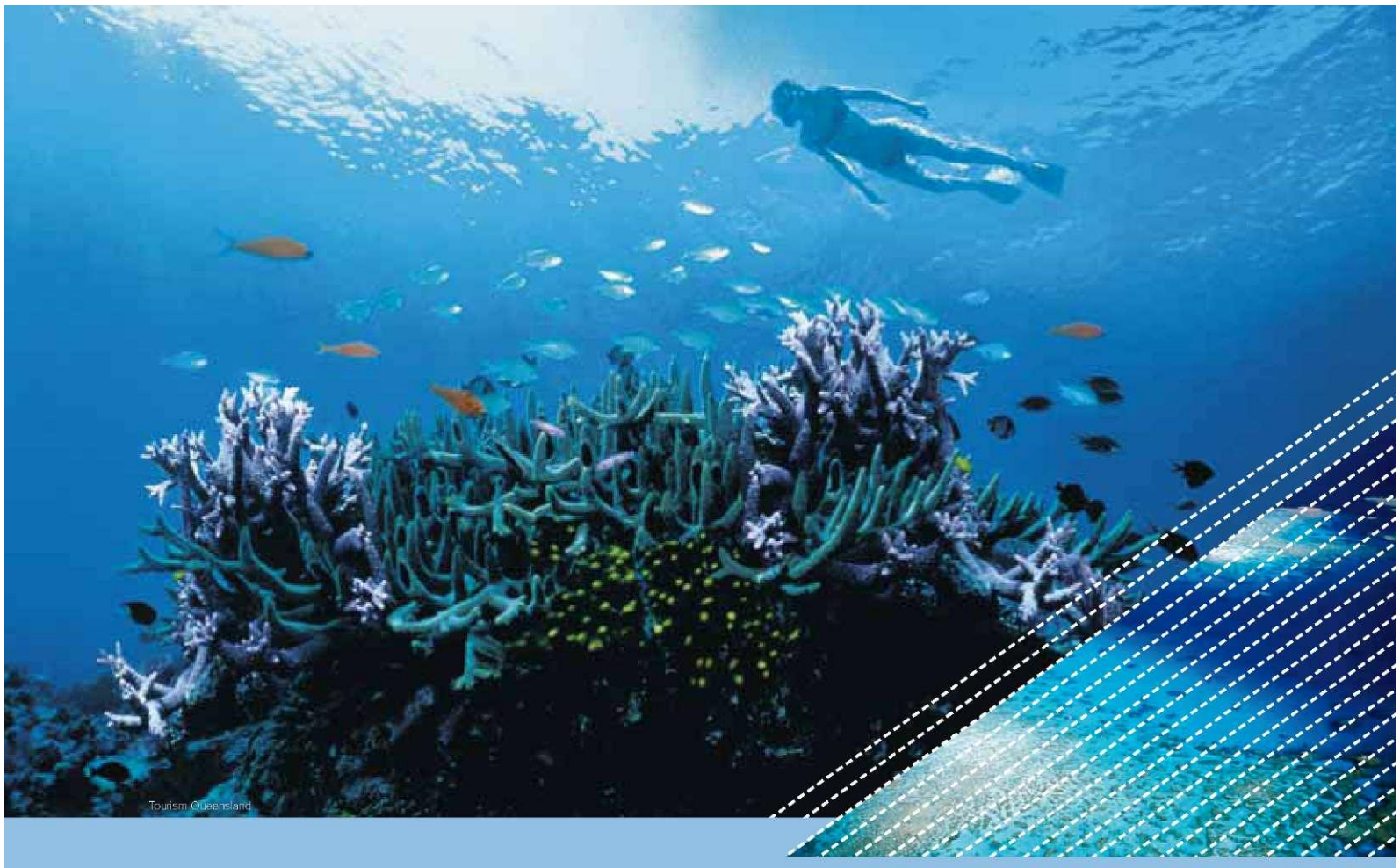

Tourism Queensland

Great Barrier Reef Tourism Climate Change Action Strategy 2009-2012

Queensland Tourism Industry Council — The Voice of Tourism

Australian Government
Great Barrier Reef Marine Park Authority

AMPTO — Association of Marine Park Tourism Operators

In partnership with

Queensland Government

Tourism Queensland

eco Tourism Australia

Lady Elliot Island Eco Resort — Great Barrier Reef

Quicksilver — In the Great Barrier Reef

WCBIA

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This document was created and released by the Great Barrier Reef Tourism Climate Change Action Group (TCCAG) under the leadership of the Great Barrier Reef Marine Park Authority. The TCCAG has representation from across the Great Barrier Reef and at the time of printing the membership of this group consisted of the following:

Daniel Gschwind
Queensland Tourism Industry Council (QTIC)

Col McKenzie
Association of Marine Park Tourism Operators (AMPTO)

Tony Baker
Quicksilver Group

Peter Gash
Lady Elliot Island Resort

Deb Lewis
Whitsunday Charter Boat Industry Association (WCBIA)

Therese Phillips
Tourism Queensland

Tony Charters
Ecotourism Australia

Lisha Mulqueeny
Great Barrier Reef Marine Park Authority (GBRMPA) – Tourism and Recreation Group

Paul Marshall
Great Barrier Reef Marine Park Authority (GBRMPA) – Climate Change Group

John Hicks
Department of Environment and Resource Management

The TCCAG would like to provide additional thanks to Lorelle Schluter (Great Barrier Reef Marine Park Authority) and Heidi Shuttenberg (James Cook University) for their assistance in the development of this Strategy.

From the Tourism Climate Change Action Group members…

As a community and as an industry we have a fundamental interest in protecting one of our greatest natural assets. QTIC is fully committed to work with industry and government to keep the Reef healthy and keep the industry at the leading edge of sustainability.

Daniel Gschwind
Queensland Tourism Industry Council

AMPTO is vitally concerned about the effects of climate change on our magnificent Great Barrier Reef and the flow on effects to our businesses. The Action Strategy provides us with a strategic way forward so that we can mitigate our carbon footprint, adapt our business practises and identify the opportunities that will occur.
The Action Strategy will be critical to the long term survival of the marine tourism industry.

Col McKenzie
Association of Marine Park Tourism Operators

I am very pleased as a member of the Tourism Climate Change Strategy Action Group to have been able to work with the GBRMPA in the development of the Great Barrier Reef Tourism Climate Change Action Strategy. As a group our objective has been to develop a strategy and convey that strategy in a user friendly way that is relevant to all tourism operators, government agencies and key stakeholders. A strategy that clearly identifies the challenges we face while providing real objectives and outcomes we can achieve. By working together we can make a difference.

Tony Baker
Quicksilver Group

We are all in the same boat. Busy with our daily challenges and issues – not enough time to address the bigger global issues that will affect us all sooner than we think. Climate Change will be the issue that will force us into taking action before that boat sinks. It's easy to talk and harder to do but start today – doing anything you, your family and your organisation can to turn the ship around. We must take action now; we are heading for a situation where our current day to day issues will pale into insignificance.
You know this is correct, but like us all you are so busy, so please take some time each day to make a small change. It all adds up to larger and larger changes.

Don't forget to enjoy each day – stay positive and keep a smile on your face. It's actually better for you and your business than you may realise. Once you start making environmental changes you will see the amazing positive results.

Peter Gash
Lady Elliot Island Resort

The WCBIA is committed to best practice principles in environmental protection, management and sustainability, particularly in and on the marine and island national parks. The WCBIA is committed to reducing the marine tourism industry carbon footprint. Climate change and continued best practice in environmental management is a priority for the Association. Relevant initiatives will be shared in partnership with the wider industry and government agencies, to ensure increased education, awareness and up-take of environmental management to ensure a sustainable future.

Deb Lewis
Whitsundays Charter Boat Industry Association

The Great Barrier Reef is a pivotal element in Queensland's tourism product mix and is known as a must-see destination for visitors from around the world.

This Climate Change Action Strategy provides essential actions for Queensland's tourism industry to respond to the issue of climate change and its effects on the Great Barrier Reef.

Tourism Queensland is proud to be part of this crucial process and will continue to support our partners, including GBRMPA, in this major initiative.

Therese Phillips
Tourism Queensland

Taking action to prepare the tourism industry for the impacts of climate change is critical. While we need to ensure we are doing everything we can to reduce our direct contributions to climate change, we also need to be mindful of the likely impacts and develop adaptation strategies. Our response needs to be swift and based on continual improvement to remain in touch with emerging scientific evidence and changing technologies.

Tony Charters
Ecotourism Australia

As the major commercial user of the Great Barrier Reef, the tourism industry has long played a pivotal role in Reef protection, stewardship and presentation. With climate change a major threat to the Great Barrier Reef, this role is increasingly important; the tourism industry needs to demonstrate it is part of the solution or it will be perceived as part of the problem.

This Action Strategy represents a powerful commitment by tourism leaders and government agencies to drive positive change on climate change and Reef health. It is an essential step for the future of the Reef and the tourism industry that relies upon it.

The release of this Strategy furthers the strong partnership between managing agencies and the tourism industry on Reef health, formalises the countless positive initiatives already being taken by operators to address climate change, and provides the framework for future action.

Lisha Mulqueeny
Great Barrier Reef Marine Park Authority

Climate change brings unprecedented challenges, especially for vulnerable ecosystems like coral reefs and those who depend on them for their livelihoods. While the GBR is likely to cope better than most coral reefs around the world, we certainly are not immune from climate change. As we rally behind the global efforts to limit greenhouse gas concentrations, we must also take measures to adapt to the range of climate-induced changes that lie ahead.

This Action Strategy, the first of its kind in the world, further strengthens the position of the GBR tourism industry as a global leader in nature-based tourism, in climate adaptation, and in stewardship for conservation. We are excited to be partnering with the GBR tourism industry to take these critical steps in tackling the challenges ahead.

Paul Marshall
Great Barrier Reef Marine Park Authority

The Department of Environment and Resource Management is keenly aware of the escalating pressures on natural systems. As an agency we are also aware of the opportunity, at this crucial moment in human history, which managers of linked social-ecological systems have to improve environmental trajectories. DERM welcomes the insights and understanding coming from this strategy. It strengthens our capacity to address some of the challenges of a changing climate.

John Hicks
Department of Environment and Resource Management

Executive Summary

Climate change represents one of the single biggest challenges facing the globe today.

For the Great Barrier Reef, climate change is a significant issue as the future health of the Great Barrier Reef and the sustainability of its tourism industry are inextricably linked and both are vulnerable to climate change. Research by Tourism Australia shows visitors from the key markets of the UK, China and Japan rank climate change in their top three issues of concern and importance in holiday planning. Through strong partnerships developed over many years, tourism industry leaders and the Great Barrier Reef Marine Park Authority, working together as the Tourism Climate Change Action Group, have developed the *Great Barrier Reef Marine Tourism Climate Change Action Strategy 2009-2012* (the Strategy).

The Strategy is intended to guide action to be taken by industry to improve reef health and the viability of the marine tourism industry. The Strategy provides guidance to the marine tourism industry operating within the Great Barrier Reef Marine Park and acts as a framework for action for management. Based on recommendations from industry leaders and operators and managing agencies, the Strategy provides a way forward for operators faced with climate-related risks, and will help them adapt to, and be prepared for, a climate change future through a business driven approach.

The ability to adapt to challenges has long been a key strength of the tourism industry. The industry has made it through challenges such as the 9/11 terrorist attacks and the global epidemic of severe acute respiratory syndrome (SARS). These and other events have shown the resilience of the industry and its ability to reinvent itself in the face of difficult conditions.

This Strategy provides a starting point for the marine tourism industry to tackle climate change and its implications for the Great Barrier Reef. The Strategy is designed to be updated and adjusted as more information about the impacts of climate change becomes available, and as new initiatives are identified and tested

Section one provides the background information on the development of the document, its rationale and goal, and the underpinning principles.

Section two presents the Great Barrier Reef Tourism Climate Change Action Group's vision for responding to climate change which is:
A Great Barrier Reef marine tourism industry that understands climate change and its impacts, is taking action to minimise its climate footprint, is business-ready to adapt to a climate change future, and is helping to protect the Great Barrier Reef.

Section three provides a clear and accessible synthesis of climate change, current climate predictions and foreseen impacts on Great Barrier Reef tourism. The marine tourism industry relies on good weather and a healthy reef ecosystem to thrive, both of which will be directly affected by climate change.

The early stages of climate change impacts are already evident with the Bureau of Meteorology recording trends of rising temperatures, increased storm intensity and declining rainfall in the region. Increased sea temperatures will increase the frequency of mass bleaching events and affect the ability of coral to build its skeleton, leading in turn to a loss of abundance and diversity in reef ecosystems. Iconic marine species such as big fish, turtles, sharks and rays will suffer from habitat changes, and whales may change their migration patterns. Seabirds will find it harder and harder to raise their chicks successfully.

Increasingly unpredictable weather, higher rainfall events and more frequent and severe weather events such as storm surges and cyclones will have direct repercussions on the tourism industry. Consequences may include a reduced number of operating days, damage to infrastructure, impacts on insurances, cancellations and increased trip re-scheduling.

Both weather and ecosystem-related damage will have significant impacts on activities offered by the Great Barrier Reef tourism industry, such as snorkelling and diving, coral viewing, viewing large iconic species such as marine turtles and sharks, bird watching, and island visits. It could jeopardise the $5.1 billion Great Barrier Reef tourism contributes to the national economy each year (Access Economics, 2007).

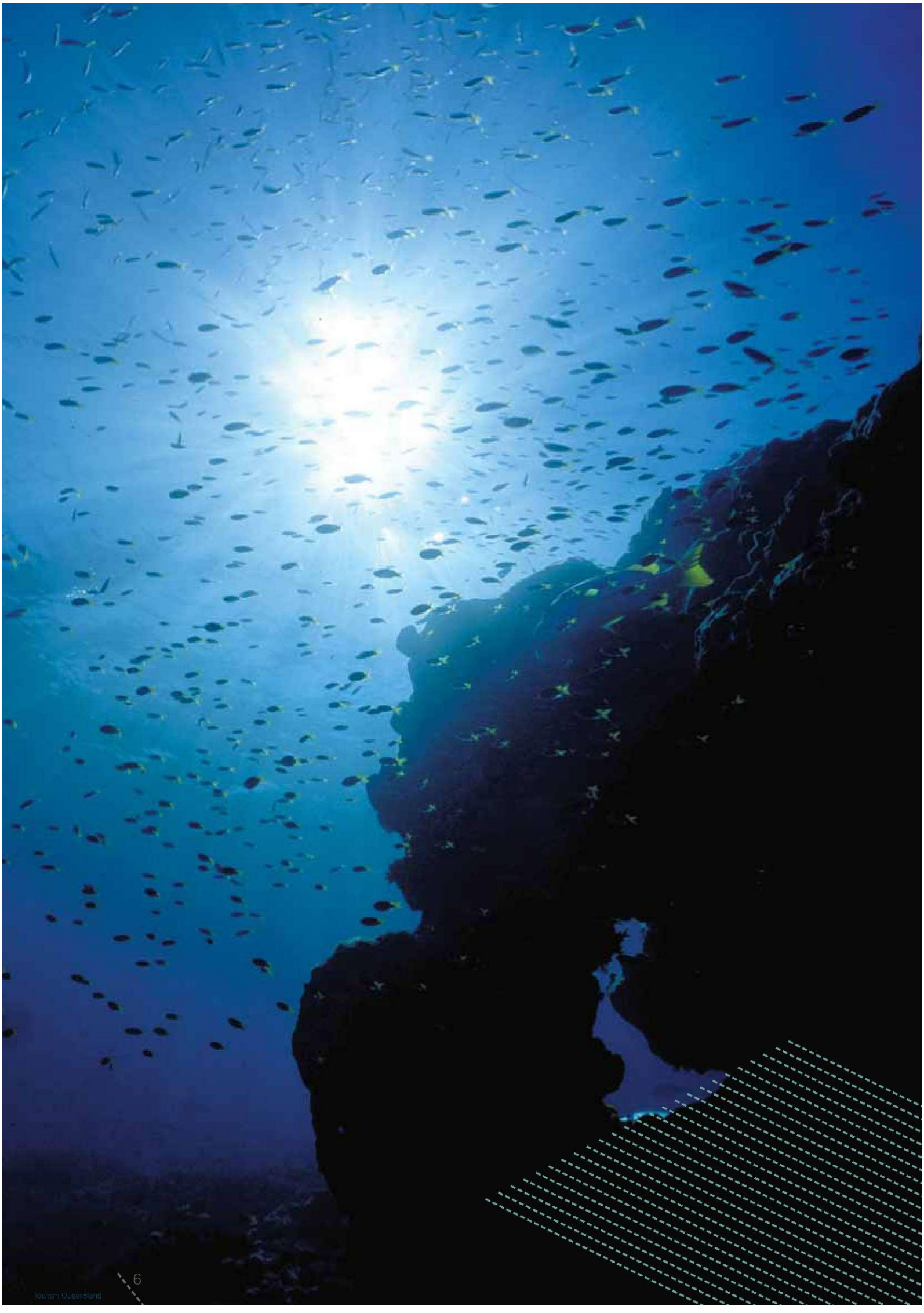
Section four of the Strategy explains how tourism operators can take meaningful actions to respond to climate change - both by leading emissions reduction strategies and by adapting their business operations to climate change. Examples include:

- Raising awareness of climate change amongst tourists and stakeholders
- Reducing the tourism operation's own carbon footprint through improved operational efficiency and certification
- Contributing to improving the resilience of the reef by reducing coral damage, disposing of waste responsibly and participating in partnership programs
- Integrating climate change into business operations and planning.

Section five presents a detailed action plan that can be adapted by tourism operators and industry stakeholders. It identifies clear objectives, and for each of these objectives, sets strategies and actions that tourism operators and reef managers can follow to reduce their impact and adapt to climate change. This section is the core of this Strategy, and includes innovative and forward-thinking suggestions that can be directly implemented.

Section six provides additional information regarding implementation of the Strategy, including the required budget and allocation of responsibility.

As this Action is not 'set in stone', feedback provided by the tourism industry partners implementing the Strategy will be critical for future revisions and updates of this document.



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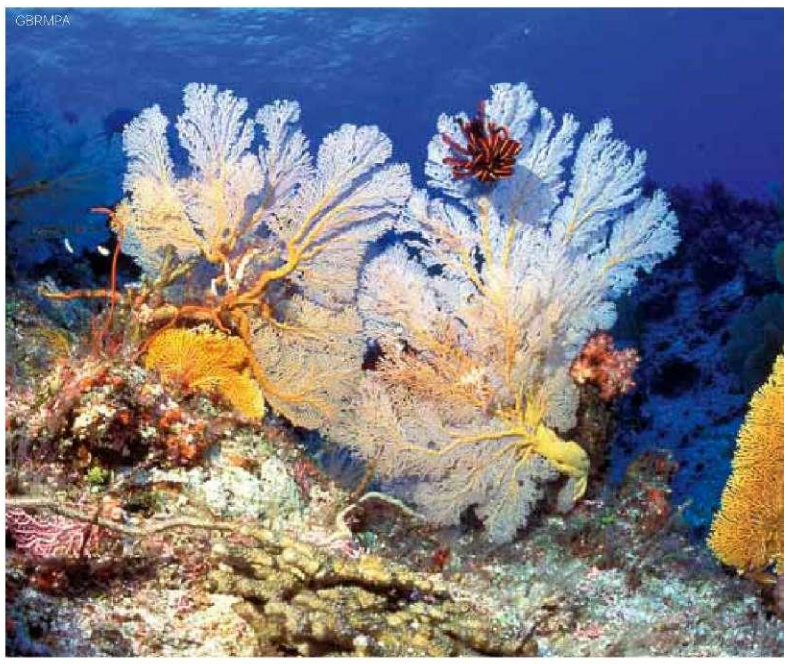
1.0 About this Strategy

1.1 Rationale

Climate change poses one of the greatest threats to coral reefs worldwide. The Great Barrier Reef (the Reef) is one of the largest, healthiest, and best managed reef systems in the world. While it can cope with stress better than most reefs, the Reef is not immune to climate change. By taking proactive action to tackle climate change, the marine tourism industry that relies on the Reef continues to be positioned as a top international and national travel destination.

Research by Tourism Australia shows visitors from the key markets of the UK, China and Japan rank climate change in their top three issues of concern and importance in holiday planning (Tourism Australia, 2008). The health of the tourism industry is inextricably linked with the health of the Reef. The condition, perceived or real, of the marine environment directly relates to the reputation of the Reef brand in the eyes of the consumer and their level of visitor satisfaction.

The intimate connection between marine tourism and the natural environment means the Reef tourism industry will face serious climate change challenges. However, the tourism industry has responded to many challenges and with adaptability as one of its key strengths, has come out the other side stronger than ever.

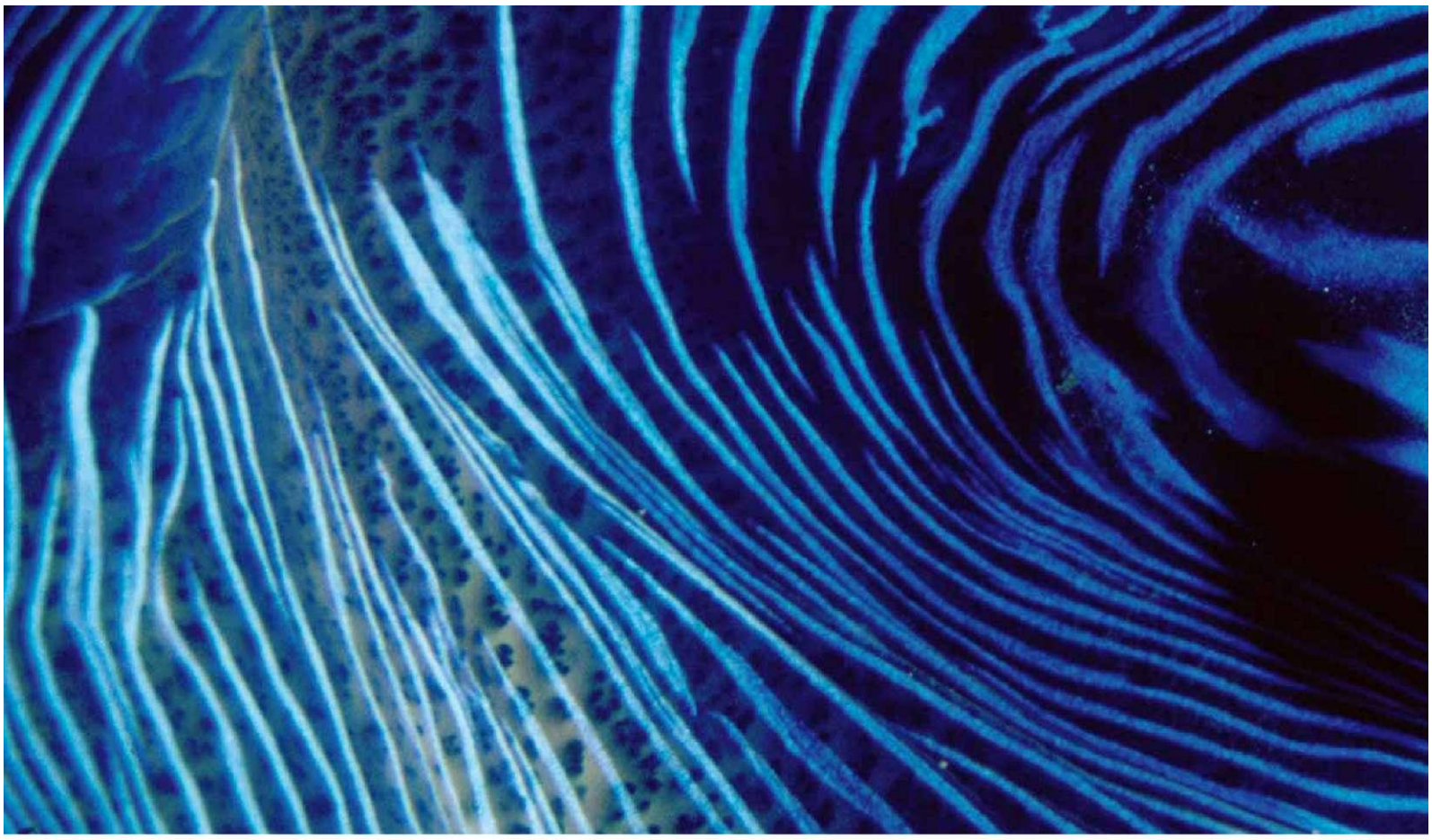

GBRMPA

In 2005, the Great Barrier Reef Marine Park Authority (the GBRMPA) and the tourism industry came together to focus on climate change mitigation and adaptation. The Tourism Climate Change Action Group (TCCAG) was formed in 2006 as a joint initiative between the GBRMPA's Climate Change and Tourism and Recreation Groups to facilitate industry action on climate change. The TCCAG was endorsed by the Tourism and Recreation Reef Advisory Committee as a forum to discuss and provide guidance on tourism-related climate change issues for the GBRMPA and to engender action to be taken by industry to improve reef health.

This Strategy directly supports the achievement of the GBRMPA's *Climate Change Action Plan 2007-2012* and care has been taken to ensure that the tourism-specific projects identified in this Strategy complement the broader climate change initiatives being undertaken by the GBRMPA.

The purpose of this Strategy is to provide a way forward for the Reef tourism industry facing a future impacted by climate change and help protect and improve the health and resilience of the Reef. The Strategy:

- Provides a way forward and framework of actions for the tourism industry to respond to climate change.
- Engenders action by individual operators which contributes to Reef health, stewardship and conservation.
- Offers a means to leverage resources to implement an effective climate change response.
- Is a tool to coordinate related projects proposed by government, research institutions, and industry partners.
- Delivers a mechanism for government and the industry to work in partnership to achieve the required policy and institutional settings to proactively manage required changes.



1.2 How this Strategy was developed

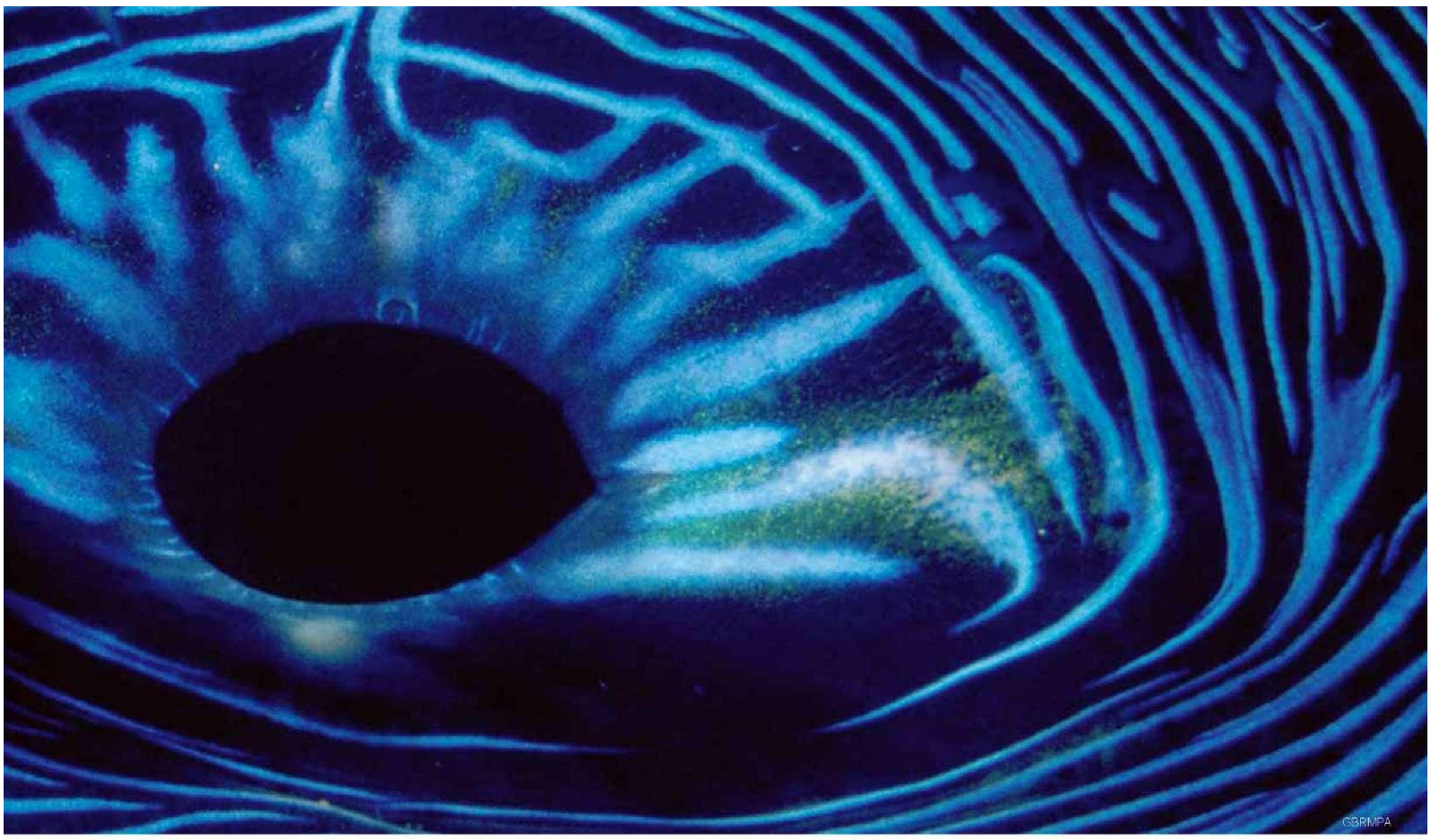
This Strategy was driven, developed and released by the GBRMPA in strong collaboration and partnership with tourism industry and agency representatives from across the Reef marine tourism industry. The following organisations form the Great Barrier Reef TCCAG and were involved in the development of this document:

The Great Barrier Reef Marine Park Authority (GBRMPA)
Queensland Tourism Industry Council (QTIC)
Association of Marine Park Tourism Operators (AMPTO)
Reef-based tourism operators (represented by Quicksilver Group)
Island-based tourism operators (represented by Lady Elliot Island Resort)
Whitsunday Charter Boat Industry Association (WCBIA)
Tourism Queensland
Ecotourism Australia
Department of Environment and Resource Management

This Strategy translates the recommendations generated through a series of industry leader and operator workshops into a strategic program of action. The introductory material will also provide a clear and concise synthesis of relevant information about climate change impacts on the Reef marine tourism industry for future communications with industry and government stakeholders.

The current version of this Strategy was developed by distilling ideas from, and collating recommendations developed at:

- The Marine Tourism Leaders Forum on Climate Change, 2-3 November 2005, Cairns.
- The Ecotourism and Climate Change workshop, 30 October to 1 November 2006, Magnetic Island, as part of Ecotourism Australia's 14th International Conference.
- Meetings of the GBRMPA's Tourism and Recreation Reef Advisory Committee.
- Meetings of the Great Barrier Reef TCCAG.
- Internal GBRMPA review.
- Peer review.

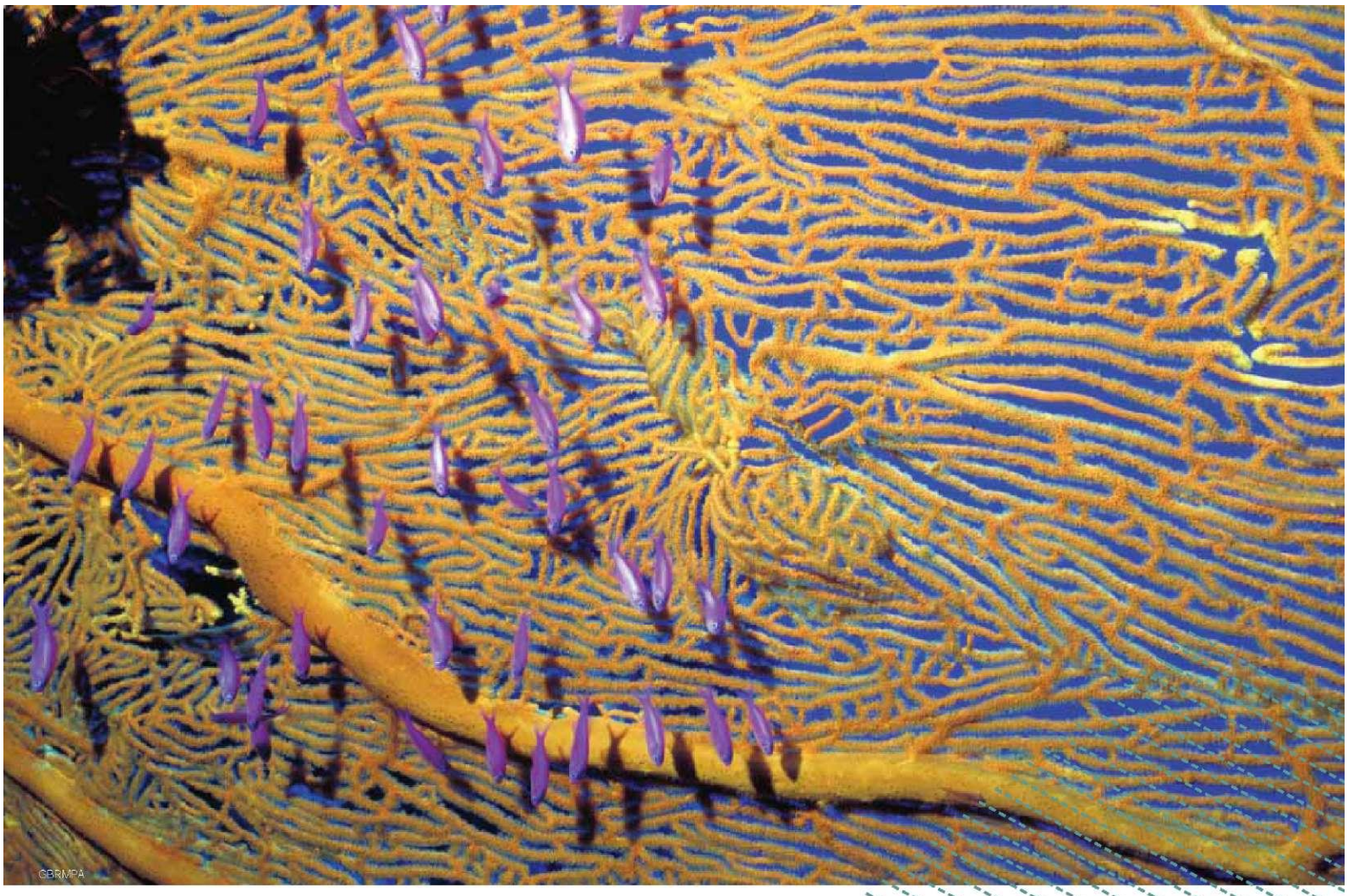


1.3 Getting involved

This document has been prepared to provide guidance to the marine-based tourism industry in the Great Barrier Reef Marine Park (the Marine Park) and to identify tangible actions to help protect and improve the resilience of the Reef. The involvement of all parties in implementing this plan is required.

Tourism operators are encouraged to become involved by taking action to reduce the impacts of climate change and working with industry associations and government agencies supporting positive climate change responses. Sections four and five of this document provide clear actions that operators can take to reduce their impact and to prepare for a climate change future.

This Strategy is a living document. As implementation of these strategies is undertaken, feedback will be sought from all partners and adjustments will be made.



2.0 A shared vision for responding to climate change

A Great Barrier Reef marine tourism industry that understands climate change and its impacts, is taking action to minimise its climate footprint, is business-ready to adapt to a climate change future, and is helping to protect the Great Barrier Reef.

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3.0 How will climate change affect GBR marine tourism?

3.1 Scope of the problem

The Reef is at a crossroads. Its vulnerability to climate change is inextricably linked to its diversity, its size and the strong reliance by communities and industries upon its resilience and ecosystem health.

The Reef is a maze of reefs and islands spanning an area of 348,000 km^2 off the Queensland coast, protected by a World Heritage Area and Marine Park. Extending 14 degrees of latitude, it is one of the largest and most diverse coral reef ecosystems in the world. The Reef supports approximately 1,500 species of fish, 350 species of hard coral, more than 4,000 species of mollusc, 500 species of algae, six of the world's seven species of marine turtle, 24 species of seabird, and more than 30 species of whale and dolphin and the dugong. The Reef is one of the truly majestic places on Earth and a thriving tourism industry relies on the conservation of this amazing natural icon.

Climate change is now clearly the most significant threat to the Reef and the marine tourism industry that relies on it. All industries must do their bit to respond to climate change, especially the tourism industry, as it is one of the first to experience the direct impacts of climate change. Already, tourism operators are impacted by the loss of coral cays, severe coral bleaching has affected localised areas, and there have been severe weather events resulting in increased trip cancellations.

The effects of climate change are not waiting off in the future; they are already being felt across the Reef. Unless the tourism industry comes to grips with the impacts of climate change on the Reef, there is a high risk that many current tourism activities will not be sustainable either environmentally or economically.

3.2 Marine tourism in the Great Barrier Reef

Tourism is the largest commercial user of the Marine Park and is an important tool in its protection and presentation. In the 1890s, organised tourism began on the Reef with pleasure cruises to Green Island, off Cairns. Over the last century, tourism has grown to become the largest commercial activity in the Reef region. In 2006/07, tourism in the Reef catchment contributed over AU$5.1 billion to the national economy and supported just over 50 000 jobs. Each year, approximately 1.9 million people visit the Reef using tourism services. They are drawn by an outstanding natural asset that consistently ranks as one of the top three 'must-see' destinations in Australia.

Tourists can experience the Marine Park through a range of activities including snorkelling and diving, fishing, boating and sailing, wildlife viewing, water sports, and aircraft tours.

Reef Tourism Facts

- Reef tourism contributes AU$5.1 billion to the Australian economy*
- Reef tourism supports over 50,000 jobs*
- 1.9 million people visit the Reef annually using tourism services**
- More than 700 operators are permitted for tourism in the Reef

* (Access Economics Pty Limited, 2006/07)

** (Based on Environmental Management Charge returns 2007)

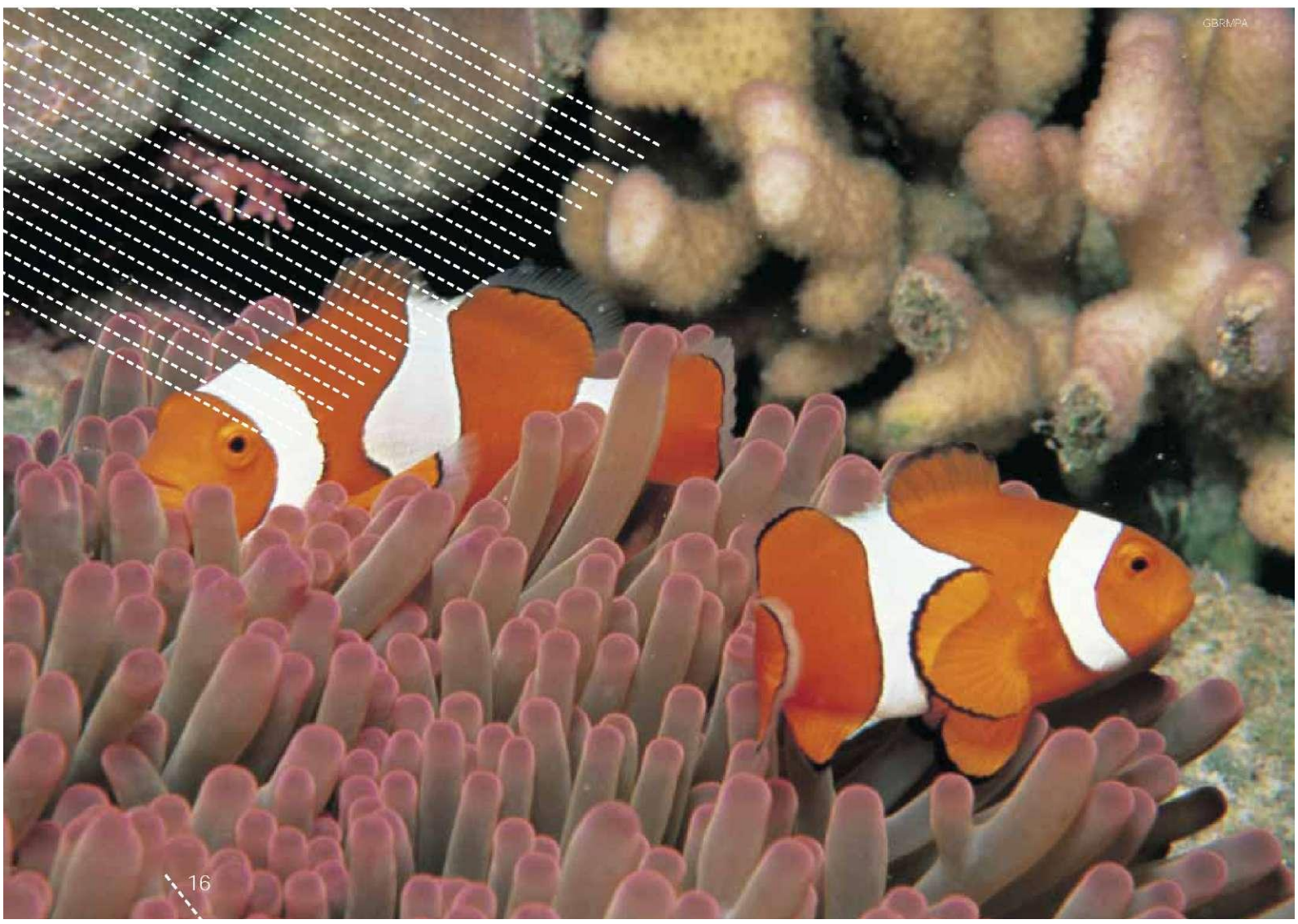
In early 2009, there were approximately 770 operators and 1500 vessels and aircraft permitted to operate in the Marine Park. The tour vessels used by operators range in size from small sailing vessels, which typically take fewer than 20 passengers, to large, luxury catamarans, which carry up to 400 passengers. There are also an increasing number of cruise ships and super-yachts cruising in the Marine Park.

Over 85 per cent of visitors go to the offshore Cairns/Port Douglas and Whitsunday areas that means localised climate change impacts could still have significant implications for the management of the Great Barrier Reef tourism industry and Australia's international reputation as a world class destination.

Destinations include a variety of coral reefs, continental islands and coral cays. In Cairns, the tourism industry focuses on day visits to pontoons and moorings and extended diving and fishing charters to offshore reef destinations. There are also aircraft and helicopter scenic flights. The Whitsunday operations focus largely on visiting resorts and island bays. Australia's largest bareboat yacht fleet operates in the waters around the Whitsunday islands.

The Reef ecosystem, its corals, marine life, and idyllic tropical lifestyle, are essential to the tourism industry and to the economic prosperity of the region.

Climate change is having wide-ranging impacts throughout the Reef. Without action now to understand and respond to these changes, the Reef and the marine tourism industry that relies upon it will face negative consequences.



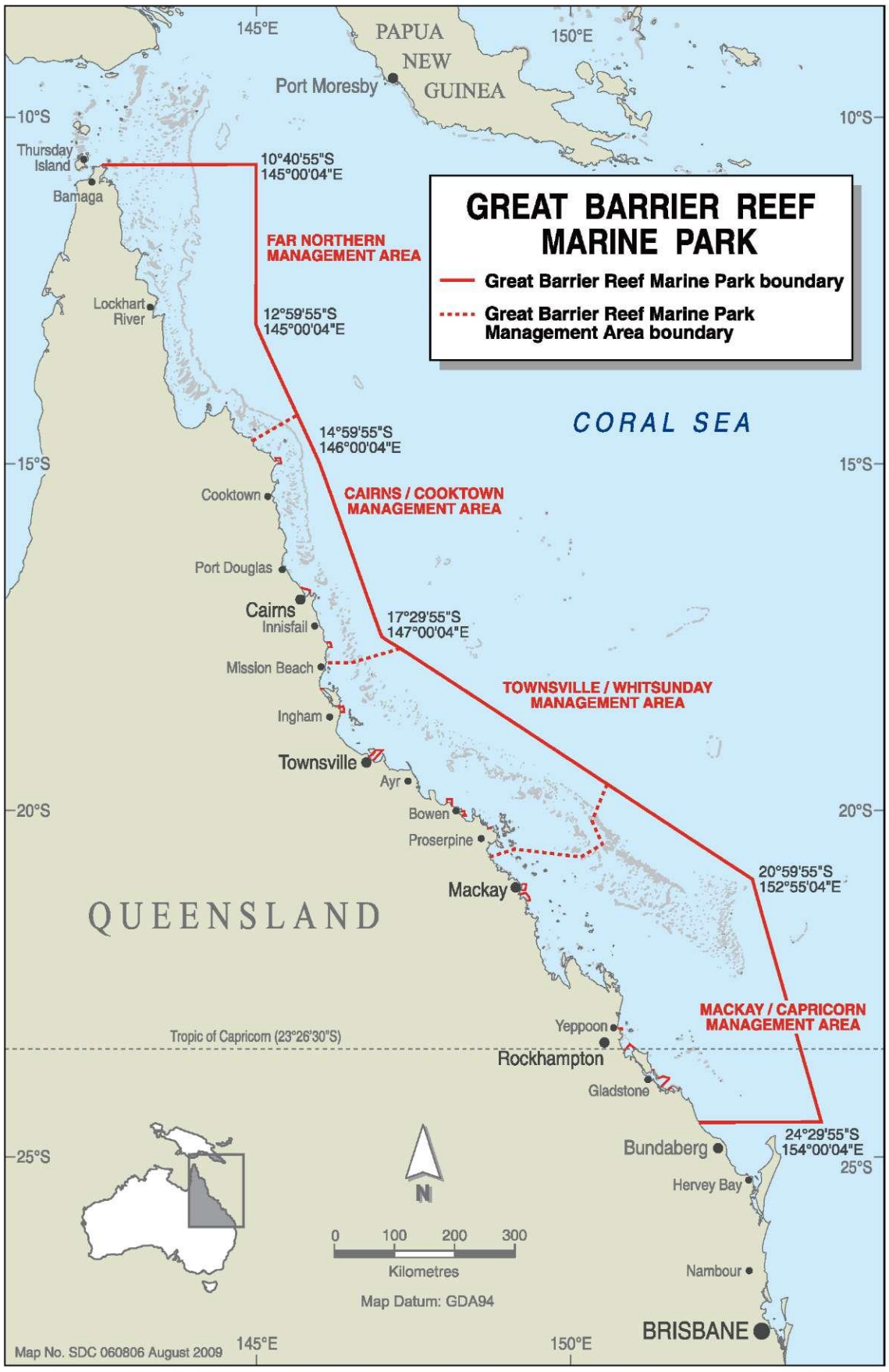


Figure 1. Map of the Great Barrier Reef

3.3 Climate change issues and implications

Why is the climate changing?

There is now scientific consensus that human activities have increased the concentration of greenhouse gases in the atmosphere dramatically, and caused significant changes in global and regional climate (see Figure 2). Atmospheric carbon dioxide (CO2), the principal gas of concern, is at levels unprecedented in at least the last 650 000 years.

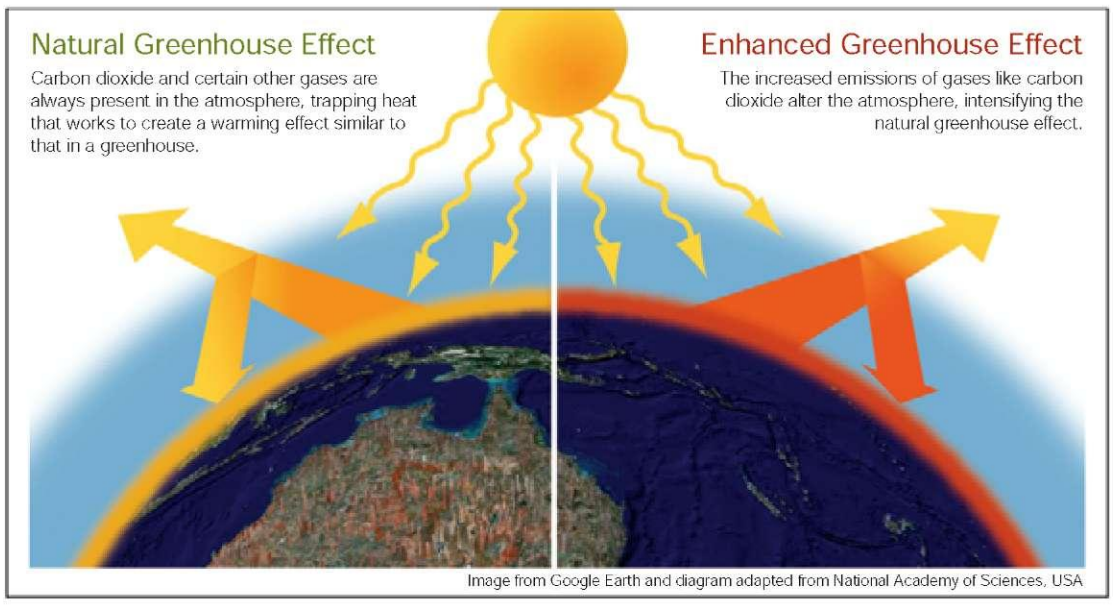


Figure 2. The Earth's blanket of greenhouse gases allows high energy light (yellow arrows) to pass through to the Eavrth's surface. At the surface, some light is converted to lower energy heat radiation. As the heat is re-radiated back to space, greenhouse gases trap some of it in the atmosphere. This process, called the greenhouse effect, warms earth to a temperature that can support life. However, human activities have increased the concentration of greenhouse gases in the atmosphere, which traps more heat. This 'enhanced' greenhouse effect is driving global climate change (Image from Google Earth and diagram adapted from National Academy of Sciences, USA).

Carbon dioxide is the most emitted greenhouse gas in Australia (74.3 per cent) followed by methane (20.5 per cent). The remaining gases make up 5.2 per cent of Australia's greenhouse gas emissions. In 2006, Australia alone produced 576 million tonnes of carbon dioxide equivalent and in that year, the five biggest sources of Australian greenhouse gas emissions were energy generation and use from fossil fuels (a huge 69.6 per cent) followed by food production (15.6 per cent), land use and management (6.9 per cent), industrial processes (4.9 per cent) and waste (2.9 per cent).

Of significant importance to the tourism industry is the notable contribution air travel makes to greenhouse gas emissions. A 1999 report by the world's top scientists (the Intergovernmental Panel on Climate Change [the IPCC]) found that aircraft were responsible for 3.5 per cent of global warming from human activities. Air traffic is predicted to be one of the fastest growing sources of greenhouse gas emissions and is likely to contribute five to 10 per cent of global warming from human activities within 50 years.

How is the climate changing in the Great Barrier Reef region?

Regional projections of air temperature, sea temperature and sea level rise for northeast Australia and the Reef are now considered conservative (Table 1) with significant changes already recorded by the Bureau of Meteorology (http://www.bom.gov.au/climate/change/).
In the last century, the average sea surface temperature has increased by 0.4°C, and since 1991, sea level in the Great Barrier Reef has risen by 50mm (Lough, 2007).

In the next 50 years, changes will be even more dramatic, with increasing annual sea surface temperatures. Recent climate observations show that rises in global temperatures and sea levels are tracking the upper part of the range projected by the IPCC. The IPCC projects a global sea level rise of up to 59cm by 2100, but emphasises the rise could be greater than this if ice-sheet melting occurs faster than expected. Records show the ice sheets of the Arctic are now melting at twice the projected rate. Without making significant changes to emissions, by the end of this century, we could be committed to an additional sea level rise of several metres.

Specific changes to Australian monsoon rainfall and storms are not as clear, but more extreme events are expected with up to a 25 per cent increase in wind speed. In addition increased rainfall variability and more protracted dry periods are expected. Already river and steam-flow records from the Queensland Department of Environment and Resource Management (DERM) show reductions in river flow are occurring (up to 50 per cent of the long term average in some streams) (http://www.nrw.qld.gov.au/water/monitoring/current_data/map_qld.php). Further significant reductions are expected. The Bureau of Meteorology records reaffirm this and show the intensity of drought and extreme rainfall events is also increasing rapidly. The intensity of cyclones is also changing (greater frequency of category four and five) and this is expected to increase.

The range of changes occurring and those projected, indicate the degree to which societies will need to mitigate against climate change. Of note is that all of these projections listed above assume some level of greenhouse gas emissions reduction and not 'business as usual'.

Table 1. Projected changes in climate for the Great Barrier Reef for 2020 and 2050.
(adapted from *Climate change and the Great Barrier Reef: a vulnerability assessment*)

Projected change	2020	**2050**
Air temperature*	+0.6 to +1.4°C	**+0.9 to +2.6°C**
Sea surface temperature*	+0.5°C	**+1.1 to +1.2°C**
Sea level rise*	+7 to +38cm	**+13 to +68cm**
Rainfall	– Reduction in total rainfall – Increase in intensity of droughts – Increase in intensity of high rainfall events	
Tropical cyclones	– Intensity of tropical cyclones expected to increase	

* relative to 1961-1990 average

Figure 3. Photo A shows a healthy, brightly coloured coral reef before mass bleaching. Photo B is a reef on the Great Barrier Reef that has bleached due to unusually hot sea temperatures. Most of the corals in photo C have died as a result of mass bleaching. The white corals in this photo are still alive, but all the others have died and are overgrown with seaweed-like algae (GBRMPA).

How will climate changes affect the Great Barrier Reef marine environment?

Climate change will have a significant impact on the Reef, including nutrient enrichment due to changes in rainfall, altered ocean circulation, sea level rise, and increased light levels - which will all impact on coral reefs. As storms become more frequent and severe, major physical damage will be inflicted on coral reefs. Higher water temperatures will cause mass coral bleaching and increase the incidence of coral diseases.

Increasing sea temperature is probably the single biggest risk factor for the Reef over the short to medium term (decades) because of its direct effect on corals. Unusually high sea temperatures are very stressful for corals, which have evolved to live at their upper temperature limit.

Corals rely on microscopic algae that live in their tissues to provide up to 90 per cent of their food requirements. These algae, called zooxanthellae, give corals their characteristically bright colours (Figure three, photo A). When the temperature becomes too hot, the relationship between the coral and its partner algae breaks down, and the coral ejects the algae. Without its zooxanthellae, the coral's white skeleton is clearly visible, which gives the appearance that the coral has been 'bleached' (Figure three, photo B). Bleached corals are still alive, and if the stressful temperatures fall soon enough, the coral can regain its zooxanthellae populations. In this case, corals will survive the bleaching event, but can suffer side effects, such as slower growth, lower rates of reproduction, and increased risk of disease. If unusually hot temperatures persist, corals are likely to die (Figure three, photo C). Coral reefs that experience high levels of mortality typically take years to decades to recover.

The Reef has experienced three significant coral bleaching events in the last decade.

Following sea temperatures of 1 to 1.5°C above the long-term average, more than 50 per cent of the reefs were affected by bleaching in 1998 and more than 60 per cent were affected in 2002. Fortunately, temperatures cooled soon enough to avoid catastrophic impacts, yet approximately five per cent of reefs suffered long-term damage in each year.

In 2006, the Reef again experienced unusually hot temperatures, but only in the southern region. Persistently high temperatures of 1 to 2ºC above long-term averages over reefs offshore from Rockhampton caused over 40 per cent of corals to die in that area. Projections for future warming in the Reef mean the frequency and severity of mass coral bleaching events is likely to increase, causing losses in the abundance and diversity of organisms currently associated with coral reef ecosystems (Figure 4). A future increase of 2°C in the average sea temperature will lead to annual bleaching affecting up to 97 per cent of reefs and almost certain large-scale mortality.

Although increased sea temperature is the most concerning climate change impact in the short term, changing ocean chemistry, known as ocean acidification, is likely to be the most significant threat to the Reef by the later part of this century.

Ocean acidification is caused by the absorption of atmospheric carbon dioxide by the ocean. This causes the pH of the oceans to decrease, which in turn has profound effects on the ability of corals, calcifying algae, plankton and shell-building organisms such as crabs and molluscs to build their calcium carbonate skeletons.

Ocean acidification is predicted to lead to an erosion of reefs, to increase corals' susceptibility to bleaching, and to affect the olfactory discrimination and ability of marine fish to find their home reefs, caused by impacts on their ear bone structure.

From a pre-industrial pH of 8.2, it is predicted the ocean's pH could fall to 7.8 by 2100. This would be associated with a 48 per cent reduction in the concentration of dissolved carbonate ions, the chemical component used by many marine organisms to make calcium carbonate shells. Recent research results show ocean acidification is already affecting calcification of key reef-building species in the Reef.

Change is expected to have far-reaching impacts on many animals that are part of the Reef ecosystem. The inter-dependency of life on reefs means loss of coral reef areas will have serious implications on a wide range of animals that rely on coral reefs for food and protection, such as fish, crustaceans, and molluscs. Fish, shark and ray populations will also suffer from reductions in reef habitat and will decline in abundance and diversity. Changes in temperature and habitat are likely to have substantial impacts on fisheries. Changes in ocean currents may cause shifts in marine mammal migration patterns. Marine turtles and seabirds may also face declines as a result of higher temperatures and sea level rise (Figure 5).

Climate change will also affect landscapes and habitats such as mangroves and islands. Mangroves will be affected by sea level rise, while islands and cays may experience changes to their vegetation, increased soil salinity, lowered water tables, cyclone damage, or even permanent loss in the case of low-lying coral cays.

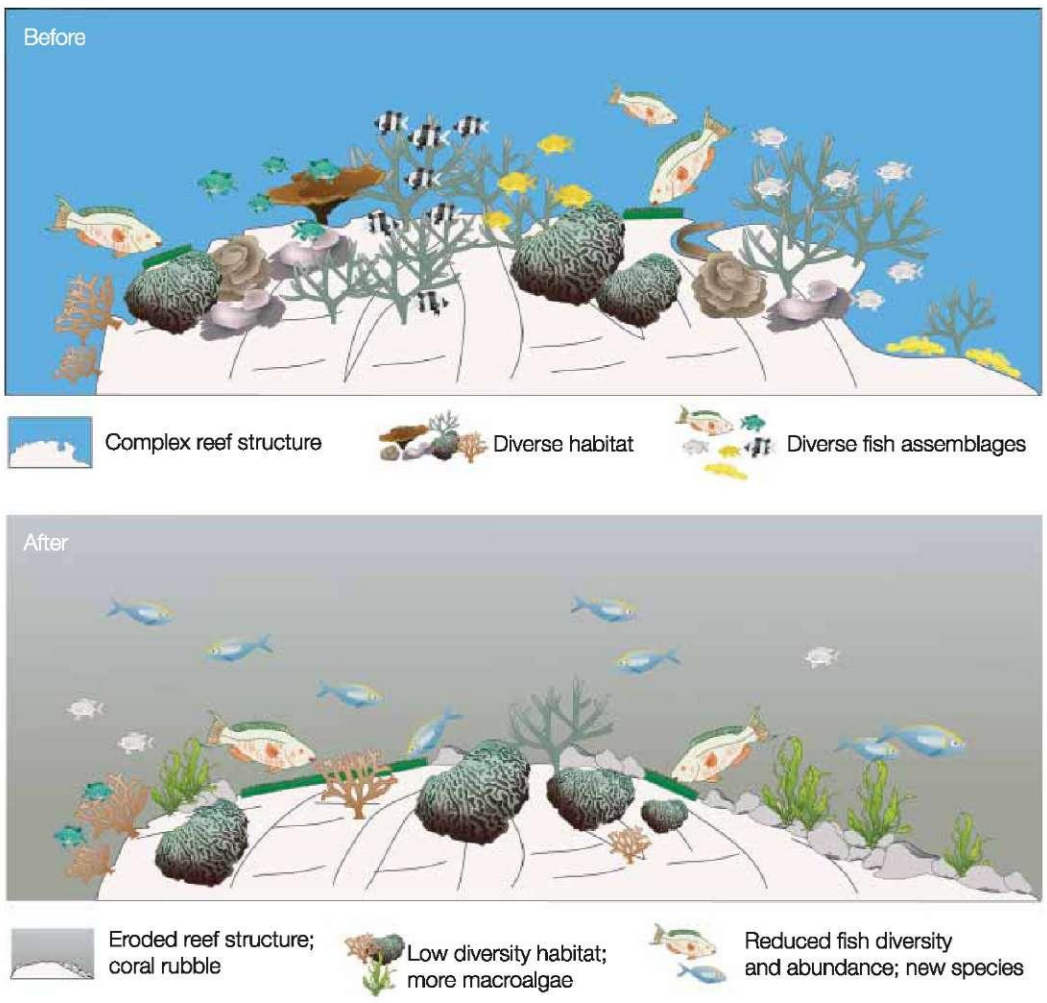


Figure 4. Transition of a coral reef environment due to climate change. Existing concentrations of greenhouse gases mean that some change in the Reef is inevitable. The extent of change will depend on the rate and severity of climate change as well as the resilience of the Reef ecosystem. Under a worst-case climate scenario, coral reefs will change from high diversity, complex ecosystems (before) to low diversity systems dominated by seaweeds, herbivorous fish, and rubble (after) (GBRMPA Climate Change Action Plan).

Figure 5. Climate change impacts are already being observed in marine turtles and seabirds. The gender of marine turtles is determined primarily by incubation temperature experienced by their eggs, and higher temperatures increase the proportion of females. Temperatures that are too high can lead to complete nest failure, which occurred on the Great Barrier Reef in 2005 when the temperature was 1.1°C above normal. Sea level rise of 38 cm will flood important turtle nesting beaches. If coastal development limits the availability of alternative nesting beaches, turtle populations could decline significantly (Hamann, Limpus, & Read, 2007). Seabirds are also vulnerable to temperature changes. Mass mortalities of seabird chicks have been observed for wedge-tailed shearwater, sooty tern and black noddy seabirds in the Great Barrier Reef during unusually warm summers. It appears that warmer seas and changing circulation patterns affect the location and depth of cool water bodies preferred by the fish that seabirds eat. As a result, seabirds appear unable to feed their chicks (Congdon & O'Neil, 2007).

3.4 Climate change impacts on the Reef marine tourism industry

The Reef marine tourism industry depends on the health of the Reef. A healthy and resilient reef system has the best chance of coping with stresses and pressures, such as higher sea temperatures which lead to coral bleaching. A resilient reef is more likely to bounce back and adapt to change, resulting in more sustainable tourism businesses, especially those reliant on high quality reefs to market their products.

Changes to the natural environment will have serious implications for Reef-based tourism. Climate change will affect operators both directly, through changes in weather patterns, and indirectly, through changes in the Reef ecosystem (Table 2).

Weather

Climate change will impact the liveability and lifestyle available to residents and tourists in the Reef region. Weather is a key factor in determining visitor satisfaction for their trip to the Marine Park. It can negatively impact the enjoyment of tourists through increased likelihood of sea sickness and reduced visibility for sightseeing, snorkelling and diving.

Windy, stormy weather also has a direct affect on reducing the number of days that operators travel to the Reef and will impact trip scheduling. Weather will force adaptation strategies such as investment in boats capable of travelling the distances in rough, exposed seas, such as those off Cairns. Other operators will have to find alternate sites as travel days to unprotected outer reefs may be reduced. Sail boat operators, such as those in the Whitsunday region, will be impacted by reduced visitation due to an increase in the number of days with strong winds and rough seas.

Tourists may alter their destination choices to avoid uncomfortably hot climates, or the risk of being infected by tropical diseases. Tourism and community infrastructure will be affected by changes in demand for energy, availability of water and changing land values. Designs for hotels and visitor centres that create shade and cool buildings will be increasingly important in the hotter times ahead.

More severe storms and sea-level rise will put waterfront and coastal infrastructure at risk, including marinas, jetties, boat ramps, roads, restaurants, accommodation, and other buildings. These increased risks to infrastructure will cause corresponding increases in the cost of insurances.

Tourism Queensland

Ecosystem changes

The major and more immediate climate change risk for marine tourism on the Reef is the effect on the marine ecosystem.

Declining coral reef condition and changes in the abundance and location of fish, marine mammals and other iconic species are likely to have the greatest impact on the industry, especially in the Cairns area which has less island experience alternatives. Research conducted on live-aboard vessels in the Reef indeed found the environmental attributes most valued by divers are: 'amazing corals', diversity of marine life (particularly fish), good visibility, opportunity to interact with large marine mammals, and interesting topography (Miller, 2006).

Most of these attributes will be negatively affected by climate change, meaning the Reef may lose some of its marketing appeal as a high quality reef destination. However, the economic strength of the Reef marine tourism industry is related to a broad range of influences and declining reef health may not necessarily translate directly into declining tourist numbers.

While climate change will negatively impact important environmental attributes of the Reef, coral reefs throughout the world will also be degraded, meaning that, on an international level, visitor expectations are likely to decline. Through continued good management, the Reef could still remain one of the world's best tourism destinations despite a decline in condition from today's standards.

An analysis by Cater (2004) demonstrated that in the past, visitation rates to the Reef were more influenced by large scale economic and social events, such as the Asian economic decline, than by the incidence of mass bleaching. Finally, small areas of well-conserved reefs may allow tourism activities to continue when widespread areas have deteriorated beyond recovery.

Given these uncertainties, the Reef marine tourism industry will be best positioned to create a positive future by taking steps now to understand possible scenarios, adapt business strategies, reduce greenhouse gas emissions and support the resilience of the Reef to climate change.

Table 2. Reef tourism activities that may be negatively impacted by anticipated climate-induced changes.

Tourism activity \ Anticipated climate-induced changes	Sample changes in the Reef ecosystem							Sample changes in the weather						$
	Less coral cover and less coral diversity	Reduced fish diversity and abundance	Fewer sharks and rays	Changes to marine mammal migrations	Reduced seabird populations	Reduced marine turtle populations	Increased water and insect borne diseases	Increased severity and frequencies of storms	Higher sea level	More frequent flooding	More frequent droughts	Higher air temperatures	More frequently higher wind speeds	Higher insurance costs
Bareboating	■	■		■	■		■	■	■	■	■	■	■	■
Bird watching		■			■		■	■	■	■	■	■	■	■
Camping	■					■	■	■	■	■	■	■	■	■
Charter boating including Pontoons	■	■	■	■		■	■	■	■	■	■	■	■	■
Cruise ships	■	■					■	■	■	■	■	■	■	■
Diving	■	■	■	■		■	■	■	■	■	■		■	■
Fishing	■	■					■	■	■	■	■	■	■	■
Island and cay visits	■	■			■	■	■	■	■	■	■	■	■	■
Motorised water sports							■	■	■	■	■		■	■
Opportunities to interact with marine mammals eg swim with minke whales				■			■	■	■	■	■		■	■
Opportunities to interact with turtles						■	■	■	■	■	■		■	■
Snorkelling	■	■	■	■		■	■	■	■	■	■		■	■
Whale and dolphin watching		■		■			■	■	■	■	■	■	■	■

*Note: the degree of impact is not differentiated in the table and varies across both activity and impact type.

3.5 Crafting a response

The Reef marine tourism industry can take meaningful actions to respond to climate change.

First, businesses need to adapt to climate change. The ability to adapt to challenges has long been a key strength of the tourism industry. The industry has made it through challenges such as the Ansett Airline collapse, SARS, threats of avian flu, and the 9/11 terrorist attacks. These and other events have shown the resilience of the industry and its ability to reinvent itself in the face of difficult conditions.

The challenges of climate change will require the tourism industry to exhibit this same adaptive capacity. Effective management responses will reduce the impacts of climate change, but some level of impact is unavoidable. The tourism industry will need to adapt to these changes to be successful into the future. This Strategy focuses on building industry resilience and viability by providing realistic strategies for adaptation.

Raising awareness of the impacts of climate change is the focus of Objective one. This includes awareness among tourism operators, visitors, and government agencies and industry partners.

The second meaningful climate change response that Reef marine tourism operators can take is engaging in measures that reduce greenhouse gas emissions, particularly from transportation and accommodation (Objective two).

Climate change is a significant challenge for Reef marine tourism. Adapting to these new conditions to create a positive future will require additional research and monitoring (Objective three) and resources. However, there are straight-forward actions that tourism operators can take today in response to climate change (Section four).

Environmental management of the Reef also needs to adapt to reflect the additional threat of climate change. Although the Reef is one of the best managed coral reefs in the world, climate change poses a significant new threat to the ecosystem.

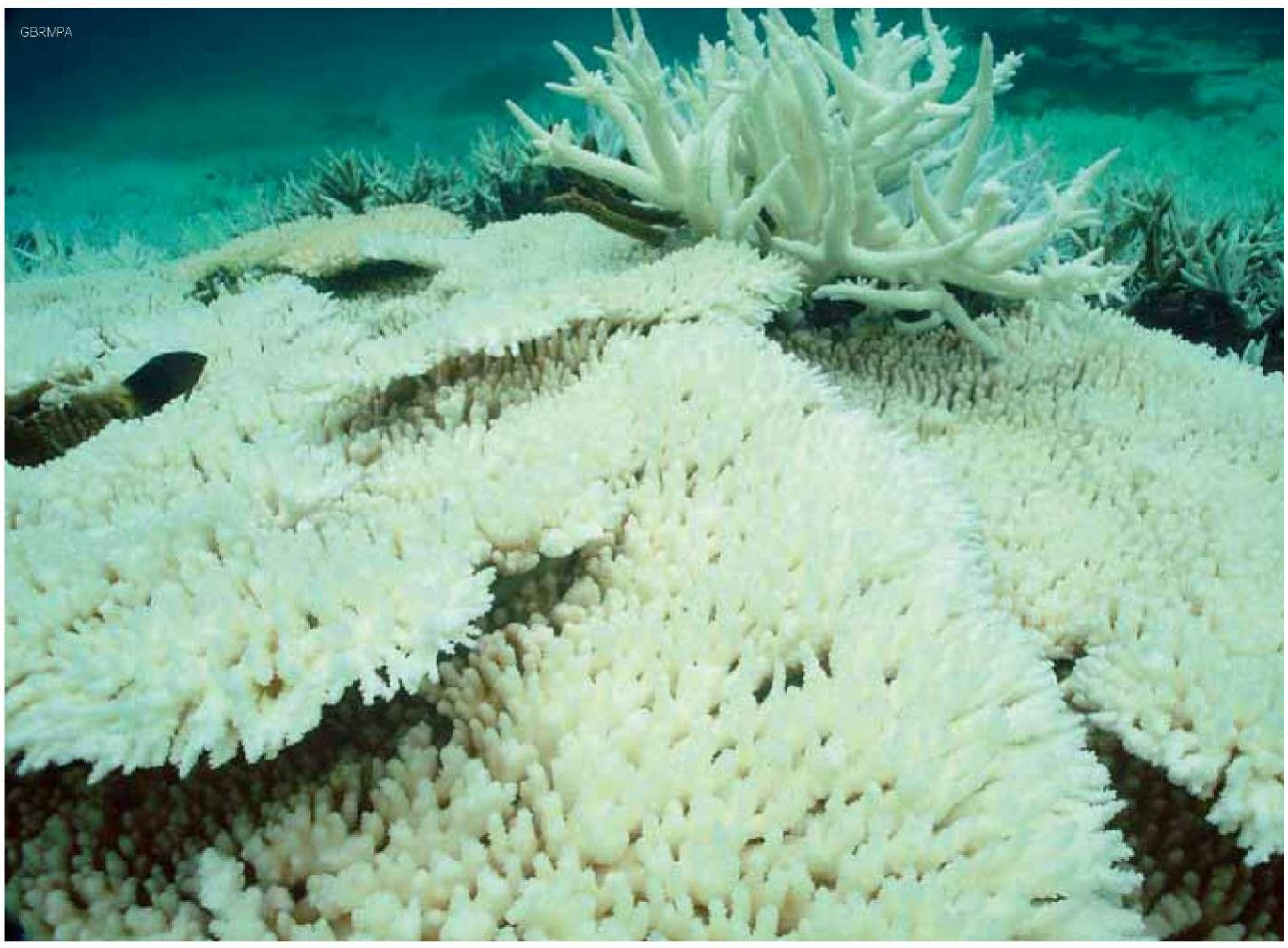
Management must now shift from actions to maintain coral reef condition as it exists today, to actions that can build a more resilient ecosystem that maximises the potential for the reef ecosystem to recover from the inevitable decline that climate change is causing. Factors that will most help the Reef to be resilient to climate change are biological diversity, good water quality, high coral cover, and strong herbivorous (plant-eating) fish populations. The Reef Water Quality Protection Plan (2003) and the rezoning of the Great Barrier Reef in 2003 to protect representative areas of the ecosystem are essential steps for supporting resilience, and protected area managers as well as operators can take additional steps to enhance the resilience of the Reef (Objective four).


Tourism Queensland

Strategies for the Reef marine tourism industry to adapt to climate change are discussed in Objective five. Marine tourism operators can implement steps to maintain or enhance visitor satisfaction despite inevitable declines in Reef condition. This can be achieved by improving services, facilities and amenities (such as using more suitable boats and using new technologies which reduce impact on the environment), building appropriate business plans and risk mitigation strategies, and undertaking actions to maintain industry viability in the face of a climate change future. Tourism operators can diversify the activities they offer and use marketing strategies that help maintain the Reef as a competitive tourism destination.

Additionally, tourism operators can plan for altered weather patterns, including more frequent incidents of severe storms, to minimise economic losses from trip cancellations, rising insurance costs, damage to infrastructure and the potential expense of additional safety measures.

Objective six focuses on actions intended to influence and facilitate change. Actions include working with governments to ensure climate change is reflected in plans and budgets and by identifying incentives to help operators take action on climate change through the collegiate development of the necessary policy and institutional settings. This objective is targeted toward the provision of planning certainty for business.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4.0 How tourism operators can make a difference

The Great Barrier Reef tourism industry is uniquely positioned to deliver powerful action on climate change both on and off the Reef.

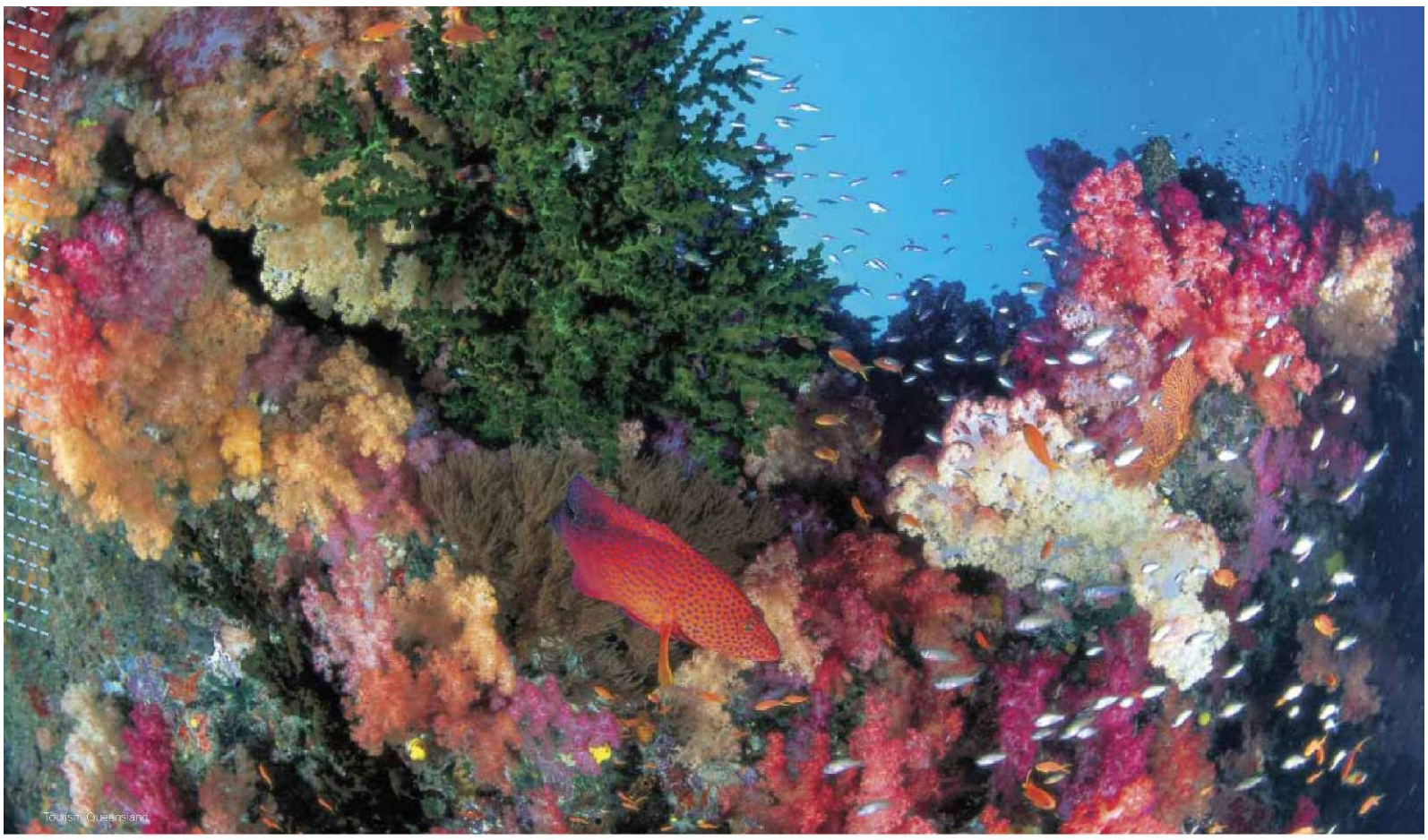
These actions will benefit both the Reef and individual operators. The greatest immediate impact comes from reducing greenhouse gas emissions from transportation and accommodation and developing and implementing adaptation strategies.

Operators also play a key role to positively influence consumer behaviour both on their holidays and at home by providing education and increasing awareness about climate change to visitors and encouraging them to reduce their carbon footprints as well.

There are also actions that help build Reef resilience generally, such as advocating on water quality and coastal development issues and introducing practices such as green purchasing.

Raise awareness

1. Engage tourists in understanding how climate change is impacting coral reef ecosystems locally and globally, and act as a change agent on climate change by encouraging visitors to take action at home. (Action 1.2.1)
2. Talk to government representatives, colleagues and friends about climate change. Let them know it's already affecting business and promote the benefits of taking positive actions to implement adaptation and mitigation strategies. (Strategy 1.3)
3. Become engaged in the GBRMPA and community-based activities that address water quality and other issues that impact reef resilience.



Reduce the operation's carbon footprint and improve energy efficiency

4. Become certified as an EcoCertified and Climate Action Certified operator. High Standard Operators in the Marine Park are eligible for incentives such as 15 year permits. (Action 2.1.2)
5. Use the Tourism Operator's Emissions Calculator available on the GBRMPA's website to calculate the operation's overall carbon footprint. Reduce greenhouse gas emissions as much as possible and then offset any remaining emissions by purchasing carbon credits, using local offset programs where possible. (Action 2.1.1)
6. Be fuel-efficient when running vessel engines, use alternative fuel sources such as biodiesel and ethanol, and order new vessels and retrofit old vessels with more fuel efficient engines. (Action 5.2.1)
7. Minimise the energy used and the waste generated by tourism operations and offices. Recycle, buy 'green power' and reduce business-related travel to cut emissions. (Action 2.1.3)
8. Assist clients in offsetting greenhouse gas emissions caused by their travel and accommodation, using local offset programs where possible. (Action 2.2.2)
9. Educate clients on actions they can take to reduce their greenhouse gas emissions at home. (Action 1.2.1)
10. Partner with 'green' businesses that are actively taking steps to minimise greenhouse gas emissions (Action 2.1.3), water pollution (Strategy 4), and other environmental impacts.

Monitor and report changes

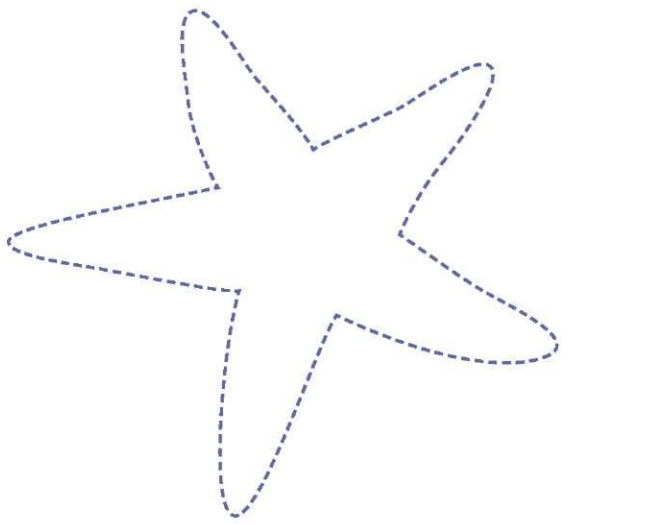
11. Understand what is happening at the sites you visit by participating in the GBRMPA's management and partnership initiatives such as Eye on the Reef, Sightings Network and BleachWatch to provide reliable reports about coral bleaching and reef condition. (Action 3.2.1)
12. Support existing research on climate change by hosting scientific researchers on your vessels who are working with managing agencies and by distributing visitor satisfaction surveys to your passengers.

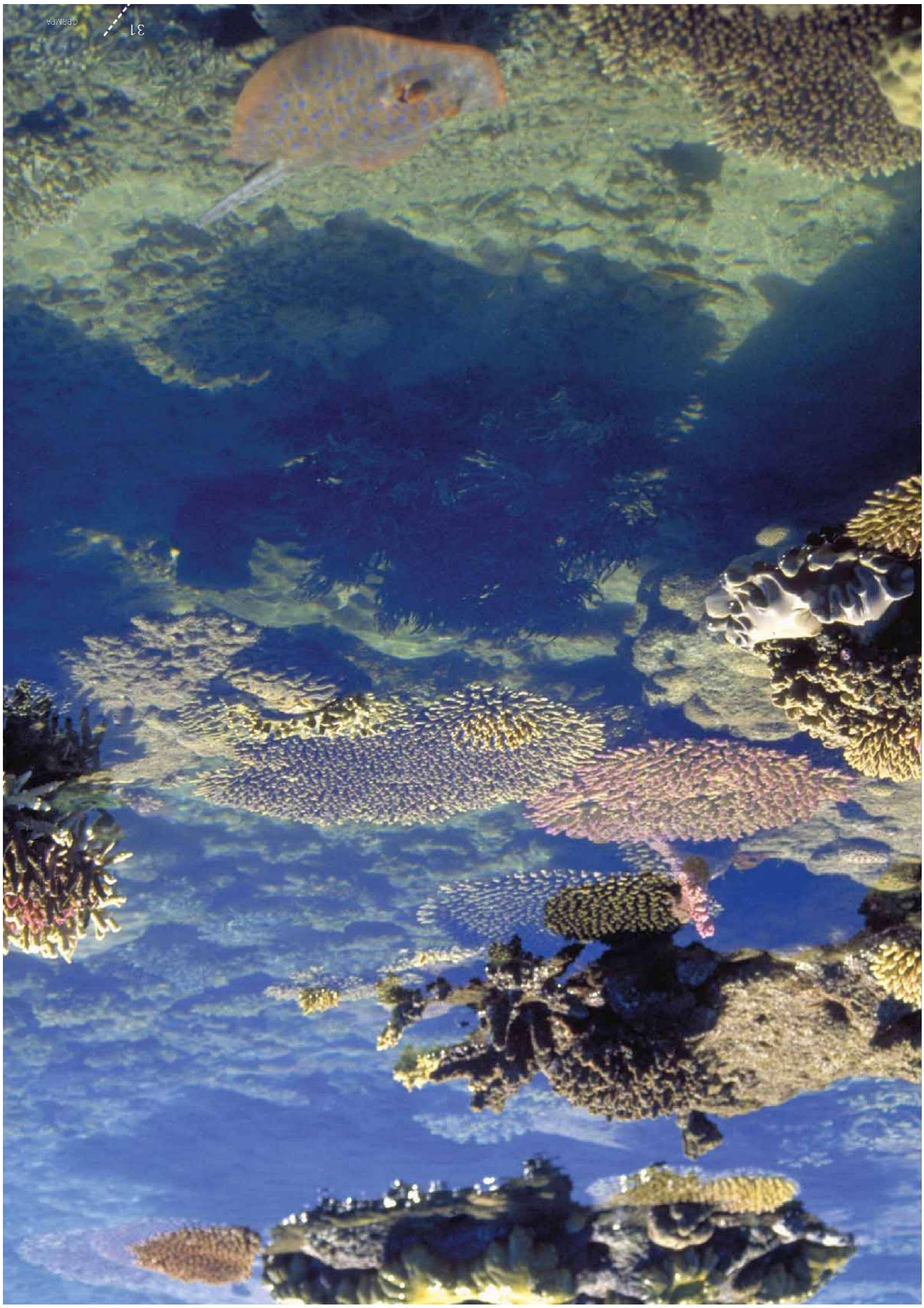
Improve the resilience of the reef

13. Minimise coral damage from anchors, divers and vessel groundings so existing coral cover is more resistant to the effects of climate change. Facilitate responsible use of public and private moorings. (Action 4.1.1 and 4.1.2)
14. Embrace the improvement of water quality as a tourism issue! Become actively engaged in community programs aimed at improving water quality, and make sure waste and wastewater are disposed of appropriately. (Action 4.2.1)
15. Work with TCCAG to become engaged in implementing this Strategy.

Integrate climate change into business operations and planning

16. Maintain visitor satisfaction with Great Barrier Reef tourism experiences by improving amenities. Changes may aim to reduce discomfort resulting from climate change, such as more stable boats, or to increase visitor comfort and customer service more generally. (Actions 3.1.2 and 5.2.2)
17. Integrate climate change adaptation into business planning by diversifying tourism activities. Diversification might involve a shift in products, destinations, marketing strategies or logistical operations. (Action 5.2.2)
18. Plan for extreme events by developing risk management plans to assist in preparing for and responding to significant events, such as mass coral bleaching. (Action 5.1.2)

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5.0 Taking action

Forty-nine actions, sitting under six objectives, provide the framework for mobilising the Great Barrier Reef tourism industry and its stakeholders on climate change. The Great Barrier Reef TCCAG members have committed to undertaking individual action under these six objectives to achieve this Strategy's vision.

An implementation document will be used to record and facilitate actions, guide responsibility for tasks and coordinate partnerships for specific activities outlined in this Strategy.

Objective 1.

Raise awareness about climate change impacts to the Great Barrier Reef

This objective aims to raise awareness about climate change among key constituencies: tourism operators (Strategy 1.1), tourists (Strategy 1.2) and the government (Strategy 1.3). Raising awareness among operators is essential to effectively implement this Strategy. Tourism operators must take action to reduce the impacts and implement response options related to climate change. Raising awareness among tourists will not only empower them to take action about climate change, but it is also good for business. The GBRMPA's High Standard Tourism Program will be integrating climate change action into the standards for the program, leading to the target of having increasing number of visitors travelling with these certified operators.

Effective interpretation about climate change impacts will assist in maintaining tourist satisfaction despite declines in reef condition. Ultimately, national and state governments in Australia have a critical role to play in reducing greenhouse gases, supporting industry adaptation to climate change, and enhancing the resilience of the Great Barrier Reef ecosystem. Engaging government and industry partners toward achieving these results is an important goal of this Strategy.


Tourism Queensland

Strategy 1.1. Raise the awareness of Reef marine tourism operators about climate change		
Action	1.1.1	**Continue the Great Barrier Reef Tourism Climate Change Action Group and disseminate relevant information through industry channels.** This includes convening at least two meetings a year and updating the implementation document.
	1.1.2	**Hold a series of industry workshops.** Hold workshops in regions along the Reef presenting information about the potential impacts of climate change, risks to the Reef marine tourism industry, and opportunities for operators to respond. These workshops will provide information identified in Action 5.1.2.
	1.1.3	**Highlight success stories**. Develop fact sheets and case studies on best practices in reducing carbon emissions and adapting to climate change. Create a business case for the change required to raise awareness and interest. The development of an International Reef Dive Site Ratings System will provide an opportunity to showcase operators committed to stewardship and improving resilience at their dive sites. The intention is to make these ratings public, leading to increased visitation based on the quality of dive site and its rating in the scheme (see Action 1.2.2).
	1.1.4	**Train staff**. Implement the GBRMPA's Tourism Staff Training Course to provide operators with information about climate change impacts, industry responses and the importance of individual actions in supporting a climate change response.
	1.1.5	**Survey tourism operators**. Undertake a survey of operators to assess the level of knowledge held by operators, identify further information requirements operators have in relation to climate change, assess the information they have been provided by the GBRMPA for accessibility and usability, and to identify willing participants for upcoming climate change pilot programs. This survey will enable a baseline for future measurement of the effectiveness of initiatives.

	1.1.6	**Integrate action being taken on climate change into the High Standard Tourism Program.** High Standard Operations are those operations that are ecologically sustainable and are helping to protect and present the Marine Park to a consistently high standard. The Great Barrier Reef Marine Park Authority relies on independent certification to identify these operations and recognises the Eco Certification Program operated by Ecotourism Australia as a certification scheme for the Marine Park, at the Ecotourism and Advanced Ecotourism levels of certification. Align Ecotourism Australia's Climate Action Certification with the High Standard Tourism Program.

Strategy 1.2. Raise the awareness of visitors		
Action	1.2.1	**Support the development of material to assist operators in the provision of high quality interpretive material related to climate change.** The distribution of *Reef Facts for Tour Guides* (Climate Change Edition) will provide tour guides with simple facts they can share with tourists to increase their understanding of climate change, its impacts on the Reef, and what they can do to help.
	1.2.2	**Support the development of an International Reef Dive Site Rating System.** This system will provide for the independent rating of dive sites around the world against predetermined criteria including factors such as environmental management and action taken on climate change. This system will provide a tool to showcase the dive sites of the Reef and their relative competitiveness in terms of quality of experience to other dive sites around the world.

Strategy 1.3. Raise the awareness of government agencies and tourism industry partners		
Action	1.3.1	**Highlight the socio-economic benefits of responding to climate change.** Develop a partnership between the communications staff of industry and related government agencies to implement a communications strategy that effectively conveys the socio-economic implications of climate change on tourism.
	1.3.2	**Work with other tourism industry organisations to raise climate change as a key policy issue**. Collaborate with other industry associations that are engaged in climate change, such as the Australian Ski Areas Association and Ecotourism Australia, to establish a unified voice in working with government on climate change policies.
	1.3.3	**Raise awareness in local communities.** Develop a communications strategy to deliver climate change messages in tourism-based communities along the Reef. Involve partners such as resorts, operators, councils, DERM, and tourism industry associations. This action links to Actions 1.1.2 and 6.1.3.


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Objective 2.

Reduce carbon footprints

The rate and severity of global climate change has significant consequences for the future of the Reef and the marine tourism industry that relies on it. The strategies for adapting business and environmental management can be considered ways of 'buying time' while actions aimed at mitigating climate change can take effect.

However this needs to be paralleled with significant commitment world-wide to reduce greenhouse gas emissions and our marine tourism industry needs to play its part. Without this commitment, the consequences and impacts of climate change will be too severe to withstand in the medium to long term.

In addition to working with governments to implement policies that can mitigate climate change (Strategy 1.3), the marine tourism industry can take direct action to mitigate climate change in three ways. First, it can reduce or offset emissions generated by its own operations (Action 2.1.1). Secondly, it can encourage other tourism businesses to limit their greenhouse gases by preferentially partnering with 'green' businesses in developing tourism packages (Action 2.1.2). Third, the industry can offset the greenhouse gas emissions associated with their operations and the emissions generated through tourist travel (Strategy 2.2).

Strategy 2.1. Audit and reduce operational greenhouse gas emissions		
Action	2.1.1	**Calculate and reduce operator emissions**. Support operators to use the Tourism Operator's Emissions Calculator developed by the GBRMPA. This calculator provides a user-friendly tool for operators to calculate and monitor their emissions over time and provides advice on ways to reduce their emissions.
	2.1.2	**Support operators to become certified** through accredited programs such as Ecotourism Australia's Climate Action Certification Program. This scheme provides operators with a framework and information to assist them in adopting best practice on climate change action, including areas such as reducing emissions in business operations and across supply chains, carbon offsetting, and risk assessment and adaptation. This action will be implemented by individual operators, taking advantage of support and incentives (6.1.3) offered by government and industry association partners.
	2.1.3	Where possible, **partner with 'climate friendly' businesses and practice green purchasing**. Reef marine tourism relies on a host of related tourism businesses to provide visitors with a positive experience. Many of the environmental impacts from Reef tourism are associated with these related businesses, such as accommodation and travel agents. By preferentially partnering with tourism businesses that are actively taking steps to minimise greenhouse gases, water pollution (4.2.4) and other environmental impacts, individual operators are creating incentives that will improve environmental practices across the industry.

Strategy 2.2. Offset emissions		
Action	2.2.1	**Identify regional 'reef friendly' options for offsetting greenhouse gas emissions**. Most tourist greenhouse gas emissions result from transportation and accommodation. A number of organisations have now created programs to help calculate and offset emissions. This action will identify suitable carbon offsetting programs that will benefit the North Queensland region by investing carbon credits in an accountable manner that delivers social and multiple environmental dividends. For example, supporting local programs that revegetate Reef catchments will provide benefits of improved Reef health and water quality leading to increased Reef resilience in the face of climate change.
	2.2.2	**Assist visitors in offsetting greenhouse gas emissions caused by travel**. Through this action Reef marine tourism operators will assist tourists in offsetting their emissions by offering options to offset their tour emissions.

Objective 3.

Support climate change monitoring, reporting and research

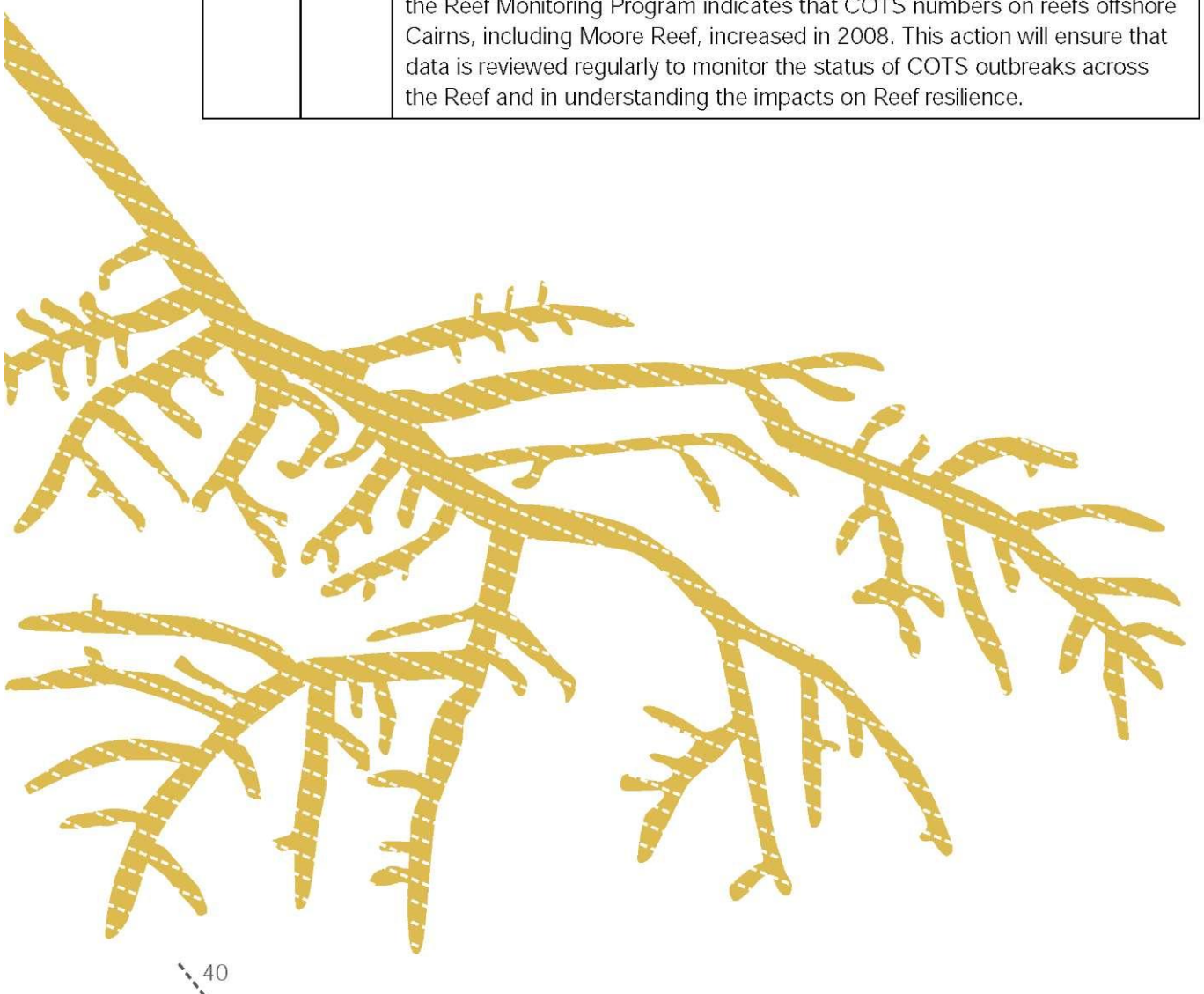
While the general implications of climate change on Reef marine tourism are known (Section 3), incorporating climate change considerations into business planning, environmental management, and infrastructure decisions requires additional, locally-specific information at useful time scales.

The first strategy under this objective articulates a research and monitoring agenda that will generate critical information to support climate change mitigation and adaptation. The second strategy is to participate in the GBRMPA's industry partnership programs Eye on the Reef, Sightings Network and BleachWatch. This objective relies on community volunteers and tourism staff to supplement observations by scientists. This information is used to better understand how to support resilience of the Reef and to identify and respond to bleaching events.

Strategy 3.1. Support research that fosters understanding of climate change and its impacts		
Action	3.1.1	**Understand how climate change will affect the Reef environment**. A comprehensive vulnerability assessment to understand how climate change will affect the Reef ecosystem has been published (Johnson, J., and Marshall, P., 2007). The next step is to identify easily translatable scenarios about how climate change will affect relevant attributes of the Reef environment at local to regional scales over timeframes relevant to business planning. Environmental attributes of interest include: changes in coral reef condition; changes in shark and fish abundance, size, and diversity; changes in wildlife migration patterns; changes in sea-level; changes in storm frequency and intensity; and changes in weather (eg, temperature, rain patterns, etc).
	3.1.2	**Understand how climate change will affect visitor choices**. Facilitate and disseminate research on how changes in ecosystem and weather conditions will influence visitor choices, in order to inform the risk assessment described in Action 5.1.2. This research should identify best and worst-case scenarios about how climate change will affect relevant sectors of the marine tourism industry at timeframes that are relevant to business planning. It is envisioned that this research will analyse, at a minimum, expected changes in tourist perception, experience, and choice resulting from: – Deteriorating coral reef condition, specifically lower coral cover and less diversity (the analysis should incorporate the expectation that reefs around the world will deteriorate as a result of climate change and that the Reef may remain relatively desirable, even in a condition that is degraded by historical standards). – Reductions in shark and fish abundance, size, and diversity as it relates to snorkelling, diving and recreational fishing. – Less comfortable weather. – Increased unpredictability of weather, including increasing storm frequency and intensity during some times of year. – Increased awareness of air travel contributions to greenhouse gas emissions and a concurrent choice by some travellers to holiday closer to home.

	3.1.3	**Understand future trends in marine tourism**. Compile information and undertake analysis of the economic drivers of the key tourism trends in tourist patterns, flows, and destination choices as necessary to inform the risk assessment described in Action 5.1.2. This may include work with the Productivity Commission. As practicable, this research should identify new opportunities for Reef marine tourism that may result from anticipated changes in global climate and broader economic and social trends.
	3.1.4	**Model the economic drivers of marine tourism and the impacts of climate change**. Work with partners to model the economic risk that climate change poses to various sectors of the marine tourism industry. Model predictions will be most useful to the extent they match the timeframes used in business planning (0-5, 5-15, and 15+ years). It is envisioned the model will incorporate best available information about environmental change, visitor responses to that change, forecast tourist patterns and flows, and climate-related costs to the marine tourism industry (eg, rising insurance costs; increased safety costs/risk; cancellations due to bad weather or deteriorating environmental amenity; damage to tourism-related infrastructure).
	3.1.5	**Learn from other reef regions already affected by mass coral bleaching.** Compare the adaptation responses of marine tourism businesses from other reef regions affected by high levels of coral mortality from mass bleaching and other causes to assist in guiding adaptation options in the Reef.
	3.1.6	**Experiment with techniques to prevent coral bleaching at high value sites.** Although strategies to prevent mass coral bleaching by shading or cooling reefs are impractical at large, ecosystem-level scales, these methods may hold some promise for protecting small, high-value tourism sites. This action will work with partners to experiment with potential techniques, such as shade cloth or sprinklers. It will also work with partners to provide a synthesis of scientific information relevant to making decisions about techniques for site enhancement.

Strategy 3.2. Support Reef monitoring and reporting programs		
Action	3.2.1	**Participate in the GBRMPA's Eye on the Reef, Sightings Network, and Marine Water Quality Monitoring programs**. The Eye on the Reef Monitoring Program is an environmental monitoring, education and stewardship partnership between the GBRMPA, the marine tourism industry, and the Reef research community. In 2009, there are thirty-five tourism operators monitoring forty-two sites along the Marine Park stretching from Hamilton Island to Osprey Reef. Through this partnership, long term data is collected on Reef health indicators, iconic and protected species, and emerging issues, such as climate change impact.
	3.2.2	**Participate in BleachWatch**. Tourism operators, tourists, and local community members can support resilience of the Reef by participating in GBRMPA's BleachWatch program. BleachWatch is a community-based monitoring program that has been designed to provide reliable reports about bleaching and reef condition from a wide range of reef sites throughout the Reef. BleachWatch is built on a network of Reef users, including tourism professionals, who voluntarily monitor and report on conditions at reefs that they visit regularly. Incidental reports by tourists or community members are important and can be submitted via the online form. This information is used to help detect the early signs of mass bleaching and to help understand the Reef's resilience to climate change.
	3.2.3	**Participate in Crown-of-thorns Starfish (COTS) Watch**. Ongoing monitoring of tourism reef sites by tourism operators as part of the Eye on the Reef Monitoring Program indicates that COTS numbers on reefs offshore Cairns, including Moore Reef, increased in 2008. This action will ensure that data is reviewed regularly to monitor the status of COTS outbreaks across the Reef and in understanding the impacts on Reef resilience.



Objective 4.

Improve the resilience of the Great Barrier Reef

The resilience of the Reef marine ecosystem to climate change is critical in determining its future and the future of the tourism industry that relies on it.

Managing for resilience recognises a process of change is underway andaims to support the ability of the environment to absorb shocks, regenerate, and reorganise. Rather than having a goal to maintain coral reef ecosystem condition as it is today, managing for resilience emphasises protecting the factors that promote survival and recovery from disturbance events in the future. For coral reef ecosystems, the most important factors to protect are biological diversity, good water quality, high coral cover and strong herbivorous (plant-eating) fish populations. This objective contains two strategies the marine tourism industry can implement to enhance the resilience of the Reef to climate change.

The first strategy aims to minimise physical impacts that can reduce coral cover. Maintaining high coral cover is a good strategy for supporting coral reef ecosystem resilience to climate change. Additionally, taking steps to prevent physical damage to reefs can help corals survive mass bleaching events. A coral stressed due to bleaching is likely to be less capable of recovering from physical injuries, and vice versa. The unusually warm temperatures that trigger coral bleaching events place substantial stress on coral colonies, even before there are any visible signs of bleaching. Once a coral is bleached, it is in a state of extreme stress, with reduced capacity for feeding, repairing injuries, and resisting diseases. Therefore, actions by marine tourism operators and recreational users to prevent physical damage from snorkelling, diving, boat anchoring, or vessel grounding are important steps toward supporting high coral cover and reef resilience.

A second strategy for supporting coral reef resilience is to enhance or maintain good water quality. Good water quality helps corals survive mass coral bleaching events and it helps reefs recover after high levels of coral mortality. Chronic water pollution negatively impacts coral health with the result that corals have lower immunity as they face stressful changes in climate, such as warmer temperatures. During mass bleaching events, acute increases in sediment and pollutants, associated with coastal development , dredging, antifouling and boat discharge, raise stress to corals and decrease the likelihood they will be able to survive the bleaching event. Additionally, the process of coral reproduction is particularly vulnerable to water pollution, and, if corals are unable to re-establish themselves, reefs that have experienced high coral mortality are unlikely to recover. For these reasons, actions to minimise chronic or acute water pollution will increase reef resilience.

The vast majority of tourism operators on the Reef conduct their operations in an environmentally responsible manner and subscribe to the Responsible Reef Practices outlined in the GBRMPA's 'Onboard' handbook for operators, but more needs to be done.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Strategy 4.1. Minimise physical impacts to the Reef		
Action	4.1.1	**Minimise coral damage from snorkelling, diving and anchoring.** Individual tourism operators will implement this action by following the Responsible Reef Practices for snorkelling, diving and anchoring outlined in the GBRMPA's 'Onboard' handbook for operators. More needs to be done to engage operators in undertaking these practices, and these practices need to be regularly reviewed to ensure they are current best practice.
	4.1.2	**Minimise vessel groundings**. Accidental vessel groundings on the Reef can cause substantial damage to coral cover in localised areas and increase the risk of an oil/fuel spill and/or the vessel sinking. Individual tourism operators will implement this action by following the Responsible Reef Practices for boating outlined in the GBRMPA's 'Onboard' handbook for operators and undertaking risk assessments and modifying operations in reference to the identified risks.
	4.1.3	**Take action on operators** not meeting minimum standards. Most tourism operators in the Marine Park are committed to adopting best practices and some are engaged in positive actions for tackling climate change and improving reef resilience. For those operators that are not meeting minimum standards, they need to be held accountable through appropriate enforcement action being taken. Ambiguities and anomalies identified in legislative and regulatory requirements will be raised for review. Operator workshops focussed on education in key compliance areas will continue to be undertaken.
	4.1.4	**Report marine incidents** such as pollution and Zoning Plan infringements, especially illegal fishing in Green Zones.

Strategy 4.2. Minimise negative impacts to water quality from daily operations or construction activities		
Action	4.2.1	**Be active in water quality issues by participating in community-based activities that aim to improve water quality in Reef catchments**. This action aims at getting tourism operators to see water quality as a significant issue affecting their livelihood and to participate in business-level actions and community-level activities aimed at improving water quality in their local catchments.
	4.2.2	**Minimise water pollution from boating and pontoons**. Individual tourism operators will implement this action by following the Responsible Reef Practices for wastewater outlined in the GBRMPA's 'Onboard' handbook for operators and by continuing to be accountable through legislation, permits and Environmental Management Plans.
	4.2.3	**Assess best practices and facilities for wastewater management in light of climate change**. The GBRMPA will work with partners to review existing policies and facilities in light of climate change. Special attention will be given to evaluating the availability of pump-out stations for large vessels.
	4.2.4	**Minimise water pollution from tourism-related construction**. Coastal construction is regulated by government agencies in and adjacent to the Reef to minimise impacts to water quality. TCCAG partners will collaborate with partners to review existing permitting guidelines in light of climate change.
	4.2.5	**Partner with businesses that minimise water pollution**. Marine tourism relies on a host of related tourism businesses to provide visitors with a positive experience. Many of the environmental impacts from Reef tourism are associated with these related businesses, such as accommodation. By preferentially partnering with responsible tourism businesses that are actively taking steps to minimise water pollution, greenhouse gases and other environmental impacts, individual operators are creating incentives that will improve environmental practices across the industry.

Objective 5.

Integrate climate change into business operations & planning

This objective outlines four strategies for adapting the Reef marine tourism industry to climate change.

The first strategy involves developing risk management plans and integrating climate change into business planning and daily business operations. Developing thoughtful approaches for dealing with new weather patterns, including increased wind speeds and more frequent occurrences of severe storms, will assist in minimising economic losses from trip cancellations, rising insurance costs, damage to infrastructure and the potential expense of additional safety measures as well as considering tourist comfort, health and wellbeing.

The second and third strategies are aimed at identifying approaches to mitigate the impacts of climate change and assisting tourism operators in maintaining economic viability despite declines in Reef condition. Operators can implement actions to maintain visitor satisfaction by improving amenities and service as well as involving tourists in understanding how climate change is impacting reefs globally. Tourism operators can diversify the activities they offer. They may also be able to use site management and marketing strategies to help maintain the Reef as a competitive tourism destination.

The fourth strategy aims to work across all levels of government and industry to protect industry related infrastructure from the effects of climate change through sound planning and development.


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Strategy 5.1. Plan for declining reef conditions and changing climate		
Action	5.1.1	**Develop a Climate Incident Response Plan for the Tourism Industry.** Working within the Climate Change Incident Response Framework being developed for the GBRMPA, develop a comprehensive Climate Incident Response Plan in collaboration between the GBRMPA and industry partners. Incorporate an updated Marine Tourism Contingency Plan into this planning process and response. Undertake scenario planning to inform likely futures and adaptive management responses.
	5.1.2	**Develop operator-specific risk management plans**. The implications of climate change necessitate a more sophisticated risk-based approach to marine tourism. Operators need to have risk management plans to assist them in preparing for events and to take action during events, such as mass coral bleaching or severe tropical storms. Guidance will be provided to operators to develop risk management plans to be incorporated into their business plans and to be informed by the research and modelling conducted under Actions 3.1.1 to 3.1.6. It is envisioned this guidance will be made available to industry operators at the regional meetings/workshop conducted as part of Action 1.1.2 and through appropriate government and industry partners. While the guidance developed through this project will be based on currently available information, it will be possible to update and strengthen guidance to tourism operators in the future as climate scenarios change.
	5.1.3	**Strengthen or develop risk management plans by local area**. Expected increases in storm frequency and intensity as a result of changing climate means that government and industry planning and policy may need to be strengthened to address likely scenarios, particularly inundation, wind damage, and implications for essential coastal infrastructure. This action is for industry to work collaboratively and proactively with government in priority areas to review, strengthen, or develop, as necessary, local risk management plans. These plans are an important part of protecting tourism businesses within the context of climate change and also as an input to risk management plans developed by individual operators as part of Action 5.1.2.
	5.1.4	**Work with the insurance industry to identify strategies that reduce risk**. Rising insurance costs have been identified as a potentially significant impact of climate change on marine tourism. Through this action, the marine tourism industry will work proactively with the insurance industry and government to identify strategies, technologies and operational procedures that can be implemented to help achieve affordable insurance for industry operators in the future.

Strategy 5.2. Develop business strategies to mitigate the impacts of climate change		
Action	5.2.1	**Assess 'green' and 'climate-neutral' technologies and strategies**. Assess the costs and benefits of potential 'green' and 'climate-neutral' technologies and strategies, including biofuels, solar power, wind power, and designs that maximise passive cooling, which could be used by operators (including accommodation operators) in various sectors of the marine tourism industry to reduce their emissions and environmental impact.
	5.2.2	**Identify responsive business strategies**. Informed by the results of Actions 3.1.1 to 3.1.6, this action will identify business strategies for responding to climate change impacts to marine tourism. Guidance will be developed for industry sectors that suggest: a) strategies for enhancing visitor experiences that may be diminished by climate change; b) strategies for diversifying tourism products to compensate for losses resulting from climate change; c) strategies for protecting investments from climate change impacts; d) alternative marketing strategies; and e) business opportunities that may result from climate change. Throughout the recommendations, the research should highlight opportunities for businesses to reduce and minimise environmental impacts, including greenhouse gas emissions.

Strategy 5.3. Maintain industry viability		
Action	5.3.1	**Invest in infrastructure, and remove impediments to infrastructure development, to assist with climate change contingency planning**. The tourism industry requires alternate opportunities, for example moorings, in the event of significant climate change impacts, such as mass coral bleaching and severe weather events effecting reef conditions.
	5.3.2	**Develop management arrangements which provide appropriate climate change contingency planning for industry and the environment to deliver adaptive management**. Quality of the site visited is believed to have an important influence on visitor satisfaction. Significant climate incidents such as localised, severe bleaching events, will require flexibility in permitting arrangements. Operators may also wish to pursue site enhancements to improve the viability of their existing arrangements. Implementing these strategies may require changes in the arrangements with protected area managers. Implementation would benefit from a clear understanding of the scientific merits of various approaches to site enhancement. This action will also involve GBRMPA reviewing existing permitting guidelines, Plans of Management, the Marine Tourism Contingency Plan, and the Climate Incident Response Plan (Action 5.1.1) to further streamline or clarify these processes in light of climate change.

	5.3.3	**Ensure compliance with existing management arrangements**. The global financial crisis has brought a focus on the price competitiveness of tourism markets. Operators who invest significant resources into adopting best practice to respond to climate change will find these investments can affect their bottom line, especially in the short term. In order to ensure a level playing field across the industry, this action aims to support Reef protection and address underperformance by stepping-up enforcement of legislative and regulatory requirements. In essence, this action ensures good quality operators are not disadvantaged by others cutting corners and 'getting away' with it. This action ties to Action 4.1.3.
	5.3.4	**Implement a public relations and marketing strategy**. Sound public relations strategies supported by marketing are essential tools for maintaining destination image amid increasing news coverage about climate change impacts on tropical ecosystems and weather. This action will develop and implement a public relations and marketing strategy to pre-empt potential negative impacts of climate change on visitor perceptions and interest in reef-based marine tourism. The public relations and marketing strategy will capitalise on global market competitiveness and may promote new experiences or a diversification of products to maintain the image of the Reef environment as an iconic coastal destination. This may include an audit of existing experiences.

Strategy 5.4. Develop environmental management and engineering strategies		
Action	5.4.1	Collaborate with agencies responsible for coastal development to implement engineering and technical solutions that reduce infrastructure risk. Climate change related impacts, such as increased frequency and severity of storms, sea-level rise, and changes in weather patterns, will increase threats to infrastructure that are vital to Reef marine tourism; specifically, ports, marinas, pontoons, roads, seaside buildings, and boats. Through this action, partners will collaborate to identify available engineering and technical solutions that can be implemented to reduce damage to infrastructure and insurance costs through retrofitting existing assets and utilising climate smart planning, zoning and development for the future.

Objective 6.

Influence and facilitate change

This Strategy articulates a proactive framework for responding to climate change. It outlines important strategies for adapting marine tourism businesses, supporting the resilience of the Reef, reducing greenhouse gases, raising awareness, and understanding what the future may hold. Implementing these strategies requires additional human capacity and financial and policy incentives. These investments are critical to the successful implementation of this plan and to realising a positive future for the Reef marine tourism industry in the context of global climate change.

Strategy 6.1. Establish incentives to facilitate change		
Action	6.1.1	**Demonstrate adaptive management.** Ensure government plans reflect appropriate actions and priorities by working with state and National governments. Specific plans that should be targeted include the Australian National Climate Change Adaptation Framework, the GBRMPA Climate Change Action Plan, the Queensland Tourism Strategy, and the Queensland Climate Change Adaptation Strategy.
	6.1.2	**Develop incentives for undertaking climate change action**. The GBRMPA currently offers extended permit terms to operators that have completed the ECO Certification Program operated by Ecotourism Australia. Appropriate incentives will be developed for marine tourism operators to adopt Climate Action Certification.
	6.1.3	I**dentify incentives that can facilitate change and adoption of best practice for climate change action**. Identify regulatory, financial, and policy incentives that will encourage operators to: 1) install and adopt technologies that will minimise their environmental impact; and, 2) incorporate climate change into their short and long-term business planning. This could take the form of small grants and/or tax breaks to help operators implement energy saving strategies and invest in green technologies. The development of an International Reef Dive Site Ratings System will provide a significant incentive for operators to adopt best practice action on climate change. With the proposal to make these ratings public, a high rated dive site linked to appropriately eco-certified operators is likely to attract more tourists. Operators will have a commercial incentive to take an active interest in protection and management initiatives related to their dives sites. This action links to Actions 1.1.3 and 1.2.2.

Strategy 6.2. Foster industry capacity to implement change		
Action	6.2.1	**Continue to engage an industry liaison position focused on climate change action within the tourism industry**. This action will aim to continue a full time position for an industry-focused manager of climate change projects who will work with partners to implement this Strategy.

6.0 Implementing the strategy

6.1 Guidance

The implementation of this Strategy relies on the engagement and oversight by tourism industry partners and protected area managers across the Reef. Leadership and guidance will be provided through the TCCAG. Additional input will be sought from tourism operators and a range of key stakeholders and government agencies.

The GBRMPA will continue to provide secretariat services for the TCCAG which will meet at least biannually to pursue the actions contained in this document.

6.2 Plan evaluation and revision

This Strategy articulates a comprehensive agenda for preparing the Reef marine tourism industry for the impacts of climate change based on the best available information. However, as an emergent threat to the Reef marine tourism industry, information about the impacts of climate change and sensible responses to it are rapidly emerging. Throughout the implementation of this Strategy, partners will review the latest information and experience gained and will propose appropriate revisions to be reflected in future versions of this document.

Key performance indicators to assess the progress and outcomes related to each action will be developed as projects are undertaken. The progress towards these targets will be reported in future updates of the Strategy.


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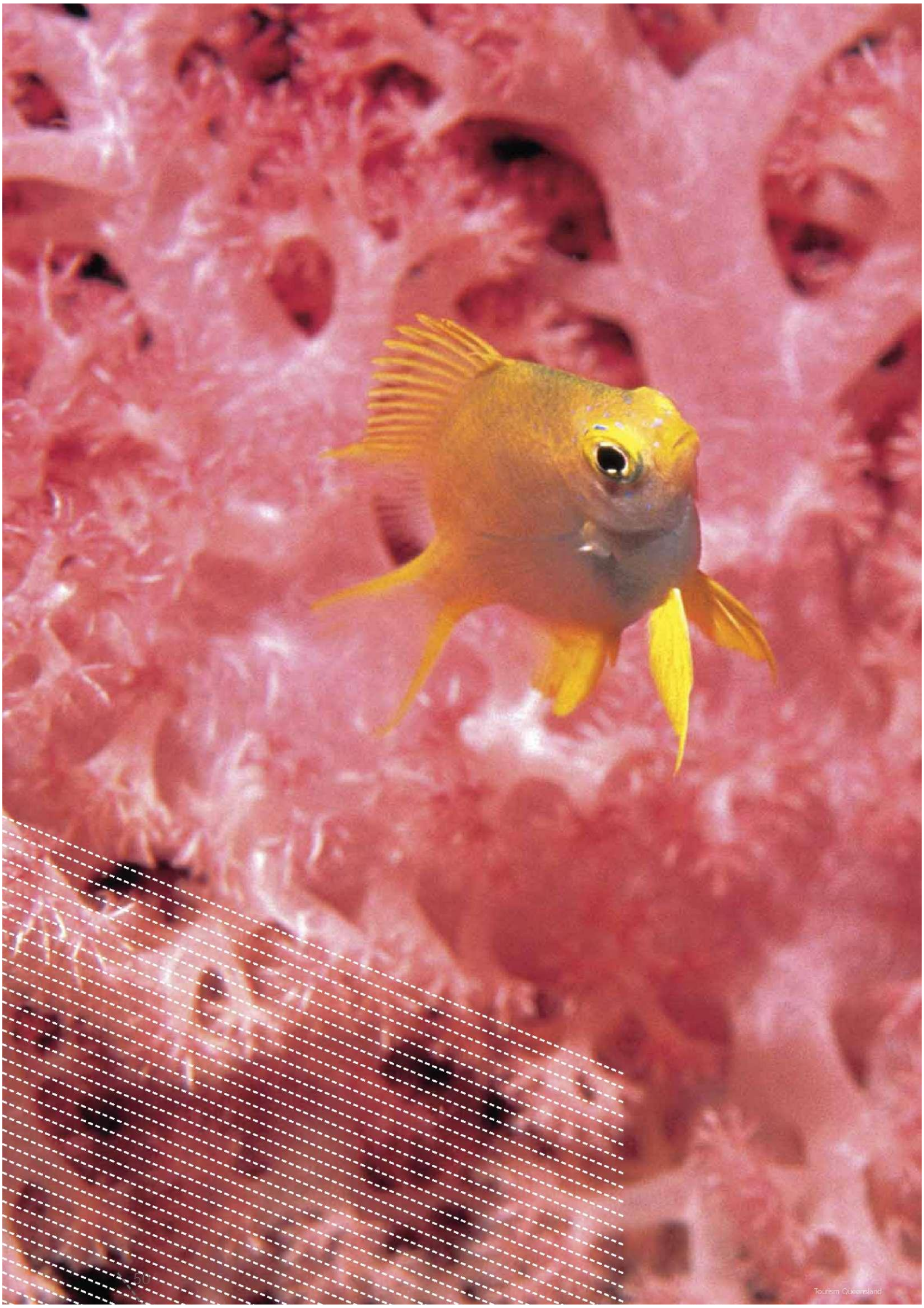

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References

Access Economics Pty Limited. (2006/2007). Measuring the Economic and Financial Value of The Great Barrier Reef. (No. 85). Townsville: Great Barrier Reef Marine Park Authority.

Cater, C. (2004). The Great Barrier Reef Marine Tourism Industry: A Review. Gold Coast: Griffith University.

Cesar, H., L. Pet-Soede, S. Westmacott, S. Mangi, and A. Aish (2002). Economic Analysis of Coral Bleaching in the Indian Ocean-Phase II. In O. Linden, D. Souter, D. Wilhelmsson & D. Obura (Eds.), Coral degradation in the Indian Ocean: Status Report 2002 (pp. 251-262). Kalmar, Sweden: CORDIO, Department of Biology and Environmental Science, University of Kalmar.

Congdon, B. and P. O'Neil, (2007). Vulnerability of seabirds on the Great Barrier Reef to climate change. In J. Johnson & P. Marshall (Eds.), Climate Change and the Great Barrier Reef: A Vulnerability Assessment. Townsville: Great Barrier Reef Marine Park Authority.

CSIRO. 2007. Climate change in Australia: technical report

Department of Climate Change (2008). White paper on Carbon Pollution Reduction Scheme.

Department of Climate Change (Cth) www.climatechange.gov.au

Department of the Environment, Water, Heritage and the Arts and the Department of Climate Change, Implications of climate change for Australia's World Heritage properties: a preliminary assessment, 2009.

Great Barrier Reef Marine Park Authority's Climate Change Response Program: http://www.gbrmpa.gov.au/corp_site/info_services/science/climate_change

Hamann, M., C. J. Limpus, and M. A. Read (2007). Vulnerability of marine reptiles in the Great Barrier Reef to climate change. In J. Johnson & P. Marshall (Eds.), Climate Change and the Great Barrier Reef: A Vulnerability Assessment. Townsville: Great Barrier Reef Marine Park Authority.

Hoegh-Guldberg, O., and H. Hoegh-Guldberg (2004). The Implications of Climate Change for Australia's Great Barrier Reef. Sydney: Queensland Tourism Industry Council and WWF-Australia.

IPCC. (1999). Aviation and the Global Atmosphere: Summary for Policymakers. Cambridge: Intergovernmental Panel on Climate Change.

IPCC 2007, Climate Change 2007: The physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor & H.L. Miller (eds), Cambridge University Press, Cambridge and New York.

Johnson, J., and P. Marshall (2007). Climate Change and the Great Barrier Reef: A Vulnerability Assessment. Townsville: Great Barrier Reef Marine Park Authority.

Kleypas, J.A, R.A. Feely, V.J. Fabry, C. Langdon, C.L. Sabine and L.L. Robbins. 2006. Impacts of Ocean Acidification on Coral Reefs and Other Marine Calcifiers. A Guide for Future Research, Report of a workshop sponsored by NSF, NOAA and the US Geological Survey. 88pp.

Lough, J. (2007). Climate and Climate Change Scenarios for the Great Barrier Reef. In J. Johnson & P. Marshall (Eds.), Climate Change and the Great Barrier Reef: A Vulnerability Assessment. Townsville: Great Barrier Reef Marine Park Authority.

Marshall, P. and H. Schuttenberg (2006). A Reef Manager's Guide to Coral Bleaching. Townsville: Great Barrier Reef Marine Park Authority.

Miller, D. (2006). Reef Condition and Reef Experience - indicators of sustainability. Unpublished Doctor of Philosophy, James Cook University, Townsville.

Overpeck, B. L. Otto-Bliesner, G. H. Miller, D. R. Muhs, R. B. Alley, and J. T. Kiehl (2006). Paleoclimatic Evidence for Future Ice-Sheet Instability and Rapid Sea-Level Rise. Science 311. no. 5768, pp. 1747 – 1750.

Rahmstorf, Stefan, A. Cazenave , J. A. Church, J. E. Hansen, R. F. Keeling, D. E. Parker, and R.C.J. Somerville (2007). Recent climate observations compared to projections. Science 316, p709

Reef Water Quality Protection Plan. (2003). Commonwealth of Australia and Queensland Government. www.thepremier.qld.gov.au/reefwater

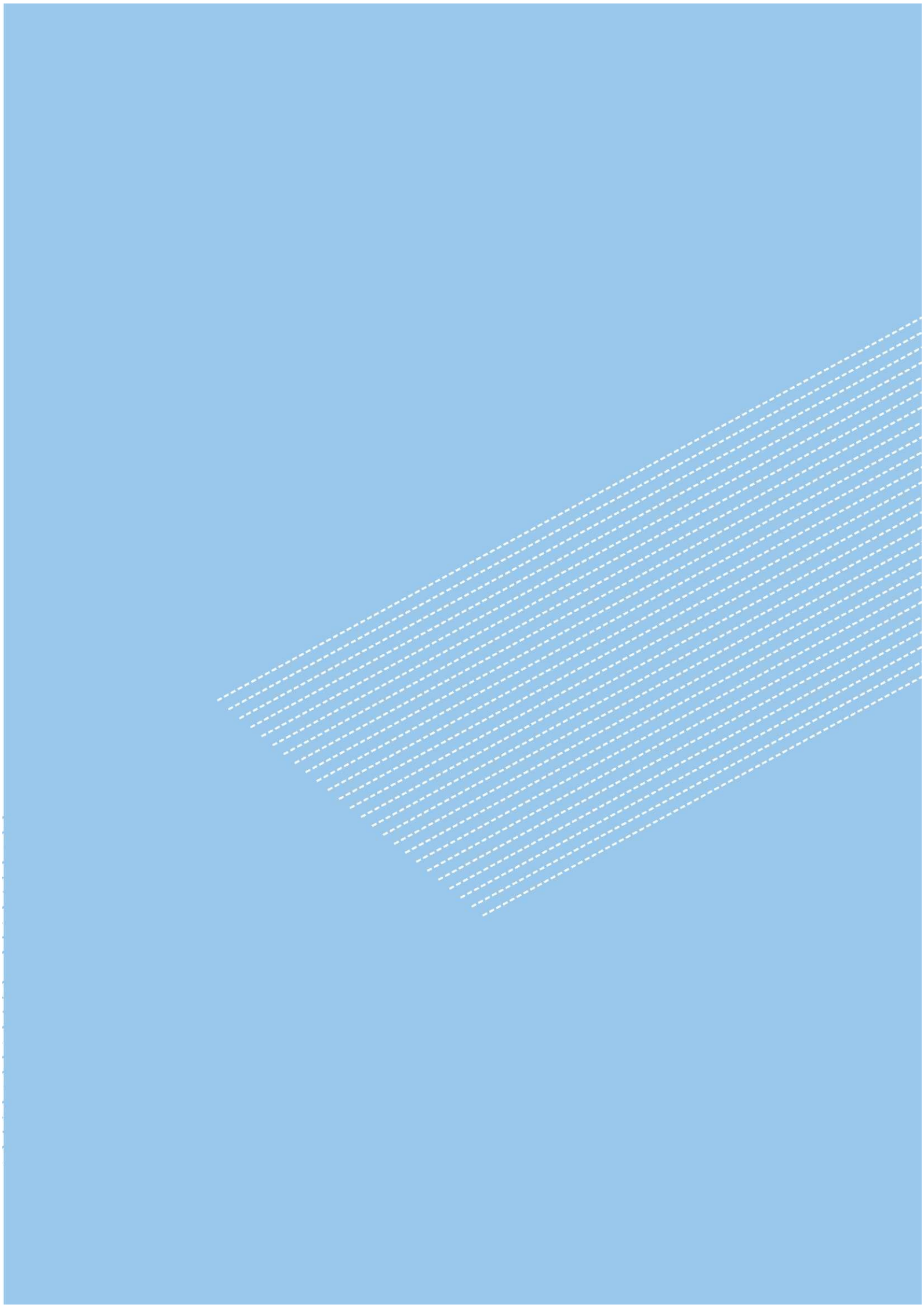
Skeat, H. (2003). Sustainable tourism in the Great Barrier Reef Marine Park. In D. Trewin (Ed.), Year Book Australia (Vol. 85, pp. 703-706). Canberra: Australian Bureau of Statistics.

Stern, N. H. (2007). The economics of climate change: the Stern review. Cambridge: Cambridge University Press.

Steiner, E. (Data to 31/03/2008), Consumer and Market Insights, Brand health and communications tracking excerpt: attitudes to climate change. Published by Tourism Australia.

Queensland government's climate change and greenhouse gas website (EPA): www.epa.qld.gov.au/environmental_management/sustainability/climate_change_and_greenhouse

Young, J., Lu, S., and Jessup, K. (2006). Community survey: full report. Canberra: Colmar Brunton Social Research.

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