL), USA: Lewis Publishers. p 315-344.

Currently, in the inshore environment, PSII herbicides are the only indicators used to report pesticides, however levels are reported as PSII herbicide equivalent concentrations (PSII-HEq) (ng L-1). This approach is used as part of the MMP to inform on nearshore pesticide concentrations[13]. It is a measure of the ecotoxicity of PSII herbicide mixtures and assumes that these herbicides act additively. It can not provide information on pesticides that have different modes of action. The intention is to move to ms-PAF reporting for pesticides in the inshore environment once this option is available. It is anticipated that this will be available for the 2019 report card.

Pesticides were not selected as an indicator for the offshore environment due the distance from the coast and consequently a lower impact from land-based pesticide run-off compared to waterway environments situated closer to the source of pollutant inputs.

It is recognised that there are other contaminants relevant to waterways in the Mackay-Whitsunday Region, such as metals. These are considered as aspirational indicators for consideration in future report cards.

4.3.2. Habitat and hydrology (freshwater and estuary environments)

Habitat and hydrology indicators were selected for the freshwater and estuary environments (Table 6). Selection of indicators differed between the freshwater and estuary environments due to the different pressures, impacts and ecosystem characteristics.

Table 6. Habitat and hydrology Indicators selected for freshwater and estuary environments.

Indicator	Freshwater	Estuary
Impoundment length	●	
Fish barriers	●	●
Flow	●	●
Riparian extent	●	●
Wetland extent	●	
Mangrove and saltmarsh extent		●

For freshwater environments the impoundment length and fish barrier indicators are both included as a measure of in-stream habitat modification. Whilst both indicators relate to artificial in-stream structures, the impoundment length indicator is a measure of the proportion of artificially ponded habitat within a basin and is driven by larger in-stream barriers, whilst the fish barrier indicator is a measure of the potential impact on fish movement and includes both large and smaller barriers that do not result in substantial ponding of habitat.

Variations in the methods applied for assessing habitat and hydrology indicators does occur between the environments due to the different characteristics of freshwater and estuary ecosystems. Details of these differences are described in the methods technical reports. The rationale and explanation on the selected indicators that constitute the habitat and hydrology indices are described below.

[13] Gallen, C., Devlin, M., Thompson, K., Paxman, C., & Mueller, J. 2014. *Pesticide monitoring in inshore waters of the Great Barrier Reef using both time-integrated and event monitoring techniques (2013 - 2014)*. The University of Queensland, The National Research Centre for Environmental Toxicology (Entox).

Impoundment Length

The basis for using this indicator is that impoundment of rivers and streams, by the construction of artificial in-stream structures, including dams and weirs, can have a substantial impact upon stream ecology and connectivity[14]. The purpose of constructing in-stream barriers is commonly to store water for later use, and impounded areas generally have increased water depth and decreased water velocities. Cycles of wetting and drying are disrupted, decreasing the occurrence of natural disturbance and altering the nutrient processing cycle. Increased sedimentation may occur, and benthic habitats may become anoxic. The spawning habitat of some aquatic organisms may be lost. Ponded environments also provide conditions that can promote algal blooms including toxic strains of cyanobacteria.

The indicator was selected with the intention to describe how much 'natural' channel habitat remained, compared with artificially ponded channel habitat which has relatively little diversity in terms of depth (benthic light availability, oxygen availability), flow rate, and wetting and drying cycles due to the river channel being filled by impounded waters. The length of impounded channel varies according to attributes such as the height of the constructed in-stream barrier and landscape features such as gradient of the channel. Given that larger impoundments are generally permanent structures, the inclusion of impoundment length for scoring habitat modification condition is open for review in future report cards as scores is unlikely to change over time.

In-stream barriers constructed to store water also disrupt the movement of aquatic organisms. Consequently, the impoundment length indicator could have some correlation with the indicator of fish barriers. However, the intended focus of the impoundment length indicator is on the ecological impact of the proportion of affected in-stream habitat and not the movement of organisms. Impoundments and ponded channel habitat are not typical in estuarine environments therefore it was not selected as an indicator for habitat and hydrology in estuaries.

Fish Barriers

Waterway barriers can impact the movement of fish within freshwater environments and also between estuary and freshwater environments. The value that the local community places on the presence of fish species is high in the Mackay-Whitsunday Region, and consequently fish barriers was selected as an indicator for both freshwater and estuary environments.

The majority of freshwater fish species of the Mackay-Whitsunday Region migrate at some stage during their life cycle. Of the 47 freshwater fish species found to occur in the Mackay-Whitsunday Region, 27 (57%) require unimpeded access between freshwater and estuarine habitats to complete their life cycle and maintain sustainable fish populations[15]. Therefore, barriers that prevent or delay connectivity between key habitats have the potential to impact migratory fish populations, decrease the diversity of fish communities in freshwater and estuaries, and reduce the condition of aquatic ecosystems[16].

The amount of longitudinal in-stream habitat available to fish species in un-disturbed, connected habitats is determined by a number of naturally occurring factors, such as: habitat availability and condition, gradient, refuge areas, water temperature and food resources. However, anthropogenic

[14] Agostinho, A., Pelicice, F., & Gomes, L., 2008. Dams and the fish fauna of the Neotropical region: impacts and management related to diversity and fisheries**.** *Brazilian Journal of Biology*, 68(4): 1119-1132
[15] Moore, M. 2016. *HR2R- Freshwater and Estuary Fish Barrier Metrics Report*. Catchment Solutions.
[16] Moore, M. 2015. *Mackay- Whitsunday WQIP barriers to fish migration health metrics*. Catchments solutions.

factors such as man-made barriers to fish passage and habitat destruction often have a far greater impact in determining the amount of connected upstream habitat available to fish. One large low transparency barrier (barrier that is most difficult for fish to pass) close to the freshwater/estuarine interface has the potential to alter upstream fish communities (and particularly the number of diadromous fish species) more than any other naturally occurring factor. Thus, selected indicators were:

- **Barrier density** (average length of stream per barrier). A measure of the average length of stream available that is unimpeded by barriers, acting as an indication of connected habitat availability.
- **Proportion of stream to first barrier** (amount of stream to the first upstream barrier as a proportion of total stream length). A measure of the average proportion of stream available upstream of the interface between fresh and saline water (for freshwater) or the estuary mouth (for estuaries) that is unimpeded by any barriers.
- **Proportion of stream to first no/low 'passability' barrier** (amount of stream to the first upstream low passability barrier as a proportion of total stream length). A measure of the average proportion of stream available upstream of the interface between fresh and saline water (for freshwater) or the estuary mouth (for estuaries) that is unimpeded by barriers that do not allow fish to pass at any time (no passability) or rarely allow fish to pass (low passability), thus having the greatest impact on fish passage.

Because passage between the freshwater and estuarine environment is critical for the migration of both freshwater and estuarine species, the same three barrier indicators are used for the freshwater basins and estuaries. However, the extent within which barriers are assessed is dependent on whether reporting is for the freshwater or estuarine environment.

Flow

Flow is an important indicator category to include in the report card due to its relevance to ecosystem and waterway health and was selected for both freshwater and estuary waterways. Water resource development in the Mackay-Whitsunday Region including water extraction, supplementation and impoundments, affects the flow regime and due to the strong link between intact flow regimes and ecological health[17], freshwater flow was selected as an indicator to measure the change from natural conditions and associated impacts upon the freshwater and estuary ecosystems.

A range of ecological assets were identified that are sensitive to changed flow conditions from water allocation and management. Ten key measures of the annual flow regime that represented these flow conditions were selected as indicators:

- Cease to flow duration and frequency (linking to amphibians, riffles and waterholes);
- Low flows duration;
- Frequency and variation (linking to low flow spawning fish species, reptiles, amphibians, riffles and waterholes);
- Flow contributed during the driest six months;
- Medium flows duration and frequency (linking to riffles), and
- High flows duration and frequency (linking to fisheries production in estuaries).

[17] Bunn S.E., Arthington A.H. 2002. Basic principles and ecological consequences of altered flow regimes for aquatic biodiversity. Environmental Management 30: 492-507.

Further information relating to flow indicator selection is available in the 'Development of report card flow indicators for the Mackay-Whitsunday and Wet Tropics regions' report[18].

Riparian Extent

The extent of riparian vegetation was determined to be an important indicator to include in the report card for both freshwater and estuary environments. Riparian vegetation provides ecological functions, habitat provision and benefits to water quality including bank stabilisation and filtering of coarse sediment inputs into waterways as well as moderating stream water temperature from shading. The loss of riparian vegetation since pre-development was selected as the indicator. Indicators of condition were identified as aspirational indicators for inclusion in future reporting.

There is no overlap in riparian extent reporting between basin and estuaries. This is because assessments of riparian extent for freshwater basins do not encroach into estuarine areas. Similarly, assessments of riparian extent in estuaries extended from the river mouth upstream only to the limit of tidal influence, therefore do not encroach into the area assessed for freshwater basins.

Wetland Extent

Wetland extent was determined to be a relevant indicator to include within the freshwater basin assessments in the report card due to its importance in ecological function, provision of habitat for a range of species and benefits to water quality including sediment retention and nutrient cycling. The loss of vegetated freshwater swamp (palustrine) systems with more than 30% emergent vegetation cover since pre-development was selected as the indicator. Indicators of condition were identified as aspirational indicators for inclusion in future reporting.

Mangrove and Saltmarsh Extent

The extent of mangrove and saltmarsh vegetation was determined to be a critical indicator to include in the report card due to the importance of these systems in both estuarine ecological function and habitat provision, and its benefits to estuarine water quality and filtering of inputs to waterways. The loss of intertidal habitat categories (mangrove and saltmarsh) since pre-development was selected as the indicator. Indicators of condition were identified as aspirational indicators for inclusion in future reporting.

4.3.3. Coral (inshore and offshore marine environments)

Coral reefs are integral to the health of the marine waters in the Mackay-Whitsunday Region, providing critical roles for habitat, biodiversity and ecosystem processes. Coral is susceptible to a range of disturbances and impacts that occur in the Mackay-Whitsunday Region including many anthropogenic related stressors[19].

The coral indicators used in the Mackay-Whitsunday report card closely follow the indicators used in the GBR report card, which are drawn from two coral monitoring programs: the MMP and the LTMP. Inshore coral monitoring programs in the Region commissioned by NQBP for Abbot Point, Mackay and Hay Point,

[18] Stewart-Koster, B., Yu, B., Balcombe, S., Kennard, M., Marsh, N. 2018. Development of report card flow indicators for the Mackay-Whitsunday and Wet Tropics regions. Prepared by Griffith University and Truii Pty Ltd for Mackay-Whitsunday Healthy Rivers to Reef Partnership and Wet Tropics Healthy Waterways Partnership.

[19] Thompson, A., Costello, P., Davidson, J., Logan, M., Coleman, G., Gunn, K., Schaffelke, B., 2017, Marine Monitoring Program. Annual Report for inshore coral reef monitoring: 2015 to 2016. Report for the Great Barrier Reef Marine Park Authority, Great Barrier Reef Marine Park Authority, Townsville.133 pp.

have been designed such that they align with indicators described in the MMP and LTMP. Data from these four programs are used to report coral condition in the report card.

The indicators are integrated into an overall coral reef condition index. The coral index is formulated around the concept of community resilience[16]. The underlying assumption is that a 'resilient' community should show clear signs of recovery after inevitable acute disturbances, such as cyclones and coral bleaching events, or, in the absence of disturbance, maintain a high cover of corals and successful recruitment processes. While coral habitats are reported in both inshore and offshore environments, some coral indicators are relevant only for inshore environments. The coral indicators and their justification include:

- **Coral cover**: High coral cover is a desirable state for coral reefs, in providing essential ecological goods and services related to habitat complexity which promotes diverse reef communities, and from a purely aesthetic perspective with clear socio-economic value. In terms of reef resilience, although low cover may be expected following severe disturbance events, high cover implies a degree of resilience to any chronic pressures influencing the reef[20];
- **Macroalgae cover**: In contrast to coral cover, high macroalgal cover on coral reefs is widely accepted as representing a degraded state. As opportunistic colonisers, macroalgae generally out-compete corals, recovering more quickly following physical disturbances. Macroalgae have been documented to suppress coral fecundity, reduce recruitment of hard corals and diminish the capacity of growth among local coral communities[17]. Macroalgae are much less evident on offshore reefs, so this indicator is not calculated for reefs in the offshore reporting zone or included in the offshore reef condition index.
- **Rate of coral cover increase (change in coral)**: A second avenue for recovery of coral communities is the growth of corals during periods free from acute disturbance. Chronic pressures associated with water quality or temperature stress may suppress the rate that coral cover increases and indicate a lack of resilience[17];
- **Density of juvenile corals**: For coral communities to recover rapidly from disturbance events there must be adequate recruitment of new corals into the population. This indicator captures this important recruitment process by recording corals that have survived the early life stages[17]; and
- **Community composition:** This metric is used in the inshore zones only and compares the composition of hard coral communities with the expected community composition given each survey site's location along a gradient in water quality. Differences from expectation are interpreted in terms of water quality conditions.

4.3.4. Seagrass (inshore marine environments)

Seagrasses are a highly productive marine habitat and provide nursery habitat for economically-important fish and crustaceans, and food for grazing mega-herbivores like dugongs and sea turtles. Seagrasses also play a major role in the cycling of nutrients, stabilisation of sediments and improvement of water quality. Recent studies suggest they are one of the most efficient and powerful carbon sinks in

[20] Thompson A, Costello P, Davidson J, Logan M, Gunn K, Schaffelke B. 2016. Marine Monitoring Program. Annual Report for inshore coral reef monitoring: 2014 to 2015. Report for the Great Barrier Reef Marine Park Authority. Australian Institute of Marine Science, Townsville.133 pp.

the marine realm. Seagrasses are impacted by a range of anthropogenic stressors including direct disturbance from coastal development and dredging, coupled with indirect effects through changes in water quality due to sedimentation, pollution and eutrophication[21].

The seagrass indicators were selected based on existing monitoring programs that are likely to continue in the future. The monitoring of seagrass is conducted by two programs: (1) MMP through JCU for GBRMPA and used in the GBR report card, and (2) the Queensland Ports Seagrass Monitoring Program (QPSMP) by JCU for Queensland Ports Authorities (including NQBP).

The seagrass indicators selected for reporting from the MMP are described in detail by McKenzie et al. (2015)[22] include seagrass percentage cover, tissue nutrient status (C:N ratio), and reproductive effort (production of spathes, flowers and fruits per unit area). The indicators selected from the QPSMP are described in detail by York et al. (2016)[23] and include mean above-ground biomass, meadow area and species composition. Both programs produce condition scores for seagrass using the three indicators specific to the program. The reporting of seagrass is planned to undergo a revision which will investigate options for integrating results from the two programs to provide a single set of indicators. The revision is being conducted by RIMReP seagrass working group led by the GBRMPA.

4.3.5. Fish

Fish are integral to the ecosystem in all four waterway environments with many species moving between these environments. Pressures and impacts on fish assemblages are present in each waterway environment and include poor water quality, degraded habitat and fishing pressure. The Region's community also places great value on native fish species. Consequently, fish were selected as indicators of ecosystem health for all four environments.

The aquatic ecosystems of the Mackay-Whitsunday Region have been significantly impacted by the surrounding land use practices. Impacts include (but are not limited to) poor quality, degraded riparian and in-stream habitats, flow modification, and barriers to fish migration[24]. The cumulative impacts of these modifications have led to changes in the condition of the Region's fish communities, adversely impacting fish abundance, species richness, fish community composition and exacerbating the prevalence of pest fish species. Significantly, where in-stream and terrestrial habitats persist undisturbed, healthy fish populations remain[25].

The freshwater fish community condition indicator developed in 2015 included two ecological indicators: native species richness and pest fish abundance. The development of a fish 'assemblage indicator' describing the taxonomic integrity of fish communities has also been identified as particularly

[21] Short, F.T. and S. Wyllie-Echeverria. 1996. Natural and human-induced disturbance of seagrasses. Environmental Conservation 23:17-27.
[22] McKenzie, L. J., Collier, C. and Waycott, M. 2015. Reef Rescue Marine Monitoring Program - Inshore Seagrass, Annual Report for the sampling period 1st June 2012 – 31st May 2013. TropWATER, James Cook University, Cairns. 173pp.
[23] York, P.H., Davies, J.N. & Rasheed, M.A. 2014. Long-term seagrass monitoring in the Port of Mourilyan – 2013', JCU Publication, Centre for Tropical Water & Aquatic Ecosystem Research, Cairns, 36 pp.
[24] Folkers, A., Rohde, K., Delaney, K., & Flett, I. 2014. *Water Quality Improvement Plan 2014-2021 Mackay, Whitsunday, Isaac*. Reef Catchments Ltd, Mackay.
[25] Moore, M. 2015b. *Mackay-Whitsunday Region freshwater fish community health report*. Catchment Solutions.

important for improving our understanding of fish in freshwater throughout the Mackay-Whitsunday Region.

Identification of appropriate indicators and development of assessment methodology are required for progressing fish indicators for the estuary, inshore and offshore environments. Development of these indicators is planned to occur in collaboration with RIMReP and other regional report card Partnerships.

4.4. Scoring approach

Each indicator has a relevant benchmark that signals if it is in very good or very poor condition. For example, water quality benchmarks are set in reference to scheduled guideline values; for freshwater and estuary habitat and hydrology indicators, benchmarks are set in reference to their pre-development state. To produce a score, relevant current data for each indicator is compared to these benchmarks, using indicator-specific methodology. Scores for each indicator are then aggregated (generally by averaging) into categories, indices, and overall scores for each reporting zone.

The method for assigning scores to indicators was developed with the assistance of experts in the relevant fields. Specific considerations were given to:

- How the current state was assessed;
- The actual meaning of the final score; and
- Ensuring the report card is comparable with other report cards and programs.

4.4.1. Guidelines and benchmarks

The process of developing the scoring method incorporates identifying and applying the existing guidelines or benchmarks that have been scheduled, endorsed and recognised for each indicator. Guidelines and benchmarks have been developed for a wide range of metrics and include federal and state water quality guidelines, environment protection policies, water quality improvement plans and NRM plans. The report card scoring methods apply the most regionally relevant recognised guidelines and benchmarks for Mackay-Whitsunday, provide consistency with the existing programs, and maintain alignment with the approaches and practices applied in report cards for other regions and areas.

For the condition assessment of water quality the most recent and locally relevant scheduled guidelines will be applied. Scheduled guideline values do not necessarily reflect an intended condition of an unmodified waterway (i.e. 'high ecological value'), but a scale of increasing modification. Guideline values can reflect an intended condition of 'slightly disturbed', 'slightly to moderately disturbed', or 'moderately disturbed' waterways[26]. For 'highly disturbed' waterways, where a long timeframe is required for an improvement to a moderately disturbed condition, an interim guideline may be scheduled for these waterways. While such a guideline reflects an improvement in current condition, for report card purposes, guidelines for highly disturbed waters are not considered an appropriate benchmark for aquatic ecosystem health. Instead, such sites will be scored by comparison to the relevant moderately disturbed guideline value.

[26] Department of Environment and Heritage Protection (2013). *Environmental Protection (Water) Policy 2009. Pioneer River and Plane Creek Basins Environmental Values and Water Quality Objectives.* Queensland Government.

4.4.2. Scoring categories

Indicators are assessed against benchmarks relating to a desired and undesirable state, and then scored using ordinal categories. These categories are easy to understand and are aligned with other report cards and methods. The Mackay-Whitsunday report card uses the following five-point grading system: Very Good (A), Good (B), Moderate (C), Poor (D) and Very Poor (E). These grades are evenly distributed within a 0 to 100 scoring range, which reflects the GBR report card approach to scoring (Table 7).

Table 7. Grades and scoring range.

Grade	Scoring range
A: Very Good	81-100
B: Good	61 to <81
C: Moderate	41 to <61
D: Poor	21 to <41
E: Very Poor	0 to <21

To promote the effectiveness of the report card as a communication tool, descriptions of grades for environmental indicators have been developed. Descriptions that apply to indicators that measure condition of water quality and ecosystem health across all environments (basins, estuaries, inshore marine and offshore marine) are provided (Table 8) as well as descriptions that apply to indicators that measure habitat extent for basins and estuaries (Table 9).

Table 8. Descriptions of environmental condition for water quality and ecosystem health indicators.

Grade	Definition of environmental conditions
A: Very Good	Conditions frequently meet guidelines or reference values and the majority of critical habitats are intact.
B: Good	Conditions generally meet guidelines or reference values and most critical habitats are intact.
C: Moderate	Some conditions do not meet guidelines or reference values and critical habitats are usually impacted.
D: Poor	Conditions often do not meet guidelines or reference values and most critical habitats are impacted.
E: Very Poor	Most conditions do not meet guidelines or reference values and most critical habitats are severely impacted.

*Reference values are determined from reference sites that are subject to minimal/limited disturbance[27].

Table 9. Descriptions of habitat extent indicators for basins and estuaries (wetlands, riparian vegetation and mangrove and saltmarsh).

Grade	Habitat extent
A: Very Good	Habitat extent is at or very close to pre-development levels
B: Good	Habitat extent is close to pre-development levels
C: Moderate	Habitat extent is moderately departed from pre-development levels
D: Poor	Habitat extent is strongly departed from pre-development levels
E: Very Poor	Habitat extent is severely departed from pre-development levels

[27] DEHP (Department of Environment and Heritage Protection) 2009. Queensland Water Quality Guidelines, Version 3, ISBN 978-0-9806986-0-2.

Decision rules have been developed to define the minimum proportion of information required to generate aggregated scores for indicators and indicator categories. For example ≥ 50% of indicators are required to generate the indicator category score, and ≥ 60% of indicator categories are required to generate the Index score.

4.4.3. Confidence measures

The report card also qualitatively assesses data confidence associated with each indicator, and thereby confidence in indicator scores. Each indicator in each reporting zone is assessed individually (i.e. each indicator in the five basins, eight estuaries, four inshore marine zones and one offshore marine zone).

The approach used to assess confidence was developed by the GBR report card. It involves considering five broad criteria: maturity of methods used, validation, representativeness, directness and measured error. To assess confidence criteria, expert opinion is sourced during the review of the results each year. This ensures the report card results accurately represent the scientific understanding and knowledge of the Region in that reporting year.

The Mackay-Whitsunday report card considers spatial and temporal representativeness as the most important criteria when assessing confidence at a regional level, so assigns the most weight to this criteria, to best reflect regional confidence of data and scores.

4.5. Condition reporting

The following subsections present the indicators that will determine the score for each environmental reporting zone. The tables provide information on which indicators are aggregated into categories and indices and on the frequency of reporting for each indicator. Importantly, gaps or low confidence in indicators that existed in the 2016 report card, are highlighted to identify the improvements required for 2017 – 2022 report cards.

An indicator gap can mean either there is a lack of available data to produce a report card score, or there may be data available, but the most appropriate way to report on the condition of the indicator/s has not yet been determined (for example, marine fish). Low confidence in an indicator is primarily driven by a lack of representativeness in the data used to produce an indicator score. This can be either temporal (for example, not enough samples collected throughout the year) and/or spatial (for example, not enough samples collected throughout the Region).

Coasters are also provided as an example of how information will be presented in report cards: highlighting the aggregated indicator category scores, index scores and overall scores for each environmental reporting zone.

Based on the availability of data, some indicators, indicator categories or indices may not be reported at this time (and will appear grey in coasters), with the aim to infill them in the future.

It should be noted that any indicators that are not assessed annually will be presented in every report card, with annotated information on the date limitations or constraints of the data. These will act as “constants” in the report card scores. These indicators are monitored less frequently, reflecting that they change over longer periods of time.

4.5.1. Freshwater basins

The report card presents a score for the environmental condition of five freshwater basins. The basin scores are based on three indices (water quality, habitat and hydrology, and fish) broken down into the indicator categories and indicators shown in Table 10 and Figure 7. Five-year program objectives to improve freshwater basin condition reporting is provided in
Table 11.

Table 10. Indicators used to determine a score for the environmental condition of each freshwater basin. Information on the status of indicators for each basin, as in the 2016 report card, is included: where an indicator is considered 'complete' in a basin, compared to where there are data gaps (□) and where representativeness provides low confidence in scores (○).

Index	Indicators categories:	Indicator	Frequency of reporting	Don	Proserpine	O'Connell	Pioneer	Plane
Water quality	Sediment	TSS	Annually	□	□	○	○	○
	Nutrients	DIN, FRP	Annually	□	□	○	○	○
	Pesticides	ms-PAF	Annually	□	□	○	○	○
Habitat & Hydrology	In-stream habitat modification	Fish barriers; Impoundment Length	4 yearly	○	Complete			
	Flow	10 indicators	Annually	□	□	□	□	□
	Riparian ground cover	Extent	4 yearly	Complete				
	Freshwater wetlands	Extent	4 yearly	Complete				
Fish	Fish	Native fish, pest fish, assemblage	3 yearly	□	□	Complete (native and pest fish only)		

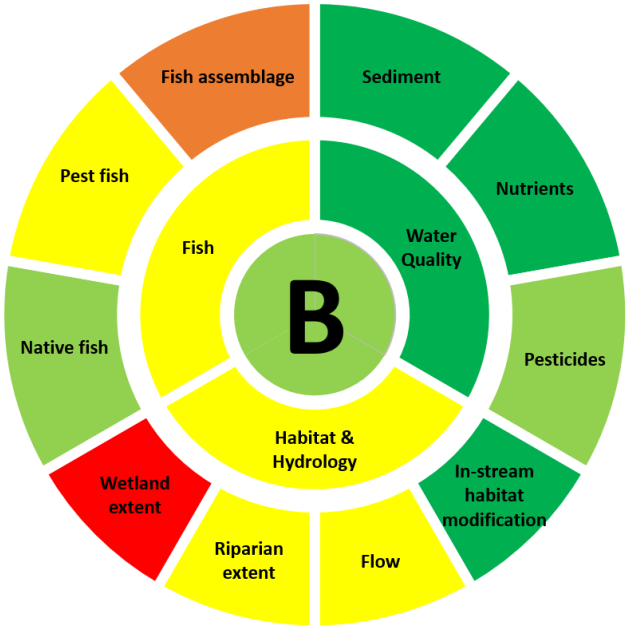

Figure 7. Example coaster and indicators for the five freshwater basins with grades represented by colours. Very Poor | Poor | Moderate | Good | Very Good | Not Available

Table 11. Program objectives for freshwater basin environmental indicators 2017 – 2022.

Water quality ▪ *Fill indicator gaps* for water quality in the Don and Proserpine basins by incorporating data from Great Barrier Reef Catchment Loads Program (GBRCLMP) sites established at the Don River and Proserpine River. ▪ *Increase confidence* in the water quality reporting in the Plane basin by incorporating data from the GBRCLMP site established at the Plane Creek. ▪ *Increase confidence* in water quality reporting by exploring the expansion of monitoring outside of GBRCLMP sites and initiate monitoring expansion where feasible. ▪ *Incorporate improvements* in information by including more pesticides into ms-PAF reporting when available.
Habitat and Hydrology ▪ *Fill indicator gap* for freshwater flow in the five basins and recommend any improvements to information (i.e. gauging stations or models). ▪ *Increase confidence* in fish barrier reporting in the Don basin. ▪ *Incorporate improvements* in information such as changes in satellites used to produce spatial imaging data layers and consider impacts that may occur to scores as a result. ▪ Explore inclusion of invasive weed indicator.
Fish ▪ *Fill indicator gaps* regarding fish in freshwaters throughout the Proserpine and Don basins. ▪ *Incorporate improvements* in freshwater fish information including new recommended indicators ('assemblage' indicator as seen in the coaster in Figure 7) and improved model/s.

4.5.3. Estuaries

The report card presents a score for the environmental condition of eight estuaries. Each estuary score will be broken down into three indices (water quality, habitat and hydrology, and fish), determined using the indicator categories and indicators shown in Table 12 and Figure 8. Five-year program objectives for Estuaries environmental indicator is provided in Table 13.

Table 12. Indicators used to determine a score for the environmental condition of each estuary. Information on the status of indicators for each estuary, as in the 2016 report card, is included: where an indicator is considered 'complete' in an estuary, compared to where there are data gaps (□) and where representativeness provides low confidence in scores (◯).

Index	Indicators categories	Indicator	Frequency of reporting	Gregory	O'Connell	St Helens/Murray	Vines	Sandy	Plane	Rocky Dam	Carmila
Water quality	Phys-chem	Turbidity; DO	Annually	Complete							
	Nutrients	DIN (constructed from NOx and ammonia); FRP	Annually	Complete							
	Chlorophyll *a*	Chlorophyll *a*	Annually	Complete							
	Pesticides	ms-PAF	Annually	○	○	○	○	○	○	○	○
Habitat & Hydrology	Flow	10 indicators	Annually	□	□	□	□	□	□	□	□
	Riparian vegetation	Extent	4 yearly	Complete							
	Mangrove and saltmarsh	Extent	4 yearly	Complete							
	Fish barriers	3 indictors	4 yearly	Complete							
Fish	Fish	TBC	Annually	□	□	□	□	□	□	□	□

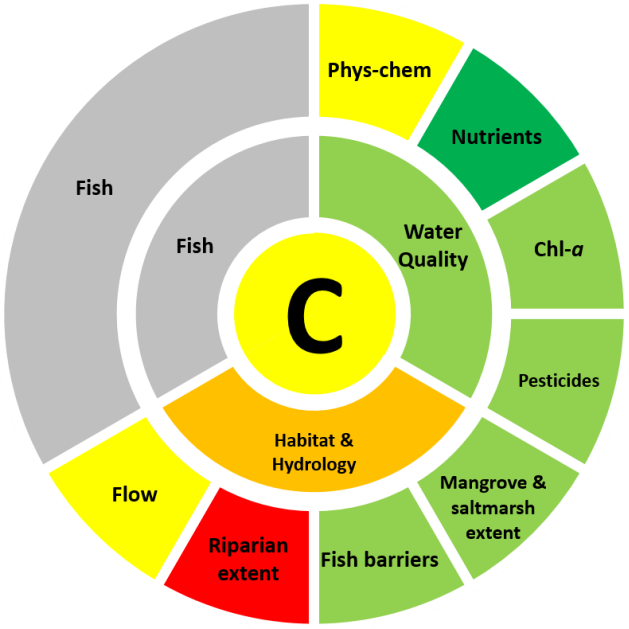

Figure 8. Example coaster and indicators for the eight estuaries with grades represented by colours. ■ Very Poor | ■ Poor | ■ Moderate | ■ Good | ■ Very Good | ■ Not Available

Table 13. Program objectives for estuary environmental indicators 2017 – 2022.

Water quality • *Increase confidence* in pesticide reporting by increasing temporal sampling during the wet season. This will include moving to report on pesticide data from Sandy Creek GBRCLMP and continuing to report pesticide data from the O'Connell GBRCLMP site for these estuaries. Moving to weekly sampling of pesticides in the wet season for all other estuaries is the aspiration however less frequent monitoring (two to three times per month) is more likely due to funding. • *Incorporate improvements* in information by including more pesticides into ms-PAF reporting when available. • *Improve confidence* in water quality reporting by considering the validity of eReefs modelling, if available.
Habitat and Hydrology • *Fill indicator gaps* for flow. This will require recommending improvements to information (gauging stations or models) and establishment of gauging stations upstream of Vines and Rocky Dam Creek estuaries and then incorporating any new data into reporting upon establishment of gauging stations.
Fish • *Fill data gaps* regarding fish in estuaries as directed by RIMReP or by undertaking scoping study for indicators and methods for assessment and initiating monitoring and/or reporting if feasible.

4.5.4. Inshore marine

The report will present a score for the environmental condition of the inshore marine area (including enclosed coastal and open coastal waters as well as some mid-shelf waters) differentiated into four reporting zones. Each score will be broken into four indices (water quality, coral, seagrass and fish), determined using the indicator categories and indicators shown in Table 14 and Figure 9. Reporting seagrass at the inshore zones requires a combined seagrass index for the major seagrass monitoring programs (Queensland Ports and MMP). The 2017 report card will use an interim display approach as described by Carter et al. (2016)[28], as approved by the Independent Science Panel. An integrated approach is being developed through RIMReP and will be available for future report cards. Program objectives for 2017 – 2022 for inshore marine environmental indicators is provided in Table 15.

Table 14. Indicators used to determine a score for the environmental condition of each inshore zone. Information on the status of indicators for each inshore zone, as in the 2016 report card, is included: where an indicator is considered 'complete' in a zone, compared to where there are data gaps (□) and where representativeness provides low confidence in scores (◯).

Index	Indicators categories: indicators	Indicator	Frequency of reporting	Northern	Whitsunday	Central	Southern
Water quality	Nutrients	NOx, PN and PP	Annually	□	Complete		□
	Chlorophyll-*a*	Chlorophyll-*a*	Annually	Complete			□
	Water clarity	TSS; secchi; turbidity	Annually	Complete			□
	Pesticides	PSII-HEq (transition to ms-PAF)	Annually	o	□	Comp.	□
Coral	Composition	Composition	Annually*	□	Comp.	□	□
	Coral change	Coral change	Annually*	□	Complete		□
	Coral juvenile density	Coral juvenile density	Annually*	Complete			□
	Macroalgae cover	Macroalgae cover	Annually*	Complete			□
	Coral cover	Coral cover	Annually*	Complete			□
Seagrass	Abundance	(% cover/biomass^)	Annually^	Interim approach complete°			□
	Reproductive effort	Reproductive effort	Annually	Interim approach complete°			□
	Tissue nutrient status	Tissue nutrient status	Annually	Interim approach complete°			□
	Meadow area	Meadow area^	Annually^	Interim approach complete°			□
	Species composition	Species composition^	Annually^	Interim approach complete°			□
Fish	Fish indicators	TBC	Annually	□	□	□	□

*Each AIMS coral survey site is monitored every two years, with monitoring of sites alternating between the years, thus coral condition is reported as a two-year rolling mean based on the most recent data for all sites.

^Indicators are developed from data collected by the Queensland Ports Seagrass Monitoring Program (QPSMP).

° Interim approach does not require all indicators to be reported in every zone. Completeness indicators that a seagrass score is provided for each zone using either MMP or Ports data, or both.

[28] Carter, A., Rasheed, M., McKenzie, L., & Coles, R. 2016b. *An interim approach to integrate seagrass monitoring results for NRM regional report cards. A case study using the Wet Tropics NRM region.* Seagrass Ecology Group-James Cook University. Centre for Tropical Water & Aquatic Ecosystem Research, Cairns

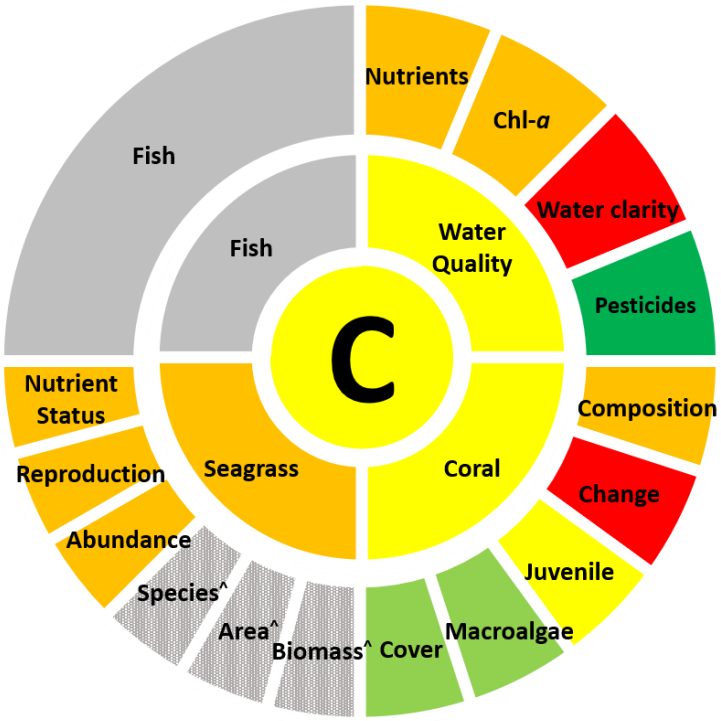

Figure 9. Example coaster and indicators for the four inshore zones with grades represented by colours. Note: where indicated (^) seagrass indicators are developed from data collected by the Queensland Ports Seagrass Monitoring Program (QPSMP). ■ Very Poor | ■ Poor | ■ Moderate | ■ Good | ■ Very Good | ■ Not Available

Table 15. Program objectives for inshore marine environmental indicators 2017 – 2022.

Water quality • *Fill indicator gaps* in the southern zone for water quality indicators by establishing a long-term monitoring program in the Region, building on initial monitoring from 2016-17 period. This includes establishment of passive samplers. • *Fill indicator gaps* in the northern zone for water quality indicators. • *Increase confidence* in pesticide reporting by including passive sampling with existing monitoring in the northern zone. • *Incorporate improvements* in pesticide reporting by using ms-PAF instead of PSII HEq, when available. • *Improve confidence* in water quality reporting by considering the validity of eReefs modelling, if available.
Coral • *Fill indicator gaps* in the southern zone for coral indicators by establishing a long-term monitoring program in the Region, building on reconnaissance surveys in the 2016-17 period. This will not include a community composition indicator. • *Incorporate improvements* in coral reporting across existing programs by resolving issues associated with different methodology for estimating benthic cover. • *Incorporate improvements* in coral reporting by considering the validity of the coral community indicator.
Seagrass • *Fill indicator gaps* in the southern zone for seagrass indicators by establishing a long-term monitoring program in the Region, building on reconnaissance surveys in the 2016-17 period.
Fish • *Fill indicator gaps* in inshore zones as directed by RIMReP or by undertaking scoping study for indicators for assessment and initiating monitoring and/or reporting if feasible.

4.5.5. Offshore marine

The report card presents one score for the environmental condition of the offshore marine area. The score will be broken down into three indices (water quality, coral and fish), determined using the indicator categories and indicators shown in Table 16 and Figure 10. Five-year program objectives for the offshore marine environmental indicator is provided in Table 17.

Table 16. Indicators used to determine a score for the environmental condition of the offshore marine environment. Information on the status of indicators for the offshore zone, as in the 2016 report card, is included: where an indicator is considered 'complete', compared to where there are data gaps (□) and where representativeness provides low confidence in scores (◯).

Index	Indicator categories	Indicator	Frequency of reporting	Offshore
Water quality	Chlorophyll a	Chlorophyll a	Annually	Complete
	Sediment	TSS	Annually	Complete
Coral	Coral change	Coral change	Annually*	Complete
	Coral juvenile density	Coral juvenile density	Annually*	Complete
	Coral cover	Coral cover	Annually*	Complete
Fish	Fish indicators	TBC	Annually	□

*Each AIMS coral survey site is monitored every two years, with monitoring of sites alternating between the years, thus coral condition is reported as a two-year rolling mean based on the most recent data for all sites.

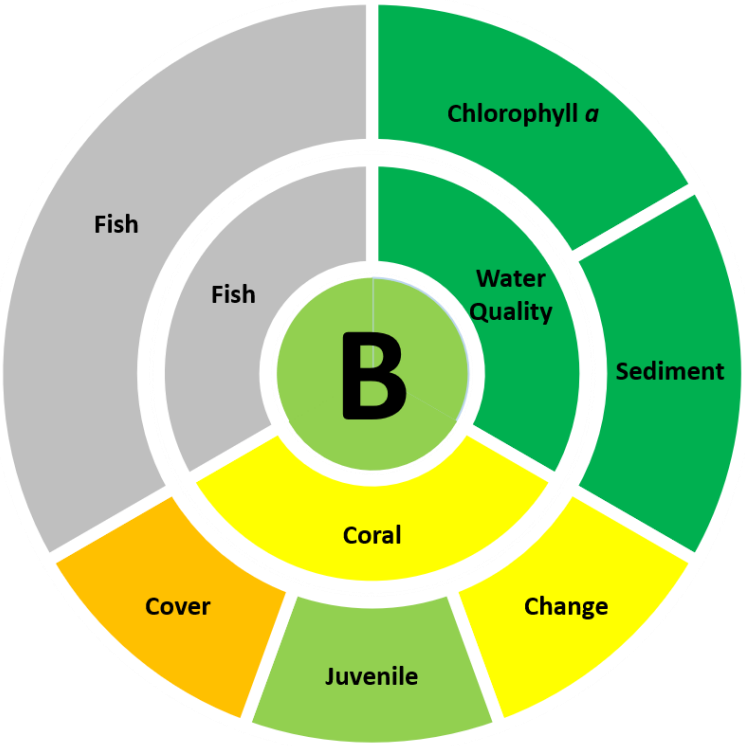

Figure 10. Example coaster and indicators for the offshore marine zone. ■ Very Poor | ■ Poor | ■ Moderate | ■ Good | ■ Very Good | ■ Not Available.

Table 17. Program objectives for offshore marine environmental indicators 2017 – 2022.

Water quality • *Continue* with current approach to reporting • *Improve confidence* in water quality reporting by considering the validity of eReefs modelling, if available.
Coral • *Continue* with current approach to reporting
Fish • *Fill indicator gaps* in offshore zone as directed by RIMReP or by undertaking scoping study for indicators and methods for assessment and initiating monitoring and/or reporting if feasible.

5. Human dimensions

5.1. Stewardship reporting

Stewardship is included in the report card and is defined as: 'responsible and sustainable use and protection of water resources, waterways and catchments to enhance the social, cultural, environmental, and economic values of the Region'. Assessing stewardship provides information on the management efforts that are implemented by different sectors/industries within the Region that provide benefits to ecosystems, such as improved land management practices. While management efforts within a sector/industry are commonly influenced by regulation, voluntary and innovative actions that exceed requirements of regulation are a major focus of the stewardship assessments for the report card.

Stewardship activities that are assessed have a direct link to the water quality in the Region (albeit, not necessarily immediate). Stewardship reporting can be used to demonstrate how on-ground activities (*responses* undertaken by landholders in the Region), impact water quality (the *state* of the natural environment).

Stewardship reporting assists in meeting various Partnership and report card objectives. In particular, the stewardship information aids the environmental report card objective to report on the *pressures* acting upon the water quality and ecosystem health in the Region's waterways. Additionally, reporting on the stewardship levels assists with the following Partnership objectives:

- Communicate information effectively and at a relevant scale to the broader community on waterway health issues with scientific integrity, independence and transparency;
- Inform planning and delivery activities of the Partners in response to the findings of the report card; and,
- Utilise the stewardship assessments in the report cards to promote Partners' activities, while drawing on the findings of the report card to identify enhanced or additional management actions.

In the report card, the extent that each sector operates under different environmental management practice levels is used to report stewardship. Environmental management practice levels are defined by available water quality risk frameworks or management frameworks. Such frameworks are currently available for grazing, sugarcane, horticulture, aquaculture, ports, industry, tourism and urban industries. Assessment of stewardship of the fishing industry and community is intended for inclusion in future report cards. These frameworks form the basis of reporting.

5.1.1. Agricultural stewardship

Within the agricultural industry, grazing, sugarcane and horticulture stewardship is reported as the area (%) under different management practice levels and displayed graphically (Figure 11). This is assessed using the approach undertaken for reporting on management practice adoption in the Paddock to Reef program[29].

[29] https://www.reefplan.qld.gov.au/measuring-success/paddock-to-reef/

New baselines for agricultural stewardship will be used from the 2018 report card onwards. While these new baselines represent a better understanding of the true area of land under different management practices, this may mean that stewardship in some agricultural industries will appear to have decreased since previous report cards. Communication to explain any changes like this will be important at, and following, the release of these report cards.

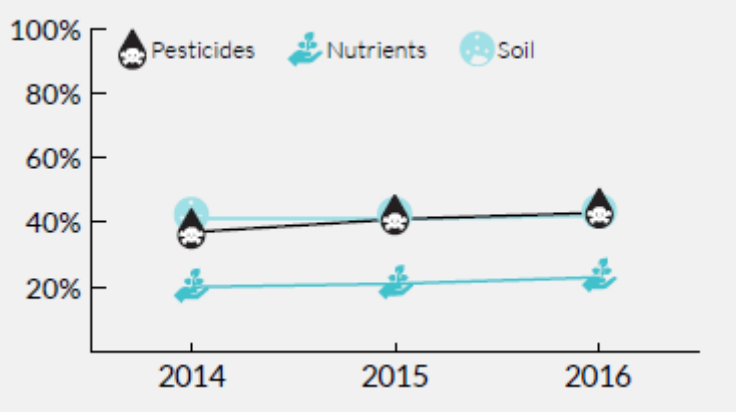

Figure 11. Example of stewardship display for agricultural industries.

5.2. Non-agricultural stewardship

Stewardship in the remaining non-agriculture sectors/industries is reported on by assessing the percent of the sector/industry that is operating at different management practice levels relating to management practice frameworks specific to each industry. The approach to reporting non-agricultural stewardship was reviewed in 2017[30]. One of the recommendations of this review was to review the framework design features for each sector/industry. Review of the framework in the urban sector began in 2018. Other sectors/industries will be systematically reviewed in subsequent years.

Reporting will continue to use the existing frameworks and approaches until review recommendations are available to be incorporated into subsequent report cards. Development of stewardship frameworks and reporting for the community sector and fisheries industry have been identified as important additions to the report card.

5.3. Cultural Heritage reporting

In 2015 the Gladstone Healthy Harbour Partnership (GHHP) and the Gidarjil Land and Sea Rangers pioneered an innovative new approach to cultural heritage monitoring through the development of cultural heritage indicators, an Indigenous Cultural Heritage Database and an annual sites monitoring program.

The Partnership followed a similar approach to monitor indigenous cultural heritage relevant to the Region's waterways for the 2015 report card. The existing Mackay-Whitsunday-Isaac TORG was instrumental in progressing this indicator. Working with external consultants, the TORG recorded and

[30] Chandler, F., Stevens, L., and Spencer, M. (2017). Independent review of non-agricultural stewardship frameworks. Alluvium.

reported on the condition of significant cultural heritage places through on-ground assessment and geographic information system data. Three areas in the Region were reported in the 2015 report card: Hook, Whitsunday and South Molle Islands, Cape Hillsborough and St Helens.

The Partnership will again work with the TORG in 2018 to re-visit sites assessed in the 2015 report card and to expand indigenous cultural heritage reporting across the Region.

It is intended that indigenous cultural heritage will be reassessed every three to five years, however outcomes from RIMReP may influence future reporting. The Partnership is committed to sharing information with RIMReP, where acceptable with the TORG, to ensure the approach used in the Mackay-Whitsunday Region is incorporated into RIMReP recommendations related to indigenous cultural heritage reporting.

The reporting of European cultural heritage will be directed entirely by available RIMReP outcomes.

5.4. Social and Economic reporting

In the 2014 pilot report card an assessment of social and economic indicators was undertaken. Data for this assessment was solely drawn from the GBR Social and Economic Long-Term Monitoring Program (SELTMP) including the National Environmental Research Program (NERP) 10.1 and 10.2 projects (which also largely aligns with the GHHP report card). These studies include a multitude of survey data which was extracted for the relevant post codes in the Mackay-Whitsunday reporting Region. However, this only presented information relevant to the GBR World Heritage Area and was not relevant to freshwater environments. For the 2015 and 2016 report cards, contextual data from the pilot report card was reported.

A repeat of SELTMP was initiated in mid-2017, which will include consideration of freshwater systems for the first time. This new data will be used in the 2018 report card and will provide an updated and more complete understanding of the social indicators as they relate to waterways in the Mackay-Whitsunday Region. Future reporting of social data will be directed by RIMReP.

Economic data relating to major industries reported in stewardship assessments will be presented as contextual information. Data will be drawn from the latest national census, the Australian Bureau of Statistics and other data sources. Future changes to reporting of economic data will be directed by RIMReP.

6. Program management

6.1. Future program

In the first three years of report card development, the reporting schedule has not always been aligned across all indicators (Table 18). With more stability in the report card and monitoring programs, along with the move to an earlier report card release time, the schedule for indicator reporting will become aligned from the 2018 report card (Table 18).

Table 18. Schedule for reporting previous and future report cards and associated data. Shades of blue help to identify where data is repeated for indicators reported at frequencies >1 year and thus when new data is reported for these indicators. B-C indicates that scores can be back-calculated.

Report card name		2014	2015	2016	2017	2018	2019	2020	2021	2022
Release year		2015	2016	2017	2018	2019	2020	2021	2022	2023
Release month		October	October	October		TBC	TBC	TBC	TBC	TBC

Indicators and data collection	Years	2014	2015	2016	2017	2018	2019	2020	2021	2022
Water quality, coral, seagrass	1	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Riparian (FW and EST)	4	2013-14	2013-14	2013-14	2013-14	2017-18	2017-18	2017-18	2017-18	2021-22
Mangrove/Saltmarsh (EST)	4	2013-14	2013-14	2013-14	2013-14	2017-18	2017-18	2017-18	2017-18	2021-22
Wetland (FW)	4	2013-14	2013-14	2013-14	2013-14	2017-18	2017-18	2017-18	2017-18	2021-22
Impoundment (FW)	4	2013-14	2013-14	2013-14	2013-14	2017-18	2017-18	2017-18	2017-18	2021-22
Fish barriers (FW/EST)	4		2014-15	2014-15	2014-15	2014-15	2018-19	2018-19	2018-19	2018-19
Flow (FW/EST)	1	B-C	B-C	B-C	B-C	2017-18	2018-19	2019-20	2020-21	2021-22
Fish (FW)	3		2015-16	2015-16	2015-16	2017-18	2017-18	2017-18	2020-21	2020-21
Indigenous cultural heritage	3?		2015-16			2017-18			2020-21	
Social	3-4?	2013-14				2017-18				
Agricultural stewardship	1	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Non-agricultural stewardship	1	2014-15	2015-16	2016-17		2017-18	2018-19	2019-20	2020-21	2021-22

The Partnership strives for continued improvement of report cards by:

- Filling gaps in existing indicators;
- Improving confidence in the representativeness of monitoring programs;
- Continuing to collaborate with different programs to better align methods; and,
- To work towards developing aspirational indicators for future reporting.

To improve the report card, operational objectives to be achieved by the 2017 – 2022 report cards have been identified for each of the environmental indices in freshwater basins (Table 19), estuaries (Table 20), inshore marine (Table 21) and offshore marine (Table 22) environments. These operational objectives are based on the indicator gaps and low confidence in representativeness highlighted in earlier sections. The year that an operational objective has been identified to be achieved by reflects a balance between the relative TWG priorities relating to environmental indicator improvements and priority projects relating to these indicators identified by the Partnership (Appendix A). Appendix B

outlines specific details for environmental indicators for the 2017 – 2022 report cards with a focus on the anticipated approach for indicator improvements, where relevant.

The Partnership's intention to begin reporting against regional targets associated with indicators, such that the report card will transition to include progress towards long-term targets, is also included as an operational objective for future report cards (Table 23). Operational objectives for human dimensions reporting are also identified in Table 23 for the 2017 – 2022 report cards. Importantly, operational objectives may be achieved by earlier report cards than those identified in each of these tables.

Achieving operational objectives for the 2017 – 2022 report cards is dependent on maintenance of existing Partnership funding and additional project-specific funding either from Partners or external stakeholders. Where operational objectives are likely to be outside of the anticipated budget of the Partnership and additional funding is likely required, these are identified as 'pending funding availability' in the Tables.

6.1.1. eReefs

Improving confidence in the representativeness of monitoring programs is a high priority for future report cards. However, given the scale of the Mackay-Whitsunday Region, using *in situ* water quality monitoring data alone to measure and report water quality at a reasonable frequency, may not be practical. Alternative options for improving the representativeness of water quality monitoring programs will be explored over the 2017 – 2022 period. This will include consideration of eReefs.

The eReefs research project is a collaboration between the Great Barrier Reef Foundation, CSIRO, the Australian Institute of Marine Science, Bureau of Meteorology and Queensland Government. The eReefs system models a wide range of marine variables covering physical properties (temperature, current, light penetration) as well as biogeochemical parameters (such as the concentration of nutrients, sediments, plankton and chlorophyll-a). Three-dimensional model outputs are generated for the entire Great Barrier Reef lagoon (from South East Queensland to Torres Strait) at various resolutions (1km and 4km) on a daily basis. It provides information on physical processes, sediment transport, biogeochemistry and ocean colour. eReefs relies on data from wave, atmospheric and global circulation models as inputs, but also on river flow and catchment pollutant load data.

In 2017, the eReefs deterministic modelling framework was used in conjunction with the *in situ* information collected in the Marine Monitoring Program and satellite observations to extrapolate water quality across the entire Great Barrier Reef. The model was used to generate the marine water quality metric used in the 2016 GBR report card.

Based on this application of eReefs, operational objectives to "Improve confidence by exploring inclusion of eReefs, if available" for water quality in the estuaries and marine systems have been outlined in Table 19 and Table 20. Before these objectives can be achieved, it will need to be determined whether the eReefs system is suitable for use in the Mackay-Whitsunday report card, and, if it is suitable, how it would be applied and whether the Partnership would approve the use of modelled data in reporting.

Table 19. Operational objectives for environmental indicators in freshwater basins for report cards 2017 - 2022. Objectives are expected to be achieved by the listed year (pending funding availability), but may be achieved earlier. Grey shaded cells show a reporting gap across the entire Region for the relevant indicator.

Report card name	2017	2018	2019	2020	2021	2022
Data reported	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22
Release date	Late 2018	Mid 2019	Mid 2020	Mid 2021	Mid 2022	Mid 2023
Water quality						
Sediment and nutrients	Maintain reporting.	Fill gap in Don and improve confidence in O'Connell and Plane basin (CLMP data).	Fill gap in Proserpine and explore expansion of monitoring (initiate expansion if feasible).	Improve confidence by initiating expansion of monitoring.	Improve confidence by incorporating modelling where feasible.	All basins reported with moderate to high confidence.
Pesticides (ms-PAF)	Maintain reporting.	Maintain reporting.	Improve confidence by incorporating more pesticides in ms-PAF, when available.	Maintain reporting.	Maintain reporting.	Maintain reporting.
Habitat and hydrology						
Riparian extent	Repeat 2013-14 data.	Report new 2017-18 data, which incorporates improvements in information.	Repeat 2017-18 data.	Repeat 2017-18 data.	Repeat 2017-18 data.	Report new 2021-22 data.
Wetland extent	Repeat 2013-14 data.	Report new 2017-18 data, which incorporates improvements in information.	Repeat 2017-18 data.	Repeat 2017-18 data.	Repeat 2017-18 data.	Report new 2021-22 data.
Fish barriers	Repeat 2014-15 data.	Repeat 2014-15 data.	Improve confidence in Don, report new 2018-19 data.	Report new 2018-19 data.	Report new 2018-19 data.	Report new 2018-19 data.
Impoundment	Repeat 2013-14 data.	Report new 2017-18 data.	Report new 2017-18 data.	Report new 2017-18 data.	Report new 2017-18 data.	Report new 2021-22 data.
Flow	Reporting gap.	Fill gap for flow.	Maintain reporting and recommend any expansion to information (i.e. models or gauging stations).	Maintain reporting.	Maintain reporting.	Maintain reporting.
Fish community						
Pest fish abundance	Repeat 2015-16 data.	Fill gap in Proserpine (gap remains in Don).	Repeat 2017-18 data.	Repeat 2017-18 data.	Fill gap in Don.	Repeat 2020-21 data.
Native fish richness	Repeat 2015-16 data.	Fill gap in Proserpine (gap remains in Don).	Repeat 2017-18 data.	Repeat 2017-18 data.	Fill gap in Don.	Repeat 2020-21 data.
Fish assemblage	Reporting gap.	Improved model (gap remains in Don).	Repeat 2017-18 data. Report assemblage indicator, if available.	Repeat 2017-18 data. Report assemblage indicator, if available.	Report assemblage. Fill gap in Don.	Repeat 2020-21 data.

Table 20. Operational objectives for environmental indicators in estuaries for report cards 2017 - 2022. Objectives are expected to be achieved by the listed year (pending funding availability), but may be achieved earlier. Grey shaded cells show a reporting gap across the entire Region for the relevant indicator. *RIMReP outcomes my impact on some objectives.

Report card name	2017	2018	2019	2020	2021	2022
Data reported	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22
Release date	Late 2018	Mid 2019	Mid 2020	Mid 2021	Mid 2022	Mid 2023
Water quality						
Nutrients, phys-chem and chlorophyll-a	Maintain reporting.	Explore additional existing data sets, incorporate these with current reporting, if available.	Maintain reporting.	Maintain reporting.	Maintain reporting.	Improve confidence by exploring inclusion of eReefs, if available.
Pesticides (ms-PAF)	Maintain reporting.	Reporting gap.	Improve confidence by including CLMP data for Sandy Creek estuary and, ideally, weekly samples in other estuaries. Incorporate more pesticides in ms-PAF, when available.	Maintain reporting.	Maintain reporting.	Improve confidence by exploring inclusion of eReefs, if available.
Habitat and hydrology						
Riparian extent	Repeat 2013-14 data.	Report new 2017-18 data.	Repeat 2017-18 data.	Repeat 2017-18 data.	Repeat 2017-18 data.	Report new 2021 data.
Mangrove and saltmarsh extent	Repeat 2013-14 data.	Report new 2017-18 data.	Repeat 2017-18 data.	Repeat 2017-18 data.	Repeat 2017-18 data.	Report new 2021 data.
Fish barriers	Repeat 2014-15 data.	Maintain reporting.	Report new 2018-19 data.	Report new 2018-19 data.	Report new 2018-19 data.	Report new 2018-19 data.
Flow	Reporting gap	Fill gap for flow (gap remains in Vines and Rocky Dam). Recommend expansion of information (i.e. models or gauging stations).	Maintain reporting.	Maintain reporting.	Fill gap for flow in Vines and Rocky Dam, if available.	Maintain reporting.
Fish community						
Fish indicators	Reporting gap.	Reporting gap.	Scope estuary fish indicators.	RIMReP directed* or develop method for fish indicators based on scoping study.	RIMReP directed* or implement pilot data collection/reporting program, if feasible.	RIMReP directed* or report fish and review/continue pilot program.

Table 21. Operational objectives for environmental indicators in inshore marine zones for report cards 2017 - 2022. Objectives are expected to be achieved by the listed year (pending funding availability), but may be achieved earlier. Grey shaded cells show a reporting gap across the entire Region for the relevant indicator. *RIMReP outcomes my impact on some objectives.

Report card name	2017	2018	2019	2020	2021	2022
Data reported	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22
Release date	Late 2018	Mid 2019	Mid 2020	Mid 2021	Mid 2022	Mid 2023
Water quality inshore						
Water clarity, nutrients and chlorophyll-a	Maintain reporting.	Fill gap in Southern inshore zone and establish long-term monitoring.	Fill gap in Northern inshore zone.	Maintain reporting.	Maintain reporting.	Improve confidence by exploring inclusion of citizen science and eReefs, if available.
Pesticides (PSII-HEq then ms-PAF)	Maintain reporting.	Maintain reporting.	Incorporate improvements in reporting by using ms-PAF, if available.	Fill gaps in southern zones and improve confidence in northern zone (include passive sampler data).	Maintain reporting.	Improve confidence by exploring inclusion of eReefs, if available.
Coral inshore						
Coral cover, juvenile cover and macroalgae	Maintain reporting.	Resolve methodology differences between MMP and Ports.	Fill gap in southern zone (multiple sites).	Maintain reporting.	Maintain reporting.	Maintain reporting.
Coral change	Fill data gap in northern zone.	Resolve methodology differences between MMP and Ports.	Fill gap in southern zone (one site).	Improve confidence in southern zone (multiple sites).	Maintain reporting.	Maintain reporting.
Community composition	Maintain reporting.	Resolve methodology differences between MMP and Ports. Consider validity of indicator.	If valid, fill gap in central zone.	If valid, fill gap in northern zone.	Maintain reporting.	Maintain reporting.
Seagrass						
Seagrass (Ports and MMP)	Maintain reporting.	Maintain reporting. Establish long-term monitoring in southern zone.	Maintain reporting.	Maintain reporting.	Maintain reporting.	Fill gap in Southern zone.
Fish community						
Fish indicators	Reporting gap.	Reporting gap.	Scope fish indicators.	RIMReP directed* or develop method for fish indicators based on scoping study.	RIMReP directed* or implement pilot data collection/reporting program, if feasible.	RIMReP directed* or report fish and review/continue pilot program.

Table 22. Operational objectives for environmental indicators in the offshore marine zone for report cards 2017 - 2022. Objectives are expected to be achieved by the listed year (pending funding availability), but may be achieved earlier. Grey shaded cells show a reporting gap across the entire Region for the relevant indicator. *RIMReP outcomes my impact on some objectives.

Report card name	2017	2018	2019	2020	2021	2022
Data reported	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22
Release date	Late 2018	Mid 2019	Mid 2020	Mid 2021	Mid 2022	Mid 2023
Water quality						
TSS	Maintain reporting.	Maintain reporting.	Directed by RIMReP* or maintain reporting.	Directed by RIMReP* or maintain reporting.	Directed by RIMReP* or maintain reporting.	Directed by RIMReP* or maintain reporting.
Chlorophyll-a	Maintain reporting.	Maintain reporting.	Directed by RIMReP* or maintain reporting.	Directed by RIMReP* or maintain reporting.	Directed by RIMReP* or maintain reporting.	Directed by RIMReP* or maintain reporting.
Coral						
Coral indicators	Maintain reporting.	Maintain reporting.	Maintain reporting.	Maintain reporting.	Maintain reporting.	Maintain reporting.
Fish community						
Fish indicators	Reporting gap.	Reporting gap.	Scope fish indicators.	RIMReP directed* or develop method for fish indicators based on scoping study.	RIMReP directed* or implement pilot data collection/reporting program, if feasible.	RIMReP directed* or report fish and review/continue pilot program.

Table 23. Operational objectives for progress to target reporting and human dimensions for report cards 2017 - 2022. Objectives are expected to be achieved by the listed year (pending funding availability), but may be achieved earlier. Grey shaded cells show a data gap across the entire reporting area for the relevant indicator. *RIMReP outcomes my impact on some objectives.

Report card name	2017	2018	2019	2020	2021	2022
Annual data reported	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22
Release date	Late 2018	Mid 2019	Mid 2020	Mid 2021	Mid 2022	Mid 2023
Progress to targets	Reporting gap.	Reporting gap.	Scoping for revision of MWI WQIP.	Review MWI WQIP and identify relevant targets.	Review MWI WQIP and determine methods for reporting progress to targets.	Report progress to targets based on revised MWI WQIP.
Human dimensions	Maintain reporting.	Report new Indigenous cultural heritage scores. Report new community values scores (SELTMP).* Report agricultural stewardship and new baselines.	Improve confidence in urban stewardship.	Improve confidence in additional non-agriculture sector stewardship (e.g. ports and heavy industry). Report community stewardship Report marine debris.	Report new Indigenous cultural heritage scores.* Report new community values scores.* Improve confidence in additional non-agriculture sector stewardship (e.g. tourism).	Improve confidence in additional non-agriculture sector stewardship (e.g. aquaculture). Report fisheries stewardship.

6.2. Progress to targets

The Partnership's intention to begin reporting against regional targets associated with indicators is included in Table 23. Targets already exist in the MWI WQIP, the Reef 2050 WQIP, the Reef 2050 Long-Term Sustainability Plan and other various regional plans. For various reasons, targets throughout each of these plans do not all align therefore there is a need for work to be undertaken to identify targets appropriate for reporting.

The Partnership will continue to work towards identifying the most appropriate targets from the suite of existing endorsed and recognised targets, to be incorporated into future reporting. This will help to ensure the Mackay-Whitsunday report card aligns with existing programs. The revision of the MWI WQIP will be instrumental to identifying and reporting progress to regionally relevant targets for the report card. RCL will develop a funding proposal for this work to be undertaken in collaboration with HR2RP staff.

Following the review of the MWI WQIP, relevant targets can be identified and methodology for reporting progress to targets determined. It should be noted that some targets may be identified as appropriate (e.g. ecosystem management targets) and progress towards these targets may be determined and reported prior to the review of the revised MWI WQIP.

Consideration needs to be given to establishing how the existing targets will be incorporated into the report card's Program Design including scoring and reporting methods.

The presentation of reporting progress to targets will also need to be determined. Early discussions within the Partnership Management Committee have identified possible options for reporting progress to targets may involve production of two separate products: one for ecosystem health and values reporting and another for stewardship and progress to targets reporting.

6.3. Future Regional considerations

In selecting additional sites for monitoring environmental indicators and human dimensions, consideration of the type and location of potential future pressures is important. There are four significant new developments that are proposed or have recently been approved within or nearby to the Region. These have been identified as having high potential to put additional pressure on the Region's waterways:

- Carmichael coal mine and rail project (proposed): Open-cut and underground coal mine with a yield of 60 million tonnes per annum in the Galilee Basin, including a 189 km railway line from the mine to Moranbah, where it will join the existing Goonyella rail system, connecting to coal terminals at the Port of Abbot Point;
- Styx Coal Project (proposed): Development of a greenfield open-cut coal mine with a yield of up to ten million tonnes per annum over a life of 20 years. Coal expected to be hauled along North Coast train line to Darlymple Bay Coal Terminal. Coastal communities, in particular St Lawrence and Clairview have been highlighted as host communities for members in the workforce;
- High value commercial agricultural land (approved): Operational works for clearing of 659.3 ha of remnant vegetation for growing grain and forage sorghum south of Clairview, and;

- Lindeman Island Project (approved): Redevelopment and expansion of the existing resort at Lindeman Island in the Whitsundays. Expected completion is 2022.

When assessing future monitoring requirements, where relevant, the footprint/possible availability of monitoring data for these developments will be considered

6.4. Updating the report card

The objectives outlined for the 2017 – 2022 report cards outline that there will be changes and/or updates to some indicators in each report card, such that no one report card will be directly comparable to the previous year's report card. While this can be managed through good communication at and, following, the report card release, it is prudent to limit changes that are undertaken to a minimum to ensure stability in reporting across years. Changes and/or updates to the report card will therefore be restricted to those that are critical to the scientific integrity and robustness of the report card. This ensures reporting differences in scores are due to changes of values and not due to changes of scoring methodology. To fulfil this, the following rules are in place relating to updates to report cards:

- Updates to scoring water quality using new scheduled guidelines will be incorporated into the report card when available;
- Updates to fill indicator gaps (i.e. grey sections of the report card) and improve confidence (i.e. new sites/increased sampling) will be incorporated into the report card when available;
- Changes that result from reviews to scoring of indicators and/or methods for data collection will be incorporated into the report card every five years (i.e. after 2022 report card);
- Amendments to errors in previous report cards will be incorporated into future report cards when available; and,
- New indicators (i.e. not a grey section of the report card) will be aggregated into scoring (i.e. index and overall scores) every five years (i.e. after 2022 report card), but can be reported on their own when available.

6.5. Data sharing and management

It is important that steps be taken to ensure data is available and accessible to inform the development of the report card. The Spatial and Scientific Information Management for Reef (SSIMR) system for data management is being utilised to manage the data used in the report card. SSIMR has two data management tools:

- DARTS: Data Recording Tool for Science; and
- SKIP: Science Knowledge and Information Provision.

DARTS will be used to capture, import, export, store and manage the report card data. All data files and technical documents used to develop the report card are stored in SKIP.

Where data is made available to the Partnership that is not intended for public release, the data owner reserves the right to enter into a data sharing agreement with the Partnership to maintain data confidentiality.

Work will be undertaken throughout 2018 to automate report card scores from raw and/or summarised data stored in SSIMR.

6.6. Report card review

The report card program design provides a plan for a five-year period for stable reporting and this also provides an opportunity to review the effectiveness of report card components over this duration. As described in the opening of section 6.46.2, changes that affect the scoring and reporting methodology are introduced every five years. Within this timeframe reviews and development of report card components will be conducted as required, with approved improvements and changes implemented at the end of the five-year period. Table 24 presents the report card components that are to be reviewed during the 2017 - 2022 plan period.

Table 24. Report card components and reviews to be conducted during the 2017 - 2022 period.

	Report card components	2017 – 2022 review
EXTENT	Five freshwater basin reporting zones	Review effectiveness of basin scale reporting and spatial representativeness of monitoring; consider sub-catchment scale reporting.
	Eight estuary reporting zones	Identify additional estuary locations that have regional significance for reporting and spatial representativeness of monitoring.
	Four inshore reporting zones	Review effectiveness of four reporting zones for inshore representation
	One offshore	Review effectiveness of one reporting zone for offshore representation
INDICATORS	Indicator monitoring methods	Review effectiveness of indicator monitoring including aspects related to confidence such as spatial and temporal representation, error and currency of methods.
	Indicator scoring methods	Review effectiveness of indicator scoring methods including baselines, scaling, aggregation and placement of indicators.
	Current indicators	Review effectiveness of current indicators and revise inclusion and placement as required.
	New indicators	Assess and evaluate new indicators and determine scoring methods and placement. This includes but is not limited to wetland, riparian and, mangrove and saltmarsh condition, groundwater and invasive weeds.
FRAMEWORK	Conceptual framework	Review application of conceptual framework and update components of framework to align with improved knowledge.
	Conceptual diagram	Update conceptual diagram to align with conceptual framework advances and improved knowledge of waterway values and interactions.

Appendix A

Partnership and Technical Working Group priorities relevant to the development of the report card.

Table A1. Partnership priority projects for 2018/19 FY. Projects are not restricted to report card improvements.

Project	Details	Reporting zone	Impacts to the report card	Deliverables	Timeframe
1. 2017 - 2022 Report Card Program Design	Examination of the existing data in each indicator category. Current data, timeframe, improvements needed (increased confidence or filling a data gap), Funding arrangements, contextual considerations (e.g. Carmichael going ahead), linkages to RIMMREP, citizen science linkages. Formalised review process for program design incl. consideration of new indicators and new datasets.	N/A	More certainty around medium term changes to datasets which may influence report card.	Report.	Due to ISP by end of May 2018.
2. Spatial expansion of WQ program (basins)	Increased monitoring points in the 5 x freshwater basins.	All basins.	Improved data confidence in basin reporting zones.	Report card basin water quality scores confidence improved.	Scoping of site locations by October 2018; Implementation TBC and dependant on collaboration opportunities.
3. Report card automation	Staged approach of: 1. Improvement of excel workflow; 2. Scoping for cost sharing of full data management and automation system; 3. Commencement of data management and automation system, project management.	N/A	No direct impacts.	Data analysis tool and potential linkages with SSIMR.	Due by release of 2017 report card (November 2018).
4. Southern inshore Project	Review 2017/18 data and design from WQ, coral and seagrass indicators. Develop ongoing monitoring plan. Cost 5 x years of project. Ensure alignment with both Ports and future MMP monitoring.	Southern inshore zone.	WQ data will be included in 2018 report card; one site included in coral coaster for 2018 report card. Seagrass baseline data collection.	Summary report and proposal to DBCT, TWG and ISP.	First year of project to be wrapped up by June 30 2018. Contracts for 2018/19 in place and project commence in July 2018.

Project	Details	Reporting zone	Impacts to the report card	Deliverables	Timeframe
5. Pesticide expansion of WQ program (estuaries)	Initiate expanded temporal sampling of pesticides in report card estuaries. This will improve confidence in pesticide scores for all estuaries (expand from reporting based on four samples per wet season to approximately 25).	All estuarine zones.	Increased confidence in pesticide score at estuarine level.	Report card pesticide score confidence improved.	Proposal complete May 2018; Contracting in 18/19 FY, monitoring initiates at first 2018-19 rain event.
6. Pesticide expansion of WQ program (inshore marine)	Include passive samplers within existing monitoring programs where pesticide data (southern) is absent or has low confidence (northern). NB Pesticides in Whitsunday zone are absent however pesticides have been deemed low risk in this zone and thus monitoring here was removed by the MMP.	Southern, Northern inshore zone.	Increased confidence in pesticide score at inshore level.	Report card pesticide score for southern zone and confidence improved in northern zone.	Proposal complete May 2018; Contracting depends on funding.
7. Indigenous Cultural Heritage	Scope of works comprises: re-assessment of sites monitored in 2016 plus identification of new sites integration/alignment with relevant RIMReP work designing and running a training program to allow TORG members to do their own monitoring on the next round of surveys.	Existing monitoring sites and potential new ones.	Cultural Heritage scores for the 2018 report card.	Reporting and report card scores.	Site work to be undertaken in June 2018.
8. Marine Debris	Scoping study into future marine debris reporting options for the Partnership.	Likely LGA based.	Likely contextual information.	Scoping study.	Completed before June 30 2018.
9. fish indicator development	Development of estuarine and freshwater fish indicators.	Estuarine, inshore and offshore reporting zones.	Fish indicators for estuarine and marine.	Scoping study.	TBC
10. Stewardship	Tourism, aquaculture, ports, heavy industry frameworks require update. Urban framework is being reviewed externally.	Sector based (not spatial).	Updated stewardship scores for the 2018 report card.	Scores and final summary report delivered by Ecological.	Surveys to commence in first quarter of 18/19 FY.
11. Educational materials	There was a preference to explore one basin as a pilot for this project, with initial preferences for the Don or Proserpine basins.	Pilot basin TBC	Comms and engagement project.	Catchment story (format TBC) and activity sheets.	TBC

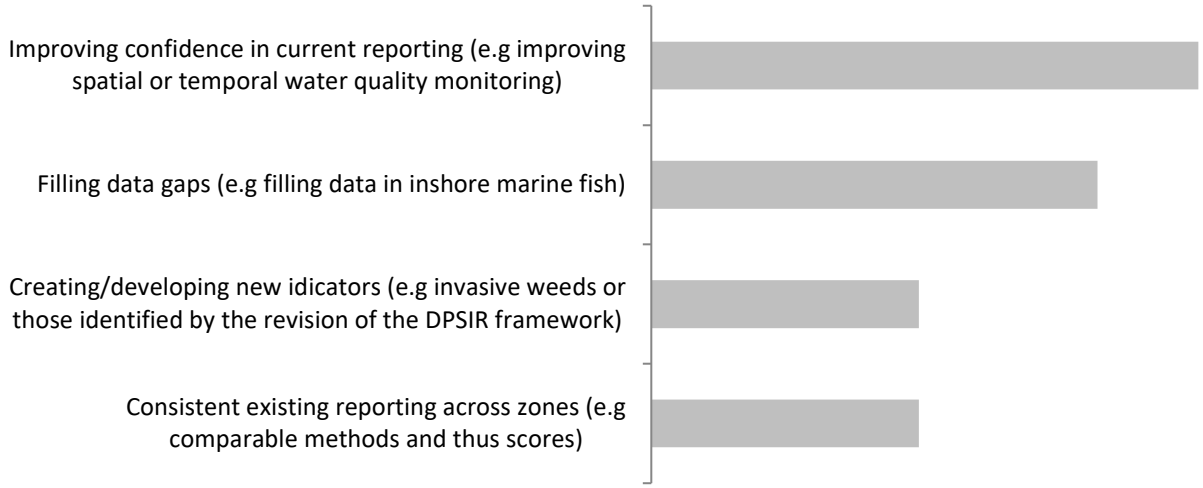

Figure A1. Broad report card improvement priorities for 2017 – 2022 report card identified by the TWG in May 2018. A larger bar indicates a higher priority of the objective.

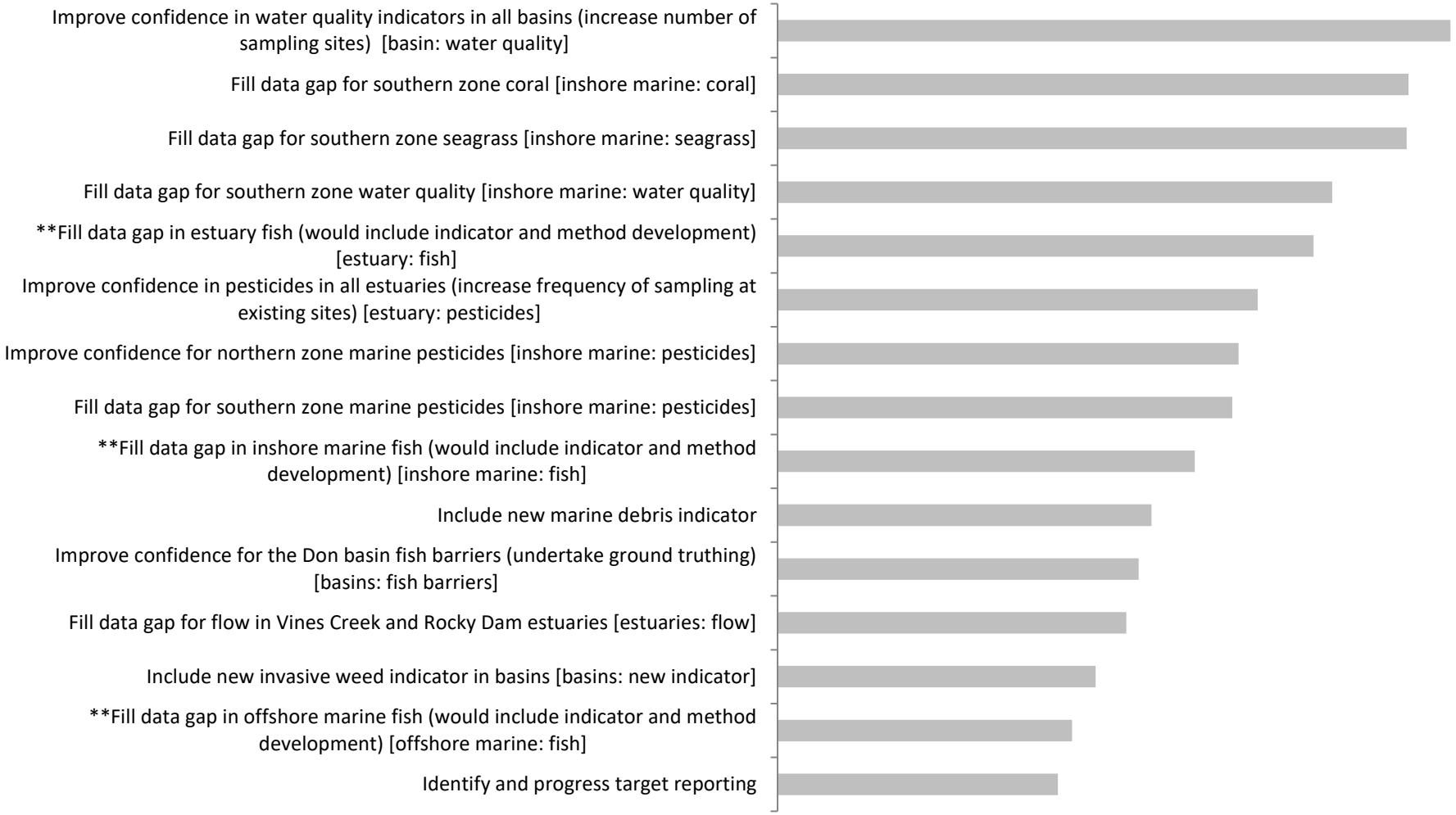

Figure A2. Detailed report card improvement priorities for 2017 – 2022 report card identified by the TWG in May 2018. A larger bar indicates a higher priority of the objective.

Appendix B

Freshwater basins

Water quality indicators

Status in the 2016 report card

Water quality scores in O'Connell, Pioneer and Plane freshwater basins for the 2014 pilot, 2015 and 2016 report cards was based on data from one end of catchment site in each basin; the O'Connell River, Pioneer River and Sandy Creek. Therefore there was low confidence in scoring.

No score was available for reporting in the Proserpine and Don basins for these report cards.

Reporting schedule 2017 - 2022

2017	2018	2019	2020	2021	2022
2016-17 data reported.	2017-18 data reported. Fill gap in Don basin. Improve confidence in Plane and O'Connell basin.	2018-19 data reported. Fill gap in Proserpine and scope and implement expansion of monitoring sites.	2019-20 data reported. Continue to expand monitoring sites.	2020-21 data reported. Improve confidence in reporting water quality in all basins.	2021-22 data reported.

Improvement objectives 2017 - 2022

Report water quality score in the Proserpine and Don basins and improve confidence in sediment and nutrient scores across the Region. Incorporate more pesticides in ms-PAF when available.

Improvement description

Incorporate more pesticides in ms-PAF when available.

Currently, the ms-PAF estimate is based on 13 PSII herbicides (ametryn, atrazine, diuron, hexazinone, tebuthiuron, bromacil, fluometuron, metribuzin, prometryn, propazine, simazine, terbuthylazine, terbutryn). The ms-PAF estimate is limited to pesticides with guideline values. Looking ahead, the toxicity data required for reporting pesticides with other modes of action is expanding. Thus, the range of pesticides included in pesticide reporting will progressively increase in future reporting as information becomes available.

Anticipated cost: NIL to the Partnership (calculation provided in-kind by DES).

Fill gaps in the Don and Proserpine basins and improve confidence in O'Connell and Plane basins.

Incorporating data from GBRCLMP sites established at the Don River in 2017 will allow for reporting water quality for the first time in the Don basin. Exploration of data from GBRCLMP site established at the Proserpine River in 2017 will be undertaken to determine if it is appropriate for reporting catchment conditions. If it is not, sampling upstream of the tidal influence will need to be initiated to ensure reporting on the Proserpine basin can occur. Incorporating data from GBRCLMP sites established at the O'Connell River (Stafford's Crossing site) and Plane Creek in 2017 will increase spatial representativeness and therefore improve confidence in scores for water quality in O'Connell and Plane basins, respectively. Additional sites throughout these basins will still be needed for confidence in water quality scores to be considered high. This data includes pesticides for ms-PAF calculation.

Anticipated cost: NIL to the Partnership (data provided through the Paddock to Reef Program), unless additional monitoring upstream of tidal influence of Proserpine River is needed.

Scope and expand monitoring sites to improve confidence in sediment and nutrient reporting.

Options for expanding monitoring to additional sites throughout the basins will be scoped by considering:

- Minimum sample design required to improve confidence;
- Value of additional data to inform existing modelling (i.e. source catchments);
- Pairing sample sites with existing gauging stations;
- Historical monitoring programs (e.g. used to inform 2008 Mackay-Whitsunday-Isaac WQIP);
- Collaboration opportunities (e.g. identifying co-investment models and/or programs where samples can be undertaken with minimal field work expenses).

Importantly, the design of the expansion program will need to account for how the program would be implemented. The Partnership will need to bear the full cost of any expansion program or will need a co-

investment/collaboration to ensure sustainability of the program. It is anticipated that the most feasible option would be co-investment or collaboration.

Aspirational improvements

Reporting of water quality scores at the sub-catchment level is an aspirational goal however it is acknowledged that modelling rather than monitoring is the most feasible way to achieve this level of reporting.

Fish barriers

Status in the 2016 report card

The original fish barrier assessment occurred in the 2015 report card (2014-15 data) and will be due for repeat assessment in the 2019 report card (2018-19 data). The 2015 assessment didn't include ground-truthing of potential barriers in the Don Basin, and therefore there was low confidence in scoring.

All barriers on 'Major' risk waterways were validated in other basins, however validation of potential barriers on 'High' risk waterways in other basins would improve accuracy of future assessments, particularly for the 1st barriers upstream on 'High' risk streams.

Reporting schedule 2017 - 2022

2017	2018	2019	2020	2021	2022
2014-15 data reported.	2014-15 data reported.	Re-assess and report 2018-19 data. Undertake ground truthing of barriers in the Don basin.	2018-19 data reported.	2018-19 data reported.	2018-19 data reported.

Improvement objectives 2017 - 2022

Improve confidence in fish barrier scores in the Don basin.

Improvement description

Undertake ground truthing of barriers in the Don basin in 2018-19 (improvement objective).
To improve confidence in the assessment of barriers in the Don basin, ground-truthing of barriers is recommended. Validating all potential barriers on 'Major' risk (purple - stream orders 4-7) waterways, of which there are approximately 25, is recommended. During such ground-truthing of 'Major' potential barriers, it would also be possible to validate some potential barriers on 'High' risk (red - SO 3) waterways (if they are in close proximity to those on 'Major' risk waterways).

This would mean the 2019 report card fish barrier assessment in the Don would incorporate new barrier information, validate all potential barriers identified in 2015 on 'Major' risk waterways and validate some barriers in 'High' risk waterways (with priority given to the 1st barrier upstream on 'High' risk waterways). This would result in significant improvements in confidence in all metrics within the Don basin.

Aspirational improvements

Currently, all barriers on 'Major' risk waterways have been validated in other basins, however validation of potential barriers on 'High' risk waterways in other basins would improve accuracy of their re-assessment, particularly for the 1st barriers upstream on 'High' risk streams.

Impoundment length

Status in the 2016 report card

The original impoundment length assessment occurred in the 2014 pilot report card (2013-14 data) and this data has been repeated in the 2015 and 2016 report cards, following the requirement to update this indicator once every four years.

Reporting schedule 2017 - 2022

2017	2018	2019	2020	2021	2022
2013-14 data reported.	Re-assess and report 2017-18 data.	2017-18 data reported.	2017-18 data reported.	2017-18 data reported.	Re-assess and report 2021-22 data.

Improvement objectives 2017 - 2022

No improvements are anticipated for this indicator over the 2017 – 2022 report cards.

Aspirational improvements

There are no aspirational improvements for this indicator.

Flow

Status in the 2016 report card

Freshwater flow was not reported in the 2016 report card. In 2017, the selection of indicators and development of methods for reporting indicators was undertaken.

Reporting schedule 2017 - 2022

2017	2018	2019	2020	2021	2022
2016-17 data back-calculated.	2017-18 data reported.	2018-19 data reported. Identify and recommend information improvements.	2019-20 data reported.	2020-21 data reported.	2021-22 data reported.

Improvement objectives 2017 - 2022

Report freshwater flow for the first time in the 2018 report card and annually thereafter. Provide back-calculated scores for flow for previous report cards.

Improvement description

Data reported for the first time and previous report cards back-calculated to include flow.

Freshwater flow data will be reported for the first time in the 2018 report card using the tool developed for this purpose. Scores for the 2014 – 2017 report cards will be back- calculated using historical flow and rainfall data.

Identify and recommend information improvements.

During collation of relevant data and calculation of flow scores it is likely that information improvements will be identified. These may relate to areas throughout basins not well represented by gauged data or pre-development models.

**NB for the 2017 – 2022 period, the Partnership does not intend to fund improvements in information that may be identified through the process of reporting flow scores.*

Aspirational improvements

Any recommendations relating to information improvements, particularly those that relate to locations throughout basins where gauged data is not well represented, would ideally be addressed by establishing gauges in these locations.

Riparian extent and Wetland extent

Status in the 2016 report card

The original riparian extent and wetland extent assessments occurred in the 2014 pilot report card (2013 data) and this data has been repeated in the 2015 and 2016 report cards, following the requirement to update this indicator once every four years.

Reporting schedule 2017 - 2022

2017	2018	2019	2020	2021	2022
2013-14 data reported.	Re-assess and report 2017-18* data. Use updated mapping.	2017-18 data reported.	2017-18 data reported.	2017-18 data reported.	Re-assess and report 2021-22 data.

Improvement objectives 2017 - 2022

Use latest mapping for riparian extent and wetland extent re-assessments.

Improvement description

Use updated mapping for riparian extent and wetland re-assessments.

Improvements to mapping and reporting undertaken as part of the Paddock to Reef program will be adopted where required in the 2017 – 2022 report cards. Pertinent improvements include:

- Updated mapping will involve using data from Sentinel 2 satellite which will improve resolution and allow for 50m buffer to be used for riparian extent re-assessments; and
- Updated reporting approach for wetland extent will include figures for modified and unmodified wetlands.

**NB Reporting of updated data will depend on its availability to the Paddock to Reef Program. If unavailable, reporting updated data may not occur until 2019 report card. This will reflect an update after five years instead of four.*

Aspirational improvements

It is intended that riparian condition and wetland condition will be reported as separate indicators in future report cards and will compliment extent indicators.

Fish

Status in the 2016 report card

The fish index was first reported in the O'Connell, Pioneer and Plane basins in the 2015 report card, based on data collected in 2015-16. This meant that the first time that fish data was reported, it was a year ahead of data reported for other, annual indicators (i.e. 2015 report card water quality scores based on data collected from 2014-15).

The same 2015-16 data was repeated in the 2016 report card, following the requirement to update this indicator once every three years.

The fish index was made up of two indicators: pest fish abundance and native fish richness.

Reporting schedule 2017 - 2022

2017	2018	2019	2020	2021	2022
2015-16 data reported.	Re-assess and report 2017-18 data (align years). Fill gap in Proserpine. Include 'assemblage' indicator (if available) and improve model.	2017-18 data reported. Include 'assemblage' indicator (if available).	2017-18 data reported. Include 'assemblage' indicator (if available).	Include 'assemblage' indicator. Re-assess and report 2020-21 data. Fill gap in Don.	2020-21 data reported.

Improvement objectives 2017 - 2022

Fill gap in Proserpine and the Don basins, include a fish assemblage indicator, improve confidence in modelling used to score fish in freshwater basins and align data collection years with other indicators.

Improvement description

Re-assess and report 2017-18 data (align years) and fill gap in Proserpine.

Re-assessments will be undertaken for the 2018 report card by using data collected during surveys conducted in October 2017 (2017-18 data). This will allow alignment of the data collection years used for other indicators. Surveys were also conducted in freshwater sites in Proserpine in October 2017, thus a score for fish will be included in the 2018 report card.

Include 'assemblage' indicator and improve model.

In late 2017, as part of the Cabinet Review process, funding was confirmed for DES to undertake the development/improvement of modelling for fish communities in the freshwater ecosystems of the regional report cards (including Wet Tropics). For the Mackay-Whitsunday Region, this project will involve improving current modelling used to report condition of fish communities in our freshwater basins so that it will include assessment of fish community assemblage and produce an 'assemblage' indicator.

Re-assess and report 2020-21 data and fill gap in Don.

The DES funding will also cover fish surveys required for reporting again in the 2020-2021 FY which will include surveys in the Don basin.

Aspirational improvements

No aspirational improvements have been identified for this indicator.

Estuaries

Water quality indicators

Status in the 2016 report card

Water quality scores in estuaries for the 2014 pilot, 2015 and 2016 report cards was based on data collected as part of the estuary monitoring program led by DES. Physical-chemical, nutrients and chlorophyll-a indicators were scored based on monthly samples at two to three sites per estuary, and therefore there was moderate confidence in scores.

Pesticides were based on ms-PAF scores calculated from four samples in the wet season at one site per estuary, therefore there was low confidence in scores.

Reporting schedule 2017 - 2022

2017	2018	2019	2020	2021	2022
2016-17 data reported.	2017-18 data reported. Use CLMP pesticide data for relevant estuaries.	2018-19 data reported. Increase sampling of pesticides in non-CLMP estuaries.	2019-20 data reported.	2020-21 data reported.	2021-22 data reported.

Improvement objectives 2017 - 2022

Improve confidence in estuary pesticide scores across estuaries. Incorporate more pesticides in ms-PAF when available.

Improvement description

Incorporate more pesticides in ms-PAF when available.

Currently, the ms-PAF estimate is based on 13 PSII herbicides (ametryn, atrazine, diuron, hexazinone, tebuthiuron, bromacil, fluometuron, metribuzin, prometryn, propazine, simazine, terbuthylazine, terbutryn). The ms-PAF estimate is limited to pesticides with guideline values. Looking ahead, the toxicity data required for reporting pesticides with other modes of action is expanding. Thus, the range of pesticides included in pesticide reporting will progressively increase in future reporting as information becomes available.

Anticipated cost: NIL to the Partnership (analysis provided in-kind by DES).

Use CLMP data for reporting pesticides in relevant estuaries.

The expansion of the GBRCLMP to reporting ms-PAF based on weekly grab samples throughout the wet season and multiple samples during events has increased confidence in pesticide reporting significantly. Moving towards using CLMP data as a proxy for relevant estuaries is a cost-effective approach to robust reporting of pesticide condition in these estuaries that will still greatly improve confidence in pesticide indicator scores for these locations. There are two CLMP sites corresponding with estuaries that are reported in the Mackay-Whitsunday report card: O'Connell River and Sandy Creek. CLMP data will be used for pesticide reporting for these estuaries.

Increase sampling of pesticides in non-CLMP estuaries.

Moving to reporting pesticides based on Sandy Creek and O'Connell River CLMP sites will leave seven other estuaries without sufficient temporal monitoring for pesticides. To improve confidence, the frequency of sampling will increase to three times per month throughout the wet season (six month period) in the remaining estuaries:

- Gregory River;
- Murray Creek;
- St Helens Creek;
- Vines Creek;
- Plane Creek;
- Rocky Dam Creek; and
- Carmila Creek

To remain cost effective sampling will be land based and will be for one site per estuary.

*The total cost will be for 2 samples per month in seven estuaries over six months (DES will fund remaining 1 sample per month in seven estuaries over six months, within the existing program).

Aspirational improvements

Moving to and maintaining weekly boat-based monitoring of pesticides in the wet season at more than one site per estuary is an aspirational objective for further improving confidence in scoring for pesticide indicators.

Fish barriers

Status in the 2016 report card

The original fish barrier assessment occurred in the 2015 report card (2014-15 data) and will be due for repeat assessment in the 2019 report card (2018-19 data). There was high confidence in fish barrier scores in all estuaries.

Reporting schedule 2017 - 2022

2017	2018	2019	2020	2021	2022
2014-15 data reported.	2014-15 data reported.	Re-assess and report 2018-19 data.	2018-19 data reported.	2018-19 data reported.	2018-19 data reported.

Improvement objectives 2017 - 2022

No improvement objectives.

Aspirational improvements

No aspirational improvement objectives.

Flow

Status in the 2016 report card

Freshwater flow through estuaries was not reported in the 2016 report card. In 2017, the selection of indicators and development of methods for reporting indicators was undertaken.

Reporting schedule 2017 - 2022

2017	2018	2019	2020	2021	2022
2016-17 data back-calculated.	2017-18 data reported. Identify and recommend information improvements.	2018-19 data reported.	2019-20 data reported.	2020-21 data reported. Fill gap in Vines and Rocky Dam if available.	2021-22 data reported.

Improvement objectives 2017 - 2022

Report freshwater flow through estuaries for the first time in the 2018 report card and annually thereafter. Provide back-calculated scores for flow for previous report cards. Fill data gap in relevant estuaries.

Improvement description

Data reported for the first time and previous report cards back-calculated to include flow.

Freshwater flow in estuaries data will be reported for the first time in the 2018 report card using the tool developed for this purpose. Scores for the 2014 – 2017 report cards will be back-calculated. No gauging stations are associated with the Vines Creek or Rocky Dam Creek estuaries therefore no data is available to report freshwater flows in these estuaries.

Identify and recommend information improvements and fill gap in Vines and Rocky Dam.

Installation of gauging stations associated with the Vines Creek and Rocky Dam Creek estuaries will be recommended. During collation of relevant data and calculation of flow scores it is likely that further information improvements will be identified which may relate to areas throughout estuaries not well represented by gauged data or pre-development models.

Cost effective options for obtaining flow data will be explored in order to obtain freshwater flow data for the Vines Creek and Rocky Dam estuaries.

Aspirational improvements

Any further recommendations relating to information improvements, particularly those that relate to estuaries where gauged data is not well represented, would ideally be addressed by establishing gauges in these locations.

Riparian extent and, Mangrove and saltmarsh extent

Status in the 2016 report card

The original riparian extent and, mangrove and saltmarsh extent assessments occurred in the 2014 pilot report card (2013 data) and this data has been repeated in the 2015 and 2016 report cards, following the requirement to update this indicator once every four years.

Reporting schedule 2017 - 2022

2017	2018	2019	2020	2021	2022
2013-14 data reported.	Re-assess and report 2017-18 data.	2017-18 data reported.	2017-18 data reported.	2017-18 data reported.	Re-assess and report 2021-22 data.

Improvement objectives 2017 - 2022

No improvement objectives.

Aspirational improvements

There are no aspirational improvements for this indicator.

Fish

Status in the 2016 report card

The fish index has not yet been reported.

Reporting schedule 2017 - 2022

2017	2018	2019	2020	2021	2022
Reporting gap.	Scope estuary fish indicators.	RIMReP directed or develop methodology for reporting fish indicators.	RIMReP directed or design data collection program if required.	RIMReP directed or implement design and 2020-21 pilot data reported for estuary fish indicators.	2021-22 data reported.

Improvement objectives 2017 - 2022

Fill gap in estuary fish reporting.

Improvement description

Scope fish indicators and methodology for reporting.

A literature review will be undertaken to scope appropriate indicators for reporting on estuary fish. This will involve exploring existing reporting approaches and available data within the Region. This information will be taken to relevant experts in the field who will act as a special working group providing advice on the most appropriate indicators and methods for reporting (scoring approach). Recommendations from this group will need to align with any outcomes from RIMReP.

Design and implement data collection.

If required, data collection program will be designed and implemented. Recommendations from RIMReP will need to be accounted for within any design.

Aspirational improvements

No aspirational improvements have been identified for this indicator.

Inshore marine

Water quality indicators

Status in the 2016 report card

Water quality scores in inshore marine zones were reported for the Whitsunday and central zones in the 2016 report card. There was a gap in the pesticide indicator for the Whitsunday and Northern zone, as well as nutrients in the northern zone and a complete data gap in the southern zone.

Pesticide scores are based on determining PSII-HEq, with higher confidence in these scores when derived from passive sampler data compared to data collected from a limited number of grab samples.

Reporting schedule 2017 - 2022

2017	2018	2019	2020	2021	2022
2016-17 data reported.	2017-18 data reported. Report nutrients, chlorophyll-a and water clarity for southern zone.	2018-19 data reported. Establish long-term monitoring in southern zone. Incorporate improvements in reporting by using ms-PAF, if available. Report nutrients in northern zone.	2019-20 data reported. Fill gaps and improve confidence in pesticides in northern and southern zone.	2020-21 data reported.	2021-22 data reported.

Improvement objectives 2017 - 2022

Fill data gaps for nutrients, chlorophyll-a and water clarity indicators in the southern inshore zone. Fill data gap for nutrients in northern inshore zone. Fill gaps and improve confidence for pesticides in the northern and southern inshore zones and move to ms-PAF reporting when available.

Improvement description

Report nutrients in northern zone.

The Abbot Point ambient water quality monitoring program provides data used to report water quality in the northern inshore zone. Due to a change in program design and data collection beginning half way through the reporting period (i.e. January 2016), there were limitations in data availability for the 2016 report card. There were also issues around high limits of reporting (LOR) which did not allow for reliable scoring of some data. Changes to who will run the program (occurring in 2018) will mean that nutrients data will be available for the full reporting period for 2019 report card onwards.

Report nutrients, chlorophyll-a and water clarity for southern zone.

Water quality monitoring was established in 2016-17 in open coastal waters near Aquila Island as a pilot ambient water quality monitoring program for the southern inshore zone. This included installation of an *in situ* turbidity data logger at one site, grab samples of nutrients and chlorophyll-a at three sites (including one at the data logger site) and secchi depth measurements at these sites.

**NB This was funded externally in full by one of the Partners in 2016/17.*

Establish long-term monitoring for southern zone.

Continued monitoring using the same program design as was used in 2016/17 is recommended for on-going reporting.

** It is anticipated that external funding will be required for this program to continue. Currently, external funding by the same Partner has been committed for the 2018-19 data collection period only. This cost does not reflect increases in costs due to inflation.*

Fill gaps and improve confidence in pesticides in northern and southern zone and move to ms-PAF reporting when available.

Inclusion of passive samplers into existing monitoring programs in the northern and southern inshore zones would fill gaps and improve confidence in current pesticide condition reporting. It is expected that reporting of pesticides will involve ms-PAF calculations by the 2019 report card. Prior to expanding sampling for pesticides there is a need to better understand the capabilities of the current eReefs model in relation to pesticides and how they are reported (as PSII HEq vs ms-PAF), including any requirements for validation and identification of any further model capabilities.

Aspirational improvements
Maintaining southern inshore water quality monitoring and exploring the use of eReefs modelling to improve confidence in reporting across all inshore zones.

Coral indicators

Status in the 2016 report card

Coral scores in inshore marine zones were reported for the northern, Whitsunday and central zones in the 2016 report card. No data was available to produce a score for the southern inshore zone. Some indicators in the northern and central zones were not reported because it takes multiple years of data before a score can be calculated for these indicators.

Methods used in the central zone are slightly different to those used in the northern and Whitsunday zones which means scores are not directly comparable between zones.

Reporting schedule 2017 - 2022

2017	2018	2019	2020	2021	2022
2016-17 data reported.	2017-18 data reported.	2018-19 data reported. Fill gap in southern inshore coral. Resolve methodology differences.	2019-20 data reported.	2020-21 data reported.	2021-22 data reported.

Improvement objectives 2017 - 2022

Fill data gaps for the southern inshore zone. Align methods where feasible between zones.

Improvement description

Fill data gaps for southern inshore coral.

A reconnaissance survey was undertaken in 2017-18 to identify appropriate sites for on-going monitoring for coral in the southern inshore zone. During this time a full set of data suitable for producing a site score for coral indicators was collected at Henderson Island. Including Henderson Island, five other long-term monitoring sites were recommended. These included: near Aquila and Temple Island, two inner shelf locations; near Connor Island, which along with Henderson Island represent two mid shelf locations, and; Pine Peak and Middle Percy Island, two outer shelf locations. However, the final outer shelf locations may be adjusted to align better with RIMReP recommendations with respect to GBRMPA zoning.

Sites at these locations will be in areas of incipient reefs or true fringing reefs where hard corals were more abundant compared to in the more common, rock attached coral communities throughout the area. Sites will be at two depths, where relevant. Coral surveys at these sites will follow MMP methodology and will occur in the late wet season/very early dry season to allow estimation of summer disturbance events and to minimise bias associated with high cover of macroalgae that links with its primary growth period.

Depending on funding, the final design and frequency of surveys may need to be adjusted.

**NB It is anticipated that external funding will be required for this program to continue. Currently, external funding by a single Partner has been committed for the two years of data collection only. These costs do not reflect increases in costs due to inflation.*

Resolve methodology differences.

Across the MMP, LTMP and two Ports programs, two different methods are used to assess benthic cover along permanent transects: the line intercept method and the photo point intercept method. Comparisons have demonstrated that the two methods can produce different cover estimates, with line intercept methods tending to estimate higher coral cover than photo intercept methods. While differences in cover estimates may not be a concern if assessing change over time at the same site, complications can arise if methods used at the same sties change in time and/or when comparing across sites where different methods have been used.

From 2017-18 onwards, the methodology used in the northern inshore zone will change from the photo intercept method (used in 2015-16 and 2016-17) to the line intercept method (photos are still taken they are not analysed). To ensure consistency within the report card, it is recommended that data used to produce coral scores in the northern zone continues to be based on photo analysis. Likewise, to ensure comparability

with MMP methodology photo analysis will be conducted of the Henderson Island surveys in the southern zone, and this data will be used to determine coral scores for the site. All scores for the central zone in report cards have been determined from data collected from line intercept methodology, which is expected to remain the same in the future.

**It is anticipated that costs for photo analysis in the northern zone will be shared between the Partnership and NQBP.*

Aspirational improvements

Align methodology used in the central inshore zone so scores are comparable across zones (move to photo analysis and back-calculate scores).

Seagrass indicators

Status in the 2016 report card

Seagrass scores in inshore marine zones were reported for the northern, Whitsunday and central zones in the 2016 report card. No data was available to produce a score for the southern inshore zone.

Indicators reported are different depending on the program that has collected the data used for scoring, thus if both programs exist in an inshore zone six indicators can be reported. In the northern and central zones data from the QPSMP is used and in the Whitsunday and central zones data from the MMP is used.

Reporting schedule 2017 - 2022

2017	2018	2019	2020	2021	2022
2016-17 data reported.	2017-18 data reported. Establish long-term monitoring program in southern inshore zone.	2018-19 data reported.	2019-20 data reported.	2020-21 data reported.	2021-22 data reported. Fill gap in southern inshore zone.

Improvement objectives 2017 - 2022

Fill data gaps for the southern inshore zone.

Improvement description

Fill data gaps for the southern inshore zone.

A baseline survey of seagrass meadows were undertaken in 2017-18 to identify appropriate locations for on-going monitoring for seagrass in the southern inshore zone. The QPSMP method was used for baseline surveys in this zone.

Long-term seagrass monitoring has been recommended for intertidal meadows surveyed between Clairview and Flock Pigeon Island (mapping 64% of the total mapped coastal seagrass in the project area). Monitoring in this location captures the diversity of meadow sizes, the two dominant seagrass species and seagrasses growing along the mainland coast and an island. This location also complements water quality monitoring and coral monitoring recommended near Aquila Island. QPSMP methodology is recommended to capture meadow scale condition.

Previous analysis has determined 10 years as the ideal length of time to develop an accurate baseline of seagrass condition against which condition thresholds can be determined. A minimum of five years data collection (with 2017-18 being the first year) before scores can be incorporated into a score for the report card is recommended. This means the first score would be produced in the 2022 report card. Scores and thresholds are recommended to be updated annually until the 10-year baseline target is reached.

A Seagrass Watch monitoring site was also re-established at Clairview in 2017-18. Monitoring of this site aligns with MMP methods and can produce data for one out of three of the MMP indicators. However, one site will not provide sufficient confidence in reporting seagrass condition across the whole southern inshore zone. Concurrently with the recommended meadow scale monitoring that will follow the QPSMP methodology, the Partnership intends to support the continued monitoring at the existing Seagrass Watch site and work to expand monitoring if feasible.

**NB It is anticipated that external funding will be required for this program to continue. The 2017-18 and 2018-19 years were fully funded by a single Partner, who has also committed to funding one further year of data collection only.*

Aspirational improvements

Align methodology used in RIMReP.

Fish

Status in the 2016 report card

The fish index has not yet been reported.

Reporting schedule 2017 - 2022

2017	2018	2019	2020	2021	2022
Reporting gap.	Reporting gap.	Scope inshore fish indicators.	RIMReP directed or develop methodology for reporting fish indicators.	RIMReP directed or design data collection program if required.	RIMReP directed or implement design and 2020-21 pilot data reported for inshore fish indicators.

Improvement objectives 2017 - 2022

Fill gap in inshore fish reporting.

Improvement description

Scope fish indicators and methodology for reporting.

A literature review will be undertaken to scope appropriate indicators for reporting on inshore fish. This will involve exploring existing reporting approaches and available data within the Region. This information will be taken to relevant experts in the field who will act as a special working group providing advice on the most appropriate indicators and methods for reporting (scoring approach). Recommendations from this group will need to align with any outcomes from RIMReP.

Design and implement data collection.

If required, data collection program will be designed and implemented. Recommendations from RIMReP will need to be accounted for within any design.

Aspirational improvements

No aspirational improvements have been identified for this indicator.

Offshore marine zone

Water quality indicators

Status in the 2016 report card

Water quality indicators, TSS and Chlorophyll-a, were reported from remote sensing data in the offshore zone in the 2016 report card.

Reporting schedule 2017 - 2022

2017	2018	2019	2020	2021	2022
2016-17 data reported.	2017-18 data reported.	2018-19 data reported.	2019-20 data reported.	2020-21 data reported.	2021-22 data reported.

Improvement objectives 2017 - 2022

No improvements have been identified.

Aspirational improvements

Review effectiveness of reporting as one zone.

Coral indicators

Status in the 2016 report card

Coral indicators, coral cover, juvenile coral and rate of coral change, were reported in the offshore zone in the 2016 report card.

Reporting schedule 2017 - 2022

2017	2018	2019	2020	2021	2022
2016-17 data reported.	2017-18 data reported.	2018-19 data reported.	2019-20 data reported.	2020-21 data reported.	2021-22 data reported.

Improvement objectives 2017 - 2022

No improvements have been identified.

Aspirational improvements

Align methodology recommended in RIMReP.

Fish

Status in the 2016 report card

The fish index has not yet been reported.

Reporting schedule 2017 - 2022

2017	2018	2019	2020	2021	2022
Reporting gap.	Reporting gap.	Scope offshore fish indicators.	RIMReP directed or develop methodology for reporting fish indicators.	RIMReP directed or design data collection program if required.	RIMReP directed or implement design and 2020-21 pilot data reported for offshore fish indicators.

Improvement objectives 2017 - 2022

Fill gap in offshore fish reporting.

Improvement description

Scope fish indicators and methodology for reporting.

A literature review will be undertaken to scope appropriate indicators for reporting on offshore fish. This will involve exploring existing reporting approaches and available data within the Region. This information will be taken to relevant experts in the field who will act as a special working group providing advice on the most appropriate indicators and methods for reporting (scoring approach). Recommendations from this group will need to align with any outcomes from RIMReP.

Design and implement data collection.

If required, data collection program will be designed and implemented. Recommendations from RIMReP will need to be accounted for within any design.