



Photo by: Matt Curnock

CSIRO's Research Impact in the Great Barrier Reef Independent Findings



Prepared by RTI International

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Prepared for

**CSIRO Great Barrier Reef Steering Committee
CSIRO Strategy's Performance and Evaluation Team**

41 Boggo Road, Dutton Park, Queensland 4102,
Australia

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List of Acronyms

AIMS	Australian Institute of Marine Science
AUD	Australian dollars
BCR	benefit-cost ratio
BoM	Bureau of Meteorology
CBA	cost-benefit analysis
COTS	crown-of-thorns starfish
CSIRO	Commonwealth Scientific and Industrial Research Organisation
FY	fiscal year
GBR	Great Barrier Reef
GBRF	Great Barrier Reef Foundation
GBRMPA	Great Barrier Reef Marine Park Authority
IPM	integrated pest management
JCU	James Cook University
QUT	Queensland University of Technology
R&D	research and development
RIMREP	Reef 2050 Integrated Monitoring and Reporting Program
RRAP	Reef Restoration and Adaptation Program
SCU	Southern Cross University
SELTMP	Social and Economic Long-Term Monitoring Program
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UQ	University of Queensland

Acknowledgement of Great Barrier Reef Traditional Owners

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) and RTI International acknowledge the Traditional Owners of the lands, seas and waters of the areas that we live and work on across Australia. We acknowledge all Aboriginal and Torres Strait Islander people and their continuing connection to their culture and pay our respects to Elders past and present.

Aboriginal and Torres Strait Islander peoples are the Traditional Owners and Custodians of the Great Barrier Reef and its Catchment, and as First Nations peoples, they hold inherent rights, interests and obligations to protect and care for their Country.

There are over 70 Traditional Owner groups along the Queensland coastline whose traditional estates extend over the Great Barrier Reef and many more groups whose customary estates form part of the Reef's Catchment.

Traditional Owner connections with the Great Barrier Reef extend over many thousands of years. It is a rich cultural land- and seascape, and Traditional Owners continue to be actively involved in the management of their Country.

Reef 2050 Traditional Owner Implementation Plan, 2022

Image 1: George Roff and Geoffrey Carlin, CSIRO

Letter from CSIRO



Photo by: CSIRO

Australia's Great Barrier Reef is a regionally, nationally and globally significant ecosystem facing unprecedented threats.

CSIRO, as one of a number of research organisations and partners working together on the challenges facing the Great Barrier Reef, has aimed to make a positive impact on the future and vibrancy of the Reef. With the completion of the six-year Reef Trust Partnership in 2023–2024, and Great Barrier Reef funding and partnerships in a transition year, it has been timely to review CSIRO's Great Barrier Reef portfolio of research and understand its contribution to the overall impact of work to date. This review has also provided an important opportunity to assess and reflect on our future direction and role in reef research.

We engaged RTI International to provide independent analysis of the portfolio and impact. This included interviews with our stakeholders and partners. We also envisaged what the future might look like for our research and modes of operation as we address future challenges in the Reef post 2030.

CSIRO has invested \$142M on Great Barrier Reef research since 2011. The portfolio review included 261 projects undertaken since 2011, across six CSIRO business units, and including research in water quality, land repair, coastal and marine restoration, modelling, social and Indigenous sciences, and crown-of-thorns starfish (COTS) research.

CSIRO's decades-long engagement in the Great Barrier Reef has positioned the organisation well to contribute along with its partners, to national and international discourse on the future of the Reef amidst climate change.

In this report, our partners recognise the important role CSIRO plays in providing interdisciplinary expertise and deep domain knowledge to address big challenges in the Great Barrier Reef, showing vision, consistency and longevity of support.

In undertaking this review we have endeavoured to better understand our own contribution to helping build the resilience of the Great Barrier Reef. In doing so, the review also reveals the critical importance of working collectively and collaboratively to achieve this goal. Solutions to target and scale the protection, restoration and adaptation of Great Barrier Reef ecosystems ultimately take a team. We acknowledge and thank our partners and stakeholders for their contributions and feedback throughout this process.

Dr Peter Mayfield
Executive Director, Environment, Energy and Resources
CSIRO

Executive Summary

The Great Barrier Reef and the enabling research landscape that supports the Reef are at a critical inflection point. The Great Barrier Reef Outlook Report 2024 captures the importance of this present moment: “The window of opportunity to secure a positive future for the Great Barrier Reef is closing rapidly ... New ways of thinking are needed to complement existing management in charting a positive path forward for the Reef and its dependent communities.”¹ Additionally, several landmark Reef research and implementation investments and collaborative projects have recently completed major stages of work and are assessing needs for future efforts.

This critical juncture for the Great Barrier Reef presents the Commonwealth Scientific and Industrial Research Organisation (CSIRO) with a timely opportunity to reflect on its past contributions in the Reef and consider how to best support future efforts to protect and restore this valued ecosystem under pressure. Led by the CSIRO Great Barrier Reef Steering Committee and CSIRO Strategy’s Performance and Evaluation Team, CSIRO commissioned RTI International, a nonprofit research institute, to evaluate CSIRO’s research impact in the Great Barrier Reef, including its role in the supporting partner landscape.

In commissioning this evaluation, CSIRO sought to better understand the following:

What is the composition of CSIRO’s Great Barrier Reef research portfolio, and how does it align with the overarching Reef 2050 Long-term Sustainability Plan (i.e., Reef 2050 Plan) goals that guide collective action in the Reef?

What social, environmental and economic value has accrued (or likely will accrue in the future) to the Great Barrier Reef through CSIRO’s research efforts?

What has CSIRO contributed to the diverse partner landscape that supports collaborative research, management and policy efforts in the Reef? What future risks and opportunities should CSIRO be aware of?

RTI's independent evaluation explored these three priorities, respectively, by conducting (1) a quantitative **portfolio review** of CSIRO's Great Barrier Reef research projects since 2011; (2) **five impact case studies** focused on areas aligned with CSIRO's long-term research and partnership engagement in the Reef, specifically coral larval settlement and reseeded, crown-of-thorns starfish control, eReefs, the Gully and Streambank Toolbox and the Social and Economic Long-Term Monitoring Program and (3) **key informant interviews** with external stakeholders familiar with the multiple roles CSIRO plays in the Reef research landscape.



Image 2: Geoffrey Carlin and Joey Crosswell

Several key findings and conclusions emerged from the evaluation, which are captured in brief as follows and presented in more detail in the following sections:

1. Overall, CSIRO delivers research contributions and enabling functions in the Great Barrier Reef and supporting partner landscape that are

- strongly aligned to national priorities set forward in the Reef 2050 Plan;
- reflective of a diverse set of research themes and capabilities, including expert advice, relevant to the multifaceted challenges facing the Reef;
- delivering material economic, environmental and social benefits to the Reef;
- valued by a diverse set of partners working to protect and restore the Reef;
- differentiated from others in the Reef partner landscape due to unique organisational capabilities such as longevity of support and interdisciplinary science strengths;
- improved by CSIRO's strengthened organisational commitment to collaborative engagement with Reef partners in the past decade and
- commensurate with CSIRO's role as Australia's national science agency.

2. CSIRO's research impact in the Reef can be strengthened by

- **expanding access to and integration of CSIRO research into Reef management and policy**, including further developing demand-responsive action research approaches that put Reef managers' and policymakers' needs at the center of the research process;
- **supporting ongoing relationship stewardship and collective action in the Reef**, including continuing to invest in the relationships, norms and shared spaces developed among partners in recent years. This is especially key amidst the uncertainty facing the Reef and its supporting partner landscape and
- **amplifying Traditional Owner engagement in Great Barrier Reef research efforts** by better weaving together Traditional Knowledge and western science in collaboration with partners such as the Australian Institute of Marine Science and James Cook University, proactively making room to share power with Traditional Owners and deepening CSIRO researchers' cultural competencies and capabilities for effective and inclusive partnership with Traditional Owners in Reef research efforts.

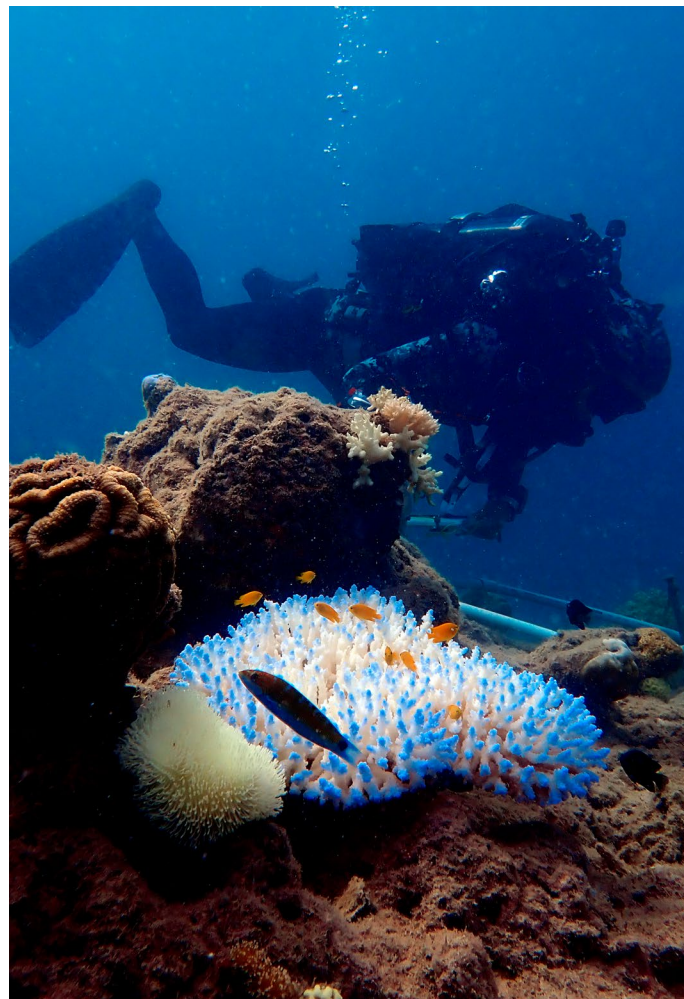


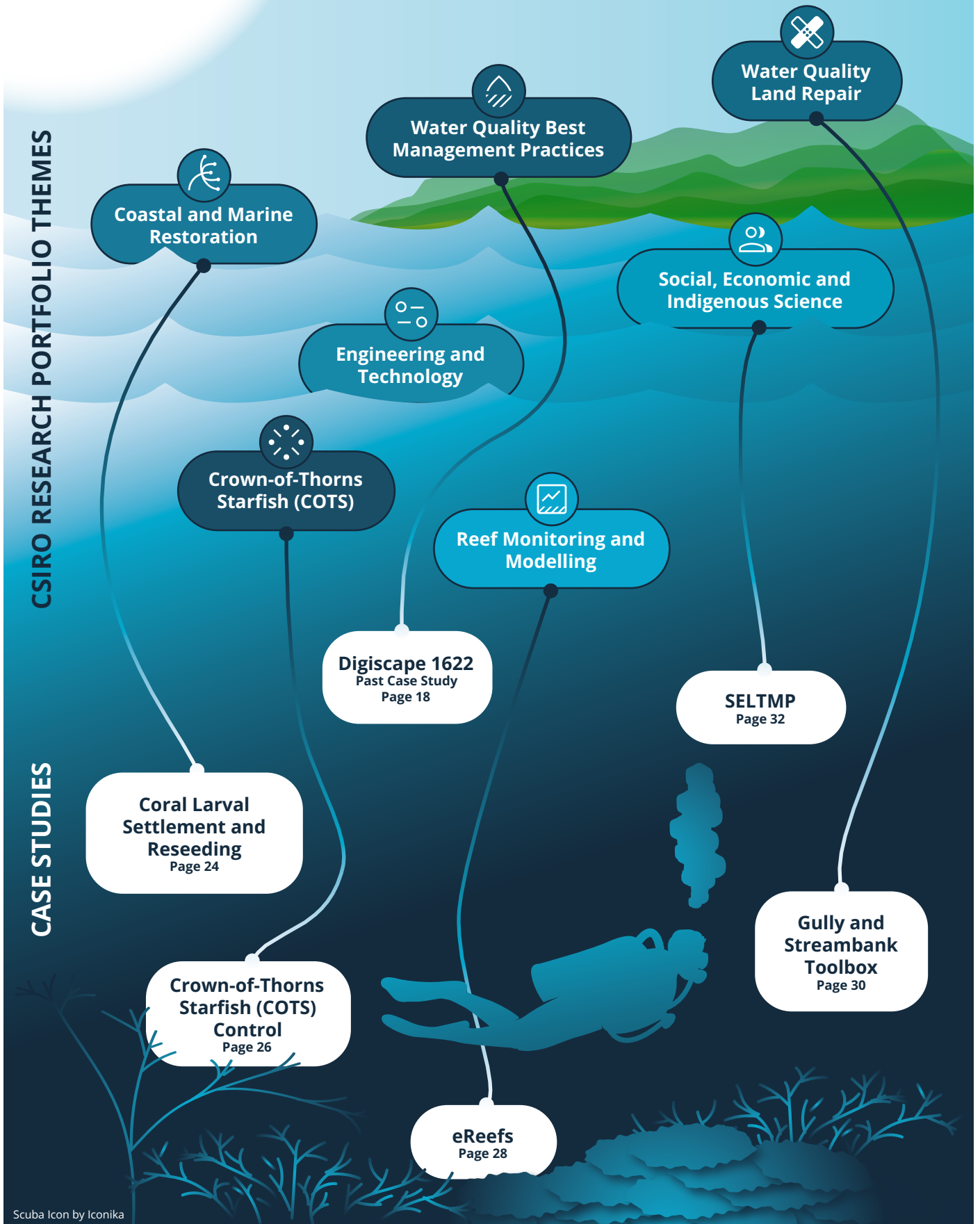
Image 3: George Roff, CSIRO

3. CSIRO has an important role to play in shaping the future of the Reef in this “critical decade” for coral reef survival.²

The evaluation identified multiple areas of excellence for CSIRO (e.g., capabilities in modelling, social sciences, and inter- and transdisciplinary approaches across the terrestrial and marine continuum) that likely will increase in importance as climate pressures on the Reef mount. CSIRO's decades-long engagement in the Reef, combined with these capabilities, position the organisation to contribute alongside partners to national and international discourse on the future of the Reef amidst climate change.

4. The emerging interventionist and resilience-based management paradigm in the Reef will shift what “best available science” entails. CSIRO has an opportunity to work with R&D partners and Reef stakeholders to anticipate and develop these capabilities in response to likely future demands. This includes being prepared to support large-scale repair and adaptation efforts in the Great Barrier Reef and other significant marine ecosystems nationally.

CSIRO's Great Barrier Reef portfolio comprises seven focus areas, shown below. This evaluation included five case studies aligned with five of these themes.



CSIRO in the Context of the Great Barrier Reef and the Reef Partner Landscape

Mobilising collective action to sustain the Reef

The Great Barrier Reef, stretching over 2,300 km and encompassing approximately 344,400 km², is the largest coral reef system on the planet. As a UNESCO World Heritage site, the Reef is a vital economic asset, contributing more than \$6.4 billion annually to the Australian economy and supporting more than 66,000 jobs.³ Home to over 12,000 marine species, the Reef is a “complex and delicately balanced ecosystem that is being challenged” largely due to climate change, raising concerns amongst scientists, policymakers and the global community.⁴ Rising sea temperatures, driven by climate change, have led to frequent and severe coral bleaching events: five of which have occurred in the past 10 years, with the most recent taking place in summer 2023–2024.⁵ Additional pressures on the Reef, including land-based pollution, pests such as crown-of-thorns starfish (COTS), coastal development and increasing ocean acidification further threaten the diverse ecosystem.⁶

In response to the growing pressures on the Reef, the Australian and Queensland governments set forth a strategic vision and investments for collective action. The 2015 publication of the first Reef 2050 Long-Term Sustainability Plan (i.e., Reef 2050 Plan) and subsequent 2021 update provide a 35-year blueprint for managing the Reef, supported by the announcement of more than \$3 billion in investments over 10 years.⁷ By creating guiding goals, the Reef 2050 Plan incentivised landscape-wide action among diverse actors, including the Commonwealth Scientific and Industrial Research Organisation (CSIRO).⁸ The 2018 Reef Trust Partnership, a 6-year, \$443 million initiative between the Australian Government’s Reef Trust and the Great Barrier Reef Foundation (GBRF), further accelerated collective efforts to protect and restore the Reef.⁹

Advancing science-based solutions for the Reef

As Australia’s national science agency, CSIRO has a long-standing commitment to research and science for the Great Barrier Reef. New science and knowledge generated by research are critical for identifying emerging risks, informing policies and management strategies, designing and adaptively managing new interventions and informing long-range planning.¹⁰ As a research and development (R&D) organisation, CSIRO works alongside peer organisations such as the Australian Institute of Marine Science (AIMS), James Cook University (JCU), The University of Queensland (UQ),

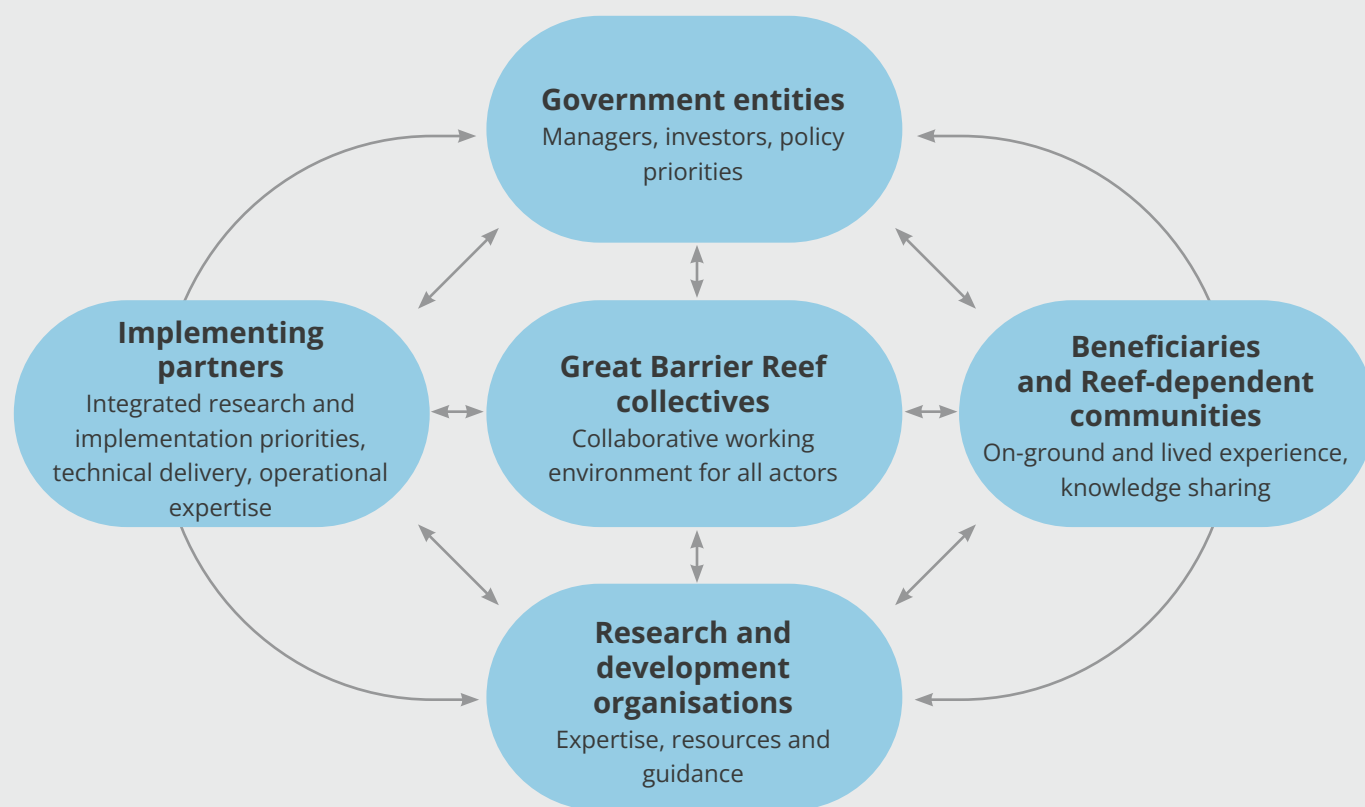
Queensland University of Technology (QUT), Southern Cross University (SCU) and others in delivering the best available science to inform policy and action in the Reef.

CSIRO and other R&D organisations do not work in isolation in the Reef but as part of a dynamic partner landscape spanning Reef managers and decision makers (e.g., Great Barrier Reef Marine Park Authority [Reef Authority/GBRMPA], the Queensland State Government, and Reef Traditional Owners), other key policymakers and decision makers (e.g., Australian Government), brokering entities (e.g., GBRF, regional natural resource management bodies), Reef-dependent communities and industry sectors (e.g., agriculture and marine tourism) as depicted in Figure 1. CSIRO and partners increasingly support integrated Reef research programs (e.g., the Reef Restoration and Adaptation Program [RRAP] and the COTS Control Innovation Program [CCIP]) that leverage the complementary expertise and resources of multiple organisations to inform current and future Reef management.

Navigating change within the Reef and the Reef partner landscape

The Great Barrier Reef and its supporting partner landscape are at a critical inflection point. The *Great Barrier Reef Outlook Report 2024* captures the importance of this moment: “The window of opportunity to secure a positive future for the Great Barrier Reef is closing rapidly. [Despite the Reef’s underlying resilience] ... the Region’s overall long-term outlook remains one of continued deterioration due largely to climate change ... New ways of thinking are needed to complement existing management in charting a positive path forward for the Reef and its dependent communities.”¹¹

Figure 1: The Great Barrier Reef Partner Landscape



Several large-scale collaborative Reef R&D programs (e.g., RRAP, CCIP and the Reef Integrated Monitoring and Reporting Program [RIMReP]) are completing major phases of work and are planning for the next 5-year R&D investment cycle. Similarly, key CSIRO-led projects such as the Social and Economic Long-Term Monitoring Program (SELTMP) and the eReefs platform also have completed current phases of work and are assessing future knowledge gaps and needs with stakeholders.

Evaluating CSIRO's Research Impact in the Great Barrier Reef

Reflecting on the past to inform future efforts

This critical juncture for the Great Barrier Reef and its supporting partner landscape presents CSIRO with a timely opportunity to reflect on its past contributions in the Reef and consider how to best support future efforts to protect and restore this valued ecosystem under pressure. Led by the CSIRO Great Barrier Reef Steering Committee and CSIRO Strategy's Performance and Evaluation Team, CSIRO commissioned RTI International, a U.S.-based nonprofit research institute, to evaluate its research impact in the Great Barrier Reef, including its role in the Reef partner landscape.

In commissioning this evaluation, CSIRO sought to better understand the following:

- What is the composition of CSIRO's Great Barrier Reef research portfolio, and how does it align with the overarching Reef 2050 goals that guide collective action in the Reef?
- What social, environmental and economic value has accrued (or will likely accrue in the future) to the Great Barrier Reef through CSIRO's research efforts?
- What has CSIRO contributed to the diverse partner landscape that supports collaborative research, management and policy efforts in the Reef? What future risks and opportunities should CSIRO be aware of?

RTI's independent evaluation explored these three priorities, respectively, by conducting (1) a quantitative **portfolio review** of CSIRO's Great Barrier Reef research projects since 2011; (2) **five impact case studies** focused on areas aligned with CSIRO's long-term research and partnership engagement in the Reef: coral larval settlement and reseeded, COTS control, eReefs, the Gully and Streambank Toolbox and SELTMP and (3) **key informant interviews** with external stakeholders familiar with the multiple roles CSIRO plays in the Reef partner landscape. Pages 38 and 39 provide further approach and methodology details.

The Goal of CSIRO's Great Barrier Reef strategic initiative:

To provide new science, capabilities, partnerships and technologies that help sustain the Great Barrier Reef as a living natural and cultural wonder.

CSIRO Great Barrier Reef Steering Committee. (n.d.). Great Barrier Reef Impact Pathway.

This report summarises the key findings and conclusions from the independent but participatory evaluation of CSIRO's research impact in the Great Barrier Reef.

A description of CSIRO's Great Barrier Reef research portfolio since 2011 precedes a high-level overview of key findings and conclusions from the evaluation. RTI designed the evaluation approach with its use in mind; the evaluation findings have been used in structured learning and visioning engagements with CSIRO research and senior business leaders to inform organisational learning and planning.

**Portfolio Review
Guiding Question**

What is the composition of CSIRO's Great Barrier Reef research portfolio, and how does it align with the overarching Reef 2050 goals that guide collective action in the Reef?

**Case Study
Guiding Question**

What social, environmental and economic value has accrued (or will likely accrue in the future) to the Great Barrier Reef through CSIRO's research efforts?

**Partner Landscape
Feedback Guiding
Question**

What has CSIRO contributed to the diverse partner landscape that supports collaborative research, management and policy efforts in the Reef? What future risks and opportunities should CSIRO be aware of?

Characterising CSIRO's Great Barrier Reef Research Portfolio

A snapshot of CSIRO's Reef-related research portfolio since 2011

From 2011 to 2023, CSIRO's Great Barrier Reef portfolio encompassed more than 261 research projects, spanning 7 focus areas and engaging 91 project leads. CSIRO's Great Barrier Reef research portfolio is funded by a mix of government, industry and internal investments totalling approximately \$142 million since 2011. The goal of "providing new science, capabilities, partnership and technologies that help sustain the Great Barrier Reef as a natural and cultural wonder" guides the portfolio.

High-level coordination and advisory support to Great Barrier Reef partners serves as a core facet of CSIRO's portfolio. Important coordination and advisory support contributions have included the provision of technical and scientific advice to support the GBRF on implementation of the Reef Trust Partnership water quality program and other elements; the then Australian Government Department of Agriculture, Water and Environment on options for the Reef 2050 Plan mid-term review and the Reef Authority on RIMReP design. CSIRO scientists serve as members of the Independent Scientific Panel and Independent Expert Panel under Reef 2050 bilateral governance arrangements and make major contributions to the Scientific Consensus Statement that informs government priorities to address a range of water quality-related threats to the Reef since the first statement was produced in 2002.

CSIRO's Great Barrier Reef portfolio is further characterised by research aligned with seven focus areas (see Figure 2 below). These contain three enabling focus areas that deliver on integrative capabilities as well as outcomes and four topical focus areas that deliver on programmatic outcomes. Each focus area reflects a significant body of scholarship and engagement representing CSIRO's long-standing efforts in the Great Barrier Reef.

CSIRO's Scientific Impact: Reef-Related Publications (2011-2024)

CSIRO's scientific impact is heavily reflected in its contributions to Reef-based literature. Between 2011 and 2024, the organisation has produced more than 530 publications on research conducted within the Great Barrier Reef portfolio. These publications have been cited nearly 19,000 times across more than 14,000 unique articles worldwide. CSIRO's most-cited Reef-based publications are collaborative works and represent a trend towards increased appetite towards international collaboration in recent years. Domestic collaborators such as AIMS (134 co-authored publications), JCU (102), and UQ (101) are CSIRO's most frequent co-authors on Reef-centric publications, while seven of CSIRO's top twenty-five collaborators in the Great Barrier Reef space hail from outside of Australia.

Figure 2: CSIRO's Great Barrier Reef research portfolio by the numbers

ENABLING FOCUS AREAS
delivering to integrative capability as well as outcomes



Reef Monitoring and Modelling
\$53M (38%) of funding across 55 projects (22%)

Reef modelling and monitoring enable actors to make decisions about preventative interventions.



Social, Economic and Indigenous Science
\$14.4M (10%) of funding across 40 projects (15%)

Incorporation of social, economic and Indigenous perspectives ensures that Reef interventions benefit all.



Engineering and Technology
\$10.1M (7%) of funding across 34 projects (13%)

Development of robust, high-quality sensing and AI/ML systems enables timely Reef monitoring and modelling.



Coastal and Marine Restoration
\$20.3M (15%) of funding across 25 projects (10%)

Ecological restoration of damaged ecosystems, including coral, is essential to Reef sustainability.



Water Quality Land Repair
\$15.7M (11%) of funding across 27 projects (10%)

Gully and stream bank repair can minimize the amount of sediment flowing into the Reef and improve water quality.



Water Quality Best Management Practices
\$18.3M (13%) of funding across 50 projects (19%)

Minimising the amount of sediment and nutrient runoff from agricultural and other land uses improves water quality.



COTS
\$7.4M (5%) of funding across 22 projects (8%)

Crown-of-thorns starfish are major predators of coral and must be effectively managed for the Reef's resilience.






Coordination and Advice | \$2.9M (2%) of funding across 8 projects (3%)





Coordination and advice fall outside the seven research focus areas comprising the CSIRO Great Barrier Reef research portfolio but are still important facets of CSIRO's engagement in the Reef and a small portion of funded activities.

TOPICAL FOCUS AREAS
delivering to programmatic outcomes

Enabling focus areas:

-  **Reef modelling and monitoring:** assessing the conditions of the catchment, coastal and marine environment of the Great Barrier Reef and, in turn, enabling informed decisions about investment priorities and potential interventions.
-  **Social, economic and Indigenous science:** integrating social, economic and Indigenous perspectives within other themes such as water quality or restoration, and to deliver outcomes for Reef Traditional Owners and the communities and industries that depend on the Reef.
-  **Engineering and technology:** developing robust, high-quality sensing systems that enable timely Reef observations, monitoring and modelling.

Topical focus areas:

-  **Coastal and marine restoration:** promoting ecological restoration of damaged coastal and marine ecosystems, including coral.
-  **Water quality land repair:** informing gully and stream bank erosion repair to minimise the amount of sediment flowing into the Reef and deliver co-benefits.
-  **Water quality best management practices:** improving grazing and farming management practices to minimise nutrient, sediment and pesticide runoff from Reef catchments.
-  **COTS:** improving the management and control of COTS outbreaks as major predators of coral that threaten the Reef's resilience.

CSIRO's Great Barrier Reef research portfolio since 2011 is distributed across the seven focus areas in terms of projects and investments.

Impact case studies aligned with five of the seven research focus areas (coastal and marine restoration; COTS control; water quality land repair; Reef monitoring and modelling and social, economic and Indigenous Sciences) underpin the independent evaluation of CSIRO's Great Barrier Reef portfolio. Pages 24–33 provide high-level descriptions and key findings from the impact case studies undertaken in this 2024 portfolio evaluation. CSIRO's Impact Framework and impact evaluation principles guide each of the case studies. Pages 38 and 39 provide additional methodology details.

Evolving from a historical foundation

RTI's review of CSIRO's Reef-related research portfolio covered research from 2011, the point at which CSIRO's internal data offered sufficient fidelity for external assessment. This recent portfolio builds on CSIRO's long-standing commitment to the Great Barrier Reef, which dates back several decades. Examples of these long-standing efforts range across several focus areas. For example, in the water quality land repair theme, CSIRO began supporting water quality monitoring in the Great Barrier Reef land-based catchments in the 1970s. This evolved to include catchment modelling to inform sustainable grazing and land management in the 1990s and sediment soil tracing in the early 2000s. CSIRO's historic involvement in water quality best management practices

centered on demonstrating how agronomic practices impact water quality and improving those practices via participatory research with landholders. For example, the 1622 Water Quality applications, analysed via a 2021 case study, exemplify efforts CSIRO has undertaken in this focus area. The textbox opposite briefly describes the 1622 Water Quality apps and links to the full case study.

CSIRO's connection to **coastal and marine restoration** research dates to the 1980s, when CSIRO researchers, then working at JCU and then AIMS, predicted and observed mass spawning of corals and described the larval development of mass spawning species and conduct in situ settlement experiments. This work laid the foundation for large-scale coral spawn slick harvesting and larval settlement developed through RRAP. CSIRO has been engaged in supporting **COTS control** research since the 1980s as well, when CSIRO began serving as a core member of the COTS research committee. Later, CSIRO researchers led the development of the integrated pest management (IPM) framework that leverages understanding of ecological interactions to mitigate the impacts of COTS on the Great Barrier Reef. CSIRO researchers have provided **coordination and advisory support** to government and other partners in the four decades as well.

Since the mid-2000s, CSIRO has increasingly integrated **social, economic and Indigenous sciences** expertise as part of its Reef-related research offering. This was driven by a growing recognition that robust policies, programs and interventions need to better (1) integrate human dimensions into ecosystem management approaches on land and water and (2) enable co-designed and participatory solutions to be developed with Reef Traditional Owners and Reef stakeholders. Examples include developing paddock to reef social indicators for practice change reporting for water quality targets under the Reef Water Quality Improvement Plan, and supporting Traditional Owner-led development of the Strong People, Strong Country framework under leadership of the RIMReP Indigenous Heritage Expert Group.

Past Case Study: Digiscape 1622 Project

Focus Area



Water Quality Best Management Practices

Description: As part of CSIRO's Digiscape Future Science Platform, the 1622 project promoted environmental stewardship in Australia's agricultural sector by providing farmers and land managers with decision support systems (DSSs) that increased their resource use efficiency and reduced agricultural runoff in coastal regions. The project was created to help reduce nitrogen-based nutrients in catchments adjacent to the Great Barrier Reef. Nitrogen runoff from agricultural activities in the coastal region has historically been one of the largest contributors to deteriorating water quality and subsequent decline in reef cover. The project was funded by CSIRO over a 5-year period (2016/17–2020/21) and comprised two applications (i.e., apps): (1) the 1622WQ information portal, which was operational at the time of the study, and (2) the 1622WhatIf DSS, which was under development. The apps provided farmers with situational awareness of runoff issues by giving them high-frequency data about water quality in nearby waterways; the apps enabled farmers to see how their fertiliser use could lead to increased water pollution and provided tools to reduce their fertiliser use.

The full Digiscape 1622 Project case study can be accessed via the CSIRO website: <https://www.csiro.au/en/about/Corporate-governance/Ensuring-our-impact/Impact-case-studies/Future-Industries/1622-Apps>

CSIRO in the GBR

Illustrative not comprehensive contributions over time

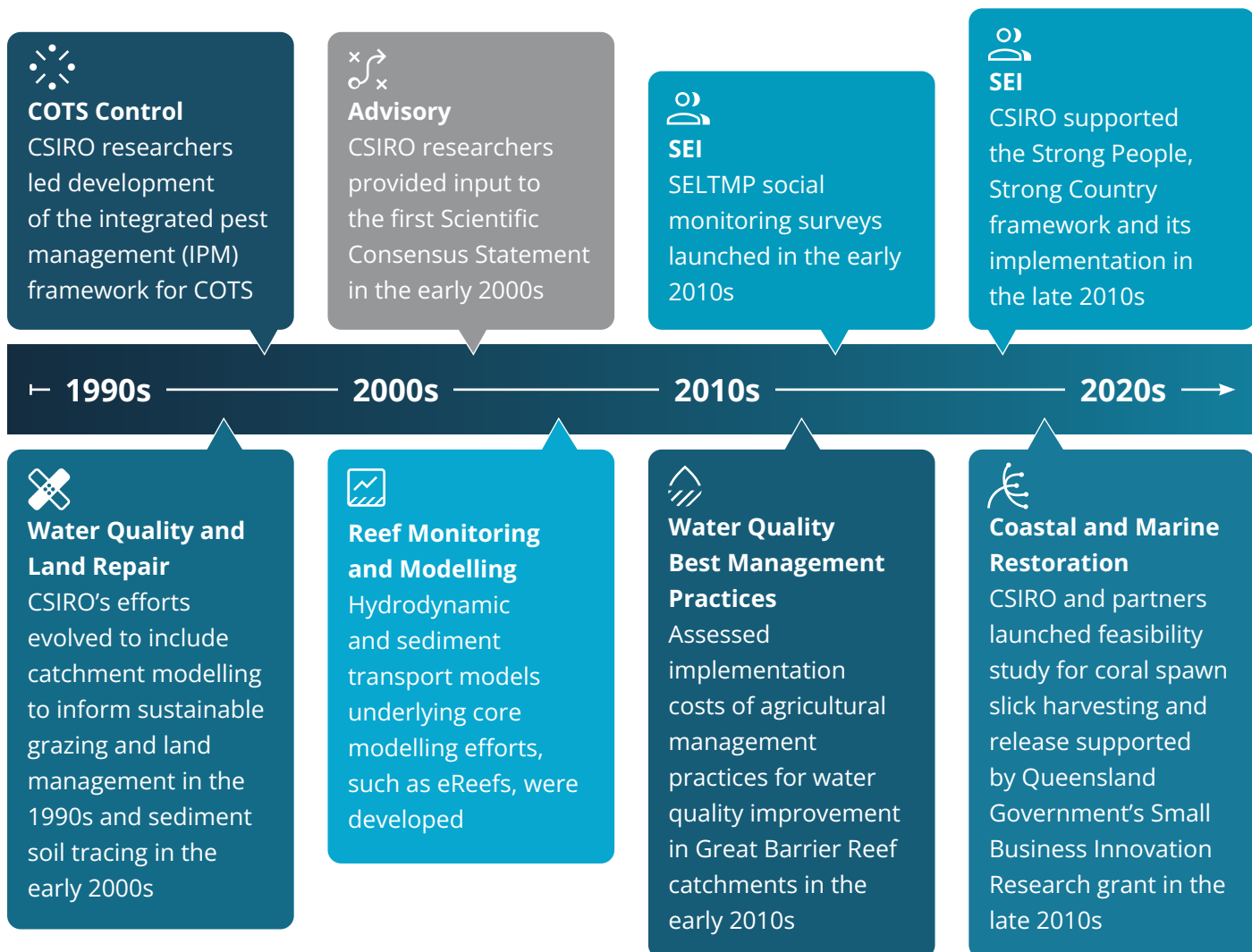


Image 4: CSIRO

Key Findings from Evaluating CSIRO's Research Impact in the Great Barrier Reef

The independent evaluation of CSIRO's research impact in the Great Barrier Reef surfaced several key findings, summarised as follows. These findings represent a synthesis of insights derived from the quantitative portfolio review, the five impact case studies and the landscape-level key informant interviews undertaken in this evaluation.

1. Overall, CSIRO's Great Barrier Reef research portfolio (since 2011) emerged as follows:

- **Strongly aligned with the overarching Reef 2050 Plan goals that guide collective action in the Reef.** The portfolio review analysis found strong alignment between CSIRO's overall Great Barrier Reef research portfolio and the Reef 2050 Plan work areas and enablers, with CSIRO projects contributing to all Reef 2050 work areas and enablers minus one.¹² External partner feedback reinforced this alignment, noting improvement in CSIRO's approach to pursuing harmonised outputs and outcomes with partners including government.
- **Reflective of multiple research themes and capabilities relevant to the multifaceted, interrelated challenges facing the Reef.** The complexity of the Great Barrier Reef ecosystem and the multifaceted nature of the sustainability challenges it faces requires research and collaborative engagement across different actors and areas of expertise. CSIRO's Great Barrier Reef research is relatively well distributed across seven core research themes spanning enabling and topical focus areas, reflecting a diverse internal capability that maps to multiple leverage points in the Reef ecosystem. Action across multiple key leverage points (e.g., water quality, COTS control, coral restoration) is needed to effect ecosystem-level change in the Reef. CSIRO is well positioned to support such ecosystem-level strategies spanning leverage points and organisations through its diverse and complementary portfolio.

2. CSIRO's Great Barrier Reef research contributions deliver materially impactful economic, environmental and social value, as demonstrated by five impact case studies reflective of CSIRO's broader portfolio.

Five impact case studies aligned with key research focus areas (coastal and marine restoration; COTS control; water quality land repair; Reef monitoring and modelling and social, economic and Indigenous sciences) underpin the independent evaluation

of CSIRO's Great Barrier Reef portfolio. High-level case study descriptions and key findings follow on pages 24–33. CSIRO routinely evaluates its ability to accomplish and generate meaningful, positive economic, environmental and social impact from its research by performing evaluative case studies. The case study assessments were guided by CSIRO's Impact Framework and impact evaluation principles. Pages 38 and 39 provide additional methodology details.

Four of the five impact case studies leveraged quantitative cost benefit analysis, excluding SELTMP due to subject matter. Of these case studies, all four found significant positive cost-benefit ratios associated with CSIRO's economic, environmental and social impact contributions. The qualitative findings across all the case studies further highlight overall positive outcomes and impacts associated with CSIRO's research contributions in the Great Barrier Reef. These contributions are not made by CSIRO alone but in concert with other actors investing and partnering in collaborative projects in the Reef.

3. External stakeholders value CSIRO's contributions to the Reef, in terms of domain-specific and enabling roles, and recognise CSIRO's distinct offerings.

External stakeholders engaged in landscape-level key informant interviews and in the case studies noted the numerous ways in which CSIRO has made positive contributions to the Great Barrier Reef and the broader partner landscape. These include domain-specific contributions (e.g., COTS control, land repair) that have supported more effective, targeted, and efficient management approaches, as well as enabling functions such as ongoing advisory support and engagement in government-led planning and consultation processes.

Key differentiators of CSIRO's efforts in the Great Barrier Reef, highlighted by external partners, include these:

- **Vision, consistency and longevity of support:** CSIRO is seen as a key contributing force behind innovative efforts such as the RRAP and the eReefs platform. CSIRO's institutional commitment to the Great Barrier Reef enables consistent support over long time horizons. This long-term vision and commitment are needed to drive systems-level outcomes but can be harder to achieve in project- and researcher-driven environments.
- **Strength of interdisciplinary science:** CSIRO has a unique ability to mobilise experts and teams for interdisciplinary and transdisciplinary research, which is critical for the complex challenges facing the Reef. Stakeholders highlighted CSIRO's breadth of expertise and ability to fill in the technical gaps of other partners in the Reef.

"CSIRO has the ability to stay the course with long-term commitments for 5–10 years."

(Partner Interview)

"CSIRO brings interdisciplinary expertise to address big challenges. This is unique."

(Partner Interview)

- **Technical expertise and credibility:** CSIRO's deep technical expertise and position as Australia's national science agency provide credibility when giving advice to government counterparts; this is a valued resource that others can leverage. Interviewees noted CSIRO's strengths in modelling and social science as complementary to other organisations in the Reef partner landscape.

4. CSIRO's improved collaborative engagement approach contributes positively to the Reef partner landscape and to better outcomes for the Reef. Stakeholders engaged in the evaluation process were clear: How CSIRO operates in the Great Barrier Reef research and partner landscape matters as much if not more than on what CSIRO focuses. Interviewees noted that CSIRO has not always been seen as a collaborative organisation in the Reef partner landscape. However, stakeholders acknowledged a change in CSIRO's posture, and today, they see CSIRO as an effective partner focused on fostering collaborative approaches and achieving shared goals. Efforts such as creating the Great Barrier Reef coordinator role and improving contracting process have lowered transaction costs for external partners seeking to engage with CSIRO. Effective partnering has enabled CSIRO to make more meaningful contributions to larger-scale, more integrated initiatives such as RRAP and CCIP.

Stakeholders also cautioned CSIRO to maintain awareness of CSIRO's perceived position within the partner landscape and uphold a balanced focus on commercialisation given the public interest associated with Great Barrier Reef research. Specific to Traditional Owner engagement, interviewees encouraged CSIRO to proactively make room for power to be shared with Traditional Owners, including in identifying shared priorities within the Great Barrier Reef, and to work with and through regional and local partners when engaging Traditional Owners and Reef-dependent communities. When CSIRO engages directly at the grassroots level, stakeholders encouraged CSIRO to focus on what it is good at and engage with deep, mutual care. This includes being mindful of creating safe spaces, ensuring adequate time and resourcing for relationship building and supporting Indigenous leadership and decision-making processes.

"[CSIRO's] work is beyond question. Taking research... and then translating it into practical applications, that is one of their big strengths."

(Partner Interview)

"[The] way of the Reef in the future will be through collaborative engagement. The more that CSIRO shows up as a humble contributor the better."

(Partner Interview)

"The most significant contribution has been CSIRO's commitment to support Great Barrier Reef programs. Stepping back from science [and] walking with us on the journey."

(Partner Interview)

About the Impact Case Studies

CSIRO annually provides its stakeholders, and itself, with robust evidence that its goal of generating meaningful and positive economic, environmental and social impact from its research is being accomplished. To accomplish this, CSIRO has adopted a general methodology for impact evaluation through a case study model guided by CSIRO's Impact Framework and impact evaluation principles. See pages 38 and 39 for additional methodology details.

Four of the five case studies performed within the Great Barrier Reef research portfolio leveraged quantitative cost-benefit analysis (CBA), a method that assesses the benefits and costs associated with a particular project, program or policy. These benefits and costs are measured relative to the counterfactual, or what could have occurred under different conditions, that has been established for the category of impact. Key terms included in the CBA findings include the following:

- Benefit-cost ratio (BCR) is defined as the net benefits of a program, project or investment divided by the net costs. A BCR greater than 1 indicates project efficiencies, whereas a BCR less than 1 indicates project inefficiencies.
- Total value or net present value is defined as how much an investment is worth throughout its lifetime, discounted to today's value, and is a monetary measure of the current value for the program of work conducted.
- Monetised benefits are evaluated quantitatively using economic analysis or statistical methodologies, with results expressed in monetary terms. Non-monetised benefits include other types of impact that are too broad, intangible or far from being realised to be monetised with confidence.¹³

The case studies should be viewed as stand-alone analyses and not comparable due to different analysis time frames, inputs, methods and project-specific contexts. All monetized findings are presented in Australian dollars (AUD).



Image 5: Matt Curnock

Coral Larval Settlement and Reseeding



Focus Area

Coastal and Marine Restoration

Analysis Time Frame

2019 through 2050

Key Collaborators

AIMS, Delft University, GBRF, Maldives Marine Research Institute, QUT, SCU, Reef Traditional Owners (including Gidarjil, Bailai, Gurang, Goreng Goreng and Taribelang Peoples), Van Oord Dredging

Background: Since 2018, CSIRO and key partners have developed and tested cost-efficient, large-scale coral larval-based approaches to enhance resilience in coral reef ecosystems. Coral reefs are vital ecosystems supporting marine biodiversity, coastal protection and global fisheries, yet they face unprecedented threats from climate change, pollution and overfishing. Large-scale coral larval techniques offer an efficient, scalable solution to Reef restoration, improving biodiversity and supporting recovery efforts in the Great Barrier Reef. Through the Coral Larval Settlement and Reseeding Program, CSIRO and partners have pioneered techniques to collect and culture hundreds of millions of genetically diverse coral spawn slicks under various conditions using environmentally sensitive reef- and vessel-based methods. These efforts aim to contribute to next-generation coral restoration approaches that repopulate targeted reefs with minimal ecological impact, thereby increasing Reef resilience.

Case Study Findings: The analysis found that CSIRO's R&D efforts contributed to the foundational restoration approach that enhances coral resilience through cost-efficient, large-scale, low-impact methods. These methods complement existing conventional techniques, which have proven insufficient to maintain ecosystem function and biodiversity amidst compounding threats to the Reef. Without such innovative approaches, the risk of losing the functional integrity and biodiversity of reef ecosystems persists. The Coral Larval Settlement and Reseeding Program methods are now contributing to broader integrated R&D programs such as the RRAP, helping to ensure healthier and more resilient coral reef ecosystems than would otherwise be possible under more costly and less scalable approaches.

Observed Impacts: Key impacts identified through quantitative and qualitative analysis include the following:

ECONOMIC	ENVIRONMENTAL	SOCIAL
<p>Monetised</p> <ul style="list-style-type: none"> Reduced costs for large-scale restoration Expansion of fishing opportunities 	<p>Monetised</p> <ul style="list-style-type: none"> Reduction in risk of bleaching amongst surviving corals and preserving coral ecosystem services <p>Nonmonetised</p> <ul style="list-style-type: none"> Increased coral diversity 	<p>Nonmonetised</p> <ul style="list-style-type: none"> Facilitation of broader community engagement and collaboration in coral restoration activities Increasing benefit to tourism operators Knowledge transfer and technology adoption across coral reef systems

Benefits: Quantitative CBA results indicate that by 2050, CSIRO's efforts in the Coral Larval Settlement and Reseeding Program are expected to realise a BCR of 49.7 for the median scenario considering three impact areas: reduction in the risk of coral bleaching, lowered costs for large-scale restoration and additional investment in coral reef restoration. RTI's analysis determined that the total value (in 2024 dollars, discounted using a 7% real social discount rate) of the Coral Larval Settlement and Reseeding Program from fiscal year (FY) 2019 to FY 2050 is estimated to be \$100.7 million for the average value scenario.

Costs: The real costs (in 2024 dollars, discounted using a 7% real social discount rate) from FY 2019 to FY 2027 are reported as \$2.1 million but do not consider R&D costs that have not yet occurred as the analysis itself projects the impacts of historical and planned investments to date. Total funding for the Coral Larval Settlement and Reseeding Program was \$5.4 million from all co-contributors. To that end, RTI apportioned CSIRO's contribution as total labour costs over all program funding, so benefits in this case study are about 46% of total benefits to the Great Barrier Reef.

Quantitative CBA results indicate that by 2050, CSIRO's efforts in the Coral Larval Settlement and Reseeding Program are expected to realise a BCR of 49.7 for the median scenario considering three impact areas: reduction in the risk of coral bleaching, lowered costs for large-scale restoration and additional investment in coral reef restoration.

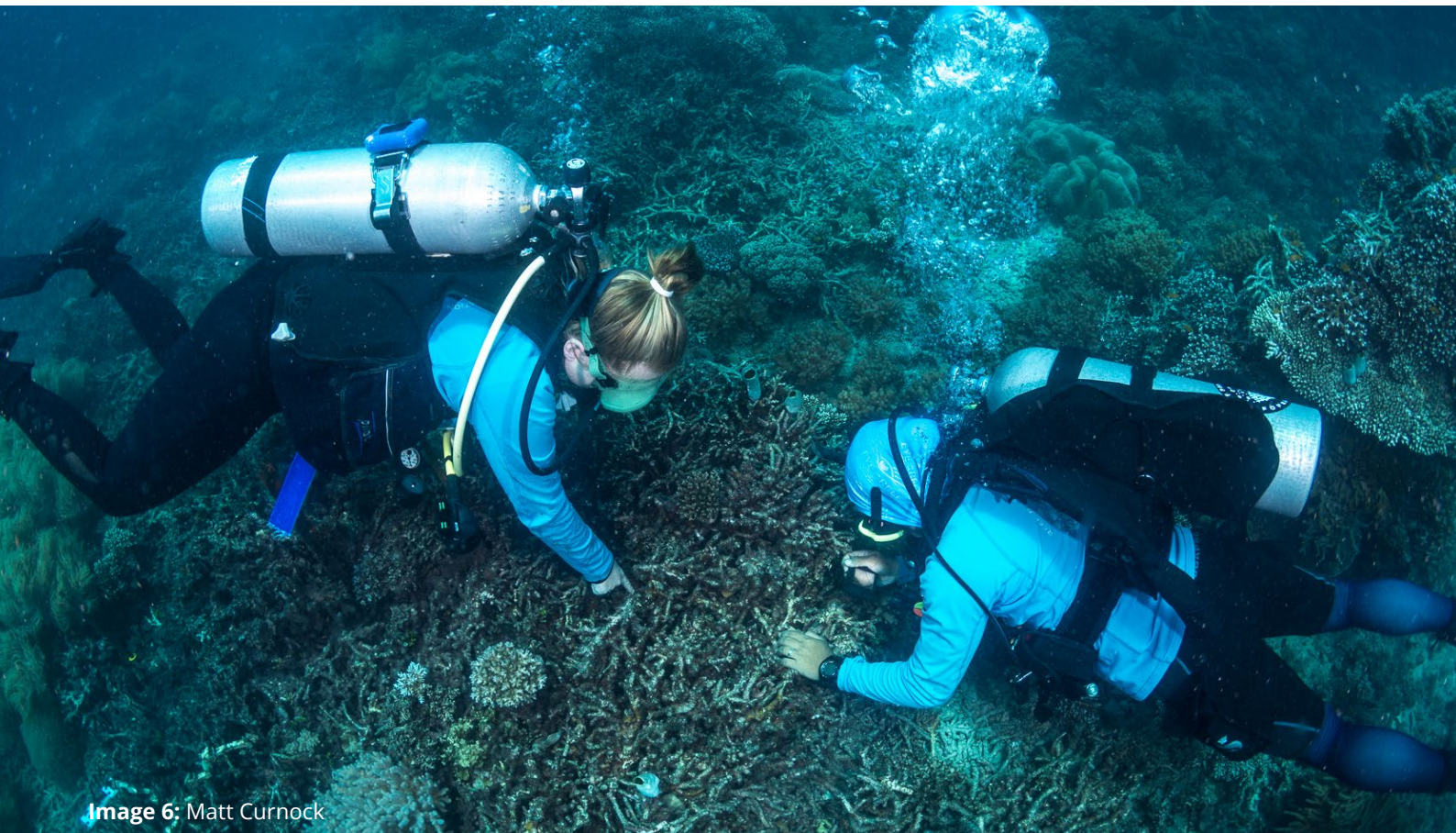


Image 6: Matt Curnock

“Our findings underscore the significance and relevance of CSIRO's contributions to innovative coral restoration techniques for future management of the Great Barrier Reef.” (2024 case study analysis)

Crown-of-Thorns Starfish (COTS) Control



Focus Area
COTS

Analysis Time Frame
2021 through 2050

Key Collaborators

AIMS, GBRF, GBRMPA, JCU, QUT, RRAP, Reef and Rainforest Research Centre, University of Tasmania, UQ, University of Sydney

Background: The CCIP was initiated in 2020 under the Reef Trust Partnership as a coordinated effort to advance new technologies for detecting and controlling COTS outbreaks. Its goal is to help decision makers and end users prioritise and respond to COTS outbreaks earlier, more accurately and more efficiently. According to the Great Barrier Reef Outlook Report 2019, COTS pose an almost certain and major threat to the Great Barrier Reef due to their high reproduction rates and appetite for coral polyps.¹⁴ Although outbreaks occur in natural cycles every 15–17 years, more rapid and frequent outbreaks have occurred in recent years, worsened by poor water quality, warmer sea temperatures and over-fishing of COTS predators. In response, CCIP has implemented 24 collaborative projects across 3 subprograms (focused on detection, prediction and response) aimed at developing a Reef-wide suite of tools for monitoring, detecting and responding to COTS outbreaks; CSIRO leads two of the three research subprograms. In lieu of CCIP's endeavours, monitoring would likely be done exclusively by manta tow, as this is the dominant method for COTS monitoring but is slower and more labour intensive. CSIRO's contribution to CCIP builds on its previous decades of supporting IPM approaches to COTS management.

Case Study Findings: The analysis found that CSIRO's research and technical support under the CCIP enables innovation and helps deliver an effective, resource-efficient IPM strategy for suppressing and preventing COTS outbreaks. Many CCIP stakeholders emphasised that this work cannot be done and cannot be orchestrated at scale without CSIRO's effort and support. This work has demonstrated the need and benefit of bringing a systematic and evidence-based decision-support approach to guiding the on-water control program within CCIP and in working with Reef managers to embed the approach into operational management and planning. The integration with Reef management and planning drives significant improvements in control vessel efficiency and embeds ecological principles into Reef management practices. Additionally, CSIRO and its partners have emphasised how Traditional Owner and community groups could be included to help scale monitoring efforts as COTS detection, control, and management technologies have become more accessible and dynamic.

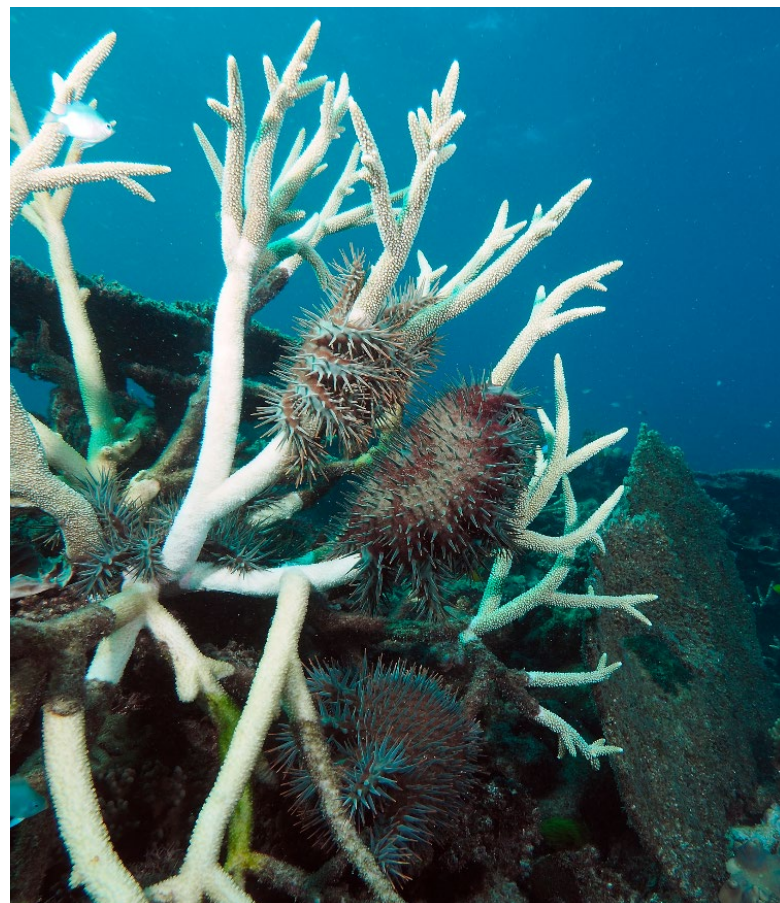


Image 7: David Westcott, CSIRO

Observed Impacts: Key impacts identified through quantitative and qualitative analysis include the following:

ECONOMIC	ENVIRONMENTAL	SOCIAL
<p>Monetised</p> <ul style="list-style-type: none"> Increased tourism and recreation Expansion of fishing opportunities Improved efficiency of COTS expeditions 	<p>Monetised</p> <ul style="list-style-type: none"> Protected coral from avoided COTS damage Improved ecosystem services <p>Nonmonetised</p> <ul style="list-style-type: none"> Increased coral diversity and ecological health 	<p>Nonmonetised</p> <ul style="list-style-type: none"> Facilitating broader community engagement and collaboration in COTS management activities Preservation of the Reef for future generations Improved safety for divers

Quantitative CBA results indicate that by 2050, CSIRO’s efforts in the CCIP are expected to realise a BCR of 2.5 for the median scenario considering three impact areas: economic impact of relevant industries, the ecosystem services from coral reefs and the value of protected coral from COTS outbreaks.

Benefits: Quantitative CBA results indicate that by 2050, CSIRO’s efforts in the CCIP are expected to realise a BCR of 2.5 for the median value scenario considering three impact areas: economic impact of relevant industries, the ecosystem services from coral reefs and the value of protected coral from COTS outbreaks. The total value (in 2024 dollars, discounted using a 7% real social discount rate) stemming from the 2021–2024 CCIP programming period is estimated as \$37.5 million for the median value scenario (across three benefit streams: direct and indirect impacts for industry, ecosystem services from coral reefs in the Great Barrier Reef and

nondirect use value), with CSIRO’s contributions accounting for \$2.6 million of that amount.

Costs: The real costs (in 2024 dollars, discounted using a 7% real social discount rate) from FY 2020 to FY 2024 are reported as \$15.6 million for the entire program, whereas CSIRO was found to have contributed to \$1.8 million in labour. To that end, RTI apportioned CSIRO’s contribution as total labour costs over all program funding, so benefits in this case study are about 12% of total benefits to the Great Barrier Reef.

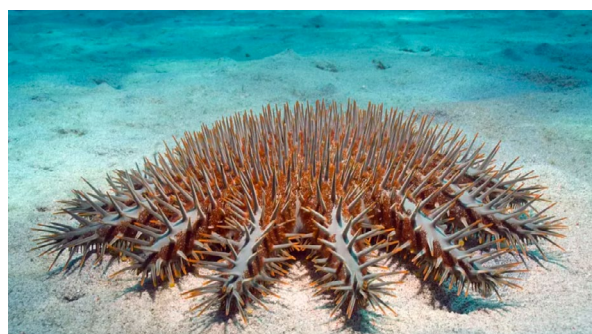


Image 8: CSIRO

“Many CCIP stakeholders emphasised this work cannot be done and cannot be orchestrated at scale without CSIRO’s effort and support.” (2024 case study analysis)

eReefs

Focus Area

Reef Modelling and Monitoring

Analysis Time Frame

2019 through 2034



Key Collaborators

Australian Bureau of Meteorology (BoM); AIMS; Australian Government (Department of Climate Change, Energy, the Environment and Water); BHP Mitsubishi Alliance; GBRF; GBRMPA, JCU, Queensland Department of Environment, Science and Innovation (Office of the Great Barrier Reef); Queensland Department of Natural Resources and Mines; Science Industry Endowment Fund; UQ

Background: eReefs is an information platform that provides data, modelling, visualisation and tools to enable applied research and support decisions and policymaking for the entire Great Barrier Reef. Initiated in 2010, with ongoing development since, it combines in situ and remotely sensed data through multiple interconnected models that enable simulation and modelling of Reef dynamics on large and micro scales. Before eReefs, the platforms that monitored the Reef relied on in situ measurement and later, remote sensing products. These tools were inadequate at measuring water quality and ecosystem health indicators at scale because of the high spatial variability of biophysical characteristics and the dynamic ocean environment. eReefs uniquely combines both kinds of datasets in a platform that allows for more sophisticated modelling of ocean currents and pollution dispersion of the entire Great Barrier Reef—and at high spatial scale. CSIRO and partners have advanced several eReefs application areas, including managing catchment runoff from nutrient, sediment and pesticide loads; regular reporting and monitoring of Great Barrier Reef health via water quality estimate data for the Great Barrier Reef report card and assessing vulnerability to coral bleaching and ocean acidification through targeted studies, among others.

Case Study Findings: The case analysis highlighted the importance of the eReefs modelling contributions to water quality goals, as the nutrient reduction estimates generated by eReefs were ultimately adopted by the Queensland Government as its official catchment targets. They were further incorporated into the Australian and Queensland Governments' Reef Water Quality Improvement Plan—a key constituent of the Reef 2050 Plan. Additionally, eReefs has increased the quantity and quality of scientific understanding of the Great Barrier Reef, as evidenced by the more than 80 publications using eReefs, of which their collective citations far exceed peer publication in the same fields. eReefs visualisations have proven effective at conveying important information about the health of the Great Barrier Reef to multiple stakeholder groups, including Reef managers. RTI analysis noted a growing interest in eReefs' connectivity modelling that has been incorporated into coral resettlement research activities and COTS management. Stakeholders highlight the eReefs partnership model (with BoM, AIMS, GBRF and initially the Queensland Government) as a key success factor, including helping to democratise access to and use of eReefs data for decision making.



Image 9: Matt Curnock

Observed Impacts: Key impacts identified through quantitative and qualitative analysis include the following:

ECONOMIC	ENVIRONMENTAL	SOCIAL
<p>Monetised</p> <ul style="list-style-type: none"> • Additional tourism, fishing and recreation resulting from improved health of coral reefs, mangroves and seagrasses 	<p>Monetised</p> <ul style="list-style-type: none"> • Sediment reduction • Nutrient reduction (nitrogen driven) <p>Nonmonetised</p> <ul style="list-style-type: none"> • Increased coral diversity and ecological health • Regular and comparable water quality monitoring 	<p>Nonmonetised</p> <ul style="list-style-type: none"> • Preservation of the Reef for future generations • Informing standards for water quality targets for local and national government • Advancement of scientific research and understanding of the Reef

Benefits: Quantitative CBA results indicate that CSIRO’s efforts to develop and implement the eReefs platform for 2019 through 2034 will generate a BCR of between 4 and 16, considering the contributions of eReefs in setting pollution reduction targets, underpinning a large range of additional value in tourism, fishing and recreation that may have been lost due to nutrient and sediment pollution without eReefs. The total value (in 2024 dollars, discounted using a 7% real social discount rate) stemming from eReefs from 2019 to 2034 was found to be \$207 million (lower range) to \$865 million (upper range).

Costs: The real costs (in 2024 dollars, discounted using a 7% real social discount rate) from FY 2019 to FY 2034 are reported as \$33.3 million, including direct and in-kind contributions.

Quantitative CBA results indicate that by 2034, CSIRO’s efforts to develop and manage the eReefs platform are expected to realise a benefit cost ratio (BCR) between 4 and 16 considering eReefs’ contributions in setting pollution reduction targets, underpinning a large range of additional ecosystem services value that may have been lost due to nutrient and sediment pollution without eReefs.

“When the idea of eReefs was first conceived, some thought that it would be unachievable to create a model that could simulate environmental processes within the entire Great Barrier Reef area. Now, after being operational for less than 10 years, eReefs has already had significant impacts on Great Barrier Reef policy and management.” (2024 case study analysis)

Gully and Streambank Toolbox



Focus Area

Water Quality Land Repair

Analysis Time Frame

2016 through 2034

Key Collaborators

The Australian Government's Reef Trust Erosion Control Program, field-level delivery partners (e.g., natural resource management groups, engineering firms, landowners), GBRF, ANU Enterprise, Griffith University, the Queensland Government

Background: The Gully and Streambank Toolbox (i.e., the Toolbox) and CSIRO's associated research and decision support activities with partners aim to counter erosion that leads to severe water quality degradation in the Great Barrier Reef lagoon. Over the past two centuries, agricultural intensification and human settlement in the Great Barrier Reef catchments have significantly degraded water quality through runoff containing sediment, nutrients and pesticides, which harm coral ecosystems and marine biodiversity. Excess sediment, nitrogen and phosphorous levels contribute heavily to coral bleaching, disease spread and broader ecosystem impacts like increased algal growth and rapid COTS outbreaks. The Toolbox serves as the technical guide that supports natural resource managers to target, design and implement their erosion control activities and ensures that industry best practices and science-based solutions are being leveraged in these efforts. First published in 2015, four editions of the Toolbox have been released, with each version improved through outcomes and lessons learned from Reef Trust erosion control projects and Queensland government water quality improvement programs.

Case Study Findings: The analysis found that the Toolbox achieves impact by reducing asymmetries of information, allowing for all actors to align under a single methodology. Stakeholders noted that the Toolbox "levels the playing field" for organisations seeking to do land repair. If instead unique methodologies were being employed by different organisations, tenders for applications would not be comparable. It is likely that the absence of a unified methodological approach would act as a barrier for entry to new players, reducing competition and likely increasing costs. The Toolbox also boosts sectoral efficiency by translating the best available science and evidence into practical advice; it helps achieve overall better outcomes by steering investment towards the most cost-effective options. Interviewees agreed that the Toolbox plays a key role as a capacity-building tool across the industry. Multiple key informants participating in the evaluation referred to it as the "go-to resource" for training natural resource management groups as they bring on new staff. Separately, the Toolbox has steered investments towards larger-scale interventions in areas that can deliver the most pollutant reduction to the Reef. Without this shift, the effectiveness of investments to reduce sediment to the Reef would likely have been lower.



Image 10: CSIRO

Observed Impacts: Key impacts identified through quantitative and qualitative analysis include the following:

ECONOMIC	ENVIRONMENTAL	SOCIAL
<p>Monetised</p> <ul style="list-style-type: none"> Increased tourism and recreation Reduced cost for sediment and nutrient management 	<p>Monetised</p> <ul style="list-style-type: none"> Sediment reduction Nutrient reduction (nitrogen driven) Carbon sequestration <p>Nonmonetised</p> <ul style="list-style-type: none"> Increased coral diversity and ecological health Phosphorous reduction 	<p>Nonmonetised</p> <ul style="list-style-type: none"> Facilitating broader community engagement and collaboration in Toolbox activities, specifically farmers, landowners and Traditional Owners Preservation of the Reef for future generations

Quantitative CBA results indicate that by 2034, CSIRO’s efforts to support the Gully and Stream Bank Toolbox and related activities are expected to realise a BCR of 25.2 for the median impact scenario considering the economic benefits of reducing sediment and nitrogen in the Great Barrier Reef and the co-benefit of carbon sequestration from riparian revegetation.

Benefits: Quantitative CBA results indicate that CSIRO’s efforts to support the Gully and Stream Bank Toolbox and related activities from 2016 through 2034 will generate a BCR of 25.2 for the median impact scenario considering the economic benefits of reducing sediment and nitrogen to the Great Barrier Reef and the co-benefit of carbon sequestration from riparian revegetation. The total value of these benefits (in 2024 dollars, discounted using a 7% real social discount rate) stemming from the Toolbox and related activities from 2016 to 2034 is reported at \$67.2 million for the median value scenario.

Costs: The real costs (in 2024 dollars, discounted using a 7% real social discount rate) from FY 2016 to FY 2034 are reported as \$2.8 million and consider all four editions of the Toolbox.

“The Toolbox serves as an example of a resource that can turn scientific findings into practical impacts ... [It] is a fundamental tool for combatting deteriorating water quality in the Great Barrier Reef and enhancing the resilience and sustainability of the Reef ecosystem.” (2024 case study analysis)

Social and Economic Long-Term Monitoring Program

Focus Area

Social, Economic and Indigenous Science

Analysis Time Frame

2011 through 2024

Key Collaborators

Australian Government's Reef Trust, GBRF, GBRMPA, JCU, the Queensland Government, Regional Waterways Partnerships



Background: SELTMP is an innovative social research project that serves as a critical platform activity for socio-economic long-term monitoring of the Great Barrier Reef under the RIMReP. The project emerged from a recognition that previous Reef management strategies largely missed an empirical understanding of people's perceptions and values of the Reef, despite the critical importance of human factors in sustaining Reef health.

First established in 2011, SELTMP has matured into a model for connecting social science to ecosystem management. It now serves as a source of scientifically valid information about how people value, use and feel about the Great Barrier Reef. From a scientific standpoint, ecosystem management before SELTMP focused on understanding the condition and trend of ecological communities, keystone species, as well as biophysical properties like water temperatures, sediment loads and other pollutants. Human attitudes towards the Reef and relationships with Reef ecosystems were largely absent from how ecosystems were managed within the Great Barrier Reef catchment and globally. Filling this gap, SELTMP now serves as a globally recognised model for conducting rigorous, end user-driven social science that can be integrated into Reef reporting and management at regional and Reef-wide scales.

Case Study Findings: SELTMP has developed into a core element of the infrastructure to monitor Great Barrier Reef catchment health as the source of social indicators for regional report cards, Reef 2050 monitoring data, incorporated into the Reef Authority's 5-yearly Outlook report, and public-facing data on peoples' perceptions and behaviours around the Reef. It is unclear how social dimensions would be incorporated into Great Barrier Reef monitoring and management without the use of SELTMP's human dimensions data. Interviews with experts credited the SELTMP team for supporting their ability to turn survey data and results into informed action by managers and stakeholders and hailed this as a key service that the SELTMP team provides end users. SELTMP's End-User Reference Group process, which helps users act on findings through its iterative methods of data gathering, analysis, and engagement, has been identified as a model approach for other monitoring projects. SELTMP's track record of effective end user-driven science contributes to CSIRO's standing in the Great Barrier Reef management system as a source of valuable scientific services and support for partner entities.

Observed Impacts: Key impacts identified through quantitative and qualitative analysis include the following:

ECONOMIC	ENVIRONMENTAL	SOCIAL
<p>Nonmonetised</p> <ul style="list-style-type: none"> • Used as a tool for justifying current management/ stewardship investments, or making a case to pivot • Reduced cost for sediment and nutrient management • Evidence of economic value of the Reef to area residents 	<p>Nonmonetised</p> <ul style="list-style-type: none"> • Human dimensions are a core element of the infrastructure to monitor Reef health • Improved Reef management programmatic design 	<p>Nonmonetised</p> <ul style="list-style-type: none"> • Perceptions, needs and behaviours of people in and around the Reef are a visible part of how the ecosystem is managed • Collaborative approach to survey design that meets the needs of a diverse user set • Findings from SELTMP help support partners in framing strategic communications • Evidence of social value of the Reef to area residents



Image 11: Matt Curnock

“SELTMP is now the longest-running human dimensions monitoring program focused on the Great Barrier Reef and has evolved into a foundational element of the infrastructure in place to assess conditions in the catchment and inform ecosystem management decision-making.” (2024 case study analysis)

Conclusions from Evaluating CSIRO's Research Impact in the Great Barrier Reef

1. CSIRO's efforts in the Great Barrier Reef are commensurate with the organisation's role as Australia's national science agency.

CSIRO's mission to "turn science into solutions to address Australia's greatest challenges" is well reflected in its Great Barrier Reef research portfolio, in terms of what CSIRO's research contributes and how CSIRO engages in the Reef partner landscape.¹⁵ The breadth of CSIRO's Reef research portfolio, the interdisciplinary expertise the organisation brings to bear, the longevity of support provided and the more collaborative and coordinated approach adopted over time align well with the expectations of a national science agency's support for a highly valued economic and cultural icon like the Great Barrier Reef.

2. CSIRO's research impact in the Reef can be strengthened by expanding on the specific capabilities outlined as follows. These capabilities, although present in some aspects of CSIRO's work, warrant additional resourcing and attention as stakeholders contend with complexity and ongoing change in the Reef.

- **Further improve access to and integration of CSIRO research into Reef management and policy:** Stakeholders encourage CSIRO to continue prioritising research contributions for actionable decision support and integrated management solutions as users (e.g., Reef managers and policymakers) face increasingly complex, interrelated challenges on the Reef. CSIRO has been moving into more user-centered, action-research and decision-support orientations in its Reef research portfolio; stakeholders value those ways of working with CSIRO and encourage the organisation to expand on demand-responsive action research approaches that put Reef managers' and policymakers' needs at the center of the research process.
- **Continue supporting ongoing relationship stewardship and collective action in the Reef:** CSIRO and other R&D organisations active in the Reef have made strides in recent years in their efforts to collaborate via large, multi-partner projects tackling increasingly integrated problems, driven by the recognised need to address the growing complexity of challenges facing the Reef and by investor, stakeholder and manager expectations. CSIRO has an opportunity, and even a responsibility, to continue investing in the relationships, norms and shared spaces that enable collective action for the Reef.

- **Amplify Traditional Owner engagement in Great Barrier Reef research efforts in collaboration with partners:** Multiple impact case studies and feedback from external key informant interviews highlight potential pathways to improve Traditional Owner engagement in CSIRO's Reef-related research efforts. This includes proactively making room for power to be shared with Traditional Owners and supporting Indigenous-led decision-making in the Great Barrier Reef. As custodians of the Great Barrier Reef, Traditional Owners hold unique rights, interests, knowledge and responsibilities. There is considerable opportunity for Reef R&D actors such as CSIRO to work more closely with Reef Traditional Owners to weave their knowledge and values with Western science. Key informants encouraged CSIRO to work alongside partners such as AIMS and JCU in doing this and engaging with deep, mutual care at the grassroots level. Opportunities to expand CSIRO's internal capability and organisational support mechanisms to better partner with Reef Traditional Owners include building CSIRO researchers' cultural competencies for Traditional Ownership engagement and driving improvements in Indigenous co-authorship and scientific leadership, especially for women in science, technology, engineering and math.

3. **CSIRO has an important role to play in rethinking Reef R&D in this “critical decade” for coral reef survival.**¹⁶ The evaluation identified multiple unique capabilities exhibited by CSIRO that are likely to become increasingly important as climate pressures on the Reef mount and as Reef managers, policymakers and others face compounding, interrelated challenges. These include CSIRO's trusted thought leadership and visioning to inform Reef programs, its organisational ability to take the long view and plan on extended time horizons and its interdisciplinary capability, as reflected in its modelling prowess and substantial social science expertise, among others.

CSIRO's decades-long engagement in the Reef, combined with these unique capabilities, position the organisation to contribute alongside partners to national and international dialogue about the future of the Reef amidst climate change. This includes working with partners to support discourse about the collective risk appetite for intervention in the Reef and providing Reef managers, policymakers and others with climate scenarios, trend analysis and other resources to inform trade-off and resourcing decisions in the face of uncertainty.

As CSIRO considers future research priorities, interviewees pointed to multiple places where CSIRO is particularly well positioned to contribute. In part, this includes continuing to leverage and grow existing strengths in modelling, social science, inter- and trans-disciplinarity and provision of high-level and embedded technical advisory support. Interviewees also invite CSIRO to support landscape-level planning for coastal restoration, flood plain management and ecosystem repair more broadly, develop integrated data and modelling systems that leverage connected data pipelines and advance reef science synthesis and science communication capabilities.

4. **The emerging interventionist and resilience-based management paradigm in the Reef will shift what “best available science” entails. CSIRO has an opportunity to work with R&D partners and Reef stakeholders to anticipate and develop these capabilities in response to likely future demands.** CSIRO can use this transitional moment in the Reef partner landscape to proactively define what the organisation is and is not well positioned to support in Reef restoration and intervention efforts vis-à-vis other partners.

A more intervention-oriented environment would require more ongoing decision-support and intervention-at-scale functions beyond CSIRO’s traditional Reef science and research roles. Additionally, Reef-related technology and engineering solutions (e.g., underwater sensors, biosensors, sensing technologies, computer vision technologies) that support artificial intelligence-enabled, automated approaches to COTS control, larvae dispersal monitoring and other functions likely will become more pronounced if Reef managers attempt to monitor and intervene across larger parts of the Reef. These shifts would require a better integration of CSIRO’s technology development, engineering and industrial expertise into Reef efforts. These shifts would also require deeper engagement on the social, economic and institutional needs for scaling up Reef management approaches.

CSIRO is already engaged in intervention-focused efforts (e.g., via CCIP and RRAP); the experimentation and learning happening within these programs will be instrumental in helping CSIRO define a future role in large-scale integrated programs focused on intervention at scale. By reflecting on these experiences and considering likely future needs, CSIRO can work proactively with partners to define how the organisation responds in support of Reef restoration and intervention efforts.



Image 12: Shutterstock

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 - Office of the Great Barrier Reef
 - Natural Capital Fund

Methodology Details

Approach and methodology details for the three key components of RTI's independent evaluation of CSIRO's research impact in the Great Barrier reef follows below.

Great Barrier Reef Research Portfolio Review

- **Key Evaluation Question:** *What is the composition of CSIRO's Great Barrier Reef research portfolio since 2011, and how does it align to collective action goals as outlined in the Reef 2050 Long-Term Sustainability Plan?*
- **Purpose:** CSIRO's Great Barrier Reef research portfolio has evolved over time, in response to government priorities and the organisation's efforts to proactively address emergent reef science needs. The portfolio review analysis enables CSIRO to zoom out and assess the overall composition of the research portfolio and its alignment to government priorities. This analysis can inform future efforts to refine the research portfolio as external and internal priorities change.
- **Methodology:** This review covers CSIRO's Great Barrier Reef mission-driven research portfolio from 2011 to 2023, with explicit focus on projects directly addressing challenges and needs of the Reef. Projects were mapped to internal and external focus areas to evaluate alignment to internal goals (i.e., CSIRO-defined research focus areas) and external goals (i.e., Reef 2050 Goals as established in the Reef 2050 Plan). Internal CSIRO project data, publicly available reports and Science Leads' feedback served as the main data sources.

Impact Case Study—Overview

Key Evaluation Question: *What social, environmental and economic value has accrued (or likely will accrue in the future) to the Reef and the partner landscape through CSIRO's research efforts, as demonstrated by five case studies aligned with CSIRO's research focus areas?*

Purpose: The five case studies aim to provide an evidence base to consider the ways in which social, environmental and economic value has accrued (or likely will accrue in the future) to the Reef from specific research outcomes. CSIRO routinely evaluates its ability to accomplish and generate meaningful, positive outcomes from its research by performing impact case studies. The case studies seek to generate greater awareness of what results and impacts have been achieved to date and to inform what is needed to advance collective action and impact in the Great Barrier Reef in the future.

Methodology: CSIRO has adopted a general methodology for impact evaluation through a case study model, see below. CSIRO's Impact Evaluation Guide highlights the main drivers behind CSIRO's interest in

Case study selection criteria

- **Representation of key research themes encompassed in CSIRO's Great Barrier Reef portfolio**
- **Longevity or complexity of work meriting evaluation**
- **Availability of sufficient data to evaluate outcomes and impact**
- **Relevance to CSIRO's future planning and partner engagement efforts**

case study evaluation and outlines a preferred, reproduceable and consistent method for doing so across all programmatic and research areas. These case studies inform CSIRO of areas where future funding allocation may make the greatest impact, provide CSIRO researchers and managers with analyses that can help improve CSIRO's research and innovation strategies and communicate and advocate to the Australian public the important role that science, research and innovation play in creating a prosperous society.

STEP 1 **Establishing the purpose and audience**

Determine what is being sought from the evaluation, for whom, the relative priority and how the evaluation outcomes will be used.

STEP 2 **Clarifying the background information**

Clarify the context by identifying the need CSIRO addresses with the work.

STEP 3 **Identifying the impacts**

Determine impacts to be evaluated, the pathways connecting them back to CSIRO and the relevant parties engaged throughout those pathways.

STEP 4 **Clarifying the impacts**

Identify a credible counterfactual, estimate CSIRO's proportional effort and establish how much impact has been realised.

STEP 5 **Selecting the appropriate mix of methods**

Select relevant economic and non-economic analysis methods for estimating impacts.

STEP 6 **Evaluating the impacts**

Measure each impact, including costs, benefits, externalities and distributional effects, with inflation and discounting in mind.

STEP 7 **Calculating measures of economic return**

Present an aggregate net present value and benefit-cost ratio across all types of impacts measured and perform a reality check.

STEP 8 **Documenting recommendations for optimising impact**

Identify and document lessons learnt, best practices and barriers to adoption.

STEP 9 **Reporting**

Document assumptions, decisions and limitations, write up the findings and disseminate results.

External Stakeholder Feedback on CSIRO's Contributions

Evaluation Question: *What do external partners view as CSIRO's core contributions to and future opportunities and risks in the Great Barrier Reef and the supporting partner landscape?*

Purpose: The Reef's multifaceted partner landscape mobilises collective action to achieve systems-wide change. The work done by CSIRO is complementary and in support of other functions performed by other Great Barrier Reef partners, such as government actors, coordinating entities, Reef managers, Traditional Owners, Reef-dependent communities and businesses and other R&D organisations. Understanding external partners' perspectives on how CSIRO operates within the broad partner landscape supporting the Reef serves as a critical input into CSIRO's own learning and strategic planning.

Methodology: RTI solicited qualitative feedback via key informant interviews from 19 individuals across 9 partner organisations active in promoting the sustainability and resilience of the Great Barrier Reef. Two additional feedback sessions were undertaken by CSIRO's GBR Coordinator. These key informants were characterised by their landscape-level perspectives; diverse organisational roles in the partner landscape (e.g., policy, research, management, broker) and ability to assess CSIRO's effectiveness from multiple vantage points due to having multifaceted relationships with CSIRO.

Notes

- 1 Great Barrier Reef Marine Park Authority. (2024). Great Barrier Reef Outlook Report 2024 executive summary.
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<https://www.barrierreef.org/news/news/this-is-the-critical-decade-for-coral-reef-survival>
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- 10 Great Barrier Reef Marine Park Authority. (2024, August 23). Science for management.
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- 11 Great Barrier Reef Marine Park Authority. (2024). Great Barrier Reef Outlook Report 2024 executive summary.
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- 13 CSIRO. (2024, October). Impact Evaluation Guide.
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- 14 Great Barrier Reef Marine Park Authority. (2019). Great Barrier Reef outlook report 2019.
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- 15 CSIRO. (n.d.). We are CSIRO.
<https://www.csiro.au/en/about/We-are-CSIRO>
- 16 Great Barrier Reef Foundation. (2021, October 18). This is the critical decade for coral reef survival.
<https://www.barrierreef.org/news/news/this-is-the-critical-decade-for-coral-reef-survival>

Images

- Cover A pair of Barrier Reef anemone fish and a school of anthias, Ribbon Reefs
— *Matt Curnock*
- Letter Photo of Peter Mayfield
— *CSIRO*
- 1 Drone image taken during the March 2024 coral bleaching event at North Point, Lizard Island, Great Barrier Reef
— *George Roff and Geoffrey Carlin, CSIRO*
- 2 Science team on January 2024 voyage, which assessed impacts of Cyclone Jasper and supported seagrass mapping activities with Juunjuwarra Rangers and Cape York Water Partnership
— *Geoffrey Carlin and Joey Crosswell*
- 3 Image taken by CSIRO Moving Corals team checking on coral larvae deployments at Eyrie Reef in March 2023
— *George Roff, CSIRO*
- 4 Surveying alluvial gully erosion in the Upper Burdekin catchment
— *CSIRO*
- 5 Tourist snorkelling at John Brewer Reef near Townsville, 2021
— *Matt Curnock*
- 6 Reef Restoration Foundation partners involved in RRAP Collaborative Monitoring Pilot project at Moore Reef, 2023
— *Matt Curnock*
- 7 Crown-of-thorns starfish feeding on hard corals at a site on Ribbon Reefs, Great Barrier Reef, in January 2018
— *David Westcott, CSIRO*
- 8 Picture of crown-of-thorns starfish on Great Barrier Reef
— *CSIRO*
- 9 In 2019, the Great Barrier Reef faced a significant threat due to muddy flood plumes caused by heavy rainfall in Queensland, Australia. These plumes carried sediment, nitrogen, and pesticide chemicals from swollen rivers, extending up to 60 kilometers from the Queensland coast to the outer-shelf reefs.
— *Matt Curnock*
- 10 Gully remediation forum field day, 2017
— *CSIRO*
- 11 Tourism pontoons on the Reef
— *Matt Curnock*
- 12 Clownfish on the Great Barrier Reef
— *Shutterstock*

CSIRO's Research Impact in the Great Barrier Reef Independent Findings



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