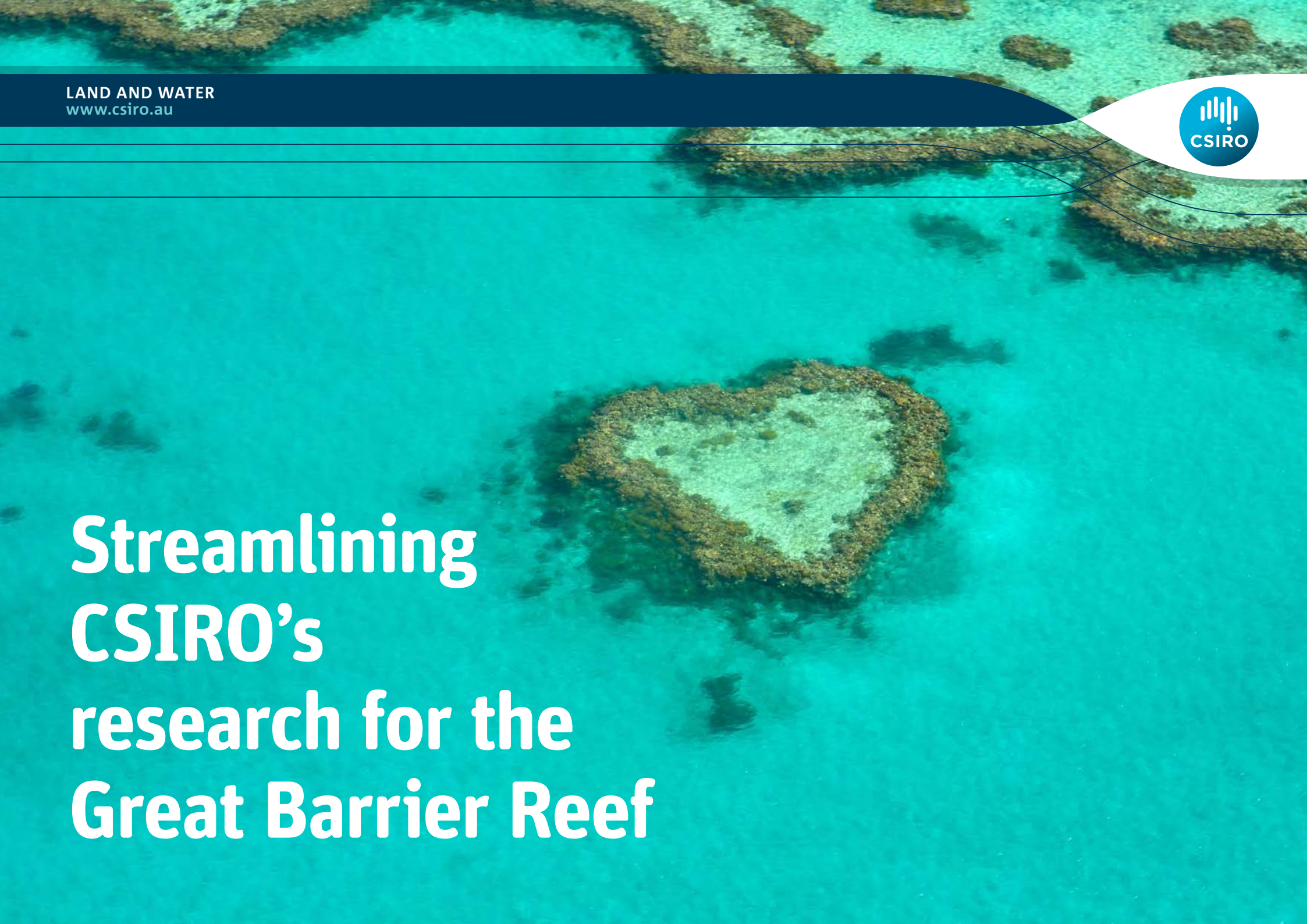

LAND AND WATER
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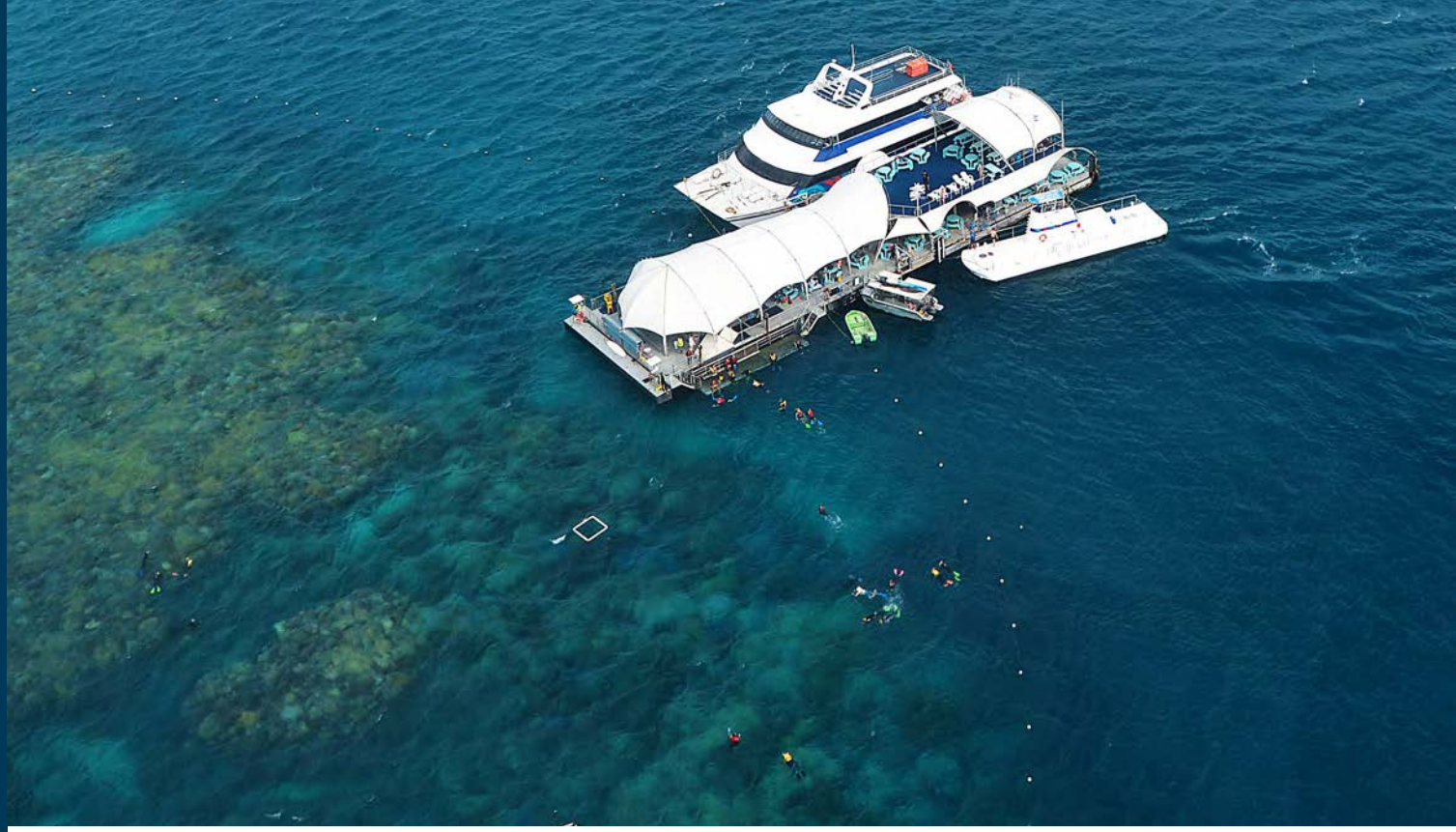
Streamlining CSIRO's research for the Great Barrier Reef

Background

Covering an area of 348,000 square kilometres, the Great Barrier Reef (the Reef) is the world's largest coral reef system. Larger than Great Britain, it comprises about 3,000 reefs and extends 2,300 kilometres along the Queensland coast. The Reef was listed on the World Heritage Register in 1981 on the basis of its Outstanding Universal Value, particularly its "exceptional natural beauty and aesthetic importance", and as an outstanding example "representing significant ongoing ecological and biological processes". While the corals that build reefs are the most visible natural 'value' in the Reef ecosystem, it is the Reef ecosystem as a whole (including seagrasses, mangroves, sandy and muddy communities, coastal wetlands, islands and continental slope depths) that is important. It is this broader ecosystem that is recognised in the World Heritage Area listing[1].



The contribution of the Reef to both the Queensland and Australian economy is estimated to be close to $6 billion a year, generating over 69,000 jobs across the tourism, recreation, commercial fishing, scientific research, and management industries. Agriculture is a dominant land use in the catchments adjacent to the Reef, employing over 35,000 people and contributing about $3.7 billion a year in gross value of production1.

For decades, the Reef has been regarded as the best managed coral reef in the world as a result of many years of joint management by the Australian and Queensland governments and collaboration with the full range of stakeholders. Despite increasing investments by both governments, the overall state of the Reef has been declining, mainly due to the cumulative effects of poor water quality entering the Reef lagoon from adjacent catchments, outbreaks of Crown-of-thorns starfish, cyclone damage, coastal development, fishing and tourism. More recently, these pressures have been exacerbated by coral bleaching, the result of a warmer ocean, caused by climate change.

In response to the growing pressures, the Australian and Queensland governments released the Reef 2050 Long-Term Sustainability Plan ('Reef 2050 Plan') in 2015[2]. It provides a 35-year blueprint for managing the Reef and represents the policy cornerstone for safeguarding the Reef, guiding government investment in protecting the Reef. Based on the actions and priorities described in the Reef 2050 Plan, we estimate that governments are contributing around $200 million a year to improve the resilience of the Reef. This level of investment is expected to continue.

The challenge

The loss of 50 per cent of the Reef's coral cover in consecutive bleaching events in 2016 and 2017 as a result of global warming is unprecedented[3]. The Reef has irrevocably changed and we need a paradigm shift in how we think about protecting it – it is a call for urgent, stepped-up action on multiple fronts. The Reef 2050 Plan provides the framework that guides policy responses, but it needs the support of Australia's world-class research capability, across multiple organisations, so that we can maximise the Reef's ability to recover. Achieving Reef 2050 Plan's implied goal of preserving the Reef's ecological function by 2050—not just that of its coral reefs, but all its ecosystems—is a highly complex challenge that requires more than simple solutions and multiple levels of governance.

Over the past two decades, CSIRO has had a significant presence in Reef-related research, with notable scientific achievements and good industry and policy-relevant outcomes. These achievements required a wide range of capabilities, primarily in agricultural production, natural resource management and estuarine and marine science. However, apart for a few clusters of coordinated activities involving small numbers of individual researchers or teams, our work has been fragmented, with poor strategic linkages across the boundaries of former CSIRO Flagships, opportunistic partnerships with other research institutions, and compartmentalised engagement with stakeholders. As a consequence of this:

- we were unable to pursue a broader systems approach
- we missed an opportunity to bring new ways of thinking and expertise
- we added less value to past investments than we otherwise might have
- mixed messages emanated from different parts of CSIRO and from the wider research community engaging individually (or competitively) with Reef stakeholders
- CSIRO was perceived as 'missing in action'
- stakeholders engaging with us and translating research outputs into policy and on-ground actions found the workload heavy and the process inefficient (cost, human resources, governance).

Against this backdrop, the challenge for CSIRO is to transcend the past piecemeal approach that led to suboptimal outcomes, help forge stronger partnerships, and ensure that we better integrate the breadth of science and convey it in a much more meaningful way to land managers and policymakers.

The response

Streamlining our Reef-related research and engagement

In response to the above challenge, in 2016 CSIRO Land and Water assumed leadership for streamlining CSIRO's Reef-related research, appointing a dedicated Reef coordinator, Christian Roth, supported by an effective cross-business-unit governance arrangement and support team.

Much of CSIRO's Reef-related research is done through the Land and Water (L&W), Agriculture and Food (A&F) and Ocean and Atmosphere (O&A) business units, with smaller contributions from Data61 and Manufacturing. The Reef Coordinator began by mapping recent and ongoing CSIRO research, finding only partial overlaps. Overall, our present research expenditure is in the order of $31 million, of which $10 million is externally funded, and with a similar quantum in opportunities in the pipeline. Roughly 43 per cent of the externally funded research is managed through L&W, with about 35 per cent and 22 per cent managed through O&A and A&F respectively. Most activities have been or are being implemented through a single business unit. Some of the multi-business-unit activities, in particular those involving Manufacturing, Data 61 and A&F, are a direct result of the establishment of Future Science Platforms, which account for a large portion of CSIRO internal funds. In other cases, greater cross-business-unit collaboration over the past two years has been facilitated by the Reef coordinator (e.g. RRAP, Reef 2050 Plan work, MIPs).

The Reef coordinator also systematically analysed internal and external stakeholders to understand how well CSIRO research outputs aligned with their needs. With a single coordination interface, we were able to quickly lift our engagement with all key stakeholders, which has broadened and deepened our critical partnerships.

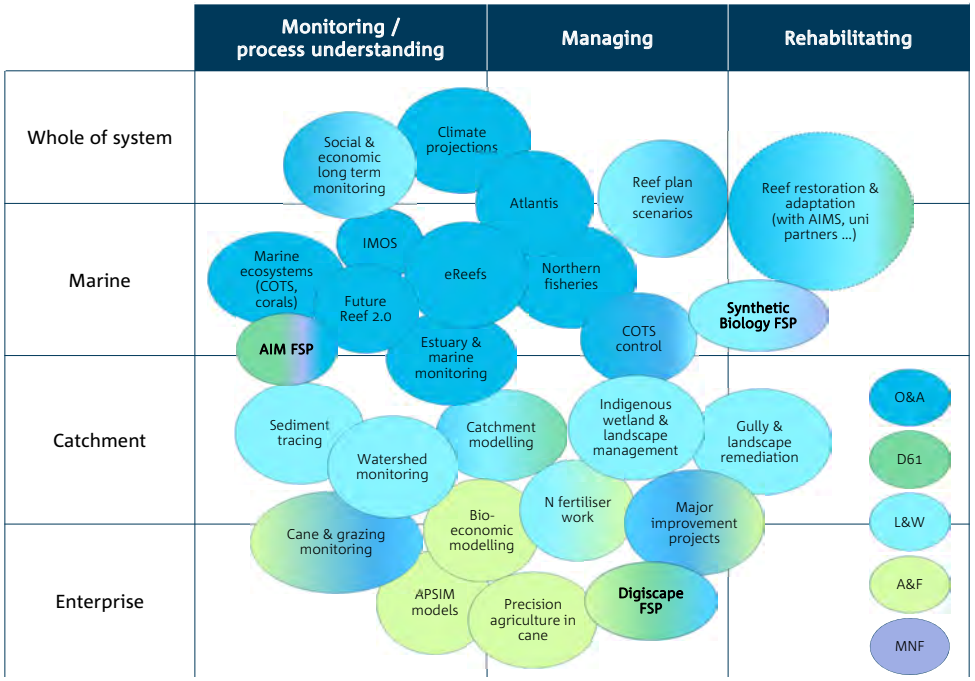


Figure 1: CSIRO's recent and current Reef-related research.

O&A – Oceans and Atmosphere
D61 – Data 61
L&W – Land and Water
A&F – Agriculture and Food
MNF – Manufacturing
FSP – Future Science Platform

Partnering with government for impact at scale

While CSIRO has a strong history of providing effective policy advice in the Reef space, in the absence of a comprehensive integrated system spanning the catchment to the ocean, and the human dimension to biophysical domains, our advice to date has largely been domain-specific and confounded by multiple voices and mixed messaging. The Reef Coordinator is providing a clear CSIRO–government interface and is shifting the engagement towards desired outcomes rather than pushing the science i.e. we are 'putting the client first'. For example, our advice on the review options of the Reef 2050 Plan[4] has led to material changes in how the plan is being framed and has determined what underpinning foundational science will be required for the next major review of the plan in 2020. We also provide ongoing advice on Reef Trust investments. As a result, CSIRO has now re-positioned itself as the trusted advisor to both federal and state governments on Reef matters.

Forming research coalitions

CSIRO's ability (and that of other research institutions) to conduct long-term, strategic and systems-based research is constrained by the fragmented and sectoral funding environment in the Reef space. In the past, this resulted in relationships between research organisations tending to be more competitive than collaborative, leading to suboptimal outcomes. Accordingly, a key thrust of L&W's Reef coordination role has been to proactively foster a consortium approach, initially with the Australian Institute of Marine Science (AIMS) and James Cook University (JCU). Successes to date include the joint support by CSIRO and JCU of the design and implementation phases of the Major Improvement Projects (MIPs) funded by the Queensland Government; the joint project on providing advice on Reef Plan 2050 review options[4]; and the formalising of a research coalition in the AIMS-led Reef Restoration and Adaptation Program.

Practice change happens in communities

Past Reef research aimed at helping land managers change their practices—in particular to help canegrowers export less nitrogen to the Reef and graziers export less sediment—was largely focused on techno-centric solutions. The determinants of behavioural change and the role of governance in enabling or constraining social change were not considered, which meant that adoption of technologies to reduce the amount of pollutants exported to the Reef has been below levels required to achieve water quality targets set in the Reef 2050 Plan. Our response has been to materially engage in the design and implementation of the Queensland Government's two MIPs in the Wet Tropics and the Burdekin Basin[1]. The MIPs are a highly innovative approach at integrating social and institutional research with land manager practice change to drive landscape repair.

A deeper partnership with Traditional Owners

Traditional Owners now manage more than one third of the Reef catchments and adjacent sea country. Until very recently, Traditional Owners had no voice but they are now seeking a seat at the policymaking table and a substantive role in shaping their livelihood opportunities in the Reef. CSIRO, together with AIMS and JCU can build on the good relationships we have forged with many Traditional Owner groups on Cape York Peninsula and the Torres Strait Islands. Under the auspices of the Reef 2050 Plan, CSIRO is partnering with other organisations to develop an inclusive Traditional Owner engagement strategy, converging the Reef preservation agenda with new Indigenous economic and livelihood opportunities—this represents a new science and partnership frontier.

Impact pathways

L&W's Reef coordination role is also responsible for providing critical thought leadership in integrating CSIRO's Reef research portfolio and non-CSIRO Reef research into an explicit impact pathway framework aligned with the Reef 2050 Plan. As outlined in Figure 2, this framework requires the concurrent and coordinated mobilisation of four primary research-based response pathways:

1. Significantly step up ongoing investments and actions to reduce pollutants exported from agricultural land in catchments adjacent to the Reef, and repair damaged landscapes.

2. Rebuild coastal wetland function and connectivity with the Reef.

3. Further strengthen the Great Barrier Reef Marine Park Authority's world-class management of cumulative impacts from land use, development, tourism and fisheries.

4. Implement a major new initiative to proactively restore damaged ecosystems, focusing on coral reefs.

Alone, none of these response pathways is enough to meet the goal in 2050. Moreover, success is predicated on drivers external to the Reef, such as global warming being curtailed to much less than 2oC and increased regional economic development having no net detrimental impacts on environmental values.

Pathways 1, 2 and 3 build on a substantial body of research, much of which originates from decades of CSIRO-led research. While some targeted research is required, our focus will be on defining and leading the cross-cutting activities. On the one hand, the Reef coordination role is a platform for enabling a one-CSIRO approach and for catalysing research coalitions. On the other hand, CSIRO's research leadership capability positions us well to synthesise the existing body of knowledge into a suite of cross-cutting research domains. In particular, social and institutional research needs to underpin the streamlining of Reef governance arrangements and policy delivery in a way that empowers local action and behavioural change. In addition, we can capitalise on major outcomes already achieved with eReefs and other modelling frameworks developed in the O&A business unit, which uniquely positions us to lead the field in developing and using next-generation, modelling-based decision-support tools and risk assessments to, for example, explore likely trajectories of change and their policy trade-offs.

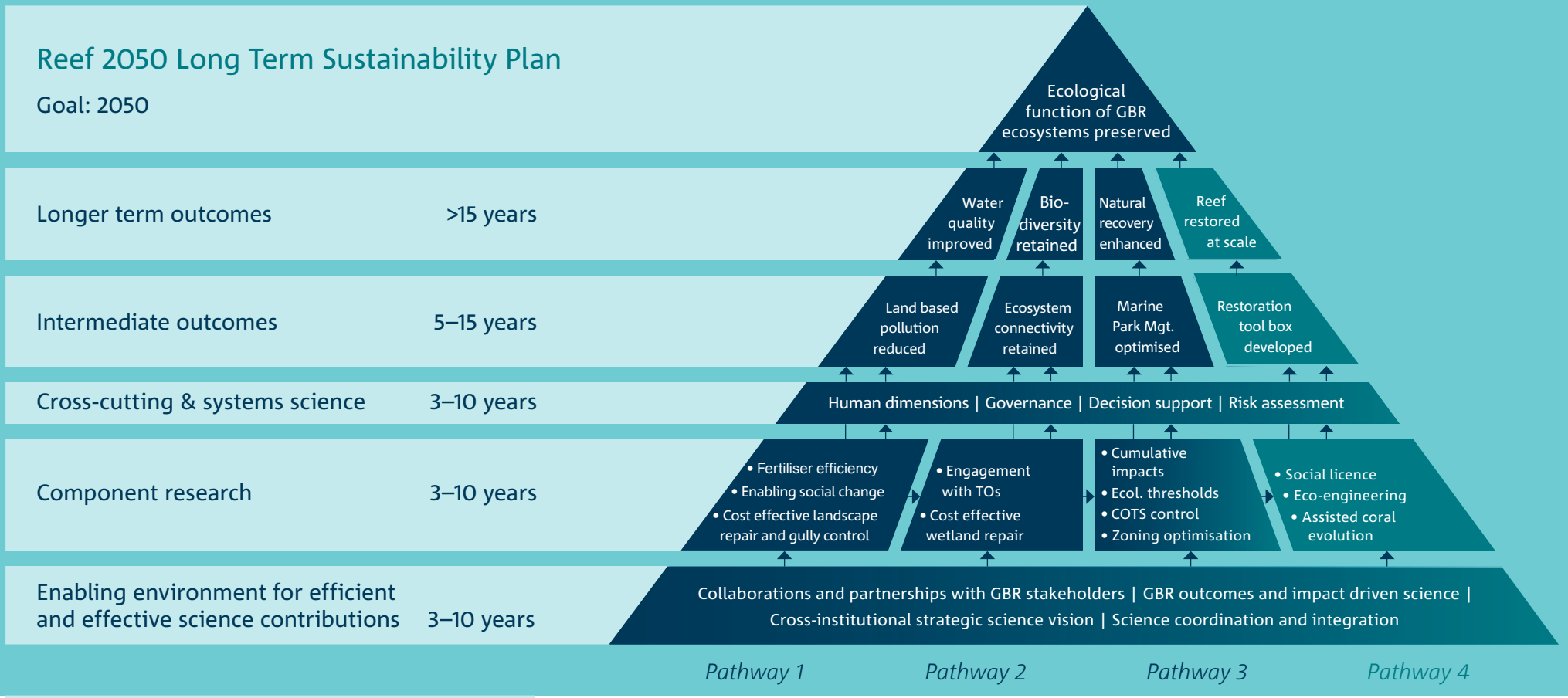


Figure 2: Research impact pathways for achieving the outcomes and long-term goal of the Reef 2050 Plan.

Note that Figure 2 only depicts the contribution of research to achieving the Reef 2050 Plan, not the wider set of Government, community and industry actions.

- Stepping up existing research
- New national reef restoration mission

Pathway 4 is new. To proactively restore the Reef we will need to significantly ramp up research in non-traditional domains (assisted evolution of corals, material sciences, automation, synthetic biology, social licence), drawing on marine ecological research and using the same cross-cutting decision-support and risk-assessment tools to evaluate the technical feasibility, ecological efficacy and social acceptance of restoration options. Intermediate outcomes for this response pathway will likely be achieved later than for the other three pathways.

This entire venture will require a broad-based partnership between federal, state and local governments, industry, community groups, Traditional Owners and research institutions—a partnership that will evolve from the stakeholder engagement mechanisms already in place under the Reef 2050 Plan. Decisions about research design, priorities and investment will need to be supported by a new, independent Reef research governance structure that is responsive, flexible and capable of fast-fail / stop-go decision-making. CSIRO has a core role in facilitating the development of such a research governance structure.

Interim feedback from Reef stakeholders

Creating a Reef coordination role as a mechanism to enhance the relevance and usefulness of its science delivery and impact is a new approach for CSIRO. Therefore, to ensure that this strategic investment is effective and its value maximised, it is being continually evaluated. A key part of this process is soliciting feedback from both internal (CSIRO) scientists and managers and external collaborators and implementing partners, using a set of guiding questions (Figure 3). The first set of interviews were carried out in February–March 2018 with key external stakeholders from the Commonwealth and Queensland governments, research institutions, research brokering entities, regional NRM bodies, and independent consultants and policy advisors. Through this process we have captured feedback on achievements; what is working well and not so well; challenges and opportunities; and suggestions for what can be done better.

Figure 3: Interview questions posed to elicit internal and external stakeholder perspectives on the value of our approach to coordinating Reef research

BACKGROUND 1

1) In your view, what is CSIRO's GBR coordination role about? What are the issues, challenges or needs that are being addressed?

OUTCOMES AND IMPACTS 2

2a) In your opinion, what difference, if any, has the CSIRO GBR coordinator made in the GBR space?

2b) Can you give specific examples and explain why they are important?

UNDERSTANDING HOW/WHY 3

3) What is it about the CSIRO GBR coordinator role or the GBR coordination efforts more broadly that made the changes you mention possible?

CONTEXT 4

4a) What do you think are the greatest challenges or bottlenecks that CSIRO's coordination efforts in the GBR face?

4b) Is there anything that has helped, or has the potential to help, CSIRO tackle or overcome some of these challenges?

REFLECTIONS & LESSONS LEARNT 5

5a) In hindsight, is there anything you think could or should have been done differently? Why?

5b) Has anything surprised you (good or bad)?

5c) If CSIRO had not funded the GBR Coordination role, what would be different?

5d) Has this experience with CSIRO's GBR coordination efforts more broadly made you and/or your organisation/agency/department/BU think about or do things any differently? If so, how?

FUTURE DIRECTIONS 6

6a) In your opinion, what/where should the CSIRO's GBR Coordination efforts focus on moving forward?

6b) What do you think is the one most critical thing that is needed for the GBR Coordination role to continue making a difference?

OTHER 7

7a) Is there anything else you would like to add? Any additional reflections?

7b) Who else would you suggest I talk with?

Results of stakeholder interviews

A synthesis of the results of the interviews, particularly in relation to questions 1, 2 and 6, is tabulated in Table 1.

TABLE 1. SYNTHESIS OF INTERVIEW RESPONSES FROM EXTERNAL STAKEHOLDERS, AGGREGATED INTO THREE MAJOR GROUPS.

INTERVIEW TOPIC	STAKEHOLDER GROUPING		
	GOVERNMENT (N=5)	RESEARCH ORGANISATIONS (N=4)	OTHER STAKEHOLDERS (N=5)
Issues / challenges CSIRO GBR coordination is addressing (Q1)	• Fragmentation of science within CSIRO and among other scientific organisations working in the GBR • Challenging for outsiders to engage with CSIRO	• Overcoming insularity in GBR research space • Mixed messages being sent in regards to collaborations, joint projects and approaches in the GBR	• Challenging for outsiders to engage with CSIRO • Complexity of CSIRO structure and internal competition within CSIRO
Opportunities CSIRO GBR coordination is providing (Q1)	• CSIRO input to strategic policy, planning and programme delivery processes • New science in GBR work • CSIRO has deeper oversight of what is going on in the GBR	• CSIRO possesses a lot of the expertise and new thinking needed for effective change in the GBR	• Helping manage complexity of institutional arrangements and stakeholders in the GBR • Facilitating collaboration between multiple research organisations
Outcomes and potential for impact (Q2)	• Avenue for Gov to engage more strategically with CSIRO; trusted, key point of contact • Increased connections between CSIRO work and Gov programs • Strengthening of policies, planning and programs improving Government's position on the GBR • Efficiency gains (AGov) through streamlined engagement	• Consistency of messages from CSIRO • Sharpened research sector's point of coordination and integration of its contribution to the GBR • Instigated new collaborations • Increased efficiency of engagement with CSIRO scientists	• Improved reputation of CSIRO • CSIRO at "more tables" in the GBR • Reduced inter-institutional rivalry between CSIRO and other organisations in their engagement with stakeholders
Specific activities and outputs that have made a difference (Q2)	• Strategic and consistent input to GBR governance bodies (Reef Advisory Committee; Reef Integrated Monitoring and Reporting Program - RIMReP) • Advice provided on Reef 2050 review options and recommendations for foundational research[4] • Fostering consortium approaches in response to government tenders or initiatives involving CSIRO, AIMS and JCU (4) • CSIRO input to the GBR Science Consensus Statement[5]	• Explaining GBR context to scientists in CSIRO; other scientists in CSIRO well-informed • Facilitating CSIRO-JCU-AIMS partnerships (eg QGov Major Improvement Projects - MIPs; Reef 2050 Plan review options tender; Reef Restoration and Adaptation Program - RRAP) • Increased connectivity with eReefs team	• Coordination of relationships with other research institutions, particularly JCU, AIMS, and CSIRO; common costings framework for CSIRO, JCU, and AIMS • Advice provided on Reef 2050 review options • Facilitation of convergence between land / NRM managers and research institutions in MIPs design and implementation
Future directions – focus (Q6)	• Foundational research to prepare for the full-scale review of the Reef 2050 Plan in 2020 • Continue to provide leadership in the RRAP • Facilitate the development of an integrated research plan for the GBR • Support the further development and implementation of the RIMReP	• Successfully take the RRAP from business case to implementation phase • Continue the integration of CSIRO catchment-to-reef capability and research	• In preparation for the Reef 2050 Plan review in 2020, provide deliberative thinking about what should be the look and shape of the Plan • Wrapping up RIMReP – provide input on final sets of trade-offs around program design • Retain focus on RRAP and eReefs
Future directions – activities to keep making a difference (Q6)	• Retain consistency and continuity of the CSIRO coordination role and its engagement with key GBR governance bodies; broaden the network • Deepen understanding of operational needs of marine management	• Retain ongoing investment in coordination role • Remain engaged in governance and research fora • Consolidate the consortium approach and deepen relationship with AIMS and JCU	• Retain ongoing investment in coordination role • Be more selective on how and where to engage

Overall, there was very strong and consistent support for CSIRO's coordination and science leadership role and a broad-based confirmation of the value it was starting to provide to external stakeholders. There was also a good degree of convergence between the different stakeholder responses. Given it is only 18 months since the Reef coordination role was formally established, we judge this to be a significant outcome and, provided we continue and deepen our engagement, we have a high degree of confidence that we will achieve the anticipated outcomes, thereby materially contributing to safeguarding the Reef.

The interviews also provided clear signals about the future focus of CSIRO's Reef-related research from the stakeholders' perspectives.

Future directions

Climate change has already changed the Reef and its impacts on the Reef are expected to increase. Maintaining the Reef's values and function is a complex challenge—we will require sophisticated approaches to better understand how actions in the catchments and the marine environment will interact with climate change impacts to determine the health of Reef ecosystems. We will need to pay more attention to the logic of identifying actions and responding to changes as they occur.

In response this challenge and in alignment with the feedback from our stakeholders (Table 1), over the next 3–5 years we foreshadow the following three interlinked research domains in which CSIRO is uniquely positioned to provide national science leadership:

1. **Systems science to underpin the management of the Reef and support the 2020 review of the Reef 2050 Plan**
   - Develop a more refined understanding of change trajectories of the Reef, in particular how climate change impacts and other cumulative impacts will play out spatially.
   - Understand ecological thresholds required to preserve ecosystem function and integrate these into a framework to inform a revised set of ecosystem targets.
   - Broaden our understanding and integration of human dimensions (particularly those related to community, and improvements in economic and systemic governance) to improve Reef outcomes and underpin a more effective delivery of Reef 2050 Plan interventions.
   - Develop a more consistent set of theme-based program logics in the Reef 2050 Plan, in conjunction with designing a more meaningful Traditional Owner and stakeholder engagement process, offering the base to more explicitly prioritise actions in the plan.

A common principle across all three domains is the recognition that CSIRO will need to continue to consolidate research partnerships, in particular with AIMS and JCU, and, where necessary, expand these partnerships to include other research organisations, as well as pursuing more, ongoing engagement with key stakeholders.

2. **Evolution of the Reef Integrated Monitoring and Reporting Program (RIMReP) into a fully-fledged Reef decision-support system with predictive capability**
   - Develop frameworks and tools that rationally and efficiently allow trade-offs to be made between the nature and purpose of the monitoring data, its value and the cost of acquisition.
   - Develop next-generation automated, more cost-effective monitoring systems.
   - Develop next-generation modelling frameworks (building on the eReefs platform) that enable more seamless modelling of the catchment-marine continuum and in which socio-ecological trajectories and climate change projections can be incorporated with computational efficiency.

3. **Design and implementation of the Reef Restoration and Adaptation Program (RRAP)**
   - Evolve and apply modelling platforms such as eReefs and CONNIE to analyse the feasibility of restoration strategies for a range of climate change scenarios.
   - Investigate what factors and processes will help achieve social acceptability of a wide range of restoration interventions.
   - Determine the best approaches to engaging key Reef stakeholders in the design phase as well as the implementation.
   - Integrate the modelling outcomes and the social research into decision-support frameworks that guide future allocations of research investments in the RRAP.

References

1. Great Barrier Reef Water Science Taskforce 2016, Great Barrier Reef Water Science Taskforce, Full report - May 2016, Office of the Great Barrier Reef, Department of the Environment and Heritage Protection, Brisbane. https://www.ehp.qld.gov.au/assets/documents/reef/gbrwst-finalreport-2016.pdf.

2. Commonwealth of Australia, 2015, Reef 2050 Long-Term Sustainability Plan, Canberra. http://www.environment.gov.au/system/files/resources/d98b3e53-146b-4b9c-a84a-2a22454b9a83/files/reef-2050-long-term-sustainability-plan.pdf

3. Australian Institute of Marine Science 2016, Coral bleaching events, GBRMPA, Townsville. https://www.aims.gov.au/docs/research/climate-change/coral-bleaching/bleaching-events.html

4. Roth, CH, Addison, J, Anthony, K, Dale, A, Eberhard, R, Hobday, A, Horner, NJ, Jarvis, D, Kroon, K, Stone-Jovicich, S & Walshe, T 2017, Reef 2050 Plan Review Options - Final Report, Submitted to the Department of the Environment and Energy, Canberra. http://www.environment.gov.au/system/files/resources/3ae3225f-eb5c-418b-8889-e523a4fbb4e5/files/reef2050-plan-review-options-final-report.pdf

5. Waterhouse, J, Schaffelke, B, Bartley, R, Eberhard, R, Brodie, J, Star, M, Thorburn, P, Rolfe, J, Ronan, M, Taylor, B & Kroon, F 2017, Scientific Consensus Statement 2017: A synthesis of the science of land-based water quality impacts on the Great Barrier Reef, : State of Queensland, Brisbane. https://www.reefplan.qld.gov.au/about/assets/2017-scientific-consensus-statement-summary.pdf

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WE COLLABORATE
WE INNOVATE

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