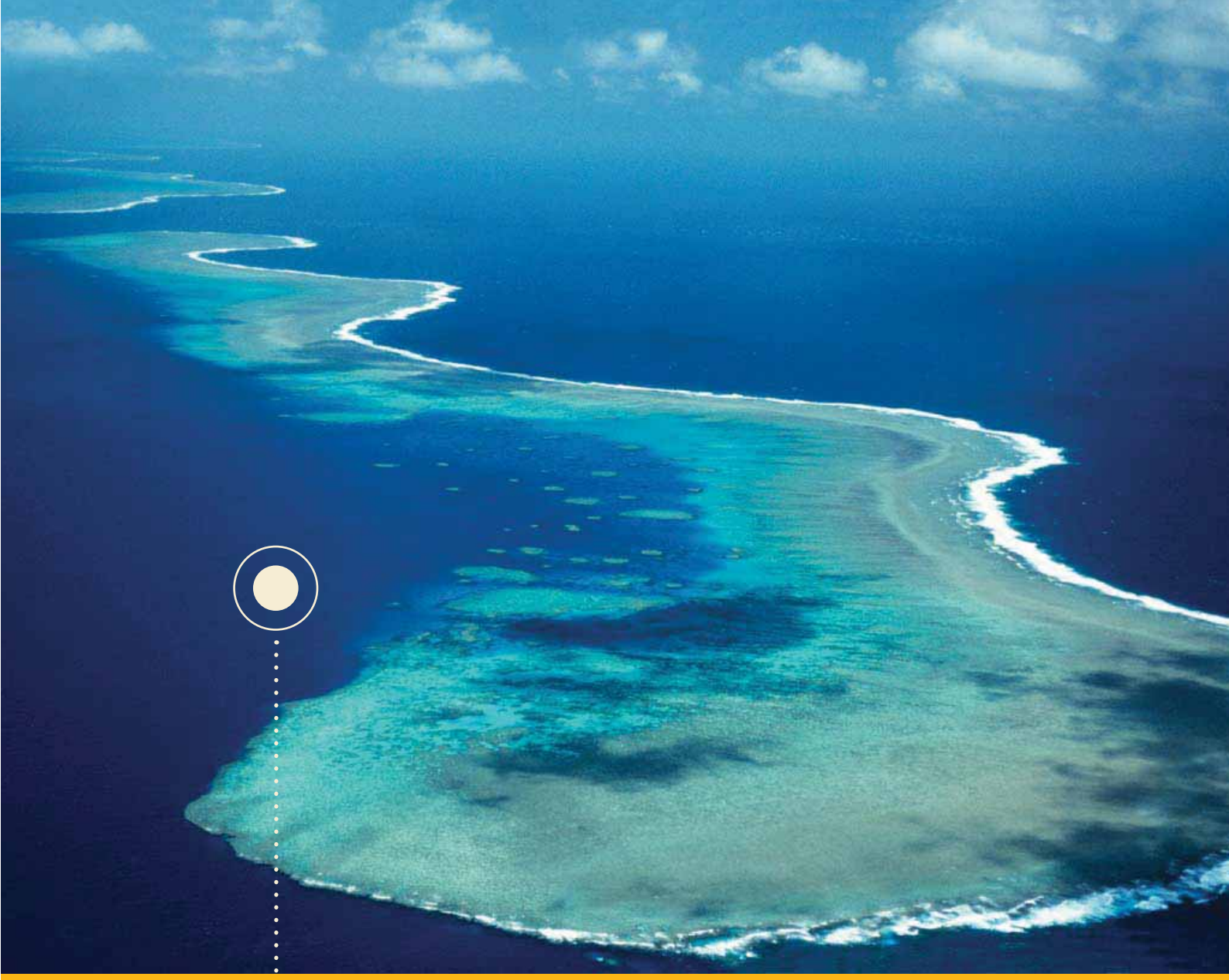

Australian Government

Great Barrier Reef
Marine Park Authority

GREAT BARRIER REEF

OUTLOOK REPORT 2009

IN BRIEF

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PREFACE

The Great Barrier Reef is a World Heritage Area that is greatly valued by Australians and by people throughout the world. It is the largest coral reef ecosystem on the planet and supports an outstanding array of plants and animals. Most commercial and non-commercial use of the Great Barrier Reef is dependent on an intact, healthy and resilient ecosystem and it continues to be a significant economic resource for Australia and local communities.

The significance of the Great Barrier Reef makes it especially important that we regularly collate our knowledge of the ecosystem and take stock of its future. The *Great Barrier Reef Outlook Report 2009* assesses what is known about the ecosystem, its use, its management and the pressures it is facing, and is a window into its future. It identifies climate change, continued declining water quality from catchment runoff, loss of coastal habitats from coastal development and a small number of impacts from fishing as the priority issues reducing the resilience of the Great Barrier Reef. It also highlights gaps in information required for a better understanding of ecosystem resilience.

The *Great Barrier Reef Outlook Report 2009* was prepared by the Great Barrier Reef Marine Park Authority based on the best available information. Many people with an interest in the Great Barrier Reef contributed to its development, including leading scientists, industry representatives and the community. The Report was independently peer reviewed.

The Outlook Report was provided to the Minister for the Environment, Heritage and the Arts on 30 June 2009 and subsequently tabled in the Australian Parliament.

This *Great Barrier Reef Outlook Report 2009 – In Brief* presents the key findings of the full Report supported by a selection of the evidence used. Its structure mirrors the Outlook Report itself, with a chapter for each of the eight assessments required under Section 54 of the *Great Barrier Reef Marine Park Act 1975*, including extracts from the assessment summaries.

The full text of the *Great Barrier Reef Outlook Report 2009* is available online at *www.gbrmpa.gov.au* or on the CD at the back of this publication.

Russell Reichelt
Chairman and Chief Executive Officer
Great Barrier Reef Marine Park Authority

EXECUTIVE SUMMARY OF THE *GREAT BARRIER REEF OUTLOOK REPORT 2009*

The following is the complete text of the Executive Summary of the Great Barrier Reef Outlook Report 2009.

The outlook for the Great Barrier Reef ecosystem is at a crossroad, and it is decisions made in the next few years that are likely to determine its long-term future. Unavoidably, future predictions of climate change dominate most aspects of the Great Barrier Reef's outlook over the next few decades. The extent and persistence of the damage to the ecosystem will depend to a large degree on the amount of change in the world's climate and on the resilience of the Great Barrier Reef ecosystem in the immediate future.

This first Outlook Report identifies climate change, continued declining water quality from catchment runoff, loss of coastal habitats from coastal development and remaining impacts from fishing and illegal fishing and poaching as the priority issues reducing the resilience of the Great Barrier Reef. It also highlights gaps in information required for a better understanding of ecosystem resilience.

The Great Barrier Reef is one of the most diverse and remarkable ecosystems in the world and remains one of the most healthy coral reef ecosystems. Nevertheless, its condition has declined significantly since European settlement and, as a result, the overall resilience of the ecosystem has been reduced.

While populations of almost all marine species are intact and there are no records of extinctions, some ecologically important species, such as dugongs, marine turtles, seabirds, black teatfish and some sharks, have declined significantly. Although the declines of loggerhead turtles and dugongs are believed to have halted, there are few examples of increasing populations in species of conservation concern. The obvious example is the humpback whale, which is recovering strongly after being decimated by whaling. Disease in corals and pest outbreaks of crown-of-thorns starfish and cyanobacteria appear to be becoming more frequent and more serious.

Coral reef habitats fluctuate naturally depending on changes in environmental conditions, but they are gradually declining, especially inshore as a result of poor water quality and the compounding effects of climate change. Habitats more remote from human use, such as the continental slope and reefs in the far north are believed to be in very good condition and portions of the lagoon floor are recovering from previous effects of trawling.

Most commercial and non-commercial use of the Great Barrier Reef is dependent on an intact, healthy and resilient ecosystem and it continues to be a significant economic resource for regional communities and Australia. Millions of people continue to enjoy their visits to the Great Barrier Reef. Major changes to the condition of the ecosystem will have social and economic implications.

The Great Barrier Reef Marine Park is considered by many to be a leading example of world's best practice management. However, the effectiveness of management is challenged because complex factors that have their origin beyond the Great Barrier Reef Region, namely climate change, catchment runoff and coastal development cause some of the highest risks to the ecosystem. These factors are playing an increasing role in determining the condition and future of the Great Barrier Reef.

Almost all the biodiversity of the Great Barrier Reef will be affected by climate change, with coral reef habitats the most vulnerable. Coral bleaching resulting from increasing sea temperature and lower rates of calcification in skeleton-building organisms, such as corals, because of ocean acidification, are the effects of most concern and are already evident.

The Great Barrier Reef continues to be exposed to increased levels of sediments, nutrients and pesticides, which are having significant effects inshore close to developed coasts, such as causing die-backs of mangroves and increasing algae on coral reefs. Substantial resources are being provided to improve water quality to the Great Barrier Reef, but progress is slow and patchy.

Coastal development is increasing the loss of coastal habitats that support the Great Barrier Reef. Human population increases within the Great Barrier Reef catchment are projected to be nearly two per cent per

annum. This will place greater pressure on the ecosystem and increase use of the Great Barrier Reef Region. Integrated planning, knowledge and compliance in managing coastal development are areas highlighted as requiring improvement.

While significant improvements have been made in reducing the impacts of fishing in the Great Barrier Reef, such as bycatch reduction devices, effort controls and closures, important risks to the ecosystem remain from the targeting of predators, the death of incidentally caught species of conservation concern, illegal fishing and poaching. The flow on ecosystem effects of losing predators, such as sharks and coral trout, as well further reducing populations of herbivores, such as the threatened dugong, are largely unknown but have the potential to alter food web interrelationships and reduce resilience across the ecosystem.

Non-extractive uses within the Great Barrier Reef, such as commercial marine tourism, shipping and defence activities, are independently assessed as more effectively managed and are a lower risk to the ecosystem; however the risk of introduced species is likely to increase with projected increases in shipping when global economic recovery occurs. While many of the management measures employed in the Great Barrier Reef Region and beyond are making a positive difference, for example the *Great Barrier Reef Marine Park Zoning Plan 2003*, the ability to address cumulative impacts is weak.

Given the strong management of the Great Barrier Reef, it is likely that the ecosystem will survive better under the pressure of accumulating risks than most reef ecosystems around the world. However, even with the recent management initiatives to improve resilience, the overall outlook for the Great Barrier Reef is poor and catastrophic damage to the ecosystem may not be averted. Ultimately, if changes in the world's climate become too severe, no management actions will be able to climate-proof the Great Barrier Reef ecosystem.

Further building the resilience of the Great Barrier Reef by improving water quality, reducing the loss of coastal habitats and increasing knowledge about fishing and its effects, will give it the best chance of adapting to and recovering from the serious threats ahead, especially from climate change.

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ABOUT THE GREAT BARRIER REEF OUTLOOK REPORT

In 2006, the Australian Government resolved that decision making for long-term protection of the Great Barrier Reef should be underpinned by a periodic Outlook Report. The Report would be a regular and reliable means of assessing performance in an accountable and transparent manner and a key input for any future changes to zoning plans and the consideration of broader issues by government.

The *Great Barrier Reef Marine Park Act 1975* was amended in 2007 requiring the Great Barrier Reef Marine Park Authority to prepare an Outlook Report for the Great Barrier Reef Region every five years. The Act stipulates that the Report must be given to the Minister for the Environment, Heritage and the Arts for tabling in both houses of the Australian Parliament. The Act does not provide for the Outlook Report to make recommendations about future protection or management initiatives.

The first Great Barrier Reef Outlook Report has been prepared by the Great Barrier Reef Marine Park Authority and is available online at *www.gbrmpa.gov.au.*

The area examined in the Report is the Great Barrier Reef Region as defined in the *Great Barrier Reef Marine Park Act 1975*. The Great Barrier Reef Region covers the area of ocean from the tip of Cape York in the north to past Lady Elliot Island in the south, with mean low water as its western boundary and extending eastwards a distance of between 70 and 250km (see Map 1).

A number of Australian and Queensland Government agencies, researchers, industry representatives and members of the public contributed to development of the Outlook Report. The Great Barrier Reef Marine Park Authority's four Reef Advisory Committees (external experts who provide independent advice on critical issues) and 11 Local Marine Advisory Committees (committees centred on regional centres along the coast) provided advice throughout the Report's development. The Great Barrier Reef Marine Park Authority held community workshops to learn about changes to the Great Barrier Reef by listening to community members' stories of the past. In addition, an Outlook Forum attended by 42 participants including scientists, leaders from industry, interest groups and the community and government representatives developed likely 'outlooks' for the Great Barrier Reef.

Two experts in protected area management, monitoring and evaluation, public policy and governance were commissioned to undertake an independent assessment of existing protection and management. Their report forms the basis of the assessment of existing measures to protect and manage the Great Barrier Reef ecosystem.

All of the habitats and species of the Great Barrier Reef Region are considered in the Report, including species of conservation concern such as the hawksbill turtle.

Throughout development of the Report, an Outlook Reference Group comprising eight experts in environmental reporting, protected area management and communication provided advice and guidance on information available, assessment methods and community engagement and presentation.

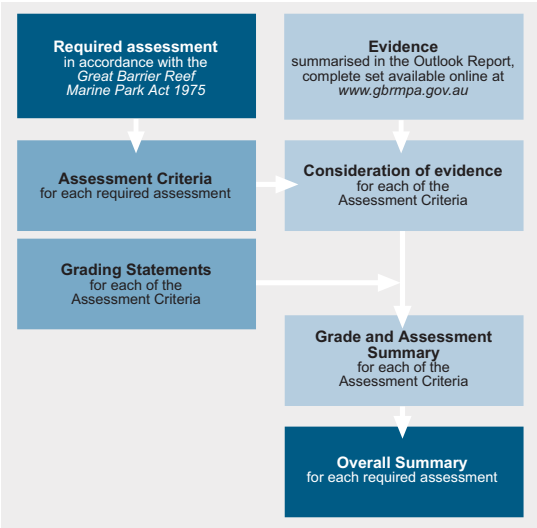
Finally, four reviewers appointed by the Minister for the Environment, Heritage and the Arts independently reviewed the contents of the Outlook Report. These reviewers are recognised national and international experts with biophysical and/or socio-economic expertise and achievements, including conducting high level policy and scientific reviews. Their comments were considered and incorporated where appropriate in finalising the Report.

The Outlook Report assesses the current state of the Great Barrier Reef ecosystem's environmental, social and economic values, examines the pressures and current responses and finally considers the likely outlook. It is structured around the eight assessments required by the Act, with each assessment forming a chapter of the Report.

For each of the assessments required under the Act, a set of Assessment Criteria allow an ordered analysis of the available evidence. An overall grade for each Assessment Criterion is provided, based on a series of grading statements.

This approach has been developed specifically for the *Great Barrier Reef Outlook Report* to meet the legislative requirements. It is intended that future Outlook Reports will follow the same process so that changes and trends can be tracked over time.

The information featured in the Report is only a small portion of all that is known about the Great Barrier Reef Region. No new research was undertaken as part of developing the Report; rather, the evidence used is derived from existing research and information sources. The complete set of evidence used to develop the Great Barrier Reef Outlook Report is available online at *www.gbrmpa.gov.au*.



The Outlook Report is based on the best available evidence. A set of grading statements (available in the full Report) guide the allocation of a grade for each Assessment Criterion in each of the required assessments.

The Great Barrier Reef Outlook Report 2009 is structured around the eight assessments required under Section 54 of the Great Barrier Reef Marine Park Act 1975.

1 THE GREAT BARRIER REEF

The Great Barrier Reef is a national and international icon, famous for its beauty and vast scale. It is the largest and best known coral reef ecosystem in the world, spanning a length of 2300 km along two-thirds of the east coast of Queensland. The reefs of the Great Barrier Reef - almost 3000 in total - represent about 10 per cent of all the coral reef areas in the world. Virtually all groups of marine plants and animals are abundantly represented in the Great Barrier Reef, with thousands of different species living there.

Areas of the Great Barrier Reef Region have been progressively included in the Great Barrier Reef Marine Park since the late 1970s. Today almost all of the Great Barrier Reef ecosystem is included within the Great Barrier Reef Marine Park which extends over approximately 344 400 km^2 (see Map 1). This Commonwealth Marine Park is complemented by the Great Barrier Reef Coast Marine Park in adjacent Queensland waters.

The Great Barrier Reef from space
The Great Barrier Reef hugs the east coast of Queensland, Australia. Its variety of reefs is substantially greater than in any other place on Earth. (Photo courtesy of the European Space Agency)

The Great Barrier Reef Marine Park is a multiple use marine park, supporting a wide range of uses, including commercial marine tourism, defence activities, fishing, ports and shipping, recreation, scientific research and Indigenous traditional use. It brings billions of dollars into Australia's economy each year, and supports more than 50 000 jobs.

Within the Great Barrier Reef Marine Park, a number of activities are strictly prohibited (such as mining and oil drilling) and there is careful management of all other activities (such as fishing, commercial marine tourism and shipping operations). A range of measures are employed to manage the various uses of the Marine Park and to protect its values. For example, a Zoning Plan defines what activities can occur in which locations, both to protect the marine environment and to separate potentially conflicting activities.

The Great Barrier Reef is a national and international icon. It was part of the Torch Relay for the 2000 Olympic Games held in Sydney, Australia. (Photo courtesy of the Quicksilver Group)

About 70 Great Barrier Reef Aboriginal and Torres Strait Islander Traditional Owner clan groups hold a range of past and present heritage values for their land and sea country, and for surrounding sea countries. These values may be cultural, spiritual, economic, social or physical, and demonstrate continuing connections with the Great Barrier Reef Region and its natural resources.

The Great Barrier Reef was inscribed on the World Heritage List in 1981, the first coral reef ecosystem in the world to have this distinction and the only such coral reef region that has ever qualified on all four natural criteria. This recognition continues to highlight the international significance of the Great Barrier Reef; it also carries an obligation and responsibility to protect and conserve its values for all future generations and to present its values to the world.

In May 2007, existing Australian World Heritage properties (such as the Great Barrier Reef) were transferred onto the National Heritage List for their World Heritage values. In addition, five Commonwealth Heritage places within the Great Barrier Reef Region and many places of historical significance including lighthouses and shipwrecks are managed to protect heritage values.

Map 1 The Great Barrier Reef Region

The Outlook Report is a report about the entire Great Barrier Reef Region, plus adjacent ecosystems where relevant.

2 BIODIVERSITY

Biodiversity is the variety among all plants and animals. It encompasses all living things, from microbes and single cell algae to marine turtles and whales, and their habitats. Importantly, it is not just a measure of how many species there are. Rather, it encompasses all natural variation - from genetic differences within one species to variations across a habitat or a whole ecosystem.

The Great Barrier Reef Region is vast, covering 14 degrees of latitude and extending 70 to 250km from the coast. It is one of the world's best known and most complex natural systems and continues to support extensive plant and animal biodiversity. Coral reefs are the best known part of the Great Barrier Reef Region, yet they make up only seven per cent of its area. Over one-third of the Great Barrier Reef Region is in fact continental slope and extremely deep oceanic habitats

The sheer scale of the ecosystem means monitoring has focused on a few key habitats and species or groups of species, generally those that are iconic (such as coral reefs, seabirds), commercially important (such as seagrass meadows, coral trout) or threatened (such as dugongs, marine turtles). There are few long-term monitoring programs established and the baseline from which to make comparisons is different for each group studied.

Ribbon reefs form an almost continuous chain in the far northern Great Barrier Reef.

Habitats to support species The Great Barrier Reef supports a wide variety of habitats from mangroves and beaches to deep open water. There is little detailed information about the status and trends of many habitat types within the Great Barrier Reef (for example the lagoon floor, shoals, *Halimeda* banks and the continental slope). The overall area of mangrove forest adjacent to the Great Barrier Reef appears to be generally stable except where there is significant coastal development. Changes in seagrass communities appear to be mainly due to natural cycles of decline and recovery although they are influenced by runoff from catchments. Available evidence indicates that the overall status of coral reefs on the Great Barrier Reef is relatively good. There is some evidence of a small decline in coral reef habitat over recent decades (figure 2.1), more so in inshore areas, but the trends are difficult to interpret as coral reefs are naturally very dynamic habitats. The decline may have already begun to affect species that depend on coral reef habitat.

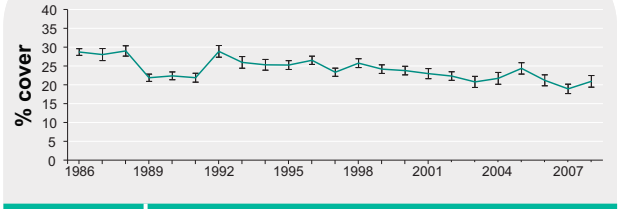


Figure 2.1 **Hard coral cover in the Great Barrier Reef, 1986-2008, as measured using manta tow surveys[1]**

Assessments of coral reef status are usually based on the amount of coral on a reef. On the Great Barrier Reef, coral cover has undergone a wide range of changes and there is no strong, consistent overall trend. As measured using manta tow surveys throughout the Great Barrier Reef, average coral cover has declined over the last 22 years, amounting to an average annual change of -0.29%. Results of another survey technique from 1993 to 2007 show a very slight increase. Other analyses suggest there may have been significant declines in coral cover prior to the implementation of systematic long-term monitoring.

Populations of species and groups of species The Great Barrier Reef ecosystem is made up of thousands of species. Nowhere near all of them have been identified and described. Populations appear to be intact for the vast majority of species or groups of species in the Great Barrier Reef ecosystem. Latitudinal and cross-shelf biodiversity appears to be being maintained; however inshore species and their habitats adjacent to the developed coast are under more pressure than those both offshore and further north. Little is known about the status of most Great Barrier Reef species such as non-commercial invertebrates, plankton and microbes. Of the more than 1600 bony fish species,

Beaches, especially on islands such as Raine Island, are important nesting areas for threatened marine turtle species. (Photo courtesy of J.E.N. Veron)

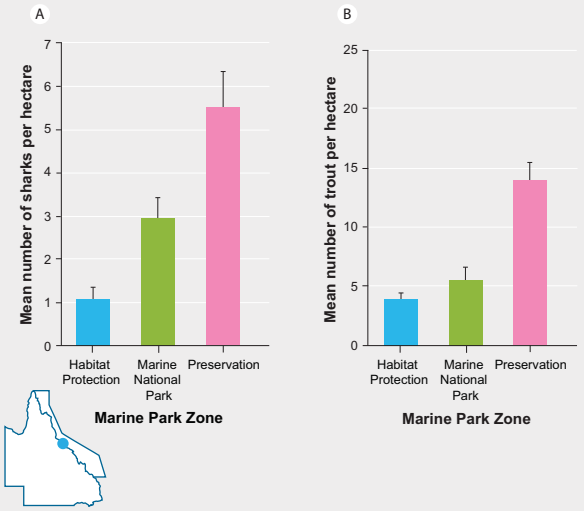


Figure 2.2 Reef shark and coral trout densities across zones[2]

The density of both (A) reef sharks (grey reef, whitetip reef, silvertip and blacktip reef sharks) and (B) adult common coral trout in the Habitat Protection Zone (open to fishing) is much reduced compared to that in the Marine National Park and Preservation Zones (closed to fishing). With regard to the two zones that are closed to fishing, the recorded differences in density are likely to be the result of illegal activity in the Marine National Park Zone. All study reefs were in the Townsville region. The black bars indicate the standard error around the mean.

only a few are known to have locally depleted populations. Populations of a number of ecologically significant species, particularly predators (such as sharks, and seabirds) and large herbivores (dugongs), are known to have seriously declined (figures 2.2 and 2.3). Declines in species or groups of species have been caused by a range of factors, some of which have been addressed, with evidence of recovery of some affected species (e.g. the humpback whale population is recovering strongly after being decimated by whaling and the southern Great Barrier Reef green turtle stock is increasing after commercial harvest in the first half of the 1900s).

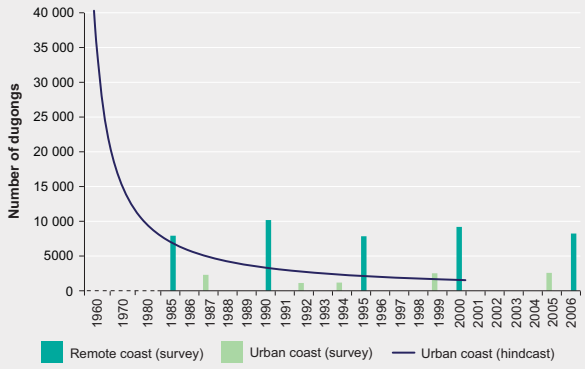


Figure 2.3 Dugong populations in the Great Barrier Reef[3 4 5]

There is serious concern for the threatened dugong. The dugong population of the 'urban coast' of the Great Barrier Reef (from Cooktown south) may have stabilised, but is about three per cent of its size about 40 years ago. The drastically reduced population is, historically, as a result of commercial hunting and incidental bycatch in large mesh (gill) nets, and more recently because of the cumulative pressures of habitat loss, incidental capture in large mesh (gill) nets, boat strikes, illegal hunting (poaching), unsustainable traditional hunting, disease and ingestion of marine debris. 'Remote coast' populations (north of Cooktown) have been relatively stable since aerial surveys began in 1985. The hindcast modelling of the 'urban coast' population (dark blue line) was based on the incidental take of dugongs in shark control program nets since the early 1960s, which was used as an index of the change.

Assessment criteria	Summary	Assessment Grade			
		Very good	Good	Poor	Very poor
Habitats to support species	For most of the Great Barrier Reef, habitats appear to be intact. Some inshore habitats (such as coral reefs) have deteriorated, caused mostly by reduced water quality and rising sea temperatures. This is likely to have affected species that rely on these habitats. Little is known about the soft seabed habitats of the lagoon, open waters or the deep habitats of the continental slope.		◯		
Populations of species and groups of species	Populations of almost all known Great Barrier Reef species or groups of species appear to be intact, but some populations such as dugongs, as well as some species of shark, seabirds and marine turtles, are known to have seriously declined, due mainly to human activities and declining environmental conditions. Many species are yet to be discovered and for many others, very little is known about their status. In time, more populations are likely to decline. Populations of some formally listed threatened species have stabilised but at very low numbers; other potentially threatened species continue to be identified.		◯		

3 ECOSYSTEM HEALTH

The concept of ecosystem health is associated with one of normality: healthy ecosystems are more-or-less unchanged or natural. In the case of marine environments, where there is usually little historic data, an ecosystem can easily be described as healthy or even pristine, when it may in fact be changing, usually for the worse (that is, the 'baseline' of what is considered normal has shifted).

Many of the key physical, chemical and ecological processes of the Great Barrier Reef ecosystem are changing and this is negatively affecting the health of the ecosystem.

Physical and chemical processes Increased sedimentation and inputs of nutrients and pesticides to the ecosystem are affecting inshore areas (figure 3.1), causing increased algal growth, accumulation of pollutants in sediments and marine species, reducing light and smothering corals. Sea temperatures are increasing because of climate change, leading to mass bleaching of corals; and increasing ocean acidity is affecting rates of calcification (figure 3.2). These physical and chemical processes combined are essential to the fundamental ecological processes of primary production and building coral reef habitats on the Great Barrier Reef.

Ecological processes It is considered that the overall food web of the Great Barrier Reef is being affected by declines in herbivory in inshore habitats because the urban coast dugong population is a fraction of its former population; in predation on reef habitats because of potential Reef-wide differences in coral trout and shark numbers on reefs open and closed to fishing; and in particle feeding on reef habitats because of the reduction in at least one species of sea cucumber. Importantly, populations of herbivorous fish are healthy - they play an important role in maintaining the

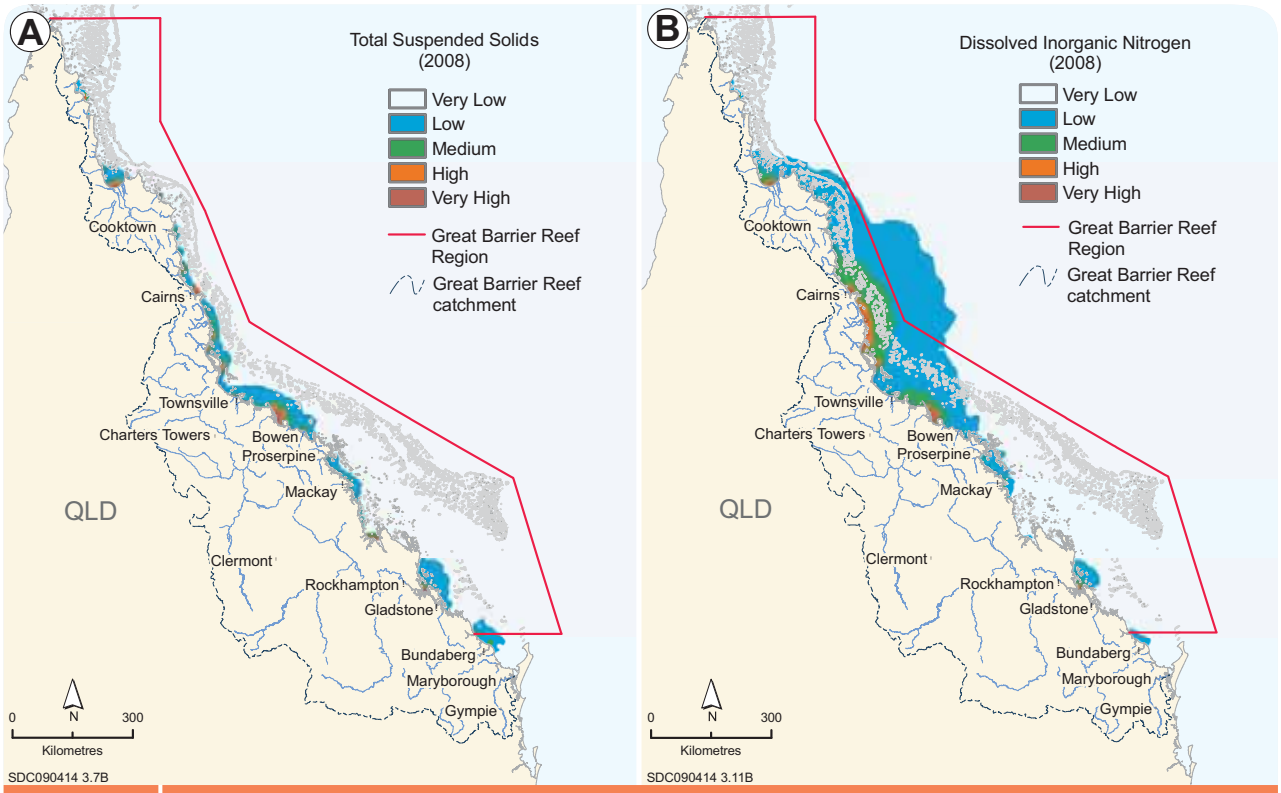


Figure 3.1 **Modelled exposure to sediments and dissolved inorganic nitrogen, Great Barrier Reef, 2008[6]**

These maps show the modelled exposure of the ecosystem to total suspended solids (A) and dissolved inorganic nitrogen (B) in 2008. Over the past 150 years sediment inflow onto the Great Barrier Reef has increased four to five times, and five to 10 fold for some catchments. In addition, dissolved inorganic nitrogen and phosphorous continue to enter the Great Barrier Reef at greatly enhanced levels, two to five times for nitrogen and four to 10 times for phosphorus relative to pre-European settlement. The coastal zone is clearly the part of the Great Barrier Reef most exposed to increased sedimentation and nutrients, especially areas close to river mouths.

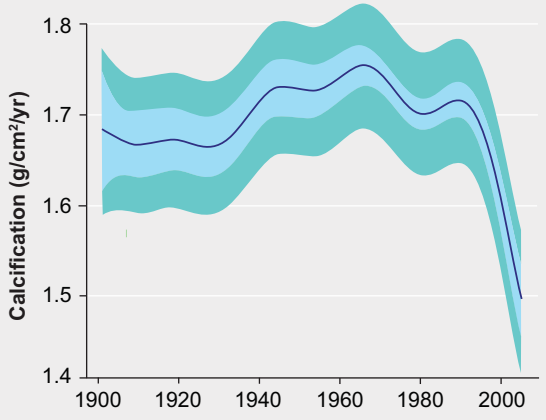


Figure 3.2 Changes in calcification in *Porites* spp., Great Barrier Reef, 1900-2005[7]

This graph shows an overall decrease in the rate of calcification in *Porites* corals on the Great Barrier Reef since 1900. Since 1980, there has been a dramatic decrease in the calcification rate, which has been attributed to increasing acidification and increasing sea temperature stress. The light blue bands indicate 95 per cent confidence intervals for comparison between years, and the green bands indicate 95 per cent confidence intervals for the predicted value for any given year. Three hundred and twenty-eight colonies from 69 reefs were sampled throughout the Great Barrier Reef. (g/cm2/yr =grams per square centimetre per year).

ecological balance between algae and coral on reefs. There is little known about trends in many key ecological processes such as microbial processes, primary production, symbiosis, competition and connectivity.

Outbreaks of disease, introduced species and pest species The incidence of coral disease may be increasing in some areas and it appears that human impacts have increased the frequency and severity of crown-of-thorns starfish outbreaks (figure 3.3). Outbreaks of other species, such as algal blooms, may indicate the ecosystem is under increasing pressure. At the same time, the occurrence of introduced marine species adjacent to the Great Barrier Reef Region is increasing.

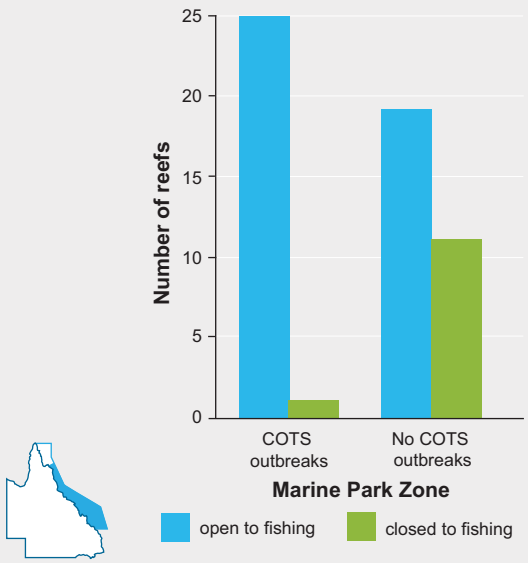


Figure 3.3 Crown-of-thorns starfish (COTS) outbreaks across zones, Great Barrier Reef, 1994-2004[8]

Outbreaks of crown-of-thorns starfish have been one of the major causes of coral death and reef damage on the Great Barrier Reef since surveys began in the 1960s. The general scientific view is that occasional outbreaks are to some extent natural, but that human impacts have increased their frequency and severity. There are significantly fewer crown-of-thorns starfish (COTS) outbreaks in zones closed to fishing (green bars) in the Great Barrier Reef. For both zones open to fishing (blue bars) and zones closed to fishing, the graph shows the number of surveyed mid-shelf reefs for which an outbreak was recorded at some time between 1994 and 2004 and those where no outbreak was recorded.

Assessment criteria	Summary	Assessment Grade
		Very good / Good / Poor / Very poor
Physical processes	The physical processes of the Great Barrier Reef are changing, in particular sedimentation and sea temperature. Further changes in factors such as sea temperature, sea level and sedimentation are expected because of climate change and catchment runoff.	Good
Chemical processes	For much of the Great Barrier Reef, the chemical environment has deteriorated significantly, especially inshore close to developed areas. This trend is expected to continue. Acidification of all Great Barrier Reef waters as a result of increased concentrations of atmospheric carbon dioxide is an emerging serious issue which is likely to worsen in the future.	Poor
Ecological processes	Most ecological processes remain intact and healthy on the Great Barrier Reef, but further declines in physical and chemical processes are expected to affect them in the future. There is concern for predation, as predators are much reduced in many areas. Populations of large herbivores (such as dugongs) are severely reduced, however populations of herbivorous fish remain intact.	Good
Outbreaks of disease, introduced species and pest species	Outbreaks of diseases appear to be becoming more frequent and more serious on the Great Barrier Reef. Outbreaks of pest species appear to be above natural levels in some areas.	Good

4 COMMERCIAL AND NON-COMMERCIAL USE

The Great Barrier Reef supports significant commercial industries, especially commercial marine tourism and fishing, providing employment equal to over 54 000 full-time positions. In 2006/07, Great Barrier Reef industries directly and indirectly contributed an estimated $5.4 billion to the Australian economy. Tourism (including activities in both the Great Barrier Reef and its catchment) contributed $5.1 billion, with commercial fishing contributing $139 million and recreational use (including fishing) contributing $153 million. At the same time, shipping activity through the Great Barrier Reef is a vital link in the production chain for many industries and services regional centres. Importantly, use of the Great Barrier Reef Region goes well beyond commercial activities. It is central to the culture of Traditional Owners, a major recreational area, an internationally important scientific resource and an important area for defence training.

Almost all commercial and non-commercial uses of the Great Barrier Reef Region are dependent on the biodiversity and health of its ecosystem. Use occurs across the length and breadth of the ecosystem with most use and impact concentrated inshore, near developed coasts and on coral reef habitats. The current state and trends of most uses are known, with fluctuations largely determined by global factors such as fuel prices, human health issues and economic development. There are some concerns about localised impacts and effects on some species with potential flow on effects to some ecological processes. The future cumulative effects of all use and the ecosystem-level impacts are poorly understood.

- **Commercial marine tourism** extends throughout the Great Barrier Reef (figure 4.1) but its impacts are concentrated in a few intensively managed areas. It makes a significant contribution to the presentation, management and economic value of the Great Barrier Reef.
- **Defence activities** in the Great Barrier Reef directly contribute to the training and operations of Australia's defence services. The majority have negligible impacts.

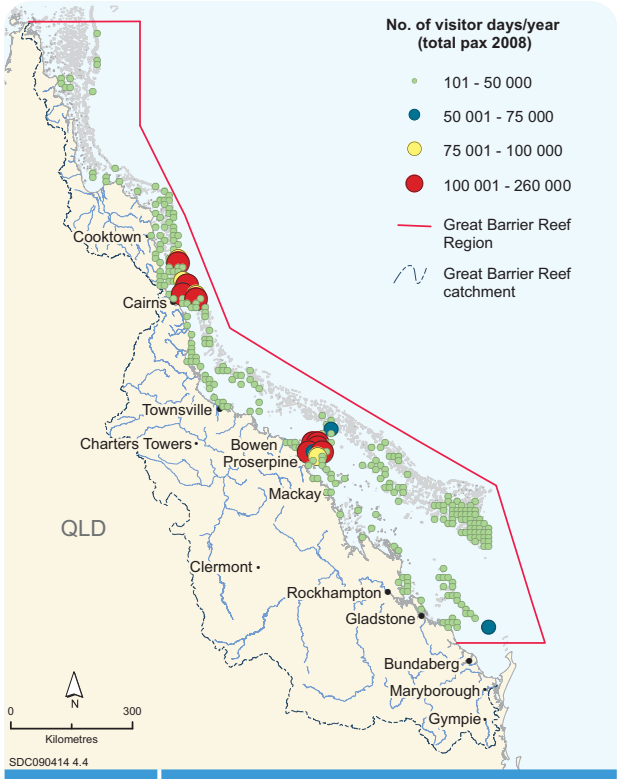


Figure 4.1 Distribution of tourism activity across the Great Barrier Reef, 2008[9]

Tourism use of the Great Barrier Reef is strongly focused on the areas offshore from Cairns and Port Douglas and around the Whitsunday islands and adjacent reefs. Around two million tourists visit the Great Barrier Reef each year. More than four in every 10 tourists are now experiencing the Great Barrier Reef with a certified high standard operator recognised by the independent Eco Certification Program. This voluntary program is additional to the mandatory management arrangements for tourism operations.

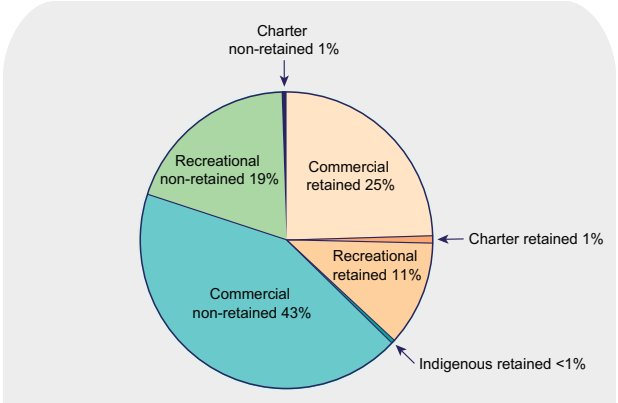


Figure 4.2 Retained and non-retained fisheries catch, Great Barrier Reef, 2007[10]

A high proportion of the 38 000 tonnes caught in the Great Barrier Reef each year is discarded. The retained catch of commercial fisheries is about twice that of the recreational retained catch. About 55 to 60 species are targeted in commercial fishing. Most species caught are carnivores (top predators and predators) or particle feeders (such as prawns). Herbivores are not generally targeted on the Great Barrier Reef.

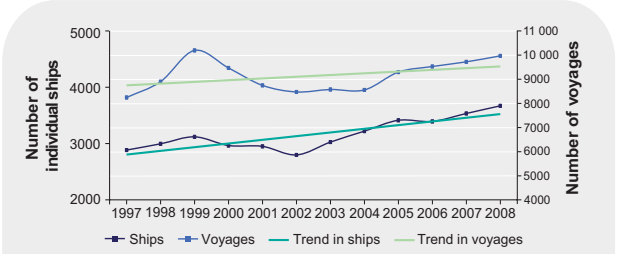


Figure 4.3 Shipping activity in the Great Barrier Reef, 1997–2008[11]

There are 10 major ports along the coast of the Great Barrier Reef and the inner shipping route is a vital part of the Queensland shipping industry. Over the last 10 years, shipping on the Great Barrier Reef has increased - both the voyages undertaken and the individual ships that operate in the Region. Improvements in shipping management have resulted in fewer major shipping incidents, despite this increase in traffic. (A voyage is defined as one passage through a section of the Great Barrier Reef.)

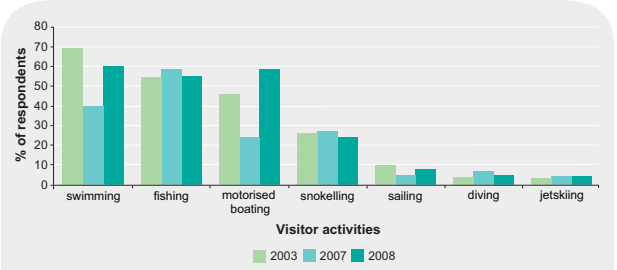


Figure 4.4 Main activities of visitors to the Great Barrier Reef[12 13]

People enjoy swimming, fishing, boating and snorkelling when they visit the Great Barrier Reef. A survey of households conducted in 2008 estimated that 14.6 million recreational visits were made to the Great Barrier Reef Marine Park in the previous 12 months by residents living within the Great Barrier Reef catchment. Visitors are consistently satisfied with their Great Barrier Reef experience and almost all people are satisfied with or unconcerned about the number of other people or vessels they see during their visit. About 60 per cent of recreational visitors visit the Great Barrier Reef between one and 10 times in a year, but a small proportion (about 15 per cent) visit the area more than 50 times a year.

- **Fishing** provides opportunities for recreation, resources for the seafood industry, and generates regional economic value. There is limited information about many targeted species and of the survival success of discarded species resulting in a poor understanding of the ecosystem effects of fishing.
- Adjacent **ports and shipping** through the Great Barrier Reef service central and northern Queensland industries and communities. Most routine shipping activities have negligible consequences. Dredging and construction of port facilities can have significant but localised impacts.
- The impacts of **recreation (not including fishing)** are mainly localised in inshore areas. Visitors to the Great Barrier Reef are consistently very happy with their visit and would recommend the experience.
- **Scientific research** improves understanding of the Great Barrier Reef and allows management to be based upon the best available information. Its impacts are concentrated primarily around research stations.
- **Traditional use of marine resources** provides environmental, social, economic and cultural benefits to Traditional Owners and their sea country. It involves a range of marine species (some of conservation concern) but levels of take are unknown. Poaching by non-Traditional Owners is a concern for Traditional Owners and management agencies. Traditional Owner aspirations are being increasingly recognised and formalised in law.

Declines in many coral reef ecosystems around the world are likely to increase the commercial and non-commercial value placed on components of the Great Barrier Reef and potentially alter use patterns in the future.

Assessment criteria	Summary	Assessment Grade			
		Very good	Good	Poor	Very poor
Benefits of use	Use of the Great Barrier Reef contributes strongly to the regional and national economy and local communities. Its economic value is derived almost exclusively from its natural resources, either through extraction of those resources or through tourism and recreation focused on the natural environment, and would be affected by declines in those resources. Millions of people visit the Great Barrier Reef every year and are very satisfied with their visit. The Great Barrier Reef is valued well beyond its local communities, with strong national and international scientific interest. The Great Barrier Reef is of major importance to Traditional Owner culture. Some users financially contribute to management.	●			
		Very low impact	Low impact	High impact	Very high impact
Impacts of use	The impacts of different uses of the Great Barrier Reef overlap and are concentrated inshore and next to developed areas. There are some concerns about localised impacts and effects on some species. In particular, species of conservation concern such as dugongs, some bony fish, sharks, seabirds and marine turtles are at risk, especially as a result of fishing, disturbance from increasing use of coastal habitats, illegal fishing, poaching and traditional use of marine resources. There is evidence that fishing is also significantly affecting the populations of some targeted species. The survival success of non-retained species is not well understood, nor are the ecosystem effects of fishing.		●		

5 FACTORS INFLUENCING THE REEF'S VALUES

The experience of the last two decades has shown that much of what will happen to the Great Barrier Reef in the future will be determined by factors external to it and to Australia. This assessment of the factors that currently and are projected to influence the Great Barrier Reef's environmental, economic and social values addresses the three major external factors – climate change, catchment runoff and coastal development plus the influence of direct use of the Region.

Many of the threats from both the external factors and those from direct use within the Great Barrier Reef are combining to cause serious impacts on the ecosystem. All these factors are significant to the ecosystem's future functioning and resilience.

Climate change Impacts from climate change have already been witnessed and all parts of the ecosystem are vulnerable to its increasing effects, with coral reef habitats the most vulnerable. The average annual sea surface temperature on the Great Barrier Reef is likely to continue to rise over the coming century and could be as much as 1 to 3°C warmer than the present average temperature by 2100. In the last decade there have been two severe mass coral bleaching events resulting from prolonged elevated sea temperatures. In addition, Great Barrier Reef waters are predicted to become more acidic with even relatively small increases in ocean acidity decreasing the capacity of corals to build skeletons (figure 5.1) and therefore create habitat for reef biodiversity in general. Sea level on the Great Barrier Reef has already risen by approximately 3mm per year since 1991. Changes in the climate also mean that weather events are likely to become more extreme and severe. Almost all Great Barrier Reef species and habitats will be affected by climate change, some seriously (figure 5.2).

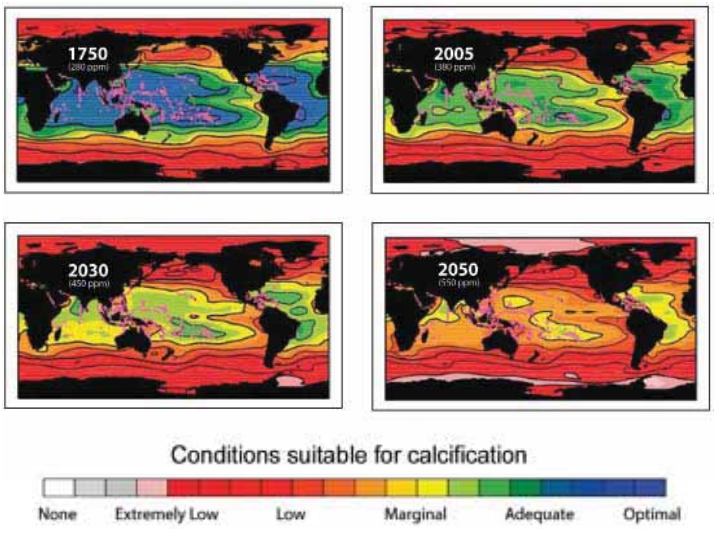


Figure 5.1 **Predicted changes in conditions suitable for calcification[14]**

In the long-term, ocean acidification is likely to be the most significant climate factor affecting the Great Barrier Reef ecosystem. Chemical changes in the ocean have already decreased oceanic pH by 0.1 units. From a current pH of 8.2 (alkaline), it is predicted that the ocean's pH could fall to about 7.8 (still slightly alkaline) by 2100. With continuing acidification of the oceans, the areas where conditions are suitable for the building of shells and skeletons will shrink and ultimately disappear. Coral reefs are shown as pink. (Modified by permission of American Geophysical Union. From Cao and Caldeira, 2008[15])

Corals live in partnership with a single-celled algae (zooxanthellae). When corals are under stress, for example when they become too hot, they expel the algae and appear bleached. If they are stressed for too long or too severely and do not regain their algae, they will die.

Coastal development Coastal development, primarily driven by mining, industry and population growth, is still significantly affecting coastal habitats that support the Great Barrier Reef (figure 5.3), connectivity between habitats and the water quality of the Great Barrier Reef. In the past 150 years, the area of the catchment that is intensively farmed has quadrupled. Over the same period, 53 000 mining leases have been granted in Queensland, with more than 3000 current as at October 2008. Mining and industrial activity has driven population growth throughout the catchment at rates faster than the Australian average, especially along the coast. The current population of the catchment is

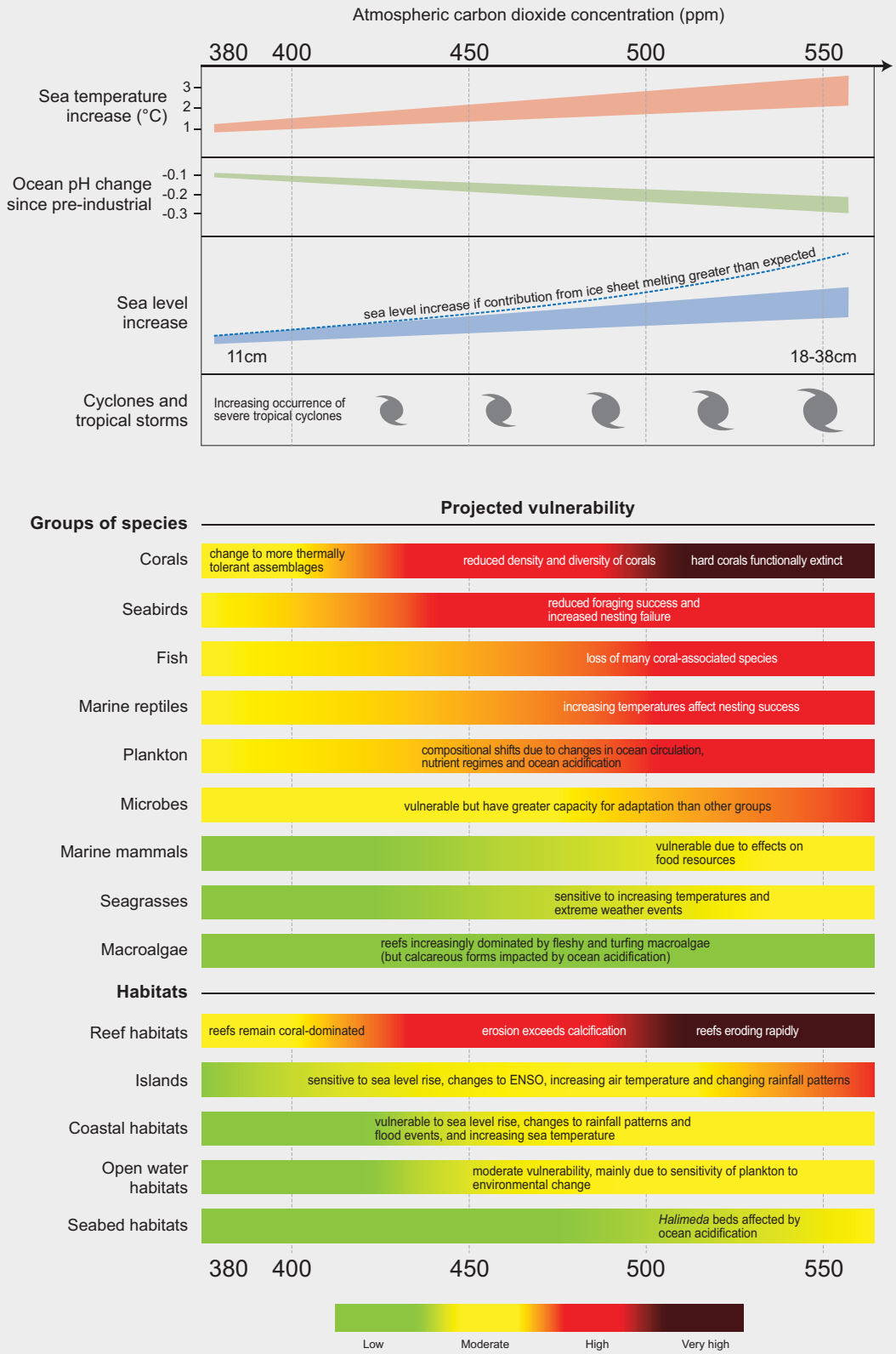


Figure 5.2 **Projected vulnerabilities of components of the Great Barrier Reef ecosystem to climate change**

This diagram shows projected vulnerability across a range of carbon dioxide concentrations. Changes in sea temperature, pH and sea level are indicative only, intended to demonstrate the scientific uncertainty around the likely values. The worst case scenario presented (550ppm) is equivalent to the Intergovernmental Panel on Climate Change scenario B1 which was predicted to be reached by about 2100. (Figure adapted from values presented in IPCC 2007[16], Hoegh-Guldberg *et al.* 2007[17], and Johnson and Marshall[18])

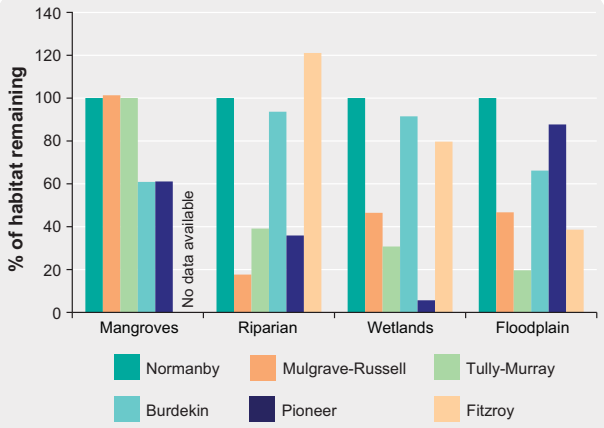


Figure 5.3 **Loss of habitats that support the Great Barrier Reef[19]**

Important coastal habitats have been largely lost from some major river systems within the Great Barrier Reef catchment particularly in more developed catchments such as the Mulgrave-Russell, Tully-Murray and Pioneer. The percentage of habitat remaining is calculated in comparison to the predicted area of each habitat prior to European settlement.

about 1 115 000 and it is expected to grow to 1 577 000 by 2026 (figure 5.4). A growing population leads to an increase in infrastructure and services and, if poorly planned and implemented, these constructions can further modify the coastal environment and cause sedimentation, water quality issues and drainage impacts. Mining and industry is also fuelling growth in ports and shipping with proposals for significant expansion in at least seven of the 10 major trading ports along the Great Barrier Reef coast.

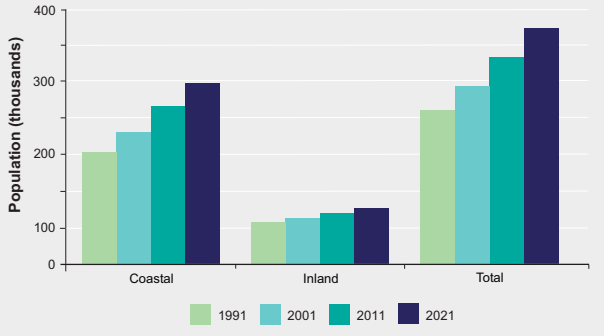


Figure 5.4 **Population growth and predictions in the Great Barrier Reef catchment[20]**

There are 72 coastal urban centres directly adjacent to the Great Barrier Reef coast, with four centres of populations greater than 50 000. Populations are predicted to continue growing throughout the Great Barrier Reef catchment, especially along the coast.

Catchment runoff The Great Barrier Reef receives the runoff from 38 major catchments which drain 424 000 km^2 of coastal Queensland. Over the last decade, the declining quality of water entering the Great Barrier Reef has been recognised as a major threat to the ecosystem. However,

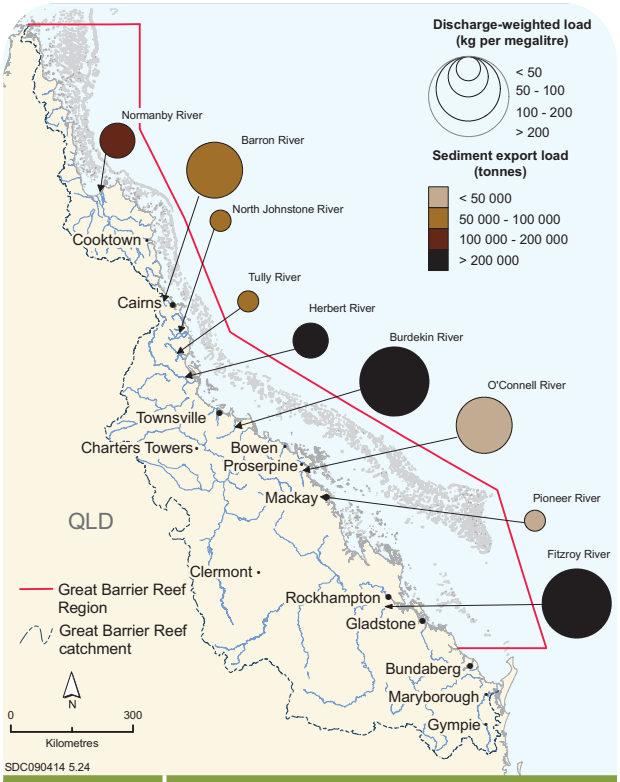


Figure 5.5 **Sediment loads entering the Great Barrier Reef, 2005/06 wet season[21]**

Over the past 150 years, sediment inflow onto the Great Barrier Reef has increased as a result of extensive forest clearing, especially of lowland rainforests and wetlands for sugar cane and of dryland forest for cattle. Catchments with large pastoral areas (Herbert, Burdekin and Fitzroy Rivers) deliver the most sediments to the Great Barrier Reef, in the highest concentrations. Soil erosion in cane farming areas has reduced since burnt cane harvesting was replaced by green harvesting and trash blanketing.

despite improvements in local land management, the quality of catchment runoff entering the Great Barrier Reef continues to cause deterioration in the water quality in the Great Barrier Reef Region. Most sediment entering the Great Barrier Reef comes from catchments with large pastoral areas such as the Burdekin and Fitzroy Rivers (figure 5.5). The load of total nitrogen delivered to the Great Barrier Reef is mainly derived from high intensity land use, fertilised cropping and urban areas. In particular, high intensity cropping is the major contributor of dissolved inorganic nitrogen (figure 5.6). Only a small proportion of the load is derived from natural areas. Pesticides from agricultural activities are present in the Great Barrier Reef ecosystem and their impacts are largely unknown. These increased concentrations of suspended sediments and agricultural chemicals are having significant effects in inshore areas of the Great Barrier Reef, close to agricultural areas. Much continues to be done to improve water quality entering the Great Barrier Reef but it will be decades before the full benefits are seen. A decline in inshore habitats will have economic and social implications for coastal communities.

Direct Use The impacts of different commercial and non-commercial uses of the Great Barrier Reef Region overlap and are concentrated inshore and next to developed areas (see

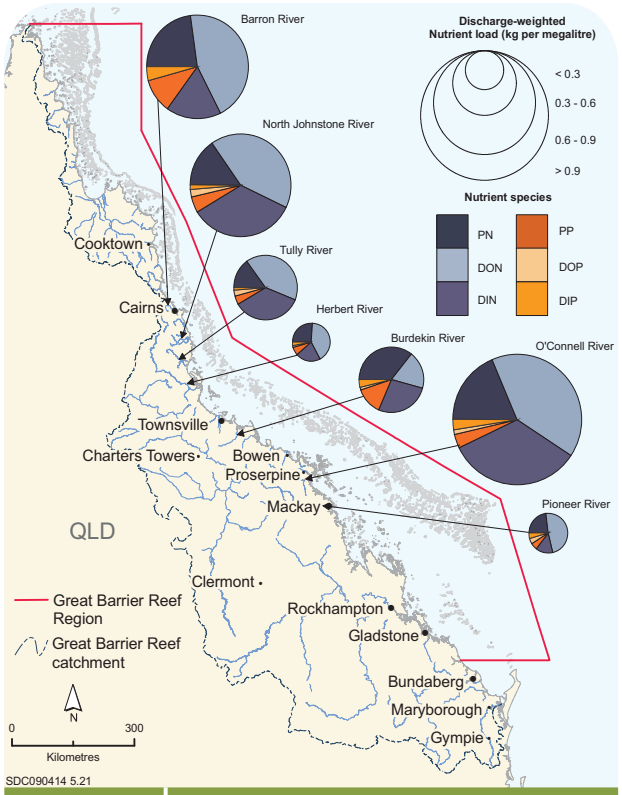


Figure 5.6 Nutrient loads entering the Great Barrier Reef, 2005 dry season and 2005/06 wet season[21]

The total nutrient load delivered into the Great Barrier Reef is now greatly increased. Most nutrients flowing into the Great Barrier Reef are from the wetter, more intensively cropped catchments (Barron, North Johnstone and O'Connell Rivers). PN - particulate nitrogen, DON – dissolved organic nitrogen, DIN – dissolved inorganic nitrogen, PP – particulate phosphorous, DOP – dissolved organic phosphorous, DIP – dissolved inorganic phosphorous.

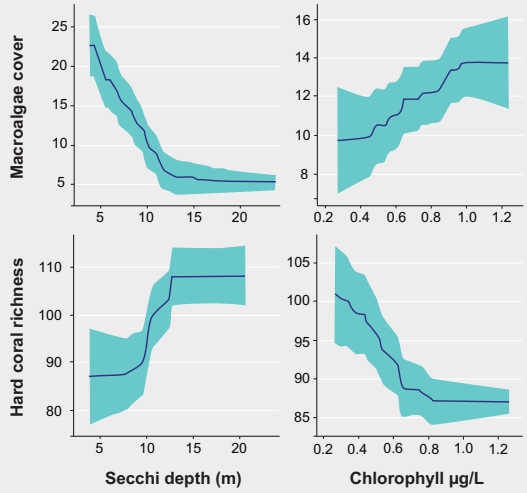


Figure 5.7 The effect of declining water quality on the ecosystem[22]

Changes in water quality affect the biodiversity of reef systems. Higher concentrations of pollutants such as suspended sediments, nitrogen and phosphorus, indicated by higher chlorophyll concentrations and lower water clarity (measured as reduced secchi depth readings), result in more macroalgae and less hard coral diversity. Such a shift drastically affects the overall resilience of the ecosystem as a dominance of macroalgae reduces the chance for new hard corals to establish and grow. Blue shading indicates 95% confidence intervals.

Chapter 4). Direct use of the Region is likely to be having minor, if any, impact on many ecosystem processes and some uses may have positive benefits through improving understanding and contributing to management. However, there are some key groups of species and ecological processes that are affected by direct use including fish populations, some species of conservation concern, predation, herbivory and particle feeding.

Assessment criteria	Summary	Assessment Grade: Very low impact	Low impact	High impact	Very high impact
Impact on environmental values	Climate change, particularly rising sea temperatures and ocean acidification, has already affected the Great Barrier Reef ecosystem and over the next 50 years it is likely to significantly affect most components of the ecosystem. The Great Barrier Reef, especially much of its inshore area, is being affected by increased nutrients, sediments and other pollutants in catchment runoff, mainly from diffuse agricultural sources, despite recent advances in agricultural practices. Coastal development is contributing to the modification and loss of coastal habitats that support the Great Barrier Reef. As the coastal population continues to grow there will be increasing use of the Great Barrier Reef and therefore the potential for further damage. Direct use of the Region is impacting on some environmental values.			◉	
Impact on economic values	Changes to the Great Barrier Reef ecosystem are likely to have serious economic implications for reef-dependent industries, such as tourism and fishing, and for adjacent communities. Perceptions about the health of the ecosystem also affect its attractiveness for tourism and recreation and, thus, its marketability. An increasing coastal population is likely to increase the economic value of Reef-based activities. The economic benefits of direct use will be affected by the impacts of external factors.			◉	
Impact on social values	An increasing coastal population is likely to increase recreational use of the Region and change people's experiences of the Great Barrier Reef with increased congestion at popular recreation locations and competition for preferred sites. A decline in inshore habitats as a result of polluted water will have social implications for dependent industries and coastal communities. Traditional Owners are concerned about rising temperatures altering the seasonality and availability of marine resources as well as the potential loss of totemic species.		◉		

6 EXISTING PROTECTION AND MANAGEMENT

Both the Australian and Queensland Governments have direct legislative responsibilities within the Great Barrier Reef Region. A joint management arrangement between the Australian and Queensland Governments ensures integrated field management of the two marine protected areas, plus protected areas on the islands within the Region. In addition, many other government agencies, stakeholders and community members contribute to protection and management of the Great Barrier Reef, both on the water and in the catchment.

Marine Parks field management is a joint operation by Australian and Queensland Government agencies.

A broad assessment of the effectiveness of the management activities currently undertaken by all these contributors is an important component in determining the major risks that remain for the Great Barrier Reef and predicting its outlook.

In order to ensure independence, the Great Barrier Reef Marine Park Authority commissioned two external assessors to undertake the assessment, including all activities that contribute to protection and management of the Great Barrier Reef.

Management actions that take place both inside and outside the Great Barrier Reef Region were examined to the extent that they influence the protection and management of the Great Barrier Reef ecosystem. The assessment followed the framework for evaluating management of protected areas developed by the International Union for the Conservation of Nature and Natural Resources (IUCN) World Commission on Protected Areas, based on a management cycle in which management is continuously evaluated and refined (figure 6.1).

Detailed information on current management was collated by both Australian and Queensland Government agencies and provided to the assessors. The assessors were also provided with advice on management effectiveness from the Great Barrier Reef Marine Park Authority's Local Marine Advisory Committees and Reef Advisory Committees, plus the Outlook Forum. The assessment examined 12 broad management topics and the full report is available online at *www.gbrmpa.gov.au*.

The independent assessors found that management effectiveness challenges are evident for those management topics that are broad in scale and complex socially, biophysically and jurisdictionally (for example climate change, coastal development, water quality and fishing). Effectiveness is strongest on issues that are limited in scale, intensity or complexity (for example defence and scientific research). Their key findings were:

- Many **biodiversity protection** measures, for example zoning plans, are making a difference, but there is no overarching framework to guide and coordinate management actions.

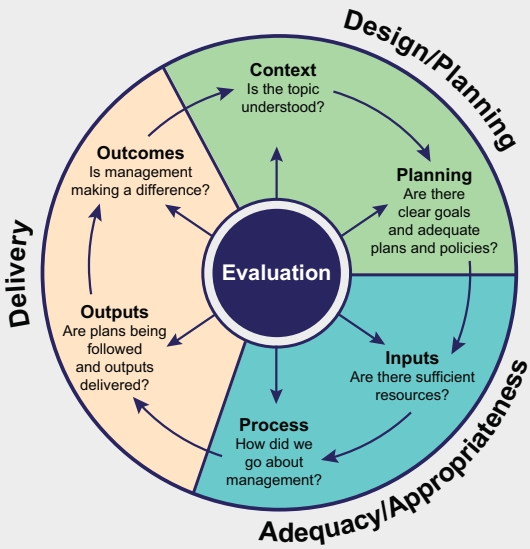


Figure 6.1 The management cycle

Effective management is a closed loop where issues are considered, plans are made, resources are expended, proper processes are followed and products and services are delivered, all leading to outcomes that address the issues. An assessment of each of the steps in this management cycle provides a complete picture of management effectiveness. For example, assessing only outcomes may indicate a particular objective has been achieved but leaves it unclear as to whether this was due to good luck or good management. Conversely, it may be hard to understand why desired outcomes were not achieved unless all management steps are examined. (Adapted from Hockings et al. 2006[23])

- A lack of integrated planning, resources and enforcement in managing **coastal development** is compromising protection of the Great Barrier Reef.
- The broad threats to the Great Barrier Reef from **climate change** are understood and management emphasis is on adaptation and improving resilience to change. (This assessment was only in relation to management measures undertaken specifically to protect and manage the Great Barrier Reef.)
- Coordinated and professional management of **commercial marine tourism** ensures a sustainable industry that contributes to Marine Park management.
- Thorough assessment, coordination and planning mean that **defence activities** are well managed in the Great Barrier Reef.
- A lack of information and coordination, plus variable uptake of best practice management, is limiting the effectiveness of **fisheries** management.
- There is strong awareness of **heritage** values and protection arrangements are in place.
- Comprehensive management and coordination has minimised **shipping** incidents. **Ports** management appears to have protected natural values, but there is a lack of overall strategic planning.
- Management of **recreation (not including fishing)** is generally indirect and coordination is lacking.
- **Scientific research** activities are environmentally sustainable and are enhancing community understanding.
- Improvements are being made in the management of **traditional use**, including joint resource use agreements, but progress is slow.
- Substantial resources are being provided to improve the **water quality** of the Great Barrier Reef, but progress is slow and patchy.

Assessment criteria	Summary	Assessment Grade: Very good	Good	Poor	Very poor
Understanding of context	Understanding of values, threats, national and international influences and stakeholders is strong for all management issues assessed. This reflects a solid information and research base and a very mature understanding of the key values of the Great Barrier Reef in both a national and international context and the actual and potential threats to those values. Understanding of stakeholders is consistently strong across all issues (in fact, it shows the strongest performance across the entire range of assessment criteria).	●			
Planning	Planning performance tends to be strongest where there are few organisations or levels of governance involved in the planning process. There are well developed planning systems in place for all issues except for coastal development where the fractured nature of the planning regime causes problems. Lack of consistency across jurisdictions is the weakest aspect of planning.		●		
Financial, staffing and information inputs	Adequacy of inputs is quite variable across the management issues, being particularly strong for defence, climate change and research and weak for coastal development. Adequacy of socio-economic and access to relevant Traditional Owner knowledge is a problem for most issues and one of the worst performing criteria across the whole assessment.			●	
Management systems and processes	Management processes are particularly strong for defence, tourism and research and weakest for coastal development and water quality. Performance monitoring, addressing cumulative impacts and application of socio-economic and Traditional Owner knowledge are a problem for most issues. The extent to which cumulative impacts are being addressed is the weakest indicator across the entire assessment. Stakeholder engagement and application of biophysical information are amongst the strongest aspects of management across all issues.	●			
Delivery of outputs	Delivery of desired outputs is weakest for coastal development and water quality and strongest in relation to defence, tourism and research. The knowledge base of the management agencies and community has consistently improved. While the majority of management programs are progressing satisfactorily (with the exception of coastal management and water quality), timeframes frequently slip and it is not yet clear that the programs are achieving all their desired objectives.		●		
Achievement of outcomes	Achievement of desired outcomes (values protected, threats reduced, long-term environmental and economic sustainability) is very variable across issues. Objectives in relation to community understanding of issues and development of effective partnerships are being achieved. Overall, greatest concern in relation to achievement of desired outcomes relates to climate change.			●	

7 ECOSYSTEM RESILIENCE

Ecosystem resilience refers to the capacity of an ecosystem to recover from disturbance or withstand ongoing pressures. It is a measure of how well an ecosystem can tolerate disturbance without collapsing into a different state that is controlled by a different set of processes. Resilience is not about a single ideal ecological state, but an ever-changing system of disturbance and recovery.

Coral reef and other tropical marine ecosystems are subject to frequent disturbances, from threats such as cyclones, crown-of-thorns starfish outbreaks and influxes of freshwater as well as from a range of human activities. These events often damage, stress or kill components of the ecosystem. Given enough time, a resilient ecosystem will be able to fully recover from such disturbances and become as biodiverse and healthy as before the impact (figure 7.1). Similarly, a resilient ecosystem may be able to absorb the stresses caused by these disturbances with little or no sign of degradation.

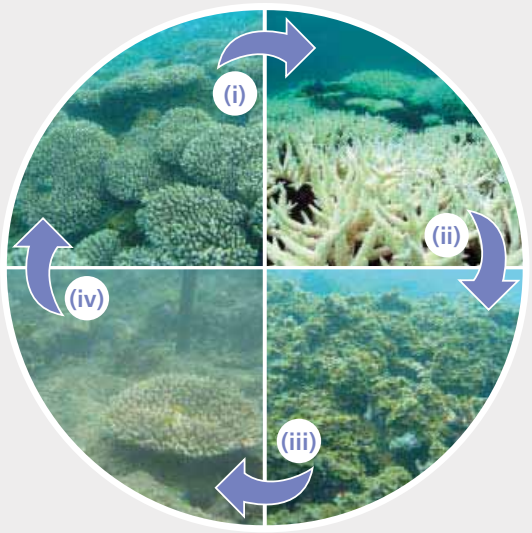


Figure 7.1 **Resilience of a coral reef habitat**

A healthy coral reef will recover from disturbances and return to its usual state. For example, in the Keppel Islands in 2006, abundant healthy corals (i) were bleached (ii), and subsequently overgrown by algae (iii). However, over the subsequent two years, surviving coral fragments regrew, and new corals settled and grew (iv), so that the reef is gradually returning to coral dominance (i). Human impacts may reduce the resilience of the system, and once disturbed, a less resilient ecosystem may fail to recover and may remain permanently in an algal dominated state (iii). (Photos i and iii by G. Diaz-Pulido, iv by L. McCook).

The overall condition of the Great Barrier Reef has been considered by a range of scientific experts from a variety of perspectives and their overall consensus is that, while the Great Barrier Reef has suffered significant degradation compared to its pristine condition, it is in far better health than most other reefs around the world.

At the scale of the Great Barrier Reef ecosystem, most habitats or species groups are in good condition; however there have been declines in species that play key ecological roles. These declines have been mainly due to direct use of the ecosystem, land management practices in the catchment, or declining environmental variables because of climate change.

There are concerns about aspects of the ecosystem's health. Sea temperature, sea level and sedimentation are all expected to increase because of climate change and catchment runoff, causing deterioration to the ecosystem. Changes in the chemical processes of ocean acidity, nutrient cycling and pesticides now affect large areas of the ecosystem. At the same time, reductions in some predator and herbivore populations may have already affected ecological processes, although the specific effects remain unknown. Outbreaks of diseases appear to be becoming more frequent and more serious.

The vulnerabilities of the ecosystem to climate change, coastal development, catchment runoff and some aspects of fishing mean that recovery of already depleted species and habitats requires the management of many factors. In some instances, the ecosystem's ability to recover from disturbances is already being compromised with either reduced population growth rates or no evidence of recovery.

A series of case studies showcase the extent to which some key functional habitats (coral reefs, lagoon floor) and ecological processes such as particle feeding (black teatfish), herbivory (urban coast dugongs) and predation (coral trout) have demonstrated recovery after human and natural disturbances. They also showcase some specific management actions that have occurred to address declines in two species (loggerhead turtles, humpback whales). The key findings of the case studies are:

- **Coral reef habitats** are recovering from multiple short-term disturbances (figure 7.2). Predicted increases in frequency and severity of disturbances will likely reduce the capacity for coral reefs to recover.
- Some **lagoon floor habitats** previously at risk are recovering from disturbances. Full recovery will take decades.
- Populations of **black teatfish** are low and are not recovering.

- The number and size of **coral trout** is increasing rapidly in zones closed to fishing.
- Trawl turtle excluder devices have arrested the decline in **loggerhead turtles** but other pressures will influence their recovery.
- The **urban coast dugong** population may take more than a century to recover and is subject to many continuing pressures.
- **Humpback whales** appear to be recovering at their maximum population growth rate 45 years after whaling stopped (figure 7.3).

The independent assessment of existing protection and management found that management is most challenging for those topics which are broad in scale (often well beyond the boundaries of the Great Barrier Reef) and complex. For example addressing climate change impacts requires global responses; coastal development and water quality require coordinated actions throughout the catchment. The management of fishing is socially and biophysically complex. The assessment indicated that addressing cumulative impacts is one of the least effective areas of management.

Notwithstanding these challenges, many of the management measures employed in the Great Barrier Reef Region and beyond are making positive contributions to resilience (as evidenced by recovery of some species and habitats). The Zoning Plans for both the Great Barrier Reef Marine Park and the adjacent Great Barrier Reef Coast Marine Park that were introduced in 2004 are the most significant action taken to enhance biodiversity protection. They provide a robust framework for management and are already demonstrating positive results. Compliance with and public support for these and other measures is a critical factor in building the resilience of the ecosystem.

Taken together, available information indicates that the overall resilience of the Great Barrier Reef ecosystem is being reduced. Given the effectiveness of existing protection and management in addressing the most significant pressures on the ecosystem (principally arising from outside the Region), this trend is expected to continue.

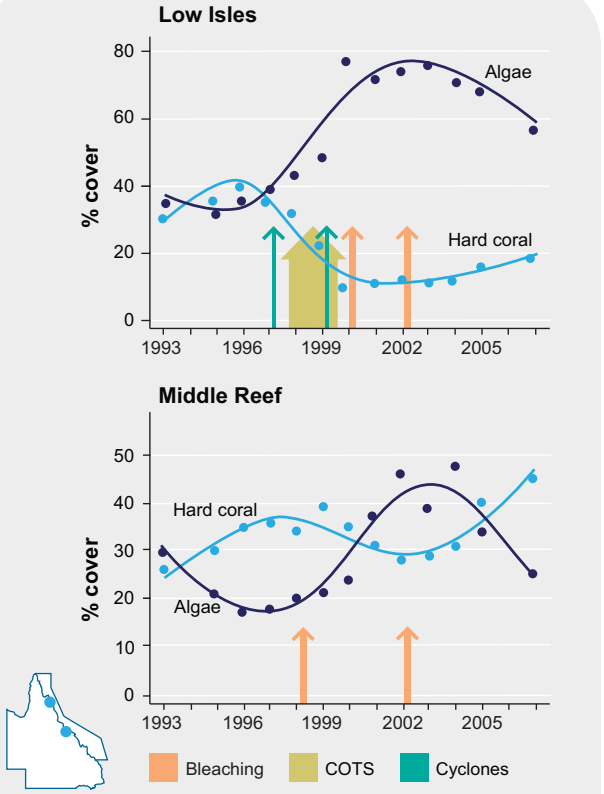


Figure 7.2 Recovery of coral following various disturbances

Multiple disturbances of bleaching, cyclones and crown-of-thorns starfish outbreaks (COTS), reduce the capacity of a reef to recover abundant corals, as seen in the slower recovery of hard coral at Low Isles. In comparison, Middle Reef experienced two bleaching events during the same time period and recovered well. (Adapted from Sweatman et al. 2008[1])

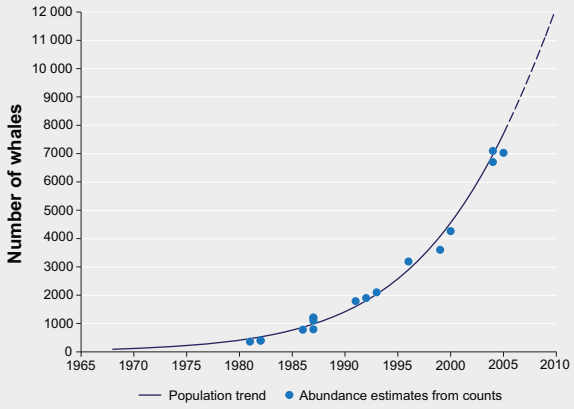


Figure 7.3 Recovery of the eastern Australian humpback whale population since whaling ceased in the 1960s

Humpback whales appear to be recovering steadily, with the population that migrates up the east coast of Australia each winter increasing at about 10 per cent per year. (The data to construct this graph was collated by Dave Paton (Centre for Cetacean Research and Conservation) and Dr Mike Noad (University of Queensland) using individual population estimates extracted from several sources[24 25 26 27 28 29 30 31])

Assessment criteria	Summary	Assessment Grade: Very good	Good	Poor	Very poor
Recovery after disturbance	Some disturbed populations and habitats have demonstrated recovery after disturbance (for example coral reefs, lagoon floor, coral trout, humpback whales). For some species recovery has been very slow (for example loggerhead turtles) or not evident (black teatfish, dugongs) and is dependent on the removal of all major threats. Increasing frequency and extent of threats are likely to reduce the resilience of species and habitats.		●		

8 RISKS TO THE REEF

To assess the risks to the Great Barrier Reef ecosystem, the Australian Standard for risk assessment (AS/NZS 4360:2004) was followed for a set of 41 identified threats. The best available information was used to determine an overall risk level for each threat, based on both its likelihood and consequence. Such a risk assessment can only include those threats to the ecosystem that are known and identified. There is likely to be more unknown and unanticipated threats that have not been considered.

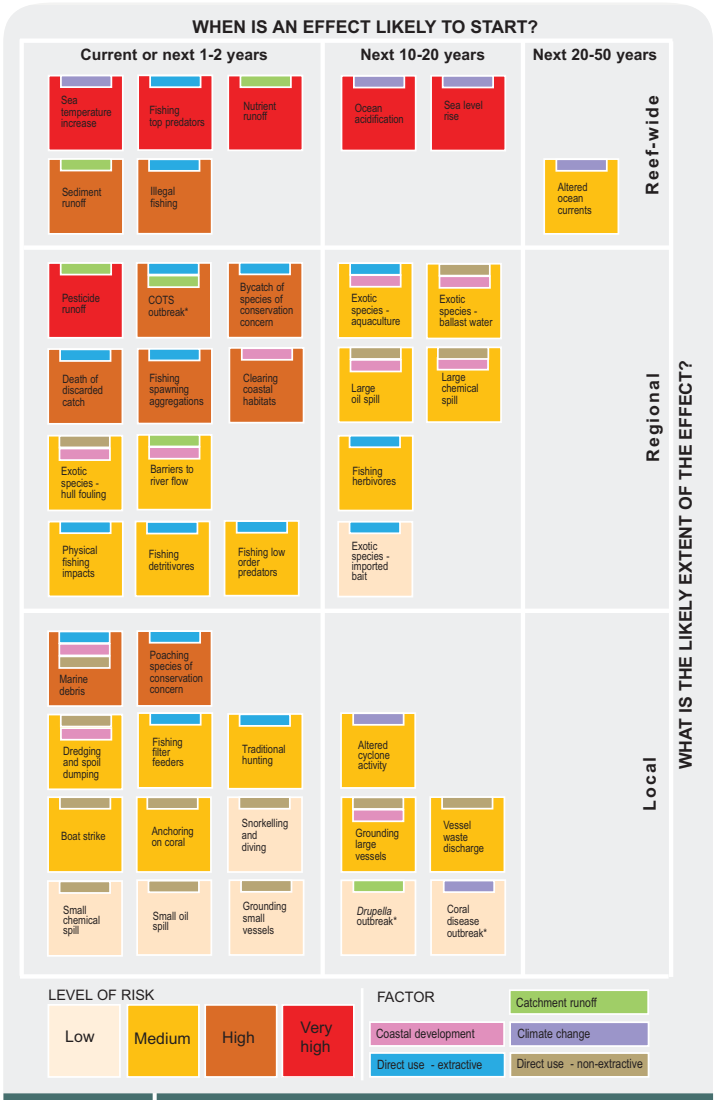


Figure 8.1 **Level of risk, extent and timing of threats and their driving factors**

Climate change and catchment runoff are driving most of the very high risk threats to the ecosystem. Most of the threats that present a very high risk to the Great Barrier Reef ecosystem are already having an effect (left hand column) or are expected to in the next 10-20 years (middle column). In addition, the threats assessed as very high risk are expected to have an effect Reef-wide (top row). Those threats for which the factors are not clearly known are marked with an asterisk (*).

Based on the outcomes of the risk assessment (figure 8.1), the greatest threats to the Great Barrier Reef ecosystem are:

- **Climate change:** increasing sea temperature, ocean acidification and rising sea level
- **Catchment runoff:** nutrients, pesticides (including herbicides) and sediments entering the Great Barrier Reef
- **Coastal development:** clearing or modifying wetlands, mangroves and other coastal habitats and ingestion of or entanglement in marine debris causing death in species of conservation concern.
- **Direct use – extractive:** extraction of top predators by fishing (e.g. sharks), incidental catch during fishing of species of conservation concern, illegal fishing or collecting (foreign or domestic), death of discarded species during fishing or collecting, fishing in unprotected fish spawning aggregations and poaching (illegal hunting) of species of conservation concern.

The threats associated with direct use of the Great Barrier Reef Region that do not involve extraction of its resources are generally of lower risk to the ecosystem.

On a positive note, several threats previously considered high risk are now assessed as low risk due to effective management arrangements. For example, the physical impacts of fishing are now a medium risk because of the management arrangements for trawling. The risk of damage

Threats to the Great Barrier Reef ecosystem associated with tourism activities have been significantly reduced and are now considered to be generally low risk.

to corals and other organisms from anchoring, vessel groundings and diving and snorkelling activities has been reduced by improved management of tourism activities, site management and education.

The individual very high risk threats of increasing sea temperature, ocean acidification and rising sea level will act across the entire Region and their impact will be compounded by each other and by other existing regional and local threats. The most serious, regional-scale risks of catchment runoff, coastal development and some aspects of extractive use have the potential to work in combination to weaken the resilience of the Great Barrier Reef and therefore its ability to recover from serious disturbances (such as major coral bleaching events) that will become more frequent in the future. The nearshore environment next to developed areas is the most at risk.

For the factors of climate change, catchment runoff and coastal development, the origins of the threats are outside the Great Barrier Reef Region (either global or within the Great Barrier Reef catchment). Management of these factors was independently assessed as some of weakest of all the management topics considered, especially in terms of outcomes (figure 8.2). The threats associated with extractive use (such as from fishing, some traditional use, some scientific research) originate from within the Great Barrier Reef Region. Like the other high risk factors; existing management of these factors was independently assessed as amongst the weakest, especially in terms of outcomes (for fishing) and financial, staffing and information inputs (for fishing and traditional use). Direct use of the Great Barrier Reef Region that is not extractive (i.e. commercial marine tourism, defence, shipping, recreation (not including fishing), some scientific research and some traditional use) is generally more effectively managed and is assessed as a lower risk to the ecosystem.

Threat-focused management measures are significantly reducing the risk to the Great Barrier Reef ecosystem from land-based aquaculture such as this prawn farm near the mouth of the Burdekin River.

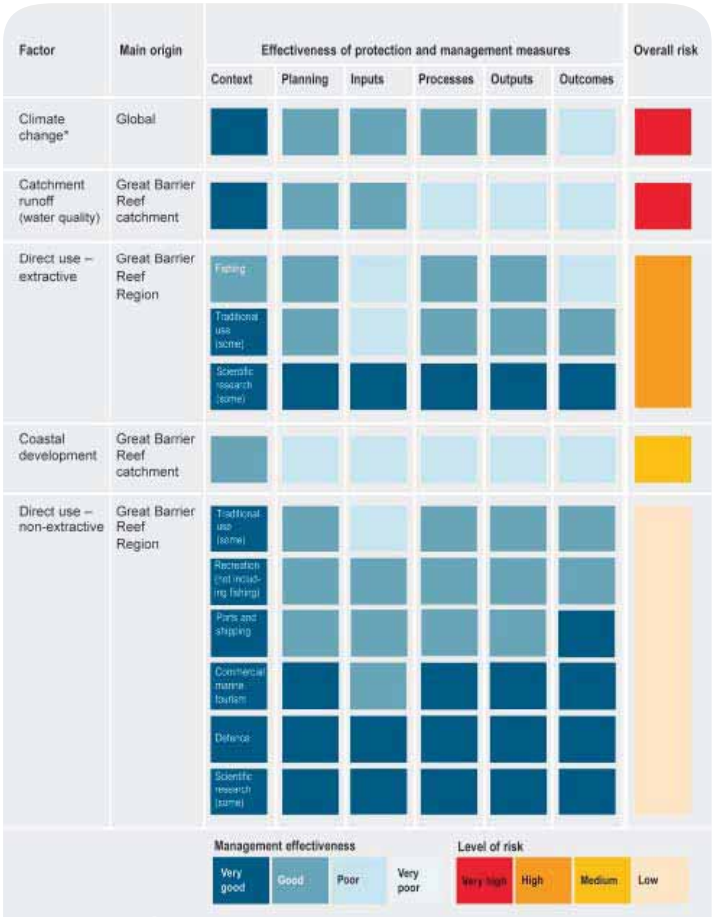


Figure 8.2 **Effectiveness of existing management for identified risk factors**

Except for direct extractive use of the ecosystem, the factors that present the highest overall risk to the Great Barrier Reef ecosystem have their origins outside the Great Barrier Reef Region. The effectiveness of management for the four highest risk factors are some of the weakest of the management topics assessed in an independent assessment. (*) The assessment of management effectiveness for the topic of climate change is only in relation to management measures undertaken specifically to protect and manage the Great Barrier Reef.

Assessment criteria	Summary	Assessment Grade			
		Low risk	Medium risk	High risk	Very high risk
Overall threat to ecosystem	The ecosystem is at serious risk from the compounding impacts of climate change, catchment runoff, coastal development and extractive use. Of the many other threats to the Great Barrier Reef ecosystem, most present a small risk individually, but combine to further reduce ecosystem resilience. Other threats are effectively managed and are now assessed as a much reduced risk.			○	

9 LONG-TERM OUTLOOK

The outlook for the Great Barrier Reef ecosystem, along with most other coral reef ecosystems, is at a crossroad, and it is decisions made in the next few years that are likely to determine its long-term future. Unavoidably, future predictions of climate change dominate most aspects of the Great Barrier Reef's outlook over the next few decades. The extent and persistence of the damage will depend to a large degree on the extent to which climate change is addressed worldwide and on the resilience of the ecosystem in the immediate future.

Climate change Many ecosystem components are already showing some effects from climate change (for example increased frequency and severity of coral bleaching and decreased density of coral structures). It is only with atmospheric concentrations of carbon dioxide between current levels and about 400ppm that the key groups of species and habitats of the Great Barrier Reef have low or moderate vulnerability to climate change. If the atmospheric concentration of carbon dioxide increases beyond these levels then there will be serious consequences for the Great Barrier Reef. At a concentration of 500ppm, it is predicted that many components of the Great Barrier Reef ecosystem would be highly vulnerable, including seabirds, fish, marine reptiles and plankton. At about this concentration of carbon dioxide, hard corals would likely become functionally extinct and coral reefs would be eroding rapidly. It is predicted that the progress of degradation will not be linear, rather ecological responses to climate change will likely occur in a series of abrupt steps separated by intervals of relatively minor change.

Coral reef habitats are particularly vulnerable to climate change and are likely to be severely impacted in coming decades.

Catchment runoff The Great Barrier Reef, especially much of its inshore area, is being affected by increased sediments, nutrients and pesticides in catchment runoff mainly from diffuse agricultural sources. With recent advances in agricultural practices and additional government programs, there has been a reduction in sediment and nutrient inputs into some coastal river systems, but a long lag time is expected before there are positive effects on marine water quality.

Most of the sediments and nutrients entering the Great Barrier Reef are delivered during flood events such as here at Taylors Beach (the outlet for the Herbert River) near Ingham. Recent flooding from the Great Barrier Reef catchment has resulted in elevated nutrient concentrations in river plumes reaching mid-shelf reefs.

Coastal development Coastal development significantly affects the Great Barrier Reef. A main driving factor is the increasing human population in the Great Barrier Reef catchment. Current projections estimate that nearly 1.5 million people will reside in the Great Barrier Reef catchment by 2026, a 40 per cent increase from the current population. Without adequate planning and careful environmental management, this growth could increase pollution and sedimentation, decrease water quality and change the natural drainage channels. The growth in human population is likely to substantially increase use of the Great Barrier Reef, particularly in areas close to population centres.

Many coastal habitats, such as those at the location for this refinery near Gladstone, have been affected by industrial development.

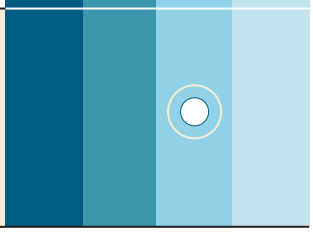
Direct use – extractive The lack of information about some target species, the fate of non-retained catch and the incidental catch of species of conservation concern means that the ecosystem level impacts of fishing are not well understood. Progress towards application of best practice management across all fisheries is being made, but not rapidly. Illegal fishing pressure, by foreign or domestic fishers, can work against management arrangements to protect the ecosystem. Changes in global fisheries production patterns are likely to increase demand for wild caught seafood and drive a diversification in the species targeted and the areas fished and increase the likelihood of illegal fishing.

The Great Barrier Reef Marine Park is considered by many around the world as a leading example of world's best practice management. Building on these existing arrangements, several major management initiatives are underway to further address the key threats to the Great Barrier Reef ecosystem. These actions and the degree to which they are effectively implemented will strongly influence the Great Barrier Reef's resilience in the future:

- The continued effectiveness of the **Zoning Plan** relies in part on the continued enforcement of zoning arrangements and ensuring reef users are aware of the Plan and its provisions.
- Effective implementation of actions under ***Reef Water Quality Protection Plan*** and the ***Reef Rescue*** initiative will contribute to improvement in water quality; however, these improvements are likely to take many years to be translated into measurable changes in ecosystem function.
- To ensure that Queensland's system for **planning and development** is responsive to its rapidly changing needs, the Queensland Government has implemented a planning reform initiative, the culmination of an extensive review of planning and development in Queensland.
- In 2008, the Queensland Government committed to implementing revised management arrangements for the **East Coast Inshore Finfish Fishery**. Measures were established to better manage the potential increasing recreational fishing pressure resulting from population growth. The management arrangements also focus on the commercial large mesh (gill) net fishery.
- As part of the *Reef Rescue Plan*, $10 million has been allocated to the development of land and sea country **Indigenous partnerships** to strengthen communications between local communities, managers and stakeholders; build a better understanding of Traditional Owner issues relating to the management of the Great Barrier Reef; and improve the sustainability of the traditional use of marine resources, especially where it is focused on species of conservation concern.
- The focus of the ***Great Barrier Reef Climate Change Action Plan, 2007-2012*** is to increase knowledge about the implications of climate change for both the Great Barrier Reef and the people who depend upon it, and to develop and support strategies to foster adaptation and minimise impacts through improving and maintaining resilience.

Variations in ecosystem response to the threats will occur along the length and width of the Great Barrier Reef. Such regional differences are now observable and are likely to become more obvious over time. Generally, the areas at most significant risk are those closest to already developed areas that have already deteriorated more because of catchment runoff and coastal development. For some of the threats related to climate change, southern areas of the Great Barrier Reef Region, especially inshore, are predicted to be the most vulnerable.

Ultimately, if changes to the world's climate become too severe, no management actions will be able to climate-proof the Great Barrier Reef ecosystem.

Assessment criteria	Summary	Assessment Grade
		Very good / Good / Poor / Very poor
Outlook for the Great Barrier Reef ecosystem	Despite the introduction of significant protection and management initiatives, the overall outlook for the Great Barrier Reef is poor. Even with the recent initiatives to improve resilience, catastrophic damage to the Great Barrier Reef ecosystem may not be averted. Building the resilience of the Great Barrier Reef ecosystem will give it the best chance of adapting to and recovering from the serious threats ahead, especially from climate change. Given the strong management of the Great Barrier Reef, it is likely that the ecosystem will survive better than most other reef ecosystems around the world.	

As descendants, we have a lifelong spiritual and physical connection to the land and sea - every living thing is connected through the circle of life. We have a lifelong responsibility to our ancestors to care for land and sea country.

Woppaburra Aspirational Statement
as part of the Woppaburra Traditional Use of Marine Resource Agreement

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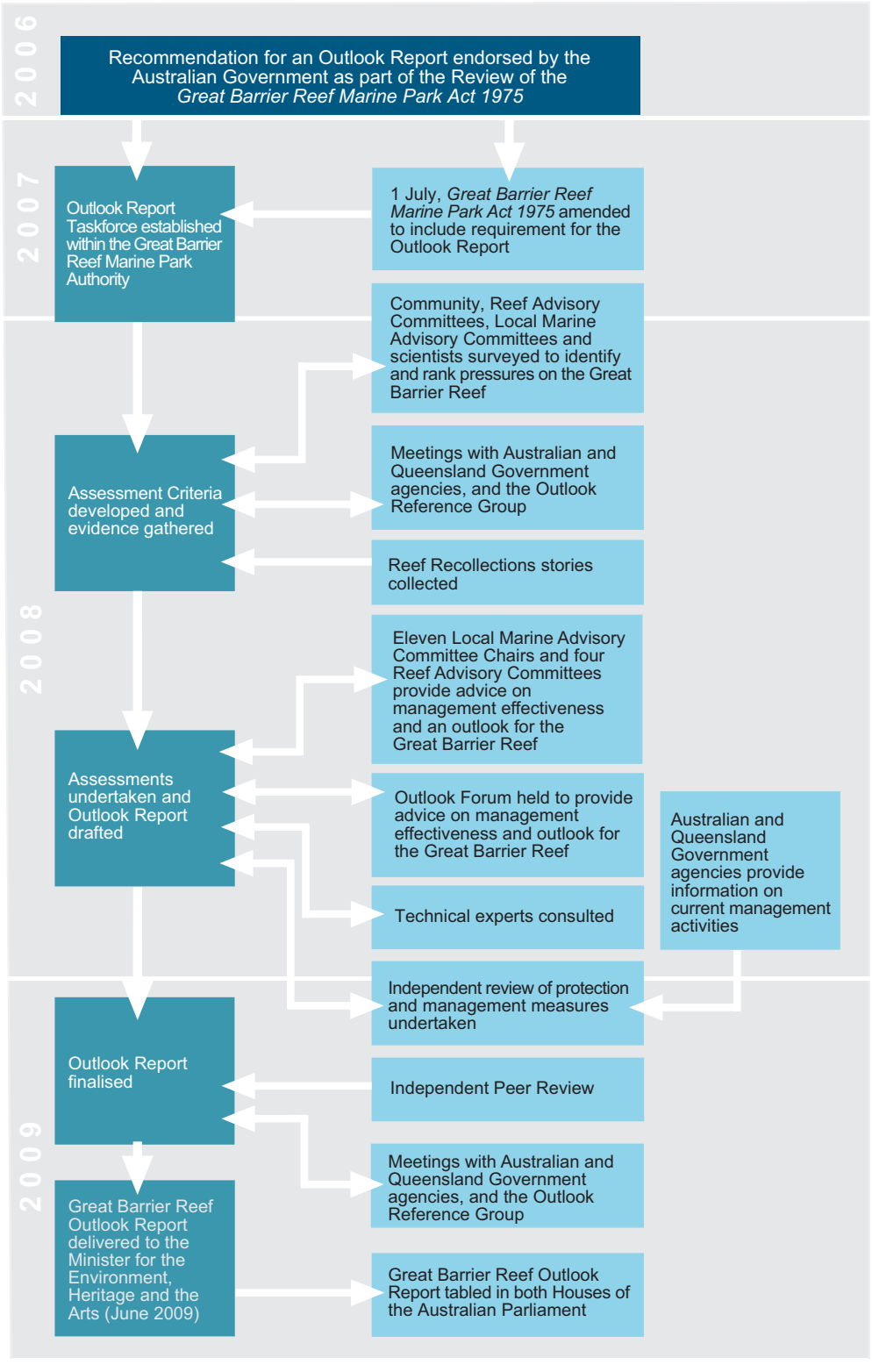
The complete set of evidence used to develop the Outlook Report is available online at *www.gbrmpa.gov.au*.

APPENDIX 1

Developing the Great Barrier Reef Outlook Report



The full text of the *Great Barrier Reef Outlook Report 2009* is available online at *www.gbrmpa.gov.au* and on the accompanying CD.

Australian Government

Great Barrier Reef
Marine Park Authority

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