



Australian Government

**Great Barrier Reef
Marine Park Authority**



**Queensland
Government**

Reef 2050
Integrated Monitoring
and Reporting Program

STRATEGY UPDATE 2018

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Foreword

This Reef 2050 Integrated Monitoring and Reporting Program Strategy provides an overview of the Reef 2050 Integrated Monitoring and Reporting Program, its progress to date, and pathway for 2018–2020.

It updates the 2015 Reef 2050 Integrated Monitoring and Reporting Program Strategy by strengthening the program's critical role and foundational work in supporting the *Reef 2050 Long-Term Sustainability Plan* (Reef 2050 Plan). The program's primary purpose is to enable timely and suitable responses by Reef managers and partners to emerging issues and risks, and underpin the evaluation of whether the *Reef 2050 Plan* is on track to meet its outcomes, objectives and targets.

Since the summer of 2015–16, the Great Barrier Reef has faced an unprecedented combination of impacts, including two consecutive years of mass coral bleaching, outbreaks of coral disease and crown-of-thorns starfish, and a category 4 tropical cyclone which crossed reefs in the Whitsundays. The resulting decline in the ecological health of the Reef is unprecedented in our lifetime. It has focused attention on both climate change as the primary driver of change for the Reef, as well as the importance of resilience-based management actions to address the impacts of climate change. In turn, this has focused attention on the Reef 2050 Integrated Monitoring and Reporting Program as the key enabler of resilience-based management under the *Reef 2050 Plan*.

Establishing an integrated monitoring program across the Great Barrier Reef and its adjacent catchment — a vast area almost as big as New South Wales — is a major undertaking. It has required program managers and partners to navigate a wide range of complex and challenging issues — many of which are still being assessed — and draw together multiple environmental, social and economic monitoring and modelling programs. It has also seen many outputs and achievements to date.

To ensure the integrity of highly valuable long-term data sets, funds have been directed to filling monitoring gaps and ensuring data continuity. These include aerial dugong surveys, the Marine Monitoring Program, zoning plan, socio-economic and shoals monitoring. As well as contributing to program development, data from these activities will inform the 2019 Great Barrier Reef Outlook Report.

Projects have been commissioned to provide program managers and partners with a better understanding of management information needs. The outputs of these projects are helping guide program development to ensure they provide maximum benefit for Reef managers and the overall health of the Great Barrier Reef.

Program development work is continuing based on the Driver–Pressure–State–Impact–Response (DPSIR) framework. This will help coordinate and integrate core monitoring, modelling and reporting programs, and provide a holistic approach considering both biophysical and human dimensions of the Reef and its catchment.

Work is underway to develop the complementary program technical capability, including spatial data management, analysis, visualisation and reporting. This will enable integrated monitoring data to be used for management and reporting. Some of this work includes an audit of the data available for Reef management and how it is stored, which among other things sets the groundwork for negotiating data sharing agreements to support an operational Reef knowledge system.

Program managers recognise partners' and stakeholders' interest in the program and continue to communicate the program's purpose, challenges and progress.

Ongoing commitment from program managers and partners is essential to achieving the program's purpose.



Contents

Foreword	3
The Reef 2050 Integrated Monitoring and Reporting Program	6
Bringing knowledge together and making it easier to use	6
Knowledge system characteristics	7
Spatial scope	9
Guidance from the Integrated Monitoring Framework	9
Recognising relationships	10
Program delivery 2018–20	11
Evaluation and continual improvement from 2020	12
Progress against the Integrated Monitoring Framework	12
Communication and engagement	12
Appendix A – Program logic	14

The Reef 2050 Integrated Monitoring and Reporting Program

PURPOSE

The *Reef 2050 Long-Term Sustainability Plan* (Reef 2050 Plan) provides an overarching strategy for managing the Great Barrier Reef. It contains actions, targets, objectives and outcomes to address threats, and protect and improve the Reef's health and resilience while allowing ecologically sustainable use. The *Reef 2050 Plan* has been developed in consultation with partners, including Traditional Owners and industry, ports, fishing, agriculture, local government, research and conservation sectors.

Key to the *Reef 2050 Plan* is the establishment of the Reef 2050 Integrated Monitoring and Reporting Program (the program). The program will provide a comprehensive and up-to-date understanding of the Great Barrier Reef — the values and processes that support it and the threats that affect it. This knowledge is fundamental to informing actions required to protect and improve the Reef's condition and to drive resilience-based management.

There are currently more than 90 monitoring programs operating in the Great Barrier Reef World Heritage Area and adjacent catchment. These programs have been designed for a range of purposes and operate at different spatial and temporal scales. The comprehensive strategic assessments of the Great Barrier Reef World Heritage Area and adjacent coastal zone — both of which formed the basis for the *Reef 2050 Plan* — identified the need to ensure existing monitoring programs align with each other and with management objectives. The program will drive coordination of existing monitoring programs to fulfil this need.

The program will provide information across seven themes that make up the *Reef 2050 Plan* outcomes framework:



ecosystem health; biodiversity; water quality; heritage; community benefits; economic benefits and governance.

The intent of the program is not to duplicate existing arrangements, but to coordinate and integrate existing monitoring, modelling and reporting programs across disciplines. For example, the *Reef 2050 Water Quality Improvement Plan* underpins the *Reef 2050 Plan*'s water quality theme and its Paddock to Reef Integrated Monitoring, Modelling and Reporting Program will form a key part of the new integrated program.

Bringing knowledge together and making it easier to use

As the key enabler of resilience-based management under the *Reef 2050 Plan*, the program's primary purpose is to enable timely and suitable responses by Reef managers and partners to emerging issues and risks, and underpin the evaluation of whether the *Reef 2050 Plan* is on track to meet its outcomes, objectives and targets.

The program's vision is to develop a knowledge system that enables resilience-based management of the Great Barrier Reef and its catchment, and provides managers with a comprehensive understanding of how the Reef 2050 Plan is progressing.



GOALS¹

This knowledge system will be:

- **Effective** in enabling the early detection of trends and changes in the Reef's environment, inform the assessment of threats and risks, and drive resilience-based management.
- **Efficient** in enabling management priorities and decisions to be cost effective, transparent and based on cost-benefit and risk analyses.
- **Evolving** based on the findings of Great Barrier Reef Outlook reports, new technologies and priority management and stakeholder needs.

To achieve its purpose, vision and goals, the program will coordinate, align and integrate existing monitoring, modelling and reporting programs to provide a comprehensive and up-to-date understanding of the Great Barrier Reef system, including its values, the processes that support its values, and the pressures that affect them. In doing so it will also capitalise on existing program investment, provide value for money, improve efficiency and avoid duplication of effort.

The program will be central to ensuring decisions regarding the protection and management of the Great Barrier Reef are based on the best available science, transparent and accountable, and underpinned by a partnership approach.

Knowledge system characteristics

Market research undertaken to inform program development identified the information products desired by managers and other stakeholders.

The ideal product identified by more than 75 per cent of survey participants was a digital spatial data (mapping) platform that incorporates visual information through a web-mapping portal, includes a navigation tool as well as a function to access predictive information.

Recognising this need, the program will deliver web-based tools that inform reporting products and management/operational decision-making. These tools will seek to **consolidate monitoring and modelling data on the Reef's values in a platform that enables the data to be mapped and analysed (e.g. Figure 1).**

¹ As part of program planning, the program's three goals have been underpinned by a series of development (to 2018 and 2019) and implementation objectives. These objectives and their contribution to the program's goals, vision and purpose, are shown in Appendix A.

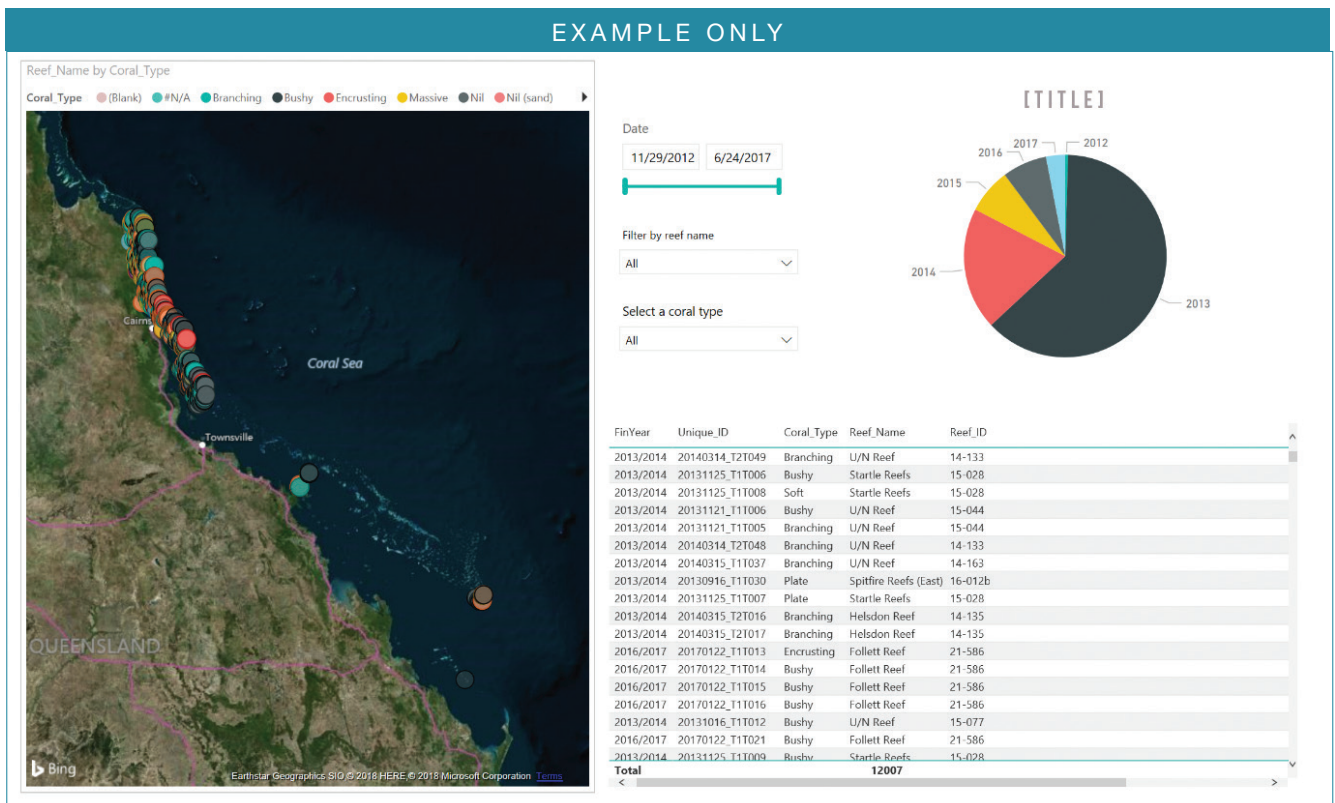


Figure 1. User interfaces will ideally provide access to consolidated monitoring and modelling data in a platform that provides mapping and an analysis feature/capability. Functionality is expected to evolve and expand over time.



Figure 2. Great Barrier Reef World Heritage Area and Reef catchment. The geographical scope of the program includes the Great Barrier Reef World Heritage Area (red line) led by the Great Barrier Reef Marine Park Authority and the adjacent catchment (orange line) led by the Queensland Government.

The platform will provide access to information for a broad range of reporting products such as compliance and incident reporting, environmental impact assessments, state of environment and management effectiveness. This system will inform reporting on the *Reef 2050 Plan* as well as reporting products such as the annual *Great Barrier Reef Report Card*, annual regional report cards and the five-yearly *Great Barrier Reef Outlook Report*, which in turn feeds into the review and continuous improvement of the *Reef 2050 Plan*.

The system will evolve to further enhance the use of predictive modelling. This will allow improved forecasting of environmental processes and changes, and facilitate better resilience-based management decisions. **The system will provide the best means of managing the Great Barrier Reef in the face of a changing climate.**

Spatial scope

The geographic scope of the program is the Great Barrier Reef World Heritage Area and its adjacent catchment (Figure 2) — a combined area as big as New South Wales. It builds on existing monitoring programs within this area which are currently used to inform marine park management. Among others these include the Great Barrier Reef Marine Park Authority’s Eye on the Reef program, programs undertaken by the Australian Institute of Marine Science and James Cook University to monitor the effectiveness of the *Great Barrier Reef Marine Park Zoning Plan 2003*, and the Paddock to Reef Integrated Monitoring, Modelling and Reporting Program that links the Reef catchment and Great Barrier Reef World Heritage Area.

Integrating monitoring programs across the catchment to the marine environment is complex but necessary to allow processes, changes and activities in the catchment to be linked to processes, changes and activities in the marine environment, and vice versa.

Importantly, **integration must also occur for both the environmental systems and processes, and the socio-economic and cultural systems and processes.**

For example, existing integration involves linking land management practices to water quality in rivers discharging to the marine system to the consequences for marine species and habitats. It then builds on this to also evaluate the subsequent benefits and costs of these changes for communities living in the catchment.

Guidance from the Integrated Monitoring Framework

The program’s development process follows the *Integrated Monitoring Framework for the Great Barrier Reef World Heritage Area* (the framework). The framework was the result of a 2013 project funded by the Australian Government through the Regional Sustainability Planning program. The project drew on expertise and networks from three National Environmental Research Program (NERP) Hubs (the NERP Marine Biodiversity Hub, NERP Tropical Ecosystems Hub and NERP Environmental Decisions Hub), the Great Barrier Reef Marine Park Authority and the Australian Institute of Marine Science. It provides the foundation for a standardised and integrated ecological, social and economic

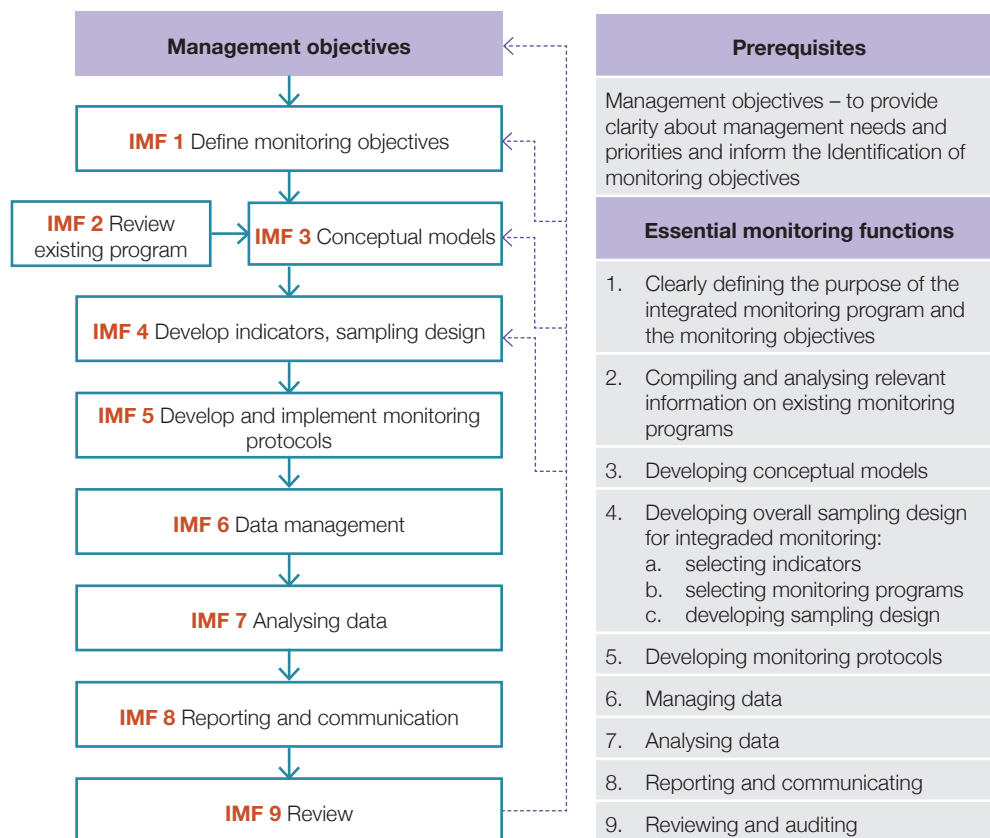


Figure 3. Prerequisites for monitoring and essential monitoring functions to be addressed based on the framework.

monitoring program. It identifies the steps to develop efficient and effective monitoring and reporting, and support management.

In doing so, the framework provides authoritative guidance and has been adopted as the foundation for program development.

Among other things, the framework identifies a series of processes to **ensure the integrated monitoring framework meets the evolving needs of managers**. As part of this it sets out the prerequisites for monitoring and the essential monitoring functions to be addressed, and explains what is required in each of these steps to integrate existing and future monitoring programs (Figure 3).

Recognising relationships

Following the recommendations of the *Integrated Monitoring Framework for the Great Barrier Reef World Heritage Area report*, the Driver–Pressure–State–Impact–Response (DPSIR) Framework (Figure 4) has been adopted as a unifying framework to characterise the Great Barrier Reef system. The use of the DPSIR framework helps bring together elements of a complex system where environmental, social and economic values are linked and interdependent.

The DPSIR framework helps to describe how **drivers** such as population and economic growth, technological development and climate change, give rise to **pressures** directly and indirectly through activities. **Pressures** – including sea temperature increase, cyclone activity and nutrients from catchment run-off (among many others) – affect the **state** of the ecological–human system which in turn **impacts** on human wellbeing. Management influences the system through **responses** that may be focused on **drivers, pressures or state**. By promoting appreciation, enjoyment and understanding of the Reef and catchment system, management can enhance community support for a mandate to implement response actions.

As well as facilitating integration of existing monitoring and modelling programs, the DPSIR framework helps guide the development of new indicators to monitor the condition, trend and resilience of the Reef’s components and processes. This will help to provide Reef and catchment managers with a better understanding of the cause-and-effect links between those components and processes.

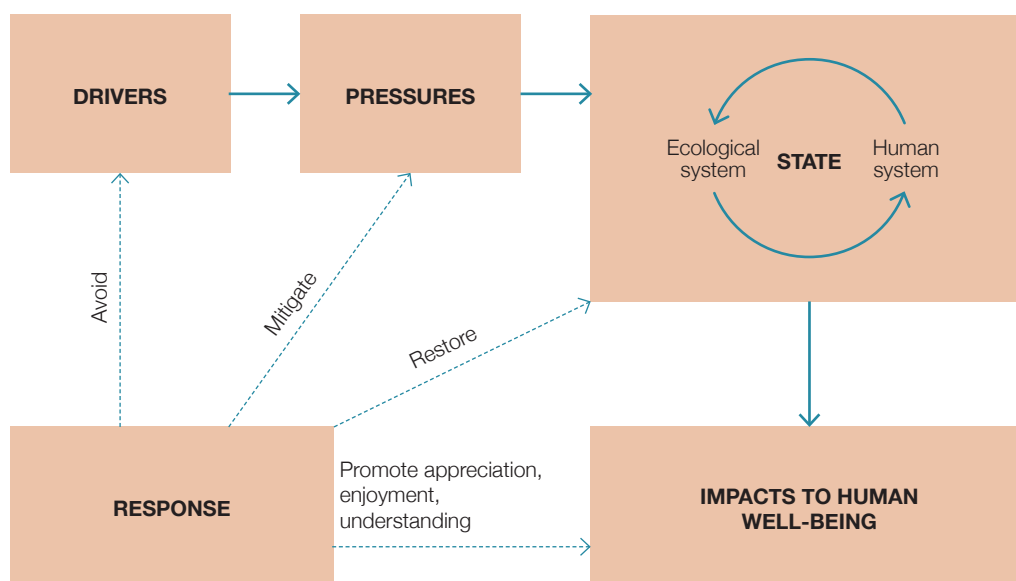
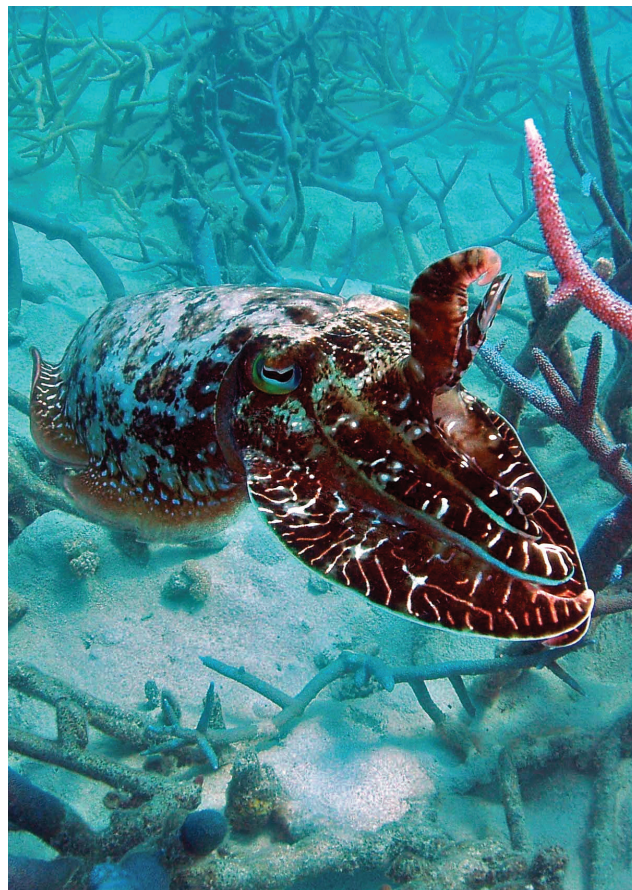


Figure 4. Driver–Pressure–State–Impact–Response framework. Monitoring of indicators provides an understanding of cause and effect relationships between DPSIR components (solid arrows), which in turn can inform management actions (dashed arrows).

Program delivery

2018–20

The program's vision is to develop a knowledge system that enables resilience-based management and informs assessment of outcomes achieved. The *Integrated Monitoring Framework for the Great Barrier Reef World Heritage Area* (the framework) (Figure 3) provides the foundation to achieve this vision.

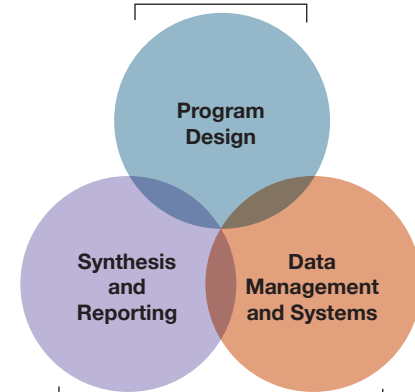
Program development began in 2016 and involves two distinct components:

1. Development of an integrated monitoring program for the Reef and its catchment (IMF 1–5).
2. Development of data management and other tools required to enable use of data for management and reporting (IMF 6–8).

To develop these components, program delivery is occurring across three parallel but related streams: program design, synthesis and reporting and data management and systems (Figure 5)².

The program design stream will deliver a proposed design for the integrated monitoring program in mid-2018. This proposed design will integrate the recommendations of expert groups that considered monitoring across 10 Great Barrier Reef and catchment themes including the physico-chemical environment, seagrass, coral, fish, megafauna, Indigenous heritage, human dimensions, catchment and estuaries, islands, and microbes. The final design will include priority monitoring indicators, and the methods, locations and frequency to measure indicators. It will also take into account feasibility, efficiency and priority in relation to management and monitoring objectives.

Development of an integrated monitoring program



Development of systems to enable the use of data for management and reporting

Figure 5. The program's vision involves two distinct components – development of an integrated monitoring program, and development of systems to enable data use. To develop these components, program delivery is occurring across three parallel but related streams (as above).

In parallel to the program design stream, work to establish the program's data management and systems infrastructure, and synthesis and reporting capability, is progressing and scheduled for completion by mid-2019. Work in these streams is interdependent because the capability to synthesise and report on data depends on how data is managed, including the platforms and systems that support data management.

Work in the data management and systems stream includes: developing protocols for managing culturally sensitive information, negotiating data sharing agreements including access, licensing and intellectual property arrangements, designing and evaluating data delivery mechanisms, and designing and evaluating prototype systems and interfaces.

2 More information on work packages within each of these streams can be found on the Great Barrier Reef Marine Park Authority's website.



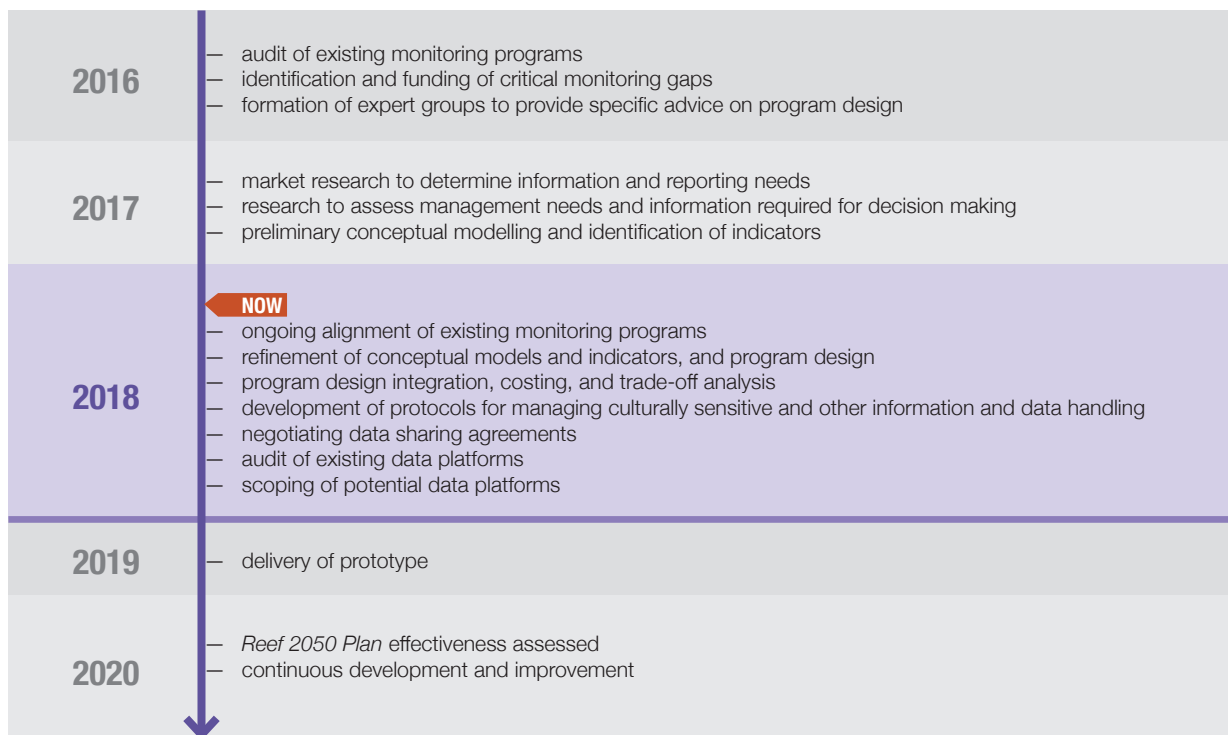


Figure 6. Major milestones achieved and work remaining for the period to 2020. Additional information about deliverables is included in the development and implementation objectives in the program logic (Attachment A).

Work in the synthesis and reporting stream includes: developing visualisations and web-based systems, mock-ups of reporting products, refining reporting requirements and core indicators, developing consistent approaches for data collection and aggregation into reporting metrics, and automation of synthesis and reporting products.

By 2019, the outputs of work across all three streams will be integrated to produce an operational prototype. The operational prototype — the first edition of the program's knowledge system — will help inform the first full review of the Reef 2050 Plan in 2020 (Figure 6).

Evaluation and continual improvement from 2020

The knowledge system delivered by June 2019 will be based on integrated on-ground monitoring and will provide managers with more comprehensive knowledge compared to what is currently available. While this will be a great leap forward, it will only be the first edition of the operational knowledge system and will improve over time.

Some of the opportunities for improvement have been mentioned earlier. For example, providing a predictive modelling capability will allow improved forecasting of environmental processes and changes. This capability is not expected to occur in the first system edition, but will evolve over time.

Issues that have arisen during program development provide other opportunities to improve the system. For example, many of the outcomes, targets and objectives in the Reef 2050 Plan can potentially be measured in a number of different ways, using different combinations of information (indicators), or different assumptions about process linkages or cause-and-effect pathways. While early editions of the knowledge system will provide information that will enable evaluations of progress towards Reef 2050 Plan outcomes, objectives and targets, the quality of that information — its comprehensiveness and degree of certainty — is expected to improve over time.

As part of implementation planning, an evaluation and continual improvement plan will be developed to ensure that the knowledge system evolves over time. This will include a process to ensure the science underpinning the program continues to be sound.

Progress against the Integrated Monitoring Framework

Table 1 (next page) indicates how program delivery aligns with the Integrated Monitoring Framework for the Great Barrier Reef World Heritage Area, based on progress as at May 2018.

Communication and engagement

Market research was undertaken to inform program development, and results assisted program managers and partners to understand the information needs and expectations of users. Commonly occurring themes identified during the market research included the large number and diversity of existing monitoring programs and products, the wide variety of stakeholder requirements and low levels of awareness of available information sources and products.

Among other things, the market research indicated effective communication with stakeholders about the program, its development and its current and future capabilities, is critical to successful implementation. In response to this, program managers established an [online communications tool](#) to provide clear and up-to-date information on the development and implementation of the program, as well as access to information about existing monitoring and modelling programs. In addition, standard communication products such as e-newsletters, steering group communiqués, monitoring videos, case studies and brochures will continue to be published.

Table 1: Progress against the Integrated Monitoring Framework

	Prerequisites	Summary of progress at May 2018
	Management objectives — to provide clarity about management needs and priorities and inform monitoring priorities and objectives	Complete – Management objectives are defined by the targets, objectives and outcomes prescribed in the <i>Reef 2050 Plan</i> . The <i>Reef 2050 Plan</i> includes all current and foundational management initiatives. In addition, work to synthesise and summarise management needs is guiding the development of monitoring objectives and program design.
	Essential monitoring functions	
Development of an integrated monitoring program for the Reef and its catchment	1. Clearly defining the purpose of the integrated monitoring program and the monitoring objectives.	Complete – The purpose of the program is defined in this document. The monitoring objectives are defined by the need to achieve this purpose with respect to the management objectives in the <i>Reef 2050 Plan</i> .
	2. Compiling and analysing relevant information on existing monitoring programs	Underway – Expert theme groups are preparing recommendations that will include a synopsis of existing monitoring programs, an evaluation of their adequacy and identification of gaps in current monitoring effort.
	3. Developing conceptual models	Underway – Expert theme groups have developed conceptual models or compiled existing ones. Recommendation reports that will include information on the current understanding of Reef and catchment systems are being prepared. These will include conceptual models and describe the relevant cause-and-effect pathways based on the Drivers Pressures State Impact Response framework.
	4. Developing overall sampling design for integrated monitoring; <ul style="list-style-type: none"> a. selecting indicators b. selecting monitoring programs c. developing sampling design 	Underway – Expert theme groups are preparing reports that will provide recommendations for monitoring design, including priority indicators, and the methods, locations, and frequency to measure indicators. These recommendations will be integrated into a final overall design that considers feasibility, efficiency and priority in relation to management and monitoring objectives.
	5. Developing monitoring protocols	Underway – To be completed as part of implementation planning. Suitability of existing monitoring protocols (i.e. instructions and standards for how data is collected, managed, analysed and reported) are being assessed. Further protocols will be developed pending resolution of final program design. Among other things, protocols will need to be sensitive to funding constraints and priority gaps, while addressing management and monitoring objectives.
Development of data management and other systems necessary to enable the use of data for management and reporting	6. Managing data	Underway – Prototype due to be completed by June 2019. Work to deliver the necessary infrastructure to display data, processes and standards that enable storage of data, and the discovery and access to data generated by the selected monitoring programs is underway. Some elements are progressing independent of program design and others are dependent on the final program design
	7. Analysing data	Underway – Prototype due to be completed by June 2019. Work to deliver the program’s data synthesis and reporting capability is progressing largely in parallel with the program design. Actual data analysis and preparation of reporting products will not commence until the program becomes operational.
	8. Reporting and communicating	Underway – Due to be completed by June 2019. Work to deliver the program’s reporting capability is progressing largely in parallel with the program design work and is expected to be complete in 2018–19. Reporting and communication of monitoring results by the program will not commence until the program becomes operational in 2019. In the meantime, reporting and communication of monitoring results will continue to be undertaken through report cards, the forthcoming Outlook Report 2019 and through existing monitoring programs.
	9. Reviewing and auditing	Not yet commenced – Review and audit of program effectiveness will occur on a regular basis when the program is operational.



APPENDIX A - PROGRAM LOGIC

PROGRAM LOGIC			
PURPOSE	To enable timely and suitable responses by Reef managers and partners to emerging issues and risks and enable the evaluation of whether the <i>Reef 2050 Long-Term Sustainability Plan</i> (Reef 2050 Plan) is on track to meet its outcomes, objectives and targets.		
	Production of a knowledge system that enables resilience-based management of the Great Barrier Reef and its catchment, and provides managers with a comprehensive understanding of how the <i>Reef 2050 Plan</i> is progressing.		
VISION OF SUCCESS	An effective knowledge system that enables the early detection of trends and changes in the Reef's environment, informs the assessment of threats and risks, and drives resilience-based management.		
	An efficient knowledge system that enables management priorities and decisions to be cost effective, transparent, and based on cost-benefit and risk analyses.		
GOALS	An evolving knowledge system based on the findings of Great Barrier Reef Outlook Reports, new technologies and priority management and stakeholder needs.		
	Fit-for-purpose By June 2020, the program is being used by managers to inform/guide management decisions, planning, actions and evaluation.		
IMPLEMENTATION OBJECTIVES (AFTER 2019)	Cost-effective By June 2020, long-term program, funding is secured to ensure <i>Reef 2050 Plan</i> evaluation objectives can be met.		
	Fit-for-future By June 2020, the program is being used by partners to help inform the review of the <i>Reef 2050 Plan</i> targets.		
	Inform the <i>Reef 2050 Plan</i> evaluation and review: Effectiveness of the <i>Reef 2050 Plan</i> including progress towards outcomes, objectives and targets is assessed.		
	Maximise investment outcomes: Funding will be prioritised based on cost-benefit, risk and trade-off analyses to meet management needs.		
	Fit-for-future The program should be future focused and its lifespan should be at least as long as the planning horizon, and natural and anthropogenic pressures it is designed to evaluate.		
	Detecting change: Early detection of trends and changes in the Reef region informs the timely assessment of key threats, future risks, cumulative effects and impacts to inform adaptive management.		
DEVELOPMENT OBJECTIVES (BY 2019)	Prioritisation: Monitoring, modelling and reporting will be integrated and coordinated to inform priority management decisions.		
	Monitoring, evaluation, reporting and improvement: The program should be reviewed on a regular basis and include means for continual improvement. This includes but is not limited to reviews in response to the findings of the Great Barrier Reef Outlook reports every five years.		
	Useability: Data and information is reliable, understandable and available in appropriate formats within required timeframes.		
	Accessibility: Program information is discoverable, easily accessed, well-documented and transparent through a well-supported knowledge management system.		
	Effective governance: The governance structure will be periodically reviewed by program partners to ensure the effective implementation and improvement of the program.		
	Research and development: Critical knowledge gaps that limit program and management effectiveness are identified and prioritised to guide research investment.		
DEVELOPMENT OBJECTIVES (BY 2019)	Research and development: Reef research and development priorities will be based on critical knowledge gaps identified by the program.		
	Research and development: Research and modelling will underpin the program so it can adapt to changing pressures, environmental conditions and knowledge, and inform better understanding of the effect of management changes.		
	A prototype guidance system that demonstrates how integrated monitoring can inform resilience-based management of coral reef ecosystems.		
The program will coordinate, align and integrate accessible monitoring, modelling and reporting programs to capitalise on existing program investment, provide value for money, improve efficiency and avoid duplication of effort.			
Existing governance arrangements for component programs have been reviewed and a plan for their integration is in place.			
Reef and regional report cards drawing on data from multiple sources (AIMS Long-term Monitoring Program, Paddock to Reef program, Eye on the Reef program, Social and Economic Long-term Monitoring Program and eReefs information) are developed.			
Data sharing agreements have been negotiated.			
The governance structure for the operational program has been developed and endorsed.			
Baseline values mapping has been completed for Great Barrier Reef.			
Monitoring for highly valuable long-term data sets is funded to ensure data continuity.			

PROGRAM LOGIC

↑
DEVELOPMENT OBJECTIVES
(BY 2018)

Program design recommendations show how integrated monitoring will be explicitly linked to management needs, and the <i>Reef 2050 Plan</i> targets, objectives and outcomes.	A fit-for-purpose integrated monitoring and modelling program design is agreed and costed.	The governance structure including a technical working group is refined and endorsed by partners to ensure the effective development of the program.
Program design recommendations show how monitoring, research and modelling will be explicitly linked through the Driver- Pressure-State-Impact-Response framework.	Data accessing, licencing and IP arrangements and challenges have been identified.	The secretariat supports the governance of the program.
Management requirements for the knowledge management and guidance system will be scoped.		The program is supported by a group of partners that are committed to and are advocates for the program.
Scoping opportunities to use environmental exposure and connectivity layers to identify a network of resilient reefs.		



FOUNDAITONS

Supporting existing Reef management, decision making and reporting								
Monitoring programs	Communication and engagement	Stewardship and partnerships	Field management	Science coordination	Fill key monitoring gaps	Continuous improvement	Governance	Integrated monitoring and decision-making framework



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