

Australian Government Great Barrier Reef

Marine Park Authority

GREAT BARRIER REEF Outlook Report 2019

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Australian Government

Great Barrier Reef Marine Park Authority

GREAT BARRIER REEF

Outlook Report 2019

IN BRIEF

The Great Barrier Reef Marine Park Authority acknowledges 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.

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Preface

The Great Barrier Reef is a vast and spectacular ecosystem and one of the most complex natural systems on Earth. The Reef is recognised for its outstanding universal value and is vitally important to Traditional Owners, communities and industries that depend on a healthy reef for community benefits and livelihoods.

The Great Barrier Reef Outlook Report is required to be published every five years in accordance with the *Great Barrier Reef Marine Park Act 1975*. It provides an evidence-based overview of the Reef's current condition, use, factors influencing the condition, management effectiveness, resilience, risks to its future and likely outlook. The contents of the Outlook Report were independently peer reviewed. This Great Barrier Reef Outlook Report 2019 — In Brief presents a summary of the key findings from the topics and chapters in the main report.

The 2019 report is the third comprehensive report in the series, and identifies that the Great Barrier Reef Region still faces significant pressures ranging in scale from local to global. Since 2014, management initiatives and local actions have demonstrated positive outcomes for less complex and small scale activities. However, achieving outcomes on the ground continues to be difficult for complex and spatially broad threats, such as climate change, land-based run-off and some remaining impacts of fishing and illegal fishing.

The Reef is core to Australia's identity and improving its outlook is critical. For the Region to remain resilient and maintain its myriad of values, Reef managers must continue to work in partnership with Traditional Owners, industries, researchers and the community to mitigate impacts and influence change.

It is important to remain vigilant, active and optimistic in managing the Reef. Actions taken now will matter and make a difference to the Region's long-term outlook. The complete report, including a complete set of references, and other supporting material are available online at <u>www.gbrmpa.gov.au</u>.

Yours sincerely

En R. Pamin

Ian Poiner *Chair* Great Barrier Reef Marine Park Authority

Executive Summary of the Great Barrier Reef Outlook Report 2019

The following is the complete text of the Executive Summary of the Great Barrier Reef Outlook Report 2019

The Great Barrier Reef is a vast and spectacular ecosystem and one of the most complex natural systems on Earth. The Great Barrier Reef Region's natural beauty and natural phenomena endure, but they are showing signs of deterioration in several areas. In 2009, the Reef was considered to be at a crossroads between a positive, well-managed future and a less certain one. In 2014, it was seen as an icon under pressure, with continued efforts needed to address key threats. Since then, the Region has further deteriorated and, in 2019, Australia is caring for a changed and less resilient Reef. The challenge to restore Reef resilience is big, but not insurmountable. However, it requires mitigation of climate change and effective implementation of the *Reef 2050 Long-Term Sustainability Plan* (Reef 2050 Plan).

The scientific evidence is clear: initiatives that will halt and reverse the effects of climate change at a global level and effectively improve water quality at a regional scale are the most urgent to improve the Region's long-term outlook. More than ever before, uses of the Region must be sustainable and effectively managed. To protect and restore habitats, species and heritage values, management agencies must complement proven techniques with innovative approaches that are targeted, science-based and risk-managed.

Climate change is escalating and is the most significant threat to the Region's long-term outlook. Significant global action to address climate change is critical to slowing deterioration of the Reef's ecosystem and heritage values and supporting recovery. Such action will complement and greatly increase the effectiveness of local management actions in the Reef and its catchment.

Gradual sea temperature increase and extremes, such as marine heat waves, are the most immediate threats to the Region as a whole and pose the highest risk. Sea temperature extremes caused successive mass bleaching events in 2016 and 2017. These events led to unprecedented and widespread coral loss, and flow on effects to fish and invertebrate communities. Such impacts also weaken Traditional Owners' enduring connection to sea country and the quality and quantity of economic and social wellbeing provided by the Reef.

Inshore water quality is improving on a regional scale, but too slowly; poor water quality continues to affect many inshore areas of the Reef. The rate of reduction of pollutant loads has been slow, reflecting modest improvements in agricultural land management practices. Future initiatives need to deliver timely, best practice agricultural land management over a wider area to improve water quality.

Natural values of the Region include **species**, **habitats** and ecosystem processes. Overall, habitats are assessed as being in poor condition. Habitat loss, degradation and alteration have occurred in a number of areas, substantially affecting populations of some dependent species. For example, the significant and large-scale impacts from record-breaking sea surface temperatures have resulted in coral reef habitat transitioning from *poor* to *very poor* condition. Not all habitats have been equally affected and their condition varies across the Region. For instance, coral reefs that have escaped impacts of bleaching, cyclones and crown-of-thorns starfish outbreaks remain in good condition.

Concern for the condition of the Region's species is also high; many species and species groups are assessed as being in *poor* to *very poor* condition. Species assessments reflect both ongoing effects of past significant population declines (for example, from historical commercial harvesting of dugongs and turtles) and current impacts that add further pressure. Humpback whales and the southern green turtle population continue to recover and the breeding rate of urban coast dugongs has improved since the impacts of cyclone Yasi and floods in 2011.

The Region relies upon the healthy functioning of a range of physical, chemical and **ecological processes**, and connection to functioning coastal ecosystems. Of the 31 ecosystem health components assessed, about 60 per cent remain in *good* to *very good* condition, but the remainder are in *poor* to *very poor* condition. Some critical ecosystem functions have deteriorated since 2014, mainly due to declines in ecological processes, such as symbiosis and recruitment, and deterioration of some physical processes, such as sea temperature and light. Some processes important to replenishment and recovery of species and habitats, such as currents, connectivity and primary production, remain in *good* to *very good* condition.

Many of the Region's **heritage values** are closely tied to the condition of the ecosystem, particularly Indigenous heritage value. Overall, many heritage values remain in *good* condition, with the exception of Indigenous heritage and some

aspects of historic heritage, which are assessed as being in *poor* condition. Community awareness and appreciation of the Region's Indigenous and historic heritage values are important to their protection and resilience. While significant work has occurred, identification and monitoring of the broad range of Indigenous, historic and other heritage values is not yet comprehensive. Greater shared knowledge of heritage values among the Region's managers, Traditional Owners and stakeholders is critical to ensuring recognition and continued protection of those values.

While the property's outstanding universal value as a **World Heritage Area** remains whole and intact, its integrity is challenged and deteriorating. Given the global scale of human-induced climate change, the size of the property is becoming a less effective buffer to broadscale and cumulative impacts. Attributes that remain in *good* condition at a Region-wide scale include the spectacular scenery, over half of the ecosystem processes, and some species components.

The Great Barrier Reef remains a significant **economic resource** for regional communities and Australia as a whole. Major changes to the condition of the ecosystem have social and economic implications for regional communities because some uses, such as commercial marine tourism and fishing, depend heavily on a functioning, resilient ecosystem. As Reef waters continues to heat, coral reefs will become less diverse than a decade ago, and the fishes seen while snorkelling and caught while fishing, will also change. Reef-dependent users need to prepare for this change.

The Region is protected and managed by a partnership between many government agencies, Traditional Owners, stakeholders and community members, and is influenced by activities occurring within and adjacent to the Region. An **independent assessment of the Region's management** found it to be *effective* for small-scale, less complex activities. Port management is already achieving positive outcomes following improvements in planning. Fisheries management is also expected to improve over the next five years with the proper implementation and resourcing of the *Queensland Sustainable Fisheries Strategy 2017–2027*.

Implementation of the Reef 2050 Plan began in 2015, marking a shift in how the Australian and Queensland governments and their partners collaborate in addressing challenges that face the Reef. Independent assessors determined the Reef 2050 Plan had improved jurisdictional consistency, coordination and resourcing across many management topics. However, achieving on-ground outcomes continues to be difficult for complex and spatially broad topics, such as climate change, land-based run-off and biodiversity.

Global, regional and local actions taken now can influence the Reef's future. Since 2014, investment in management of the Reef and its catchment has been unprecedented. This has enabled the delivery of significant protections and tangible actions through the *Great Barrier Reef Blueprint for Resilience* and the *Reef 2050 Water Quality Improvement Plan*, which have set the framework for improved resilience-based management and protection of values.

Threats to the Reef are multiple, cumulative and increasing. Researchers and management agencies are constantly being challenged as research and monitoring efforts strive to keep pace with a rapidly changing Reef. The Reef 2050 Integrated Monitoring and Reporting Program, once established, will be a game-changer — providing coordinated access to information about the Reef, its catchment and human use of the Region.

A comprehensive **risk assessment** of 45 threats to the Region's ecosystem and heritage values considered the residual risk, after taking into account the current management regime. The 10 threats identified in 2014 as presenting a *very high* risk to the Region's ecosystem and heritage values are again the highest ranked in 2019. Of the *very high* risk threats, most relate to climate change or land-based run-off (water quality) affecting values on a Region-wide scale. Given the current state of the Region's values, actions to reduce the highest risks have never been more time-critical.

Without additional local, national and global action on the greatest threats, the **overall outlook** for the Great Barrier Reef's ecosystem will remain *very poor*, with continuing consequences for its heritage values also. The window of opportunity to improve the Reef's long-term future is now. Strong and effective management actions are urgent at global, regional and local scales. The Reef is core to Australia's identity and improving its outlook is critical. For the Region to remain resilient and maintain its myriad of values, society must play a pivotal and urgent role in mitigating impacts and adapting to change. It is important to remain vigilant, active and optimistic in managing the Reef. Actions taken now by managers, Traditional Owners, researchers, stakeholders and the community will matter and make a difference to the Region's long-term outlook.



Assessments within the report

Figure 1.3 in main report: Each of the assessments required under the Great Barrier Reef Marine Park Act and regulations applying to the Marine Park forms a chapter of the report. The assessments relating to the Region's ecosystem and its heritage value and those examining the threats, responses and risks inform an assessment of the likely outlook for the Great Barrier Reef Region.

About this Report

The Great Barrier Reef Marine Park Authority (the Marine Park Authority) prepares an Outlook Report for the Great Barrier Reef Region every five years. The *Great Barrier Reef Marine Park Act 1975* (Cth) (the Act) and the regulations applying to the Great Barrier Reef Marine Park (the Marine Park) specify what the report must contain and the relevant statutory timeframes.

Outlook Reports are a regular and reliable means of assessing the overall performance of all measures to protect and manage the Great Barrier Reef (the Reef) in an accountable and transparent manner. The report provides a summary of the long-term outlook for the Reef based on assessments of condition, use, influencing factors, management effectiveness, resilience and risks. The Act does not provide for the Outlook Report to include recommendations about future protection or management initiatives.

The jurisdictional scope of the report covers the entire Great Barrier Reef Region (the Region). The Region is a Commonwealth jurisdiction, covering approximately 346,000 square kilometres, from the tip of Cape York in the north to past Lady Elliot Island in the south. The Region's boundary is slightly larger than the Marine Park and includes about 70 Commonwealth islands. The State of Queensland has jurisdiction over the majority of islands in the Great Barrier Reef (approximately 980 islands) which are, therefore, not included formally within the Region. However, where it is relevant to the health of, or factors influencing, the Great Barrier Reef ecosystem and its heritage values, the report looks beyond the Region's boundaries and includes information about adjacent islands, neighbouring marine areas and the Great Barrier Reef river catchments (the Catchment).



Parrotfish on a reef. © Matt Curnock 2016

The first Great Barrier Reef Outlook Report was released in 2009 and the second in 2014. This Outlook Report, like previous reports, plays a significant role in informing Australia's reporting to the World Heritage Committee addressing the

'In Brief' presents the grades for each chapter's assessment criteria. More detailed information, including grades for the components within the criteria, can be found in the full report. property's world heritage status, as well as the review of the *Reef 2050 Long-Term Sustainability Plan* (Reef 2050 Plan) and effective management of the Great Barrier Reef. To maintain the comparative value of the Outlook Report over time, changes to the assessed components have been limited to instances where they significantly improve the validity or utility of the assessment.

The report is structured around the nine assessments required by the Act and its regulations, with each assessment forming a chapter of the report. The four chapters on the values of the Great Barrier Reef focus on current condition and trends. Likely future trends in those values depend on the drivers influencing them, which are discussed in later chapters. Economic and social values of the Reef, which depend on the health of the ecosystem, are considered in a range of places in the report.

A four-point grading scale has been used since 2009 and is continued for consistency. The grade allocated is a 'grade of best fit', based on a qualitative assessment of the available evidence. Evidence is drawn from existing research and information sources from the last five years.

The Outlook Report has been prepared by the Great Barrier Reef Marine Park Authority, with contributions of evidence from a number of Australian and Queensland government agencies, researchers from a range of institutions, industry data-holders and Traditional Owners. The outcomes of an expert elicitation workshop involving more than 30 scientists and other stakeholders contributed to the assessments of biodiversity, ecosystem health and heritage value.

Five independent experts assessed the effectiveness of existing protection and management arrangements for the Region's ecosystem and its heritage value and, where relevant, the Catchment. The assessors' reports form the basis of the assessment of existing measures to protect and manage the Region. Four expert reviewers, appointed by the Australian Minister for the Environment, independently reviewed the draft Outlook Report. Their comments were considered in the final report.

2 Biodiversity

The Region is one of the world's most diverse and remarkable ecosystems and contains the largest coral reef system in the world. Biodiversity forms an important component of natural heritage and is integral to ecosystem resilience. Biodiversity is critical to Traditional Owners of the Great Barrier Reef and the outstanding universal value of the world heritage property.

Legacy human-use impacts, such as historical land clearing and overfishing, have caused significant environmental change in the past and continue to have major effects today. Species and habitats that are still recovering include dugongs, turtles, whales and some islands that were cleared and mined for guano. A shifting baseline occurs when the natural baseline gradually shifts over human generations, and becomes an accepted norm due to a lack of experience, memory and knowledge of its past condition. Spanish mackerel populations and the condition of some coral reefs are examples where normal baselines have shifted.

score 60 Seagrass abundance 50 40 30 20 10 1999-00 2004-05 2009-10 2014-15 Seagrass abundance score for inshore meadows, 1999-2018

Figure 2.5 in main report: Abundance scores (with standard errors) for inshore seagrass meadows from Cape York to Burnett-Mary region. Note: more sites, including intertidal and subtidal, where added since Outlook Report 2014, which may have affected the scores. Source: McKenzie et al. in press

The overall condition of the Region's biodiversity depends on maintaining the condition of all its habitats, species and the

interconnections between them. For both habitats and species, grades provided are for the entire Region. The size of the Region is extensive and therefore variability in condition exists. For example, reefs that escaped impacts of bleaching, cyclones and crown-of-thorns starfish outbreaks remain in good condition.



Fluffy herald petrel chick on Raine Island. © Queensland Parks and Wildlife Service, photographer: G. Burrows



A young flatback turtle. © Matt Curnock

80

70



Green turtle strandings in the Region, 2000-2018

Figure 2.13 in main report: Green turtle strandings (dead or alive) in the Region from 2000 to 2018. Stranded turtles that were not identified to species level are not included in the graphed data, so the total is potentially higher than shown. Most records are from Cairns to the southern end of the Region. Cyclone Yasi and associated flooding occurred in early 2011 and led to widespread damage of inshore seagrass meadows (foraging habitats). Source: Department of Environment and Science (Qld) 2018



Habitats to support species The Great Barrier Reef ecosystem consists of a broad range of habitats which can be highly variable in condition across the Region. The condition of habitats (as a group) is rated poor, and was previously rated good in 2014. This deterioration reflects that habitat loss and degradation or alteration in a number of areas have had persistent and substantial effects on populations of some dependent species. Many habitats had declining trends, and the two key habitats where confidence in grades is adequate (seagrass meadows and coral reefs) are rated as being in poor and very poor condition, respectively.

The significant and large-scale impacts on coral reef habitats (and coral species as discussed below) from extreme sea surface temperatures due to global warming have resulted in these components transitioning from poor to very poor condition for the first time in the history of Outlook reporting. The Region was affected by consecutive mass coral bleaching events in the summers of 2016 and 2017. In 2016, intense heat exposure caused severe bleaching in the northern third of the Great Barrier Reef. while in 2017 severe bleaching mainly affected the central region. Evidence of cascading effects on coraldependent species, such as some bony fishes and invertebrates is emerging.

Seagrass meadows are one of the most important habitats in the Region — they stabilise the seafloor, protecting it from erosion and cyclones, and play an important role in nutrient cycling and carbon sequestration. Seagrass meadows provide highly productive habitats for fish, invertebrates and algae and are the primary food source for dugongs and green turtles. Inshore seagrass abundance increased at most locations from 2011 to 2016, following multiple years of



Cumulative footprint of coral bleaching in the Great Barrier Reef during the summers of 2016 and 2017

Figure 2.6 in main report: Dots indicate: (orange) surveyed reefs where >60 per cent of corals were bleached; and (blue) reefs that were surveyed but had no or negligible bleaching. Source: ARC Centre of Excellence for Coral Reef Studies

declines. However, recovery slowed or stalled across most of the Region in 2016–17.

On a regional scale, coastal habitats, including mangroves, islands and beaches, and coastlines remain in good condition. However, confidence in these grades is limited given a lack of broadscale quantitative data and ongoing monitoring.

Mangrove forests are a critically important habitat providing nursery and breeding areas for many commercial and noncommercial species. They also provide important ecosystem services, including coastal protection, pollution absorption, nutrient cycling, primary production and carbon storage. Severe cyclones since 2014 have caused localised dieback in some locations, although overall this habitat is assessed as being in good condition.

Some islands are showing signs of recovery from past impacts. In locations where islands have suffered recent disturbances (for example, Whitsunday Island), recovery is being observed. Intervention actions over many years have aimed to remove or mitigate threats, to enable recovery and build resilience to future threats. These actions include habitat restoration through replanting, re-profiling beaches, installing fencing (for example, Raine Island) and fire management.

Exposure to high sea surface temperatures and severe cyclones are also likely to have influenced the condition of other habitats, such as the lagoon floor, shoals and the water column, which are rated good but deteriorated. The water column is a critical habitat linking all habitats within the Region; it has deteriorated in some inshore areas due to the impacts of land-based run-off. Alteration of the water column may have occurred in a number of areas following record-breaking temperature extremes, potentially leading to substantial effects on some species. The condition of water column habitat is good but borderline with poor.

Populations of species and groups of species The Region is home to thousands of species and provides important habitats for species of conservation concern such as dugongs, whales, dolphins, seabirds, marine turtles, sharks and rays.

Concern for the condition of the Region's species is high; many groups of species are assessed as being in poor to very poor condition. Species assessments reflect both ongoing effects of past significant population declines (for example, from historical commercial harvesting of dugongs and turtles) and current impacts that add further pressure. Rising sea temperatures and thermal extremes due to global warming are affecting the abundance and health of many species groups including corals, invertebrates, some bony fishes, marine turtles and seabirds. Since 2014, there have been widespread and significant declines in many coral species. In 2018, recruitment of coral larvae declined by 89 per cent averaged across the Region as a result of consecutive bleaching events which reduced the adult broodstock. Warming temperatures are resulting in the feminisation of green turtles originating from nesting beaches in the northern Region, potentially leading to significant scarcity or absence of adult males in the future.



A small pod of snubfin dolphins socialising near Repulse Bay, south of Airlie Beach, as captured by a drone. © GBRMPA

There are a few instances where species have improved in condition. Humpback whales have demonstrated strong recovery, while the southern population of green turtles continues to recover slowly. The breeding rate of urban coast dugongs has improved since the impacts of cyclone Yasi and subsequent flooding in 2011.

The trend in condition of many species or groups of species have deteriorated, mainly due to human activities and climate change impacts. Deterioration has now occurred throughout the Region, not just the southern two thirds, and is particularly evident in coral species.



Islands support a variety of animals. © GBRMPA

Summary criteria

Habitats to support species:

The condition of habitats overall is poor at a Region-wide scale, because habitat loss, degradation or alteration has occurred in a number of areas leading to persistent substantial effects on populations of some dependent species. There is a high level of variability in the scale and condition of all habitats assessed, and data for the majority of habitats are limited. For many habitats considered in good condition overall, condition is usually lower closer to the coast and in the vicinity of developed areas. The isolation of *Halimeda* banks and continental slope from the mainland, and their depth, contribute to their very good condition. Extreme sea surface temperatures and localised flood plumes have affected many habitats, particularly seagrass meadows and the water column, and caused widespread deterioration in coral reef habitats.



Populations of species and groups of species:

The majority of species or groups of species have declined, mainly due to human activities and climate change impacts. Findings reflect both ongoing effects of past significant population declines (for example, from historic commercial harvesting) and impacts on the habitats they depend on. Deterioration (to varying extents) has now occurred throughout the Region, not just the southern two thirds, and is particularly evident in coral species. Some species (such as humpback whales and some turtle populations) show continuing recovery from historical declines.



3 Ecosystem health

The condition of the Region depends on a range of chemical, physical and ecological processes, the health of connected coastal ecosystems, and impacts of disease and pest outbreaks. In order to understand ecosystem health, an understanding of species diversity, species abundance and ecosystem processes is required, rather than of biodiversity

alone. An ecosystem is considered healthy if it is able to maintain its structure and function in the face of external pressures.

Exposure to both acute and chronic disturbances, such as record high sea temperatures and poor water quality, have contributed to an overall decline in ecosystem condition. Of the 31 ecosystem health components assessed, about 60 per cent remain in good to very good condition; the rest are in poor to very poor condition.

Some **physical processes**, such as freshwater inflow and sediment exposure, have remained stable since 2014. No consistent trend is evident for cyclones and wind, although it is noted that over 50 per cent of the Reef area has been exposed to destructive waves from six tropical cyclones over the past five years. Extreme thermal stress in 2016 and 2017 and continual ocean warming at an unprecedented rate, underpin the deterioration of the sea temperature grade from poor to very poor. Given sea temperature influences the distribution, survival, reproduction, growth, physiology and productivity of marine



Predation is a key ecological process. © Tane Sinclair-Taylor

organisms, habitats and species are strongly affected by this physical process. Ecological processes such as symbiosis and reef building have been negatively affected. Above-average annual sea surface temperatures have been observed for the Great Barrier Reef every year since 2012, and present day temperatures of Reef waters are approximately 0.8 degrees Celsius warmer than when records began.

Water currents support connectivity, promote larval dispersal and support biodiversity. While currents remain in good condition, they are deteriorating. The East Australian Current has already warmed and extended south by approximately 350 kilometres.



Sea surface temperature anomalies for Great Barrier Reef waters, 1900–2018 Figure 3.6 in main report: Above-average annual sea surface temperatures have been observed for the Great Barrier Reef Region for every year between 2012 and the present, and have been persistently high for the past two decades. Anomalies are the departures from the 1961–1990 standard averaging period. Black line indicates a five year running average. Source: Australian Bureau of Meteorology 2019 Rivers and streams from the Catchment drain an area of around 424,000 square kilometres. The frequency of freshwater flows has increased cumulative pressures on the Region since European settlement. This has affected recovery of inshore coral and seagrass habitats, which are inhibited by the reduced time between high-flow periods. Despite this longer-term change, freshwater flow was near or below the long-term average for the Catchment between 2013 and 2018, similar to the period 2004 and 2007. The correlation between low rainfall, low flows and coral recovery was observed in the Burdekin region from 2013 to 2018, where coral condition improved from poor to moderate. The condition of freshwater flow is considered stable overall across the period 2014 to 2018.

Chemical processes include nutrient cycling, ocean pH (or acidity) and salinity. Ocean pH has deteriorated since 2014. The ocean has already absorbed approximately 30 per cent of the atmospheric carbon dioxide that has originated from human activities, lowering the pH. Perhaps the largest risk from ocean acidification is a change in the



Clownfish in a bleached anemone Figure 3.9 in main report: The clownfish (Amphiprion percula) nestled within a bleached host anemone during the 2016 marine heatwave on the Great Barrier Reef. © GBRMPA 2016, photographer: Jessica Stella

deposition of calcium carbonate by calcifying organisms, such as corals. Reduced calcification can result in coral skeletons being more brittle and at greater risk of breakage from strong waves.

The two other chemical processes are relatively stable: ocean salinity is unchanged and nutrient cycling remains in poor but stable condition. Nutrients are essential for the growth and survival of organisms. Nutrient cycling is one of the most important ecosystem processes, and involves transferring nutrients from the physical environment through uptake by organisms and passing them through food chains. Most southern inshore areas of the Region are exposed to elevated nutrient concentrations, particularly during the wet season.

Although some improvements are being made in agricultural land management practices to reduce nutrients and sediments from land-based run-off, there are significant time lags between changes in management and improvements in marine processes. There have been changes to nutrient cycling occurring since European settlement, affecting inshore ecosystems, especially seagrasses and corals.

Ecological processes, including particle feeding, primary production and competition, remain poorly understood. The loss of large areas of coral habitat in 2016 and 2017 has affected some key ecological processes, such as symbiosis, particle feeding, primary production, recruitment and reef building.

Microbial processes are critical for regulating the composition of the atmosphere, influencing the climate, recycling nutrients and decomposing pollutants. Despite their importance, most microbial processes remain poorly understood, particularly in the marine environment. Information on the status of most microbial processes in the Region, one of the main drivers underpinning ecosystem function, is limited and represents a large knowledge gap. Although some spikes in disease have occurred for some species, no clear trend is apparent for the Region's microbial processes.



Woody vegetation clearing rates in the Reef Catchment, 1988-2017

Figure 3.12 in main report: Values in this figure are an estimate of the clearing rate occurring in the 12-month period to 1 August. Source: Adapted from Department of Science, Information Technology and Innovation (QId) 2017 and Department of Environment and Science (QId) 2018

Based on the unprecedented decline of hard coral cover and changes in coral community composition following mass coral bleaching in 2016 and 2017, it is highly likely that symbioses involving coral have significantly deteriorated. The recent decline of fish diversity and reduction in abundance of some species will also affect associated symbioses. As a result, the condition of this process has deteriorated since 2014.

Predation influences the distribution, abundance, behaviour, fitness and evolution of prey species. Reef shark and coral trout abundances have been affected by past fishing, and recent research suggests it may take 20–40 years of effective no-entry protection to restore shark population numbers. Well-managed no-take zones effectively protect predatory fishes and sharks over small and large scales. Trends may be influenced by habitat structure declines, particularly for coral trout, which are dependent on habitat complexity.

Herbivory is an important ecological process involving the removal of plant matter, cycling of nutrients and can assist with the dispersal of seagrass. Following disturbance, herbivory plays an important role in reef recovery. There is some variability in herbivory across the Region, but these are not to the extent that they are significantly affecting ecosystem function. Overall herbivory is in good condition and has remained stable.

The process of recruitment is one of the key ways in which depleted populations are replenished. Recruitment is reduced for many key species, in particular, corals, fishes and some marine turtles and seabirds, largely due to chronic and acute disturbances.

The deteriorating condition of many ecological processes has affected the integrity of the Region's outstanding universal value.

Coastal ecosystems that support the Great Barrier Reef remain in poor condition overall. Healthy, functioning coastal ecosystems are critical for the long-term health of the Reef. The trends of most components have stabilised. Woodlands and forests is the only coastal ecosystem type that continues to deteriorate, following a further reduction in its extent. The clearing rate in the Catchment has increased overall, peaking at 47 per cent (1660 square kilometres) of the total statewide woody vegetation clearing rates in 2016–17. In 2017–18, 93 per cent (approximately 3690 square kilometres) of clearing was primarily for increased pasture for grazing.

Outbreaks of disease, introduced species and pest species The incidence of coral disease increased sharply in the winter of 2016 following mass bleaching and continued into the summer of 2017. Incidence of coral disease was greatest on reefs that had experienced the longest exposure to warmer than average sea surface temperatures in the winter of 2016 and summer of 2017. Although it is unknown what proportion of corals in the Region were affected, one study observed a reduction in coral cover by more than half due to a combination of bleaching and white syndromes disease in early 2017. Between 2014 and 2018, the crown-of-thorns starfish outbreak that started in 2010 in the Cairns–Cooktown Management Area, gradually spread south, to reefs off Innisfail and Townsville. In 2017, an independent outbreak was identified in the Swain Reefs. The severity of these outbreaks continues to reduce live coral reef habitat. Programs to eradicate introduced pests have been successful on some islands.

Summary criteria

Physical processes:

The majority of physical processes have remained stable or continued to decline, except currents and cyclones and wind. Further changes to these processes are expected due to the continued influence of climate change and land-based run-off, with broad implications for the Region.

Chemical processes:

The chemical processes within the Great Barrier Reef are generally in good condition. However, nutrient cycling continues to be affected by land-based run-off. Ocean salinity has remained stable largely as a result of low rainfall. Ocean pH has decreased as a result of climate change.

Ecological processes:

The majority of ecological processes on the Great Barrier Reef have deteriorated. Significant declines in coral cover throughout the Region are likely to have affected some key ecological processes, such as connectivity, symbiosis, reef building, competition and recruitment. However, as time lag effects are common after mass bleaching events, impacts may still be unfolding. Ecological processes are expected to continue to decline due to climate change impacts and inshore land-based run-off.

Coastal ecosystems that support the Great Barrier Reef:

A broad understanding of the condition of each coastal ecosystem remains a significant knowledge gap, even though some are subject of extensive management effort (saltmarshes, wetlands, woodlands and forests). Many grades and trends are limited or inferred. Since 2014, the woody vegetation clearing rate in the Catchment continued to increase. The main purpose for this clearing was for agriculture.

Outbreaks of disease, introduced species and pest species:

Outbreaks of disease are localised and patchy across the Region. Although pest control programs have been successful on local scales, introduced species continue to be recorded. Other outbreaks, such as Trichodesmium have increased, but data are limited on a broad scale. The severity of the crown-of-thorns starfish outbreak continues to seriously affect coral reef habitats.

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Good

Deteriorated

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Good

Stable

Good

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Poor Stable

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Poor Stable

4 Heritage values

The Great Barrier Reef's heritage values are assessed against natural (world heritage and national heritage), Indigenous, historic (Commonwealth and other) and other heritage (social, aesthetic and scientific) values.

World heritage and national heritage values The Great Barrier Reef was inscribed on the World Heritage List in 1981 and included on the National Heritage List in 2007. The outstanding universal value has been maintained, but it is increasingly challenged. The Great Barrier Reef remains whole and intact, however, significant components that underpin all four natural world heritage criteria for which the World Heritage Area was inscribed have deteriorated since its inscription. One criterion - habitats for the conservation of biodiversity - is assessed as poor, which aligns with the assessment findings in Chapter 2. Widespread coral mortality (as a result of sea temperature extremes in combination with predation by crown-of-thorns starfish) and impacts from severe cyclones, have affected the aesthetics and natural beauty of some parts of the



Woppaburra seasonal calendar showing important totems. © Dr Harry Van Issum, artwork by Glenn Barry 2016

Region above and below the water. There has been alteration of some processes important to major stages of the Earth's evolutionary history, such as reef building, sea-level rise and sea temperature. Climate change remains the greatest risk to the outstanding universal value of the World Heritage Area and its integrity.

Indigenous heritage values include tangible and intangible heritage and are interlinked with the condition of the Reef's natural components. The effects of acute and chronic disturbances across the Region over the past five years have affected the condition of the Region's Indigenous heritage value, some of which is irreplaceable (for example, songlines). The very limited available evidence in both 2014 and 2019 for Indigenous heritage value constrains confidence in both grade and trend.

Historic heritage values Five properties in the Region are on the Commonwealth Heritage List: Low Island and

Low Islets lightstation (including its significance to Kuku Yalanji and Yirrganydji Traditional Owner groups), Dent Island lightstation, Lady Elliot Island lightstation, North Reef lightstation and Shoalwater Bay Military Training Area. The places are well maintained and have been identified and included in relevant inventories.

Historic heritage components include other lightstations, shipwrecks, aircraft wrecks and other places of historic significance. Published condition and trend data are lacking for most sites, so confidence in the grade and trend is limited or inferred. Positive progress has been made towards gathering evidence on shipwrecks and aircraft wrecks.



Nature is inseparable from Indigenous cultural identity

Figure 4.3 in main report: Songlines, stories, cultural practices, significant places, totems, structures and other elements of tangible and intangible Indigenous heritage weave people and the natural world together.



The significant discovery in late 2018 of the precise location of the shipwreck of the *Martha Ridgway* increased the baseline data for this component. The vessel was lost over 170 years ago on a voyage from New Zealand to Bombay (now Mumbai). The *Martha Ridgway* shipwreck was found on the reef of the same name using a variety of survey methods and remote sensing equipment, including aerial surveys (drone), magnetometer surveys and visual census. The wreck is significant for many reasons, including its size and its association with the historic Raine Island beacon.

Other heritage values Social, aesthetic and scientific values are included in this assessment. The significance of the World Heritage Area still transcends national boundaries and remains a source of pride for the Australian public broadly. The social heritage value of the Region is considered to be in good condition. How society thinks and feels about the state of the Reef is at the heart of the Region's social heritage value. In 2017, climate change, pollution and agricultural run-off were considered by Australian residents to be the biggest threats to the Reef.



Carter Reef research platform (offshore Lizard Island), where researchers would stay overnight, was demolished in the early 1990s. © Australian Museum

A 2017 survey of approximately 3900 people living close to or deriving benefit from the Reef (local and national residents, tourists, tourism operators, and commercial fishers) highlighted the wider community's concern about the declining condition of the Reef, and a strengthening connection to its environment and natural beauty.

Summary criteria

Natural heritage values — world heritage value and national heritage value: The Reef's world heritage and national heritage value represents the outstanding universal value of the Region. Outstanding universal value remains, however, the grade is borderline with poor because the condition of the property has deteriorated to varying extents with respect to criteria vii, viii, ix and x. While the property remains whole and intact, ecosystem resilience is deteriorating and the property's size is becoming less effective as a buffer against these disturbances.	Good (borderline with poor) Deteriorated
Indigenous heritage values: Aboriginal and Torres Strait Islander peoples are increasingly reasserting their role in sea country management and protection of Indigenous heritage. The condition and trend of Indigenous heritage values are tied closely to the condition of natural heritage values. The condition of many values remains limited.	Poor Stable
Historic heritage values — Commonwealth heritage values: The five places in the Region included on the Commonwealth Heritage List retain the values for which they were listed. The condition and trend of most places are based on limited published evidence. However, the inference from managers is the properties retain their integrity and are in good condition.	Good Stable
Historic heritage values – other: Many historic heritage components have not been systematically identified, resulting in an inferred trend for several components. Further investigation since 2014 has uncovered a lack of evidence on condition and trend across most components, and the grade has been updated to reflect this.	Poor No consistent trend
Other heritage values: The Region's scientific heritage value is escalating. The Australian people's concern about the declining condition of the Reef is an emerging observation, as their connection to its environment and natural beauty continues to be strong.	Good No consistent

Commercial and non-commercial use

Use of the Region continues to provide significant economic and social benefits. In 2015–16, tourism, fishing, other recreational uses and scientific activities in the Region made an estimated total contribution to the Australian economy of \$6.4 billion per annum, an increase of about 14 per cent since 2011-12. In the same period, the Reef supported an estimated total national employment of 64,000 full-time equivalent positions.

Commercial marine tourism Record levels of tourism visitation occurred in 2016 despite coral bleaching events. However, visitation declined in some areas, particularly in the Whitsundays in 2017 following cyclone Debbie. A slight decrease in visitation in 2017, from around 2,406,000 visitor days, to approximately 2,240,000 visitor days has continued with a marginal increase in 2018. Tourism use and associated impacts mainly occur in a few high-use areas. The most significant threats include incompatible uses, where tourism use may displace or affect another user group (such as Traditional Owners or recreational users); groundings of vessels; emissions (both from air travel and vessel operations) and, in some locations, marine debris and discharge of sewage.



Underwater reefscape view of diver on Patches 3 Reef. © Matt Curnock 2018

Defence activities in the Region directly contribute to Australia's defence capacity. The economic benefits of most defence training activities to the coastal communities adjacent to the Region are not quantified. Defence continue to deliver and support environmental monitoring and management.

Fishing continues to be an important use of the Region and source of income and lifestyle for Queensland coastal communities. In 2015–16, the total value of commercial fishing in the Region was estimated to be \$104 million. In 2017, the commercial harvest (retained catch) of fisheries product in the Region was about 7600 tonnes, not including marine aquarium fish or coral. The gross value product forecast for Queensland-wide commercial and recreational fisheries combined for 2018–19 is \$275 million (\$181 and \$94 million, respectively). Recreational fishing in the Region's estuary and ocean waters targets a range of species, mainly finfish and invertebrates. The species kept most often by recreational fishers varies geographically.

Illegal fishing continues to add pressure to an already deteriorating system, and concerns exist for some species harvested by commercial and recreational fishers. New management arrangements for all commercial and recreational fisheries in the Region are currently being developed, as part of the implementation of the Queensland Sustainable Fisheries Strategy 2017-2027.



TOP THREE SPECIES KEPT IN 2016

Top three species caught and kept by recreational fishers during a 12-month period (November 2015 to October 2016) Figure 5.6 in main report: This infographic highlights regional variation in the fish species most commonly harvested by recreational fishers, using data gathered through surveys conducted at boat ramps. Source: Department of Agriculture and Fisheries (Qld) 2017



Recreation (not including fishing) Continued population growth and economic wealth will increase the demand for recreational activities in the Region. The number of recreational vessel registrations between 2014 and 2018 is the highest recorded since reporting began. Most recreational impacts are minimal (with cumulative impacts largely unknown) and concentrated around major population centres. Recreational vessel groundings are higher than either tourism or commercial fishing vessels. Since 2014, management initiatives have increased the number of reef protection markers and public access moorings in the Region. These management initiatives help to protect coral communities under threat from recreational boating damage by raising awareness and influencing the distribution of recreational activities within the Region.



Research and educational activities are often concentrated around research stations. Impacts are generally minor or locally constrained, given current management arrangements. Research underpins

Investment in reef protection markers (RPMs) and public moorings within the Region, 2016–17 to 2018–19 Figure 5.17 in main report. Source: Queensland Parks and Wildlife Service 2019

Figure 5.17 in main report. Source: Queensland Parks and Wildlife Service 2019

management of the Region and has broad and growing economic and social benefits.

Ports Combined trade throughput at the priority ports in the Region (Townsville, Abbot Point, Hay Point/Mackay and Gladstone) exceeded 262 million tonnes in 2016–17, representing a 3.4 per cent decrease from the previous year. Since 2014, the combined effect of regulatory changes, a cooperative approach to managing the impacts of port development and changed market conditions has decreased some of the threats from ports. The volume of sea disposal of capital dredge material across the ports in the World Heritage Area has reduced significantly since the last Outlook Report. However, localised impacts from ports remain, predominantly from maintenance dredging and associated disposal of dredge material, artificial light from port infrastructure, noise and other pollution.

Shipping includes vessels greater than 50 metres in overall length, including cruise ships and large recreational or commercial superyachts. The number of ships travelling through the Region has remained stable since 2014, except for cruise ships which have continued to increase. Ships are getting bigger, which will increase associated pressures, such as anchoring impacts on the sea floor and sediment suspension from propeller wash, particularly within the shallow inner route. Shipping safety is well regulated in the Region, and the impacts are generally known and managed.

Traditional use of marine resources includes undertaking of lawful activities, such as fishing and collecting, as part of Aboriginal and Torres Strait Islander peoples' customs or traditions for the purposes of satisfying personal, domestic or communal needs. Managing agencies continue to work with Traditional Owners to protect Indigenous heritage values, conserve biodiversity, enhance the resilience of the Reef, and maintain connection to land and sea country. In 2018, nine Traditional Use of Marine Resources Agreements and one Indigenous Land Use Agreement were in place, an increase of two agreements since 2014. Combined, these agreements cover approximately 25 per cent of the Region's coastline.

Summary criteria

Economic and social benefits of use:

Economic and social benefits to the Region continue to be in very good or good condition. Commercial and non-commercial use continue to contribute to the Region's economy. The social benefits of fishing and recreation contribute significantly to health and wellbeing. The Reef is of major importance to Traditional Owners.

Impacts of use on the Region's values:

The observed impacts from direct use of the Region are mainly localised. However, collectively, the impacts of this use are obvious (to varying degrees) in many locations. Fishing is a high-impact use occurring throughout the Region and some aspects remain a concern. Marine incidents involving small vessels have increased. As the population increases, use of the Region and associated impacts are likely to increase. The cumulative effects of direct use of the Region coupled with a deterioration of its natural and heritage values amplifies the identified impacts.



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Factors influencing the6 Region's values



The Region's values are influenced by four main factors: climate change, coastal development, landbased run-off and direct use. These are, in turn, affected by broader drivers of change, including economic and population growth, technological development and societal attitudes.

Drivers The main drivers increasing pressure on the Region's values are economic and population growth; management will become more challenging if growth outpaces the implementation of protective management measures (such as setting limits on use of sensitive locations). In June 2018, the Catchment population was approximately one million with an annual growth rate of 0.3 per cent since 2013. A significant proportion of Queensland's economic activity takes place in the Region and its Catchment. Economic growth in Queensland has maintained an average annual growth rate of 2.4 per cent over the last decade. More than 90 per cent of the Queensland saleable coal is exported overseas from ports within the Region and shipped through the Region. In 2016–17, the gross value of agricultural production in Queensland was \$14 billion, with approximately half derived from agriculture within the Catchment. Advances in technology have changed knowledge, management and use of the Region, and in some instances have helped reduce environmental impacts. Understanding societal attitudes is essential for long-term planning and evaluation of management decisions.

Climate change Overwhelmingly, climate change is the primary factor affecting the Reef, and both the magnitude and rate of change exceed the extent of natural variation over the last millennium and over glacial-interglacial time scales. In the past four



Average warming of annual sea surface temperature between 1880 and 2018 for the Great Barrier Reef

Figure 6.6 in main report: Annual sea surface temperature (SST) was extracted from the Met Office Hadley Centre for Climate Prediction and Research (HadlSST1 data set) for 1-degree latitude x 1-degree longitude grid boxes for the Region. Source: Rayner et al. 2003

years, many worst-case scenario climate-change predictions made over 30 years ago have now been realised, and our understanding of the future conditions of ecosystems in the Region has grown considerably.

At current rates of warming, global mean temperature would reach 1.5 degrees Celsius between 2030 and 2052. There is also a very high risk of exceeding 1.5 degrees Celsius and approaching two degrees Celsius by 2065. Warming of 1.5 degrees Celsius would have serious implications for many ecosystems; warming of two degrees Celsius would result in a completely new climate regime under which many ecosystems would undergo irreversible change. The extent to which the climate will change in coming decades depends on current and future greenhouse gas emissions.

Sea surface temperatures in the Australian region have warmed by around 1.0 degrees Celsius since 1910. Subsequently, the Reef has warmed by 0.8 degrees in the same period (Figure 6.7 overleaf), with severe impacts already observed in the Region. Effects from sea-level rise and ocean acidification are slowly increasing, but are not having nearly the same immediate and Region-wide impact as increases in sea temperature. Coral reefs and coral-dependent species are the most vulnerable to sea temperature increases, as evidenced by the 2016 and 2017 mass coral bleaching events. Cascading effects have already resulted in the decline of coral-associated fish and invertebrates. As the climate continues to change, the capacity of hard corals to survive, grow and reproduce is increasingly compromised. Seagrass meadows are less vulnerable to temperature increases, however, do suffer under extreme conditions (water temperatures above 40 degrees Celsius).





Projected vulnerabilities of components of the Reef ecosystem to climate change Figure 6.7 in main report:

Vulnerability differs for a number of ecosystem components and depends on total atmospheric carbon dioxide concentrations. Changes in sea temperatures, ocean pH and sea level are indicative only, based on the latest climate projections. Source: Adapted from values presented in Gatuso et al. 2015 and Hoegh-Guldberg et al. 2018

* For the first time since human existence, the planet's atmosphere has reached 415ppm

The Region's key habitats, such as coral reefs, seagrass meadows and mangroves, have a natural resilience against acute physical disturbances, such as tropical cyclones, intense rainfall, freshwater flood plumes and heatwaves. However, climate change is exacerbating both acute and chronic disturbances in the Region, shrinking recovery windows and overwhelming resilience capability. In the past four decades, warming due to climate change has resulted in a five-fold increase in severe coral bleaching events globally, and it will amplify the effects of other influencing factors, such as direct use, coastal development and land-based run-off.

Coastal development The Region's ecosystem remains vulnerable to the effects of legacy, current and future coastal development, as well as cumulative impacts. Urban and industrial development occupies a small proportion of the Catchment (less than 0.7 per cent) and minimal expansion has occurred since 2014. Urban run-off is a lower threat than run-off from other major land uses such as agriculture, which covers about 72 per cent of the Catchment. Agriculture is the main pollutant source affecting the condition of the marine ecosystem, via land-based run-off from the Catchment.

Modifying coastal ecosystems for coastal development limits their ability to provide ecosystem function and services to benefit the values of the Great Barrier Reef. Barriers to flow, such as tidal barrages and tidal works, have historically been installed to prevent the ingress of saline tidal waters and often to provide road access to the foreshore. While data are limited on the extent of these structures across the Catchment, the available evidence suggests the Wet Tropics had more waterways free of barriers in 2015–16 than the Mackay–Whitsunday region in 2013–14.



Relative catchment priorities and likelihood of exposure of Reef ecosystems to dissolved inorganic nitrogen

Figure 6.13 in main report: Assessment of the relative priority of each of the Region's 35 catchments according to their contribution to the modelled likelihood of exposure of Reef ecosystems to anthropogenic dissolved inorganic nitrogen (illustrated by shading in marine areas). Source: James Cook University adapted from Waterhouse et al. 2017

Land-based run-off Poor water quality is a major contributor to the current poor state of many coastal and inshore marine ecosystems in the Region. The Region continues to be vulnerable to exposure to pollutants (mainly sediments, nutrients and pesticides) transported from land-based run-off resulting from unsustainable agricultural land management practices. Land-based run-off can seriously threaten the Region's natural and Indigenous heritage values and, therefore, the success of Reef-dependent industries (fishing and marine tourism). Poor water quality can also affect social attributes, such as people's health and wellbeing, personal connections, enjoyment and appreciation of the Reef.

Best practice agricultural land management has been identified as the activity having the greatest potential to improve water quality entering the Region. It takes a significant period of time for improved land practices to influence the condition of inshore ecosystems. After a period of early uptake, the rate of adoption of agricultural best practice has slowed.

Catchment modelling indicates very poor progress against nutrient reduction targets and moderate progress against suspended sediment reduction targets. Fine sediments are of most concern for areas with shallow seagrass meadows and inshore coral reefs, because they are lighter, remain suspended for longer, travel further and are resuspended with winds and tides. The highest pesticide concentrations are generally found at Mackay–Whitsunday sampling sites, whereas the pesticide risk is lower adjacent to Cape York and the Wet Tropics.

Following periods of comparatively low sediment, nutrient and pesticide loads, inshore ecosystems have demonstrated some ability to improve, provided they do not experience extra stresses. The observed recovery of seagrass meadows in inshore areas between 2012 and 2018, for example, was partly due to an absence of severe cyclones and below-average rainfall and freshwater discharge.

Other pollutants, including metals and metalloids, antifouling paints, pharmaceuticals and personal care products (such as cosmetics and soaps) can be found in the Region. The cumulative effects and monitoring information on spatial and temporal variation of these pollutants is limited. The distribution and effects of per and poly-fluoroalkyl substances (PFAS) in the marine environment are not well understood. The source of marine debris in the Region varies along the coast, but is dominated by plastic remnants.

Direct use The Region is used for a range of activities including commercial marine tourism, defence activities, fishing, recreation, research and educational activities, ports, shipping and the traditional use of marine resources. Declining ecosystem condition reduces the benefits that



Marine debris clean up by Tangaroa Blue. © GBRMPA, photographer: Christian Miller

Reef-dependent industries and people can derive from the Reef. Non-Reef-dependent uses (such as ports and shipping). which are not directly connected to the Region's natural values, are affected by external factors (such as market forces and extreme weather). The cumulative effects of multiple direct uses occurring in one location, coupled with broad influences of climate change, remain a significant issue and management challenge.

Vulnerability of heritage values to influencing factors Of the four main factors influencing the Region, climate change remains the greatest threat to the Region's heritage values. The outstanding universal value of the Great Barrier Reef and Traditional Owners' interactions with the natural environment are highly vulnerable to the factors influencing the Region. Where heritage values are known (for example, lightstations), ongoing maintenance reduces the asset's vulnerability. Irreversible damage or loss of Indigenous and historic heritage values can arise from direct use through intentional or unintentional removal of, or damage to, significant artefacts or sites of Indigenous significance. Inappropriate behaviour or presence of people at certain sites can also affect Indigenous heritage values.

Summary criteria

Impact on ecological values:

Climate change has had a widespread effect on ecological values fundamental to the Region's identity. High coral mortality due to thermal bleaching events has transformed the Reef. Evidence of cascading effects of coral loss on fish and invertebrate abundance and diversity are emerging. Negative impacts to ecological values associated with coastal development, land-based run-off and direct use are being amplified under the strong signal of climate change.

Verv hia Future: Increasing



Impact on heritage values:

The Region's natural heritage value is already impacted by climate change, transforming the reefscape through reductions in species and habitats and altered ecological processes. This status, coupled with Traditional Owners' connection to sea country, places Indigenous heritage values of the Region under growing pressure. Historic heritage values remain vulnerable to a changing climate and impacts from human interaction.



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High Stable

Future:

No consistent trend

Impact on economic values:

The economic value of Reef-dependent uses relies on a healthy Reef ecosystem. For non-Reef-dependent uses, economic value is aligned with market forces and population growth in the Catchment. Effects of ecological declines may become apparent over the next few years.

Impact on social values:

Ecosystem decline as a result of climate change and land-based run-off will affect community health, wellbeing and enjoyment derived from the Region. An increased concern for the Region and its ecosystems has been recorded. However, across the broad spectrum of influencing factors, evidence is limited about the effect of disturbances on social values.



Existing protection and management

Effective management of the Region remains a complex task given local, regional and global threats. Protection and management of the Region is a partnership between many Australian and Queensland government agencies, local government, Traditional Owners, researchers, stakeholders and community members, undertaking activities both on the water and in the Catchment. An understanding of the effectiveness of these activities is important in determining the likely resilience of the Region's ecosystem and heritage values, assessing the major risks that remain for the Great Barrier Reef and predicting its outlook.

The effectiveness of existing measures to protect and manage the Region's ecosystem (natural heritage value) and its heritage value (Indigenous, historic and others) was independently assessed by five experts. The assessment follows the International Union for Conservation of Nature framework for assessing management effectiveness of protected areas. The approach is consistent with the 2009 and 2014 assessments.

The activities of all relevant Australian and Queensland government agencies that perform Reef management and other contributing partners were evaluated for six elements of the management cycle: context, planning, inputs, processes, outputs and outcomes. Fourteen broad management topics were considered against each of the six elements. Some key outcomes were:

- A comprehensive suite of management tools, complemented by strong industry partnerships, contribute to the sustainable management of **commercial marine tourism** activities.
- The management framework for **defence activities** continues to deliver effective environmental monitoring and management, commensurate with the low level of evident risks.
- **Fishing** management is shared between the Australian and Queensland governments. Implementation and resourcing of the *Queensland Sustainable Fisheries Strategy 2017–2027* are expected to improve the management effectiveness of fishing over the next five years.
- New legislation and management processes are coordinating holistic planning for future **port** developments.
- A major undertaking in **recreation (not including fishing)** since 2014 has been the review of the Whitsundays Plan of Management 1998.
- Management of **research activities** aims to minimise impacts through a risk-based permits process. Knowledge from research continues to inform management.
- **Shipping** is generally well regulated and managed within the Region. Although shipping incidents will inevitably occur, the rate of incidents is low within the Region.
- Traditional Use of Marine Resources Agreements remain one of the management success stories of the Region.
- Widespread coral bleaching events in 2016 and 2017 have increased attention on climate change as the principal threat to the Reef. Management effectiveness of climate change is the weakest topic assessed, with most
- Planning systems to effectively address coastal development have evolved and improved over the past five years.

elements trending down or declining in grade.

- Planning approaches to address **land-based run-off** continue to improve. Knowledge of water quality continues to be well understood, although outcomes continue to be poor due to significant time lags.
- The rate at which the system is changing following disturbances makes the protection of **biodiversity** values a challenge. Cumulative impacts, including from mass coral bleaching, cyclones and crownof-thorns starfish, have dramatically changed management in the Region.



Marine Park vessel Reef Sentinel — one of the range of vessel and aircraft surveillance platforms used in the multi-agency compliance program for the World Heritage Area. © GBRMPA



- Recognition of the **heritage values** of the Region has improved since the last Outlook Report. Traditional Owner groups have expressed concern that they are not yet fully recognised as partners in management and that some cultural sites are deteriorating.
- **Community benefits** are now included in many of the policy and decision-making guidelines because of the Reef 2050 Plan.

Management effectiveness remains strongest for topics of limited scale or complexity. However, management challenges are evident for broadscale, complex topics, such as biodiversity, climate change, fishing and coastal development, and achieving outcomes on the ground continues to be difficult.

Many of the improvements in management effectiveness since 2014 are a result of the Reef 2050 Plan, which has improved jurisdictional consistency and coordinated a range of actions, targets and objectives to address the key threats to the Region. Planning systems for ports and fishing have received the most profound reforms under the Reef 2050 Plan. A separate high-level assessment, the Reef 2050 Insights Report, provides insights into the effectiveness of the contributions of the Reef 2050 Plan.

Summary criteria

Understanding of context:

Context is assessed as the strongest management effectiveness element in 2019. Across most management topics this element was mostly stable or improving. However, context has declined for biodiversity and traditional use of marine resources. Understanding of values, direct and indirect threats and stakeholders is generally strong. Some aspects of biodiversity, ecosystem health and environmental conditions are less understood as a consequence of the bleaching events and other cumulative pressures, such as cyclones and crown-of-thorns starfish predation. Tourism, defence activities, ports, recreation, research activities, shipping and land-based run-off are well understood. This reflects a solid information and research base and a very mature understanding of the key values in the Region.

Planning:

Significant efforts have been made in planning for a number of topics, such as ports, fishing, research activities, shipping and coastal development. However, planning effectiveness has continued to decline for climate change measures specific to the Region, principally as a result of defunding, changing policy and a lack of clarity about future directions. Planning has also declined for recreation largely because plans have not been reviewed since 2014. The lack of systems to ensure adequate monitoring is the weakest aspect of planning overall.

Financial, staffing and information inputs:

Adequacy of inputs is variable across management topics, being least effective for climate change. Most topics did not adequately understand and apply Indigenous heritage and historic heritage information inputs. Resourcing has significantly increased for many areas of Reef management, through the Reef 2050 Plan and associated investment strategy. The Reef Joint Field Management Program and the Marine Park Authority have received significant stabilisation funding. The Queensland Government has also provided significant funding through the Office of the Great Barrier Reef. Staff inputs have been variable since 2014 across both governments, with injections in some places (biodiversity and community benefits) and reductions in others (climate change and coastal ecosystems).

Management systems and processes:

Management processes are particularly strong for defence activities, shipping, research activities and management of land-based runoff. They are weakest for climate change. Stakeholder and community engagement and application of biophysical information are the strongest aspects of management across all topics. Governance is generally strong, except for climate change. The application of socioeconomic and heritage knowledge, and setting of targets to benchmark performance are problematic for many topics, but processes are generally stable to improving.

Delivery of outputs:

Delivery of desired outputs was rated as effective or mostly effective for all topics except climate change and recreation. It is strongest for commercial marine tourism, defence activities, research activities and traditional use of marine resources. The knowledge base of managing agencies and the community has consistently improved. While the majority of management programs are progressing satisfactorily, timeframes frequently slip and it is not yet clear that the programs are achieving all their desired objectives.

Achievement of outcomes:

Achievement of desired outcomes is highly variable across the management topics. Objectives are being achieved in relation to community understanding of issues and development of effective partnerships. Overall, performance is strong, particularly for research activities, shipping, ports, commercial marine tourism and defence activities. Performance is weakest for climate change and the management of climate change is ineffective. Biodiversity outcomes have declined markedly, principally as a result of cumulative impacts and bleaching events in 2016 and 2017.



Good

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Good Stable

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Good Improved

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Good

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Good Stable

8 Resilience



The resilience of the Great Barrier Reef ecosystem and heritage values are assessed through a series of case studies, which are continued from the 2009 and 2014 Outlook Reports.

Ecosystem resilience in the broadest sense, is the capacity of a system to absorb disturbance and reorganise so as to retain essentially the same structure, function, identity, and feedback systems. Resilience cannot be measured directly — assessing the resilience of a system depends on how well it responds to, withstands, adapts and recovers from disturbances.

• **Coral reefs** Since 2014, many reefs in the northern, central and southern regions have been affected by a range of disturbances, including freshwater flood plumes, destructive waves associated with cyclones and extreme thermal stress. In 2016 and 2017, the Great Barrier Reef experienced its first back-to-back coral bleaching events, which caused mass mortality of corals in shallow reef habitats, particularly in the northern and central parts of the Reef. Cyclone Debbie and outbreaks of crown-of-thorns starfish have caused further loss of coral cover in the central and southern areas of the Reef. As a result of these cumulative impacts, average hard coral cover has undergone a steep decline.

Although the Reef has bounced back from many disturbances in the past, the overall trend for coral reef habitats within the Region is one of long-term decline. Global warming has deprived the Reef of sufficient time for many coral communities to recover between acute events. The direct impacts of further climate change, combined with chronic stressors, will further reduce reef resilience and deplete coral-associated species. Because of the increase in the frequency and intensity of disturbances, ecosystem resilience may already be on an irreversible path of decline.

The results of the other case studies on ecosystem resilience are:

• Lagoon floor habitats The previous Outlook Reports concluded that some lagoon floor habitats previously at risk were recovering from disturbances with the expectation that full recovery will take decades. Since then, the lagoon floor has been exposed to various impacts and human activities. Monitoring data are limited.



Multiple disturbances have impacted the Great Barrier Reef since 2014

Figure 8.2 in main report: The Reef has been exposed to multiple, severe disturbances that have reduced resilience. For full details and interpretation of this figure, refer to the main report. Left map: Source: Adapted from Gruber et al. in 2019. Middle map: Source: Adapted and updated from Poutinen et al. 2016. Right map: Source: Adapted from Hughes et al. 2019 and Lui et al. 2017



- Black teatfish (sea cucumber) Industry-led surveys in 2015 found the population biomass had increased to at least 70 per cent of its unfished biomass. However, these data were collected before several acute and severe disturbances to the surveyed areas between Townsville and Cape Grenville to the north. The resilience of black teatfish populations is limited and their sensitivity to overfishing and climate change will affect recovery.
- **Coral trout** resilience has deteriorated following disturbances causing broadscale loss of habitat structural complexity and their preferred prey in some locations. Some recovery since 2013 is evident and more pronounced in no-take areas. Decreases in coral trout catch are likely to occur as sea temperatures increase, particularly in the warmer northern sector of the Reef.



Number of tagged loggerhead turtles nesting, Woongarra coast, 1967–2017

Figure 8.5 in main report: Data for the 1967 and 1968 nesting seasons are population estimates. Data for nesting seasons from 1969 to 2017 are derived from population censuses. Nesting seasons occur over summer and are referred to by the year in which they start. Source: Department of Environment and Science 2018 and Limpus 2008

- Loggerhead turtle Management interventions over the last few decades have successfully reversed declines in loggerhead turtle nesting numbers on some beaches. However, the effects of overseas fishing bycatch and marine debris on the number of juvenile turtles reaching and settling into Great Barrier Reef feeding grounds may be undermining the population's overall resilience.
- **Urban coast dugongs** Despite evidence of some improvement since 2011, the potential increase in urban coast dugong populations would be strongly dependent on the condition of seagrass meadows and efforts to reduce direct mortality threats.
- **Humpback whales** continue to recover, with population estimates now between 58 and 98 per cent of the pre-whaling population.

Heritage resilience is the ability of a heritage place, structure or value, to experience impacts or disturbance while retaining the inherent heritage value for which it has been recognised. Three case studies illustrate the likely resilience of some heritage values in the Region:

- **Cultural practices, observances, customs, and lore** Resilience of this component is probably improved within the Lama Lama case study area near Princess Charlotte Bay in the far northern part of the Region. Traditional Owner-led governance and management systems are well-established. The resilience of intangible values, such as many of the Region's Indigenous heritage values, depends strongly on the active involvement of the custodians of those values to make sure connections and knowledge are kept alive.
- **Lightstations** rely on management actions to support their resilience and maintain their inherent heritage value. Evidence of improved resilience of lightstations since 2014 is limited, although managers are confident the inherent heritage value of these assets is retained.
- **Historic shipwrecks** Ongoing monitoring of condition is important to understanding resilience of historic shipwrecks. As a case study, the 2015 and 2018 inspections of the *Foam* shipwreck provide updated evidence that the shipwreck remains in good condition.

Summary criteria

Ecosystem resilience:

Black teatfish, loggerhead turtles and dugongs have shown an ability to recover from disturbance after significant management intervention. As a result of severe disturbance (thermal stress) coral reef habitats have significantly decreased. As a result, coral trout, which depend on these habitats, are also in decline. Increasing frequency and severity of some threats are likely to reduce the resilience of species and habitats in the Region.



Heritage resilience:

The resilience of Indigenous heritage values continues to depend on the active involvement of custodians, and access to land and sea country. Resilience of the Region's historic heritage value has not been widely analysed by managers. Shipwrecks exist in a dynamic marine environment, which may degrade their structure naturally over time. Limited evidence is available to comprehensively quantify the resilience of the Region's heritage values.



9 Risks to the Region's values

Management of the Region must consider the full range of threats to the Region's ecosystem and heritage values (natural, Indigenous, historic and other heritage values). The risk assessment is based on the information presented in Chapters 2 to 8. The assessment systematically reviews the current and future risks presented by known threats, and summarises the residual risk to the Reef after consideration of existing protection and management measures. Two separate risk assessments are presented, one for the Region's ecosystem and one for its heritage values.

Forty-five threats are considered in the assessment; four threats have been added since 2014. The close connections between ecosystem components and heritage value components mean the projected risk for many threats is equivalent for both sets of values.

Threats of highest risk Of the very high risk threats, most relate to climate change or land-based run-off (water quality) affecting the ecosystem and heritage values at a broad, often Region-wide, scale and are happening now. The 10 threats identified in 2014 as presenting a very high risk to the Region's ecosystem and heritage values are again rated as very high risk. The threats assessed as very high and high risk (grouped by influencing factor) are:

- **Climate change** The single most pervasive and persistent influencing factor continues to be climate change, with four climate change-related threats posing very high risk (and one posing high risk) to the Great Barrier Reef on a Region-wide scale. The implications of global tipping points in the physical climate system are of urgent concern. Not only is the direct influence of these threats on the Region's values significant, they also have the potential to exacerbate and amplify the impact of other threats. The same threats flow on to present a serious risk to heritage values.
- Land-based run-off The continuing inputs of nutrients, sediments and pesticides and the time lag between reduced inputs and improved ecosystem condition, mean land-based run-off will continue to be a serious risk to the ecosystem. Attributes of outstanding universal value will continue to deteriorate, especially in inshore areas.
- **Coastal development** The combined effect of modifications to coastal ecosystems across the Catchment is not irreversible but widespread and serious. The function of linked terrestrial–marine ecosystems is affected by barriers to water flow and modification of coastal habitats. Artificial light from urban and industrial development will continue to grow.
- **Direct use** The threats associated with fishing (illegal fishing and poaching, extraction of predators and particle feeders, extraction from unidentified or unprotected spawning aggregations, incidental catch of species of conservation concern and discarded catch) are all rated as high or very high risk. The effects of fragmentation of cultural knowledge and undesirable behaviours at heritage sites are likely to continue, and may affect the ability of Traditional Owners to undertake cultural practices.



Medium risk

High risk Very high risk

Figure 9.4 in main report: The influencing factors that present the highest overall risk to the Region's values have their origins outside the Region. Note: the management effectiveness assessment for the topic of climate change is only in relation to management measures undertaken specifically to protect and manage the Reef.



		Influencing factor						
Threat	Ecosystem	Heritage values	Timing	Climate change	Coastal development	Land-based run-off	Direct use	
Altered weather patterns				٠				
Sea-temperature increase				•				
Ocean acidification				•				
Sea-level rise			10+	•				
Modifying coastal habitats					٠			
Nutrient run-off						•		
Sediment run-off						•		
Outbreak of crown-of-thorns starfish						•	٠	
Illegal fishing and poaching							•	
Incidental catch of species of conservation concern							•	
Altered ocean currents				•				
Barriers to flow					•			
Marine debris						•	•	
Discarded catch							•	
Extraction of particle feeders							•	
Extraction of predators							•	
Fragmentation of cultural knowledge							•	
Foundational capacity gaps							•	
Incompatible uses							•	
Artificial light					•		•	
Damage to reef structure							•	
Extraction from spawning aggregations							•	
Illegal activities - other							٠	
Pesticide run-off						•		
Outbreak of disease				Cumulative effect of many factors				
Outbreak of other species				Cumula	ative effec	t of many	/ factors	
Terrestrial discharge						•		
Acid sulfate soils					•	٠		
Disposal of dredge material					•		•	
Dredging					•		•	
Noise pollution					•		•	
Exotic species					•	٠	•	
Behaviour impacting heritage values							•	
Damage to seafloor							٠	
Extraction of herbivores							٠	
Grounding — large vessel							٠	
Grounding - small vessel							٠	
Spill – large chemical					•		٠	
Spill — large oil					•		٠	
Vessel strike							٠	
Vessel waste discharge							٠	
Wildlife disturbance							•	
Atmospheric pollution					•		٠	
Genetic modification			5+				•	
Spill - small							•	

The risk level has increased for seven threats: altered ocean currents, artificial light, damage to reef structure, extraction of particle feeders, illegal activities (not including illegal fishing and poaching), grounding of small vessels, and wildlife disturbance. Only one risk has decreased since 2014 — the risk posed by disposal of dredge material, which has decreased from high to medium because of new management measures that restrict disposal of material from capital dredging.

Effectiveness at managing threats It is widely acknowledged that many of the threats with the highest risk levels originate outside the Region. The overall risk associated with climate change (very high), coastal development (high) and land-based run-off (high) have remained the same as in the 2009 and 2014 Outlook Reports. However, independent assessors found the effectiveness of management in relation to climate change has continued to weaken. Direct use of the Region is assessed overall as a medium risk.

Cumulative impacts While the threats are assessed individually, they do not operate in isolation. The extent, nature and implications of the cumulative impacts on the Region's ecosystems from disturbances over the past 10 to 15 years are not yet fully understood. However, the extensive coral bleaching events in 2016 and 2017 highlighted the fragility of the system and the need to actively address climate change, continue efforts to support resilience, and reduce and manage all other threats.



Summary of threats arising from factors influencing the Region's values, and associated scale, timing and risk level

Figure 9.2 in main report: This figure links identified threats with the key factors influencing the Region's values that have most influence on them either directly or indirectly.

Summary criteria

Overall risk to the ecosystem (natural heritage values):

The threats likely to affect the Region's ecosystem in the future are increasing and compounding, placing the ecosystem at very high risk. The most serious risks arise from certain threats associated with climate change, land-based run-off, coastal development and some aspects of direct use (particularly fishing). Other threats relating to direct use are more effectively managed and of less overall risk to the Reef.





Many heritage values are closely connected to the ecosystem. The projected risk to the Region's heritage values from most threats are, therefore, the same as for the ecosystem. Heritage values are at very high and increasing risk. The most serious risks are climate change, land-based run-off, coastal development and some aspects of direct use.



10 Long-term outlook

The long-term outlook of the Great Barrier Reef is built from the evidence presented in the preceding assessments. Specifically, an understanding of current condition and trend of the ecological (natural heritage value), economic, social and heritage (Indigenous and historic) values of the Region; the factors influencing those values; the effectiveness of protection and management measures; the resultant resilience of the Region's ecosystem and its heritage values; and the risks the ecosystem and heritage values are facing.

The Region was at a crossroads in 2009, with an opportunity for its long-term outlook to be improved through timely actions. In 2014, assessments indicated all threats needed to be reduced to prevent the Region's overall condition worsening from poor. Since then, the outlook for the Region's ecosystem has become very poor. Climate change is escalating and is the most significant threat to the Region's long-term outlook. The Region and those people dependent on it are already experiencing climate change and, as a result, a changed and less resilient Reef.

Values

Biodiversity

- . The condition of seagrass meadows and coral reefs, the habitats most is known about, are assessed as being poor and very poor. Most other habitats are considered in good condition, although less is known about them and confidence in grades is lower
- . Several species or groups of species have deteriorated since the last Outlook Report. Over half of those assessed are in poor condition and corals are in very poor condition.
- Unprecedented declines in coral habitat since 2016 across the northern two-thirds of the Region have outweighed recovery.
- Inshore seagrass meadows have not recovered as quickly as expected since disturbances in 2011–12.
- Heightened concerns exist for the future of loggerhead, hawksbill and northern green turtles, due to climate change and fishing pressures outside the Region.
- · Humpback whale and southern green turtle populations continue to recover strongly.

Ecosystem health

- · Sixty per cent of 31 assessed ecosystem health components remain in good to very good condition; the remainder are in poor to very poor condition.
- Region-wide deterioration has occurred in ecological processes, including symbiosis, recruitment and reef building.
- · Connectivity, which is crucial for recovery from disturbance, remains in good condition.
- Vegetation clearing in the Catchment continues to contribute to soil erosion and release of fine sediment into the Region.
- A crown-of-thorns starfish outbreak has persisted and expanded for almost a decade, causing significant coral damage across much of the Region.

Heritage values

- Declines in natural heritage values are affecting Indigenous and world heritage values.
- · Commonwealth historic heritage and other heritage values (social, aesthetic and scientific) are being maintained.
- · Outstanding universal value remains intact but is being increasingly challenged.
- · The size of the World Heritage Area is becoming less effective as a buffer to disturbance, particularly against the broadscale impacts of climate change.

Values | Threats, responses and risks

Commercial and non-commercial use

- · Marine tourism visitation has generally increased since 2014.
- · Fishing practices and management continue to improve. Sustainability concerns exist for some species and illegal fishing and poaching remain issues.
- · Legislative changes have improved management of ports and shipping, reducing capital dredge material disposal and the risk of shipping incidents. Increasing size and numbers of ships continues to be a concern.
- · Research and monitoring remain critical to effective management of the Region.

Outlook

Long-term outlook for the Region's ecosystem and heritage values

Figure 10.1 in main report: Summary of the findings underpinning the long-term outlook for the Region's ecosystem and heritage values.

Factors influencing the Region's values

- Societal attitudes about the Reef are complex and influence behaviours and decision-making.
- Overwhelmingly, climate change is the primary issue affecting the Reef, and its influence is increasing faster than previously predicted.
- · Increasing and record-breaking sea temperatures have affected the Region and pose the most immediate threat to values.
- · Efforts to improve water quality entering the Region have resulted in a gradual reduction in some pollutants from the Catchment. However, water quality targets are not being met, which is compounding the effects of climate change and slowing recovery of inshore ecosystems.
- Poor agricultural land management practices in the Catchment remain the greatest contributor to poor water quality. Past and current development (such as land clearing and modification of waterways) in the Catchment continues to affect the Region.
- . Human population in the Catchment is expected to grow at 1.1 per cent per year, further increasing direct use of the Region (for example, tourism, recreation and recreational fishing).

Existing protection and management

- Management of the Region is good across all six effectiveness criteria when considering the 14 management topics as a group.
- The Reef 2050 Plan has improved jurisdictional consistency, coordination and resourcing across many management topics.
- Improvements within management topics are most notable for ports, heritage values and fishing.
- Declines in effectiveness occurred for some aspects of managing biodiversity values, climate change and recreational use (excluding fishing). · Management challenges remain for complex, spatially extensive values such as biodiversity and threats from climate change, land-based run-off and fishing
- managers. For other threats, recent plans have not had time to translate into outcomes (such as the Queensland Sustainable Fisheries Strategy).
- · Some threats (such as sea-temperature increase) are both global and national issues, not directly in the control of day-to-day Reef and Catchment Knowledge of ecosystem and heritage condition is not keeping pace with disturbance frequency, delaying management actions.

Resilience

- · Case studies of some species show continuing recovery from past impacts, but concerns remain for other species. Humpback whales have demonstrated resilience by continuing to recover strongly since harvesting ended outside the Region.
- · Reef resilience is being severely compromised by global warming, which has resulted in mass mortality of adult coral and subsequent 89 per cent decline in coral recruitment. • Loggerhead turtle recovery may be affected by low levels of juvenile recruitment.
- · Community awareness and appreciation are important to the resilience of the Region's historic and Indigenous heritage values. Lack of data makes the current state of heritage resilience difficult to guantify.
- . The Region's resilience has deteriorated due to an increased frequency of disturbances; ecological recovery from recent disturbances will take far longer as a result.
- Sea-temperature extremes and other threats will continue to undermine resilience.
- · Management actions at all scales are needed to reduce drivers, support recovery and build resilience. For example, localised coral reef restoration efforts are increasing and the largest ever crown-of-thorns starfish control program is underway.

Risks

- Threats identified as posing the highest risk are already affecting ecosystem and heritage values at a Region-wide scale.
- The 10 threats identified in 2014 as presenting a very high risk to the Region's ecosystem and heritage values are again the highest ranked.
- . Of the very high risk threats, most relate to climate change or land-based run-off (water quality).
- · Direct use impacts are amplified by climate change and pose ongoing risk given the declining state of the Region's ecosystem.
- Interest in habitat restoration and other interventions is increasing, and the risks posed by these activities are not yet well understood.
- Developing and implementing effective responses to cumulative impacts requires continued evolution of policy and practical actions.



CHAPTER



CHAPTER



Threats, responses and risks









Likely future trends Given the current state of the Region's values, actions to reduce the highest risks have never been more time-critical. Strong mitigation actions within the next decade are necessary to achieve the best possible outlook for the Reef and future generations. Specifically, early and effective global and national action on climate change, coupled with local actions to maintain condition and facilitate recovery from disturbances, are imperative over the next 10 years if the Region is to have a positive long-term outlook. Whether the Region's condition continues to deteriorate depends on a combination of immediate global action on climate change, effective management of remaining risks that originate within the Region and its Catchment, and the Region's resilience.

Prospects for the outstanding universal value of the Great Barrier Reef World Heritage Area Previously, when the climate regime was considered more stable, protection and management approaches were generally considered to be effective in protecting the World Heritage Area. However, the Great Barrier Reef World Heritage Area, like other world heritage properties globally, is increasingly affected by anthropogenic climate change. Given the global scale of humaninduced climate change, the size of the Region is becoming a less effective buffer to broadscale and cumulative impacts. Outstanding universal value remains across all four criteria for which the Reef was inscribed on the World Heritage List. However, the condition of the property has deteriorated to varying extents with respect to criteria vii, viii, ix and x.

Current and future initiatives to improve the long-term outlook In 2015, one of the greatest multi-jurisdictional efforts to protect the Reef, the Reef 2050 Plan, was implemented. Although beyond the scope of the Reef 2050 Plan, demonstrable effective global, national and local efforts to mitigate climate change are needed urgently within the next decade if the Reef is to recover and persist. A comprehensive review of the plan in 2020 will address the findings of this Outlook Report to continue the transformational progress required.



- Coral bleaching events and other impacts accumulating, and recovery time increasing
- Intensifying pressures are slowing seagrass meadow recovery
- Warmer temperatures cause more female and fewer male marine turtles
- Indigenous heritage and community wellbeing impacted
- A stable nature-based tourism industry, but in restricted locations as areas recover post-disturbance
- Viable fishing industries, but lower catches post-disturbances

Future pathways for the Great Barrier Reef Region

- Fewer colourful reef fish
- Loss and degradation of some seagrass meadows
- · Annual marine heatwaves twice as likely
- Unreliable weather affects reef use
- More island-based and water sport tourism; less snorkelling and diving • Fisheries may target different species, more

disease prevalence in fish and crustaceans

- Turtles, seabirds and dugong in rapid decline Annual marine heatwaves three times as likely
 - Extreme weather events far more frequent

Coastal protection reduced and coast

sea level

less habitable

• Irreversible impacts to Indigenous heritage and community wellbeing

Mangroves shift shoreward in response to rising

Fisheries may transition to new products and markets (algae and herbivorous fish)

Figure 10.2 in main report: The two outlook pathways provide examples of what the future may look like depending on whether key risks are adequately mitigated within required timeframes. The pathways are indicative and based on a large body of evidence from the previous chapters. Supporting evidence: Hughes et. al. 2018, King and Karoly 2017, IPCC 2018, Gaffuso et. al and Wang et.al. 2017

At local and regional levels, direct management actions do reduce some pressures. Localised ecosystem recovery is being observed in some areas, but it is slow. Current efforts that are effective in ensuring that use is sustainable and compliant with environmental protection rules should be continued. Catchment management actions aimed at reducing pollution in land-based run-off are not working fast enough and a significant step change is needed to accelerate improvement in the quality of water flowing into the Reef.

Multi-agency efforts to explore tangible and scalable reef restoration and adaptation measures have begun. A suite of innovative and targeted measures that provide largescale options for management in future are being explored. However, the success of restoration efforts depends on favourable Reef conditions for growth and recovery, which will not occur unless the rate of anthropogenic climate change is halted and reversed.

Notwithstanding the seriousness of the challenges the Region faces, there is still hope for its recovery if effective and timely mitigation of risks occur within the next decade. By protecting the environmental and heritage values of the Region, the lifestyles and livelihoods of the communities who live on its coastline and the intrinsic value to the global community will also be maintained. All actions that promote recovery processes and limit further decline will improve the Region's long-term outlook.

It is important not to lose optimism by thinking the job is too big, or to think that a changed Reef is far in the future actions taken now will matter.

Overarching

- Reef 2050 Long-Term Sustainability Plan (2018) and Reef Trust investment • Great Barrier Reef Blueprint for Resilience (2017)
- Reef 2050 Integrated Monitoring and Reporting Program
- Scientifically valid, ongoing monitoring involving the community

Natural heritage values

- (biodiversity and ecosystem health)
- Reef Joint Field Management Program expanded biodiversity protection and enhanced compliance activities
- Queensland Sustainable Fisheries Strategy 2017-2027 commitment to implementation and outcomes
- Crown-of-thorns starfish control expanded efforts to protect coral cover
- Islands and fringing reefs Queensland Government values-based framework for Queensland islands
- Reef Restoration and Adaption Program implementation

Heritage values (Indigenous and historic)

 Aboriginal and Torres Strait Islander Heritage Strategy for the Great Barrier Reef Marine Park (2019) — increasing understanding and protection of Indigenous heritage

Climate change

- State-wide Land Restoration Fund- support for

- Sustainable Ports Development Act 2015 (Qld) management of port related development
- Wetlands in the Great Barrier Reef Catchments Management Strategy 2016–21

Direct Use

- Public moorings and reef protection markers expanded network
- North-East Shipping Management Plan revision due for release 2019
- Port master plans and Maintenance Dredging Strategy for Great Barrier Reef World Heritage Area Ports
- Vessel monitoring for commercial fishing vessels
- Traditional Use of Marine Resources Agreements -
- expanded coverage
- Marine debris reduction initiatives national threat abatement plan, Marine Park Authority position statement, and funded citizen science programs

Improved resilience of the Great Barrier Reef Region

Figure 10.3 in main report: Current and future initiatives to improve the Region's values and support resilience.

Summary criteria

Outlook for the ecosystem:

The Reef has fundamentally changed since 2009. The threats affecting the Region's ecosystem (natural heritage values) are increasing, compounding and expanding in scale; they are driven strongly by climate change. Multi-jurisdictional solutions and on-ground management involving stakeholders and the community are highly valuable. However, outcomes are being undermined by climate change. The window of opportunity to influence the Reef's long-term future is now. Strong, effective management actions are urgent at global, regional and local scales.





Outlook for heritage values:

Many of the Region's heritage values are closely tied to the condition of the ecosystem. The projected risk to these values from most threats is, therefore, the same as for the ecosystem. The most serious risks to the Region's overall heritage value are from climate change, land-based run-off, coastal development and some aspects of direct use. Identification and monitoring of the broad range of Indigenous, historic and other heritage values is not yet comprehensive. Greater shared knowledge of heritage values among the Region's managers, Traditional Owners and stakeholders is critical to ensuring recognition and continued protection of those values.



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