

BRIEFING PAPER: 14 MARCH 2024

UNDERWATER BUSHFIRE

VIBRANT GREAT BARRIER REEF FADING TO A SHADOW OF ITS FORMER GLORY



SUMMARY

- 1.** Thursday 14 March, 2024 marks 365 non-stop days of global ocean temperature records falling.
- 2.** Ocean heating has led to devastating bleaching of coral reefs world-wide, with widespread bleaching now occurring across the Great Barrier Reef.
- 3.** It took around 8,000 years for the Great Barrier Reef to develop. Following seven mass bleaching events, including five in the past nine years, that have repeatedly damaged this complex ecosystem, the Great Barrier Reef has most likely crossed a tipping point and is fading into a new, 'shadow state'.
- 4.** The rapid and significant changes to our Great Barrier Reef underscore the alarming impact that climate pollution is having on the ecosystems that sustain us. Burning coal, oil and gas is leading to abrupt, significant and irreversible changes.
- 5.** Our national environment law is failing to protect the Great Barrier Reef from climate pollution with 740 polluting projects waved through since the law came into effect.
- 6.** The Australian Government has an opportunity right now to better protect the Great Barrier Reef by fixing our national environment law so that it properly tackles climate pollution.



INTRODUCTION

The Great Barrier Reef is a source of wonder, vibrant life and, for many Australians, part of our national identity. But the health and vibrancy that led to Earth's largest living structure being dubbed one of the seven natural wonders of the world is fading, as the ocean around it heats up due to climate pollution.

Another mass bleaching event – likened to an underwater bushfire due to the destruction it wreaks – is underway (GBRMPA 2024). Heat-trapping pollution from coal, oil and gas is responsible, with all seven mass bleaching events on the Reef recorded since 1998. This is part of a devastating wave of bleaching events striking coral reefs worldwide, with an alarming outlook for reefs across the Pacific over coming weeks (NOAA 2024a).

Our ocean sits at the heart of the climate change story (Morgan et al. 2023). More than 90 percent of the excess heat stored in our climate system due to climate pollution has been absorbed by the ocean (IPCC 2019) and this is driving an extraordinary rise in sea surface temperatures.

2023 saw ocean surface temperature records smashed as extreme marine heatwaves engulfed the eastern tropical Pacific and northern Atlantic (Cheng et al. 2024; Hoegh-Guldberg et al. 2023). The unrelenting rise in sea surface temperature continued into 2024, with Thursday 14 March marking 365 consecutive days on which a new global average sea surface temperature record was set for that day of the year (Climate Reanalyzer and NOAA 2024).

The deterioration of our Great Barrier Reef is a clear demonstration of our rapidly unfolding climate crisis. It's now likely we are crossing a tipping point for tropical coral reefs worldwide, including this irreplaceable ecosystem. This has significant consequences for our wellbeing, coastal communities that rely on reefs for their livelihood and potential knock-on effects for biodiversity and climate that we are only beginning to understand.

The abrupt changes underway on the Great Barrier Reef portend even greater dangers, and the possibility of crossing points of no return in our climate system. Cutting climate pollution further and faster from coal, oil and gas is the only answer.

Right now, the Australian Government can take a crucial and long overdue step to give the Great Barrier Reef its best chance of survival by fixing our outdated national environment law – the Environment Protection and Biodiversity Conservation (EPBC) Act. While this law is meant to protect the Reef and other precious, natural places, it has a massive blindspot when it comes to the number one threat facing coral reefs worldwide – climate change (Hughes et al. 2023).

This briefing paper provides an update of what's unfolding on our Great Barrier Reef, situates this event in the broader context of ongoing change to our climate and oceans, and explains how we can do more today to better protect the Great Barrier Reef as well as everyone and everything that depends on it.



Figure 1: Coral bleaching occurs when there is an accumulation of heat stress, causing corals to expel the symbiotic algae that provide them with essential nutrients and give them their brown colour. Sometimes, this also leaves behind beautiful coral pigments.

HOW OCEANS ARE HEATING AND CORAL IS BLEACHING

365 DAYS OF RECORD-BREAKING OCEAN HEAT

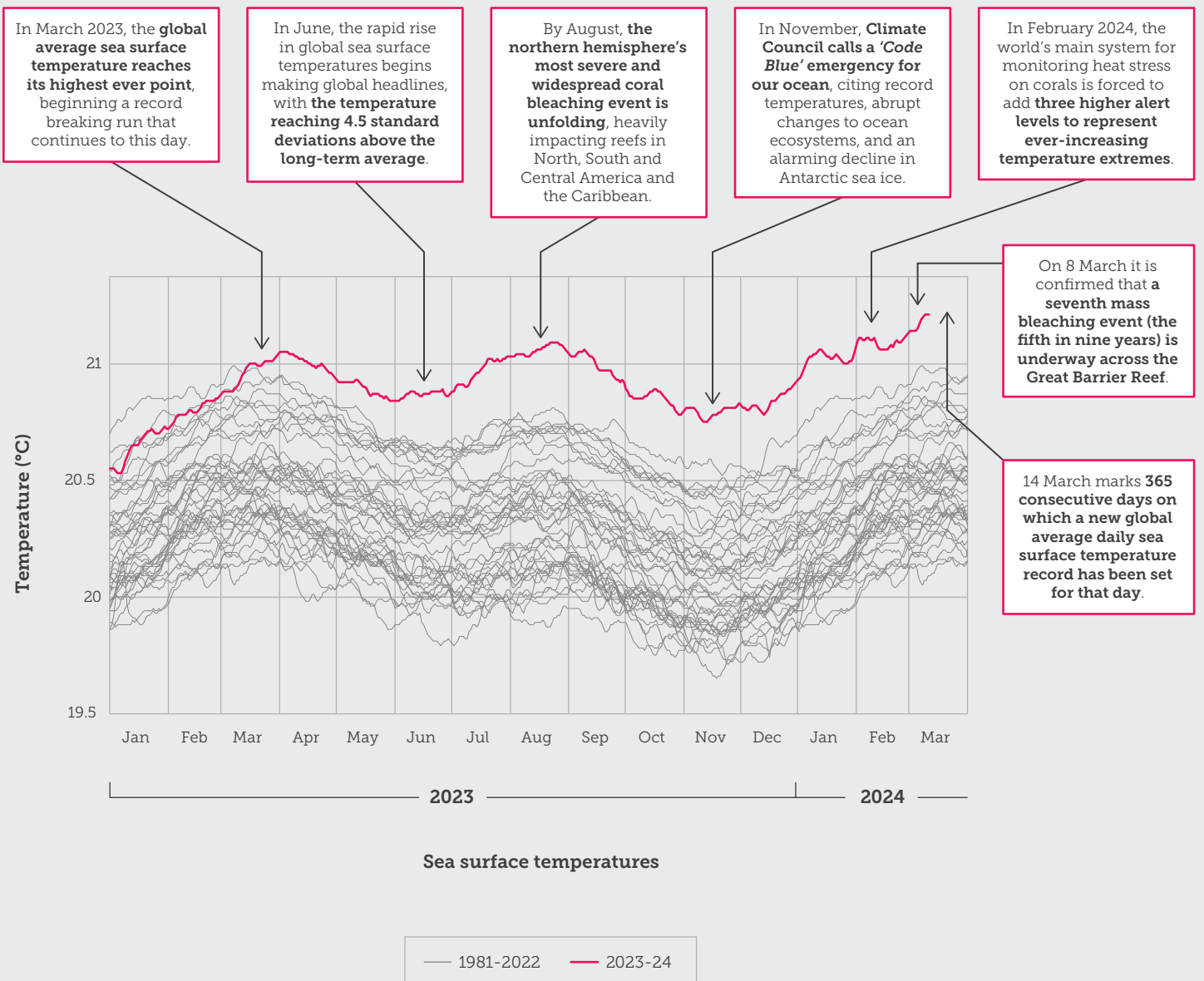


Figure 2: On 14 March 2024, the world will have registered 365 consecutive days on which a new global daily sea surface temperature record has been set for that day. This astonishing year for our ocean has also seen an alarming decline in sea ice and devastating bleaching across the world's tropical coral reefs. **Source:** Based on data from the National Oceanic and Atmospheric Administration (NOAA) and adapted from www.climateanalyzer.org – a project of the Climate Change Institute at the University of Maine.



CORAL REEFS IN HOT WATER THE WORLD OVER

The seventh mass bleaching of the Great Barrier Reef follows coral bleaching events throughout 2023-24 that have already devastated tropical coral reefs in the northern hemisphere. Together, these events likely constitute a fourth *global* mass bleaching event (Reuters 2024).

Coral bleaching occurs when waters become too warm and there is an accumulation of 'heat stress'.¹ Too much heat stress causes corals to expel the symbiotic algae (*Zooxanthellae*) that provide them with essential nutrients. Prolonged, severe or repeated bleaching can kill corals, which then impacts the myriad of marine life that depends on them. More than a quarter of all marine life – including over 4,000 species of fish – are dependent on coral reefs in their life cycle (EPA 2022).

The last global mass bleaching event of coral reefs ran from 2014 to 2017, when the Great Barrier Reef lost nearly a third of its corals. It's been estimated that about 15 percent of the world's coral reefs saw major loss of their corals during this event.

Just as heatwaves on land are getting hotter, longer and more frequent, so too are marine heatwaves. This means bleaching events and coral die-offs are likely to occur more often, be more severe when they do, and that reefs have less and less time to recover between events. In 2023, many Caribbean coral reefs experienced historically high heat stress that began up to two months earlier than usual, and continued for longer (Hoegh-Guldberg et al. 2023).

Our fire agencies have had to review and update their bushfire warning systems in light of climate pollution making off-the-chart events much more likely. Similarly, after "extreme accumulations of coral bleaching heat stress in 2023 in multiple regions of the world", the National Oceanic and Atmospheric Administration (NOAA)'s Coral Reef Watch – the world's main system for monitoring heat stress on corals – added three higher alert levels in February 2024 (NOAA 2024b).

The previous highest level – bleaching alert level 2 – represents "risk of reef-wide bleaching with mortality of heat-sensitive corals". In recent times levels of accumulated heat stress are regularly well above this threshold. New alert levels (3 to 5) provide guidance on what to expect at these higher levels of heat stress, with level 5 representing risk of near complete die-off (more than 80 percent of corals).

At the time of writing, the latest daily bleaching alert from NOAA's Coral Reef Watch (Figure 3) shows that in addition to parts of the Great Barrier Reef being under severe heat stress, many coral reefs in the Pacific – including around Fiji, Vanuatu, and New Caledonia – are at alert level 3 or above.

¹ Heat stress is measured in Degree Heating Days (DHDs). One week of water temperatures that are 1°C above average represents 7 DHDs. One week of water temperatures that are 3°C above average would be 21 DHDs, and so on.

MARCH SNAPSHOT: HOW CORAL REEFS ACROSS THE SOUTHERN HEMISPHERE ARE UNDER SEVERE HEAT STRESS

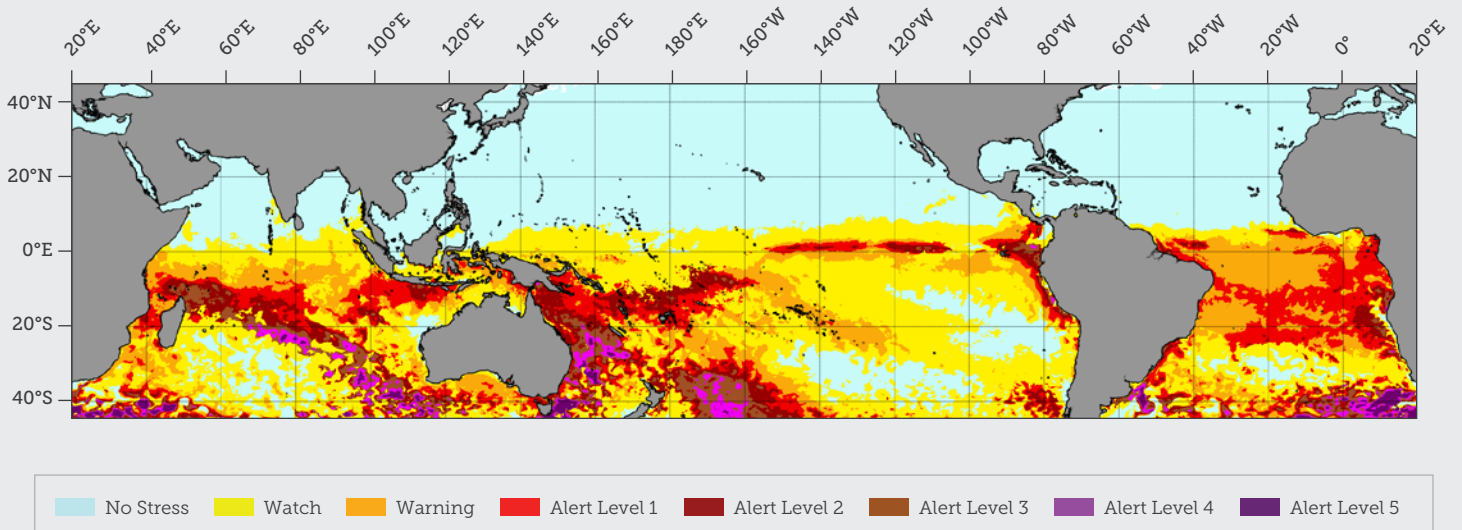
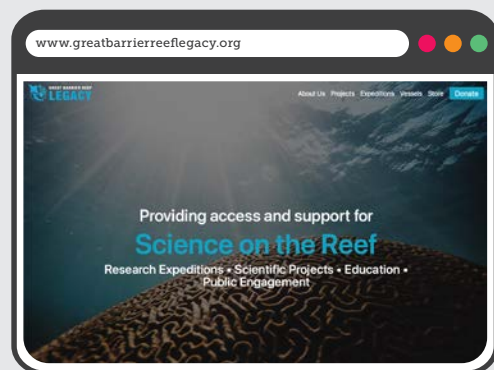


Figure 3: The seventh mass bleaching of the Great Barrier Reef follows similar events in other parts of the world, with a likely global mass bleaching event underway. Around Australia and many parts of the Pacific, coral reefs are experiencing dangerous levels of heat stress. **Source:** NOAA Coral Reef Watch, 7-day Maximum for 9 March 2024.

CREATING A CORAL ARK

Marine scientists and conservationists are working hard to secure the long-term survival of coral reefs and to preserve coral biodiversity for generations to come. This includes creating 'biobanks'.

The Forever Reef Project – an initiative of Great Barrier Reef Legacy – is a ground-breaking initiative to collect living specimens of the world's coral species. Acting as a 'coral ark', the Forever Reef Project will maintain the living biodiversity of corals before they are lost to us and future generations. This repository of live fragments and genetic material can be used to aid in global reef research and restoration efforts.



Learn more at:

www.greatbarrierreeflegacy.org



SIGNS OF BIGGER TROUBLES

ABRUPT AND IRREVERSIBLE CHANGES TO THE CLIMATE SYSTEM

By digging up and burning coal, oil and gas humanity is blanketing the Earth in heat-trapping pollution. 2023 was the hottest year on record, and our global temperature is now rising faster than at any known time in Earth's history.

The rapid deterioration of our Great Barrier Reef and other tropical coral reefs worldwide is a clear example of how climate pollution is the biggest threat to human societies and the ecosystems we depend on for our health, wellbeing and survival. Protecting people and the places we love depends on building out clean energy and non-polluting ways of doing things, so we can phase out coal, oil and gas.

Our climate system includes a number of 'tipping elements', which once pushed beyond a certain threshold – known as a 'tipping point' – may undergo abrupt and irreversible changes (Steffen et al. 2021). Tropical coral reefs are one such tipping element, alongside the ice sheets, ocean currents, and large ecosystems like the Amazon Rainforest.

FADING GLORY: HOW TROPICAL CORAL REEFS ARE ENTERING A NEW, SHADOW STATE

In 2022, a major review of the available science on tipping points concluded that tropical coral reefs were likely to cross a tipping point at around 1.5°C of global warming above pre-industrial levels but that the tipping point could be as low as 1°C (Armstrong McKay et al. 2022).

The world has already over-heated by around 1.2°C, and is likely to surpass 1.5°C of global warming sometime in the 2030s (IPCC 2023) or earlier.² In other words, it is possible we have already crossed a point of no return, setting in motion an irreversible collapse of the Great Barrier Reef and other tropical coral reefs worldwide.

Many scientists fear the Great Barrier Reef is already in far deeper trouble than was thought only a few years ago.

A 2018 study concluded that if countries honoured their existing targets and policies for cutting climate pollution, the Great Barrier Reef could still be expected to experience severe bleaching twice a decade on average by 2041, and every year by 2051 (Heron et al. 2018).³ Those projections now appear highly conservative considering the mass bleaching event that is unfolding now on the Great Barrier Reef is the fifth within only nine years.

2 Today almost all scenarios that limit warming to 1.5°C involve a period of temporary 'overshoot'. In other words, temporarily exceeding global warming of 1.5°C and then bringing the average global temperature back down by removing enormous quantities of greenhouse gases from the atmosphere. This involves the large-scale use of carbon dioxide removal technologies and the restoration of ecosystems. The period from February 2023 to January 2024 marked the first 12-months in which the global average temperature spiked to 1.5°C above pre-industrial levels. Breaching 1.5°C over a single year does not equate to exceeding the 1.5°C temperature goal as defined by international agreements or United Nations bodies. That goal is based on temperatures averaged over 20 or 30 years. (30 years is the standard reference period used by the World Meteorological Organisation. However, the most recent Intergovernmental Panel on Climate Change assessment used a reference period of 20 years.)

3 This projection is based on RCP4.5,* which is what is most likely to play out based on all countries implementing their existing commitments to reducing greenhouse gas emissions. It corresponds with a likely global average temperature rise of around 2.7°C by 2100, and is far short of the pace of emissions reductions required to meet the goals of the Paris Agreement. The study also includes projections for RCP8.5 – a scenario in which the world takes little or no action to reduce greenhouse gas emissions – and which corresponds with a likely global average temperature rise of around 4.4°C by 2100. Under that scenario, the Great Barrier Reef could be expected to experience severe bleaching on average twice a decade by 2035, and every year by 2044.

*RCPs or 'Representative Concentration Pathways' are possible trajectories for greenhouse gas concentrations used by the World Climate Research Program Coupled Model Intercomparison Project and the Intergovernmental Panel on Climate Change's Fifth Assessment Report. The number after RCP refers to the amount of 'radiative forcing' – a measure of the change in the energy balance in the atmosphere due to greenhouse gas emissions.

Figure 4: Coral bleaching explained.

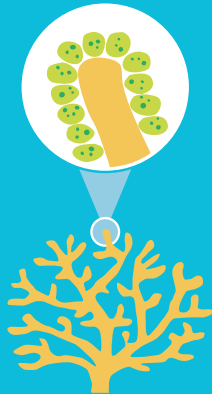
WHAT IS CORAL BLEACHING?

Coral reefs are highly vulnerable to climate pollution. Warmer ocean temperatures and other stressors cause coral bleaching events which can damage and destroy coral reefs and the ecosystems they support. Mass coral bleaching is a recent phenomenon. The first global bleaching event occurred in 1998.

1 HEALTHY CORAL

Coral and algae depend on each other to survive.

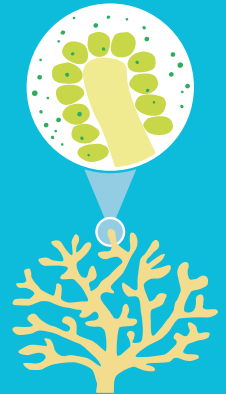
Corals have a symbiotic relationship with microscopic algae called zooxanthellae that live in their tissues. These algae provide their host coral with food and give them their colour.



2 STRESSED CORAL

If stressed, algae leave the coral.

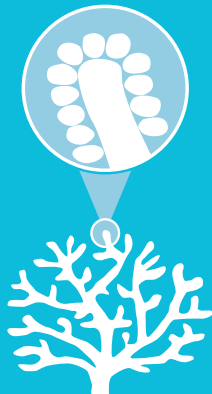
When the symbiotic relationship becomes stressed due to increased ocean temperature or pollution, the algae leave the coral's tissue.



3 BLEACHED CORAL

Coral is left bleached and vulnerable.

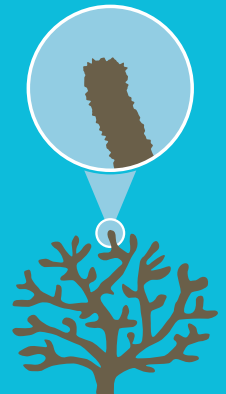
Without the algae, the coral loses its major source of food, turns white or very pale, and is more susceptible to disease.



4 DEAD CORAL

Coral is left bleached and vulnerable.

Without enough plant cells to provide the coral with the food it needs, the coral soon starves or becomes diseased. Soon afterwards, the tissues of the coral disappear and the exposed skeleton gets covered with algae.



CHANGE IN OCEAN TEMPERATURE

Increased ocean temperature caused by climate pollution is the leading cause of coral bleaching. Water temperature higher than the average summer maximum – just 1°C higher for four weeks can cause bleaching.



RUNOFF AND POLLUTION

Storm generated precipitation can rapidly dilute ocean water and runoff can carry pollutants - these can bleach near shore corals.



OVEREXPOSURE TO SUNLIGHT

When temperatures are high, high solar irradiance contributes to bleaching in shallow-water corals.



EXTREME LOW TIDES

Exposure to air during extreme low tides can cause bleaching in shallow corals.



The Great Barrier Reef has shown an impressive ability to recover from widespread bleaching and other disturbances if given a chance. However, recovery requires reprieve and those opportunities are disappearing. For example, the Great Barrier Reef would typically get a reprieve from heat stress during La Niña conditions due to increased cloud cover. But in 2022 we saw large sections of the reef bleach during a La Niña event for the first time. It takes coral reefs 10-15 years to recover from mass bleaching, and even then the corals that grow back are less diverse and more vulnerable to further such events. Repeated bleaching would mean the end of the reef as we know it.

We must consider that even with efforts to curb climate pollution this decade, the amount of heat held in the ocean will continue to increase year on year due to the greenhouse gases already in the atmosphere and our ocean. In other words, while cutting climate pollution further and faster will influence global ocean temperatures over the longer term and significantly limit future harms, marine heatwaves will become more severe in the near term, placing the Great Barrier Reef and other tropical coral reefs under even greater heat stress.

It took around 8,000 years for coral reefs to develop into what is now known as the Great Barrier Reef: the largest living structure on Earth that's home to a vast network of coral reefs and iconic species like whales, turtles and dolphins, as well as thousands of types of fish.

There are now strong grounds to believe that it is not merely possible but in fact likely we have already crossed a tipping point for tropical coral reefs. This is changing the Great Barrier Reef from its former state – a system characterised by vibrant hard reef-building corals – to a new shadow state likely to be characterised by more sponges, less coral coverage and a reduced diversity of species.

CONSEQUENCES OF CROSSING A TIPPING POINT

When a large ecosystem or other tipping element is tipped into a new state this can devastate the communities who depend on it.

In the case of coral reefs, millions of people worldwide – especially in developing countries in the tropics – depend on coral reefs for their food and the protection of their coasts (Schultheiß 2023). There will also inevitably be knock-on effects for other ecosystems and the wider marine food webs linked to coral reefs. More than 60,000 Queenslanders depend directly on the Great Barrier Reef for their livelihoods. We all depend on healthy oceans for our wellbeing, food, economic prosperity, cultural heritage and more. First Nations communities, who have maintained a continuous connection to the Great Barrier Reef for countless generations, are particularly impacted by these losses.

Crossing tipping points may also worsen climate change. For example, the abrupt thawing of arctic permafrost would release vast amounts of greenhouse gases into the atmosphere, amplifying global warming. The collapse of the ocean currents that distribute heat around the Earth's surface would have a dramatic effect on the weather patterns we all depend on for our survival. By their interconnected nature, the tipping of one or two elements could lead to an irreversible cascade, with catastrophic consequences for human societies (Steffen et al. 2021).

The growing likelihood that we have crossed a tipping point for tropical coral reefs including the Great Barrier Reef is both deeply troubling in its own right, and a stark warning about the need for far greater cuts to climate pollution this decade. It suggests that other tipping points could also be triggered at lower levels of global warming than previously thought, and that we need to work much harder to protect the ecosystems on which we depend for our health, prosperity and survival.

HOW OUR NATIONAL ENVIRONMENT LAW IS WORSENING OUR CLIMATE POLLUTION PROBLEM AND FAILING THE GREAT BARRIER REEFV

2000: Australia's Environment Protection and Biodiversity Conservation (EPBC) Act comes into effect



740

fossil fuel projects have been given the green light in Australia since the EPBC Act came into effect

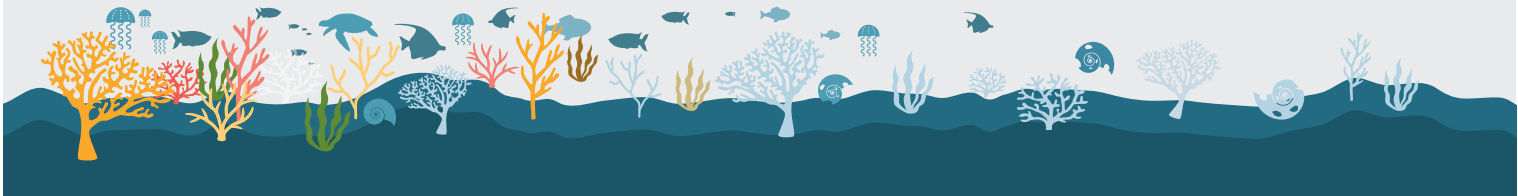
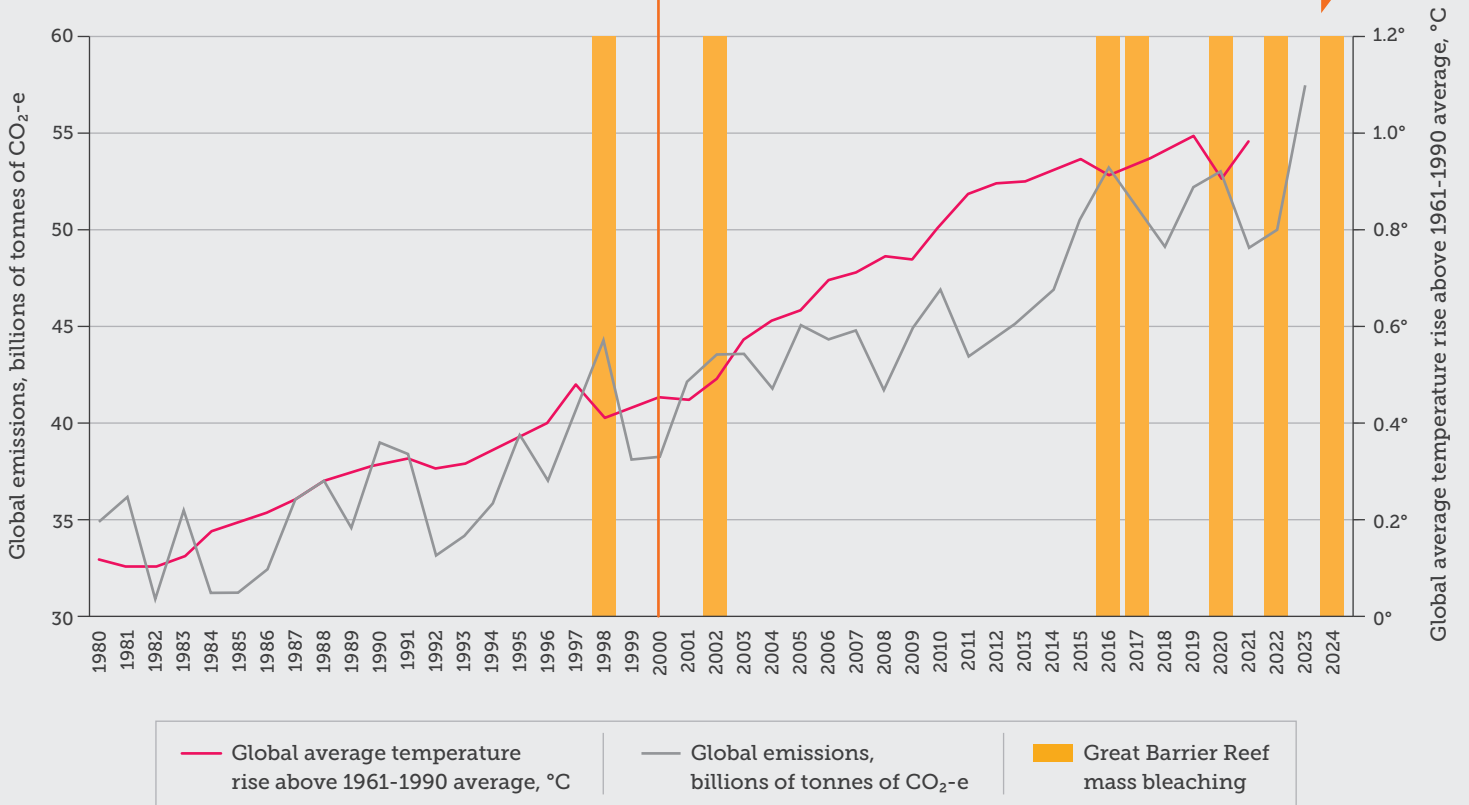


Figure 5: Our national environment law has failed to protect the Great Barrier Reef from its number one threat: climate change. 740 fossil fuel projects have been approved in Australia since the Environmental Protection and Biodiversity Conservation Act came into effect in 2000.



CONCLUSION

Our Great Barrier Reef is in grave danger, being forever altered by climate pollution from the burning of coal, oil and gas.

The latest in an unrelenting series of mass bleaching events shows we have entered very dangerous territory for our climate system, and must work far harder to protect critical ecosystems like the Great Barrier Reef from climate pollution so they can continue to support us.

Anyone proposing to use more coal, oil or gas is reckless. An astonishing 740 fossil fuel projects have been waved through since our national environment law – the Environment Protection and Biodiversity Conservation (EPBC) Act – came into effect (Hughes et al. 2023). This includes at least five since the last mass bleaching of the Great Barrier Reef and the election of the current Federal Government. Every one of these polluting projects is further endangering the Great Barrier Reef and all who rely on it.

Right now the EPBC Act does not consider climate pollution from new developments, and is failing to protect the Great Barrier Reef from its number one threat: climate change. The Australian Government has an opportunity to better protect precious places including the Great Barrier Reef by fixing our woefully outdated and inadequate national environment law so it assesses climate pollution risks.

In the same way that every polluting project is doing us further damage, every step we take to clean up climate pollution will better protect the places and people we love. While the Great Barrier Reef is fading, there is still so much we can and must fight to save. Every avoided tonne of climate pollution, and every fraction of a degree of avoided warming, lowers the risks of crossing further tipping points in the climate system and gets us closer to a brighter, safer future for all Australians.

VIEW FROM THE FRONTLINE: PROFESSOR OVE HOEGH-GULDBERG



Ove Hoegh-Guldberg has spent his career understanding the impacts of climate change on coral reef ecosystems. He was one of the first scientists to warn of the danger that rising ocean temperatures posed to corals. Speaking from Heron Island on the southern Great Barrier Reef, Ove shared the following observations with Climate Council:

Recent warming of the water around Heron Island has triggered mass coral bleaching and sick corals are as far as the eye can see. It is truly horrifying.

We are seeing an unprecedented rise in sea surface temperatures across the planet, showing we are not doing anything near enough to reduce greenhouse gas emissions.

The leap in temperature has already wiped out the corals of Florida and the Greater Caribbean. We are clearly losing the war.

For a long while, the southern Great Barrier Reef has avoided the devastating impacts of ocean warming. Now all that has changed with devastating consequences.

The impact of climate pollution is driving our beloved Reef to the brink, and unless we act faster many other natural and human systems will tumble. The implications of these changes are unimaginable.

It is time for us to urge all governments to take emergency action at a scale which matches that of the growing threats to life on Earth.

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IMAGE CREDITS

Cover image: Northern Great Barrier Reef, October 2023. By Divers for Climate.

Figure 1 - Page 2: Coral Bleaching at Lizard Island by XL Catlin Seaview Survey.

The Climate Council is an independent, crowd-funded organisation providing quality information on climate change to the Australian public.

The Climate Council acknowledges the Traditional Owners of the lands on which we live, meet and work. We wish to pay our respects to Elders past and present, and recognise the continuous connection of Aboriginal and Torres Strait Islander peoples to Country.

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