



Australia's National
Science Agency

Science solutions for protecting and preserving the Great Barrier Reef



A research-led approach

CSIRO draws on a wide range of expertise to help solve some of society's greatest challenges through innovative science and technology.

Our approach to research is a collaborative one, and we benefit from many longstanding relationships with stakeholders and collaborators such as universities, industry and fellow research organisations.

As Australia's national science agency, CSIRO, we are a trusted entity ideally positioned to provide scientific analysis and data to support informed decision making by government and industry. In the context of preserving Australia's biodiversity for the future, these relationships are critical.

These relationships and our combined scientific expertise is vital for the effective management of the Great Barrier Reef and the complexity of challenges it will face into the future.

We acknowledge the continuing sea country management and custodianship of the Great Barrier Reef by Aboriginal and Torres Strait Islander Traditional Owners, whose rich cultures, heritage values, enduring connections and shared efforts protect the Reef for future generations.

Snorkelers exploring the northern reef wall at John Brewer Reef, offshore from Townsville.

Image by Matt Curnock, CSIRO





Fisherman on the Great Barrier Reef.
Image by Matt Curnock

A natural and cultural icon

The Great Barrier Reef is 2,300 kilometres long and spread along Australia's eastern coastline, stretching from the top of Queensland down to Bundaberg in central Queensland. It is home to a wealth of marine biodiversity. This complex ecosystem, however, is being threatened from human activities both locally on the reef, regionally along its coastline, and globally.

The greatest threat to the Reef is climate change and its impacts. The other main threats are associated with coastal development, land-based run-off, pests like crown-of-thorns starfish and threats from direct use of the Reef such as fishing.

The Reef has shown the ability to recover from impacts. However, over the past 10 years four mass coral bleaching events have occurred in 2016, 2017, 2020 and 2022.

Rapidly recurring bleaching events do not give the Reef ecosystem time to recover from the damage caused by these events.

Recent marine heatwaves are the primary cause of mass coral bleaching and damage to coral reefs including the Great Barrier Reef. Estimates from scientific modelling predict more frequent, hotter and longer-lasting marine heatwaves over larger areas in the future.¹

In response to the growing pressures on the Reef, the Australian and Queensland governments released the Reef 2050 Long-Term Sustainability Plan (Reef 2050 Plan) in 2015 and it continues to be updated. It provides a 35-year blueprint for managing the Reef, it represents the policy cornerstone for safeguarding the Reef and guides government investment and broader stakeholder action in protecting the Reef.

¹ State of the Climate 2020: Bureau of Meteorology (bom.gov.au)

Managing the Reef in an uncertain future

The pressures on the Reef are varied, sometimes interconnected, sometimes overlapping and they can occur over different timescales.

Today many parts of the Reef remain in excellent condition. The Reef's ecosystem has huge built-in resilience that allows coral to recover when given the chance – but the number of such reefs has been declining over time. And the number of reefs in poor condition is increasing.²

Recent warming events and cyclones on the Reef have severely impacted reef ecosystems and the livelihoods and industries that rely on it. These events have occurred on top of regional and local pressures from catchment land-use, coastal developments, fishing and crown-of-thorns starfish outbreaks.

The trajectory of continued global change is uncertain. However, one way to prepare is to consider future scenarios.

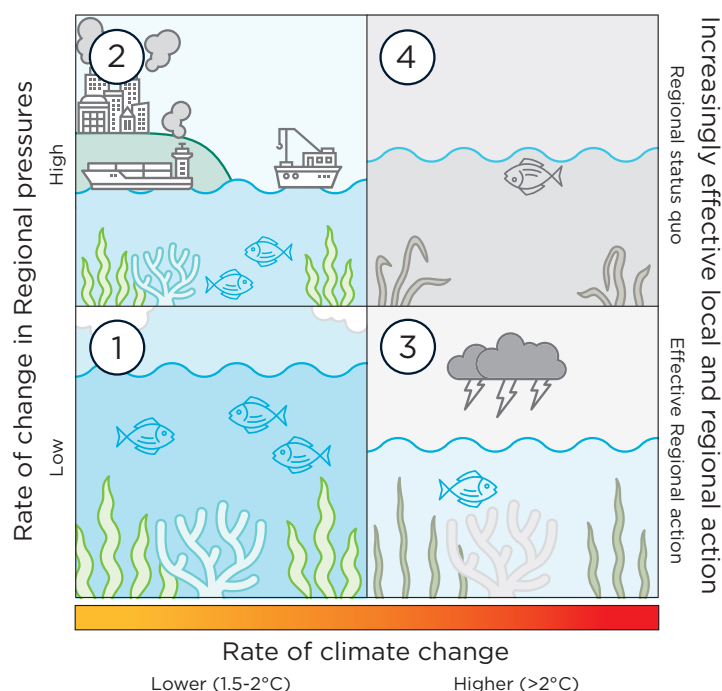
For example, if the world met the Paris Agreement's highest goal (< 1.5°C warming above preindustrial levels)³ then continued climate change would be limited but not insignificant. This possible future would

provide opportunity to support the natural resilience of GBR ecosystems. Conversely, in a future world that warmed > 2°C, this ability to support the natural resilience of the Reef's ecosystems becomes less effective.

The rate of climate change is not under direct control of Reef decision makers. However, the rates of change regarding regional pressures are more responsive to governance and management decisions (see trajectories 1 and 2). Australia is leading the world with increasingly effective local and regional action to improve water quality and combat coral eating pests that weaken the Reef's overall resilience (see trajectory 3).

The challenge to maintain the Reef is complex and will require sophisticated approaches to better understand how actions in the catchments and marine environment will interact with climate change impacts to determine the health of reef ecosystems.

Using trajectories to better understand how we can build Reef resilience⁴



² Reef Snapshot Summer 2020–21 (gbrmpa.gov.au)

³ Position Statement Climate change (gbrmpa.gov.au)

⁴ Adapted from Reef 2050 Plan Review Options (environment.gov.au)



Coral reefs provide important habitat for many fish species.
Image by Shutterstock

Collaborative science is delivering results

Preserving the Reef's ecological function by 2050 – not just of its coral reefs, but of all its ecosystems – represents a highly complex challenge. It requires broad based partnership between Australian governments, industry, landholders, community groups, Traditional Owners and research institutions.

The Australian Institute of Marine Science (AIMS), CSIRO and the Great Barrier Reef Marine Park Authority (the Authority) are the lead federal science and management agencies for the Reef.

We have a long history of working with partners in the Great Barrier Reef World Heritage Area and adjacent catchments, spanning the full continuum from inland to outer reef.

CSIRO has taken a proactive role in facilitating a broad-based coalition of partners and has built on existing and new research initiatives.

Our current work includes:

- Understanding and predicting the impacts of climate change.
- Improving water quality by reducing pollutants from agricultural land.
- Working with Traditional Owners to support their aspirations to monitor reef health in culturally relevant ways, and realise their rights and interests in Reef management and decisions.
- Supporting marine park management including managing crown-of-thorns starfish and modelling tools.
- Ocean acidification and coral bleaching research
- Partnering with the Reef Restoration and Adaptation Program (RRAP) including harvesting coral spawn, modelling environmental responses to climate and management interventions and designing stakeholder participation. The Program is funded by the partnership between the Australian Governments Reef Trust and the Great Barrier Reef Foundation.
- Understanding the perspectives of Reef residents and those whose livelihoods depend on it.

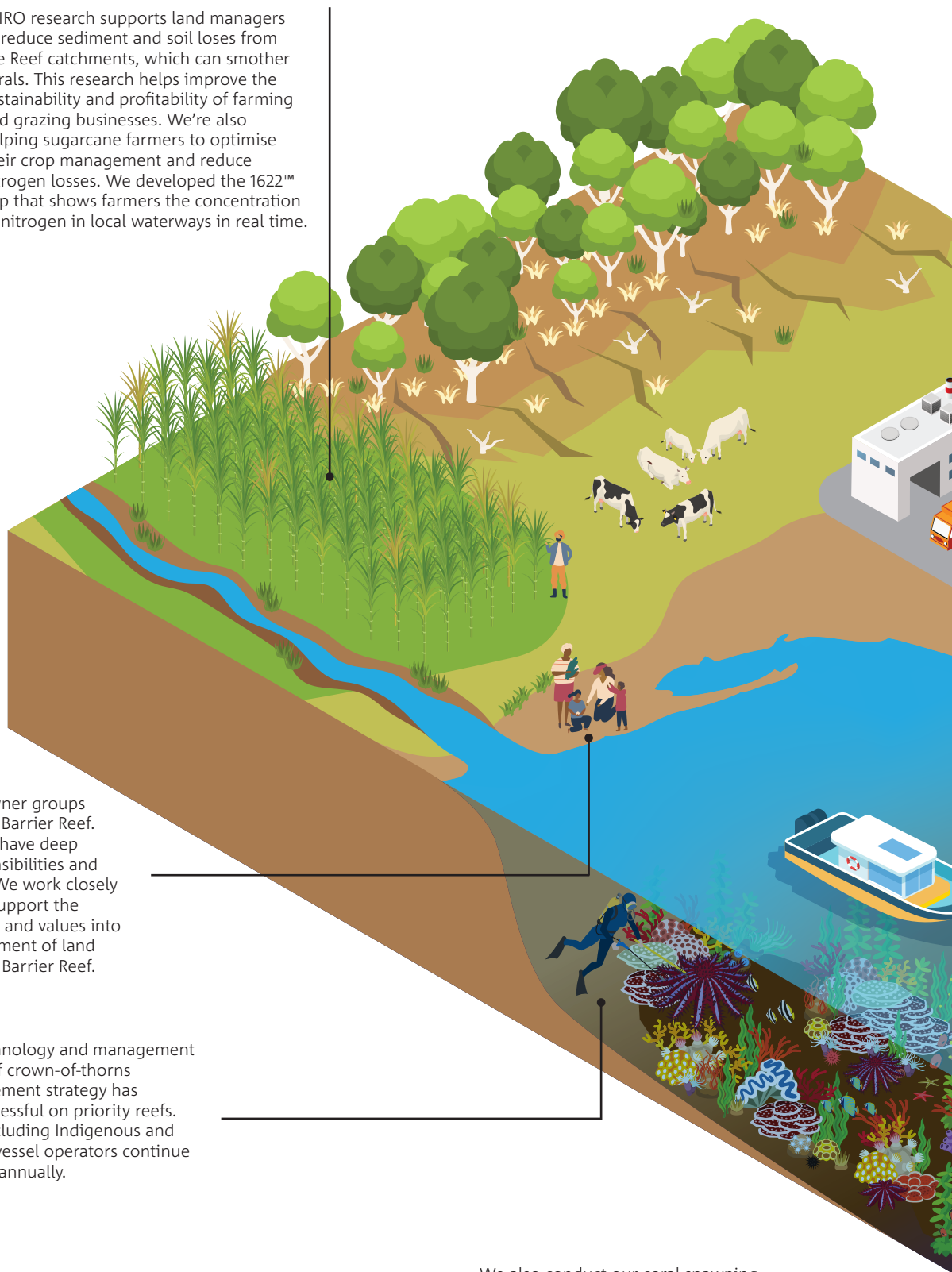
Solving the greatest challenges for the Great Barrier Reef

CSIRO research supports land managers to reduce sediment and soil losses from the Reef catchments, which can smother corals. This research helps improve the sustainability and profitability of farming and grazing businesses. We're also helping sugarcane farmers to optimise their crop management and reduce nitrogen losses. We developed the 1622™ app that shows farmers the concentration of nitrogen in local waterways in real time.

More than 70 Traditional Owner groups span the length of the Great Barrier Reef. As the Reef custodians, they have deep spiritual connections, responsibilities and relationships with the Reef. We work closely with Traditional Owners to support the inclusion of their knowledge and values into decisions about the management of land and sea country in the Great Barrier Reef.

We work on developing technology and management plans to control the threat of crown-of-thorns starfish. The current management strategy has been tested and proven successful on priority reefs. Professional COTS divers (including Indigenous and youth trainees) and control vessel operators continue to cull thousands of starfish annually.

We also conduct our coral spawning work under the Reef Restoration and Adaptation Program (RRAP) program. This cultures larvae in the millions and places them back onto damaged reefs.



The Great Barrier Reef's complex and delicately balanced ecosystem is being challenged. Impacts are being felt in deteriorating water quality due to land-based pollution, rising water temperatures and more extreme weather events due to climate change, pests such as crown-of-thorns starfish, coastal development and increasing ocean acidification. They are being seen in dramatic losses in coral cover and habitat.

Reef managers require an up-to-date understanding of how people value, perceive and interact with the Reef for effective management. SELTMP is the Social and Economic Long-Term Monitoring Program for the Reef, led by CSIRO. Its researchers have conducted large-scale surveys of Reef user groups in 2013, 2017 and 2021.

As a partner in the Reef Restoration and Adaptation Program (RRAP), we are working with marine park managers to test the effectiveness of novel management interventions such as marine cloud brightening, under current and future climate scenarios, to protect reefs from marine heat waves. This involves extensive modelling to assess the usefulness of these technologies as well as understanding their social acceptance.

We help provide large-scale assessment of ocean acidification and coral bleaching events. We use remote sensing, models such as eReefs and data visualisation to provide a picture of what is currently happening on the Reef and what will likely happen in the future.



Heart Reef in the Great Barrier Reef, Whitsundays

As Australia's national science agency and innovation catalyst, CSIRO is solving the greatest challenges through innovative science and technology.

CSIRO. Unlocking a better future for everyone.

Contact us

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