





# Corals in CRISIS

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There is a crisis taking place right now in the world's oceans. Coral bleaching, caused by stressful environmental conditions driven largely by climate change, has already caused widespread death of corals and huge areas of reefs around the world are under threat. Despite being affected by two significant worldwide coral bleaching events—in 1998 and 2002—Western Australian coral reefs are still in a relatively healthy state. But that doesn't mean this will always be the case. What can we do to help safeguard our coral reefs?

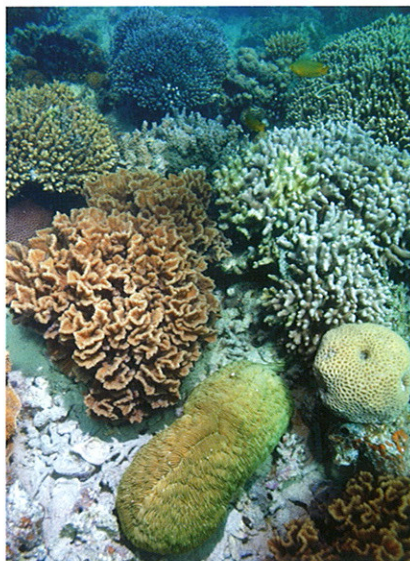




A mass coral bleaching event in 1998 affected every geographical coral reef realm in the world and it became the most severe on record at that time. Within Australia, aerial surveys of the Great Barrier Reef Marine Park revealed that 67 per cent of inshore reefs had high or severe levels of bleaching. On the worst affected reefs, 80 per cent of corals died during the following months. Even more severe was the event in 2002, when aerial surveys of 641 reefs recorded bleaching in almost 60 per cent of them. Up to 90 per cent of corals died on the worst affected inshore reefs.

Similar scenarios were occurring in most coral reefs around the world. It is estimated that this event caused the loss of at least 16 per cent of the world's coral reefs—a loss of more than 25,000 square kilometres of reef. Coral reefs in many parts of the Indian Ocean—such as along the eastern coast of Africa—could not recover from coral bleaching and died. The most recent major coral bleaching event occurred in the Caribbean in 2005 (one of the two hottest years since records started in 1880).

The impact of coral bleaching has not been well studied in Western



Australia. We do know that during the 1998 mass coral bleaching event, Scott Reef, an offshore Kimberley atoll (see 'Life in isolated oases', *LANDSCOPE*, Winter 2007) was one of the worst affected coral reefs in WA, losing 80 per cent of its coral to depths of 30 metres. Severe bleaching was also recorded in 80 per cent of corals in the Mary Anne Island Group, south of Barrow Island, which is within an area that will be considered for new marine parks and reserves (see 'Pilbara and Eighty Mile Beach: multiple objectives, one marine planning process', *LANDSCOPE*,

Autumn 2008). Although there is a knowledge deficit from WA, the extensive research conducted on the Great Barrier Reef and elsewhere has ensured that marine scientists are gaining a thorough understanding of the events that give rise to coral bleaching.

### Biology of bleaching

Reef-building corals (hard corals) thrive in the warm waters of tropical and subtropical latitudes, having developed into extensive coral reef ecosystems over thousands to millions of years.

The great majority of hard corals are able to exist in these nutrient-poor waters through maintaining mutually beneficial (symbiotic) relationships with tiny cells of algae known as zooxanthellae. The microscopic zooxanthellae find a safe haven in the living tissue of reef-building corals and contribute to giving the corals their colours. Like other plants, they capture energy from the sun by photosynthesis, producing energy-rich compounds absorbed by the coral host. Corals are highly dependent on this relationship, receiving up to 90 per cent of their energy requirements in this way.

This symbiotic relationship between the coral and the zooxanthellae, however, can run into problems during prolonged, higher-than-normal sea temperatures. Under these conditions, the sun's energy leads to the production of highly corrosive oxygen radicals by the zooxanthellae within a coral polyp. This damages the part of the algae where

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**Main** A healthy staghorn coral garden at Ningaloo Marine Park.

*Photo – Suzanne Long/DEC*

**Inset** Bleached coral at Rowley Shoals Marine Park.

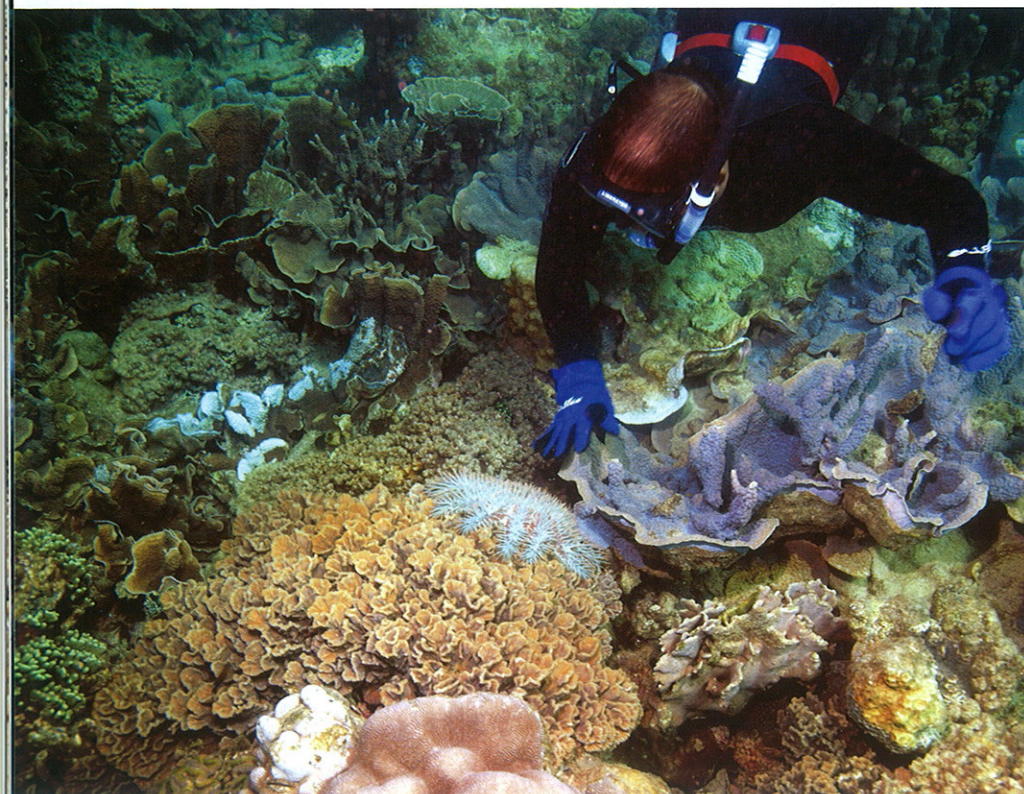
*Photo – John Huisman*

**Above** What WA stands to lose: a diversity of healthy corals in the Montebello Islands Marine Park.

*Photo – Suzanne Long/DEC*

**Left** Regular monitoring of WA's marine parks by Department of Environment and Conservation scientists will enable the department to monitor coral bleaching.

*Photo – Suzanne Long/DEC*







**Above** The Arolhos Islands has the world's most southerly coral reef system.

Photo – David Bettini

photosynthesis takes place. As a result, corals expel the algae and the corals look paler as the loss of zooxanthellae renders the tissue largely transparent. The calcium carbonate skeleton is then clearly visible, making the coral appear bright white or 'bleached'.

Although corals are often able to recover from such events quite well, especially if the high temperatures do not go on for extended periods (there is also great variation between different coral species, and even between different colonies of the same species, in their susceptibility to bleaching events), projections of climate change suggest that, by the year 2100, the global average temperature is likely to increase between 1.8 to four per cent from 1980 to 1999 values. This would have catastrophic effects on the world's coral reefs, including those in WA.

Less commonly, coral bleaching can also be caused by anomalously low sea water temperatures. This occurred at Ningaloo Marine Park in July 2006, when most of the back-reef sections were bleached from aerial exposure during low spring tides that coincided with unusually low air temperatures. Fortunately, within a few weeks, almost 100 per cent of affected corals

recovered. This was the first major sea temperature-related coral bleaching event recorded at Ningaloo Marine Park, highlighting the importance of careful conservation management to maintain the reef.

### **A new threat: ocean acidification**

A paper published in *Science* magazine in December 2007 argued that unchecked global warming would potentially decimate coral reefs and the 100 million people and one million species depending on them. The study used information built up over the past decade to project how reefs would look if greenhouse gas emissions were, or were not, controlled.

At the same time as the world's oceans are warming, their acid levels are increasing due to higher levels of carbon dioxide in the atmosphere dissolving into the waters. This is potentially disastrous for reef-building corals, as acidification affects their ability to form skeletons. The level of carbon dioxide concentration in the Earth's atmosphere is currently 380 parts per million, the highest in at least one million years, if not 20 million years. According to the paper's authors, if future emissions exceed 500 parts per million the world's reefs will disappear on a large scale. Once this critical threshold is reached, a coral is unable to extract carbonate from the water

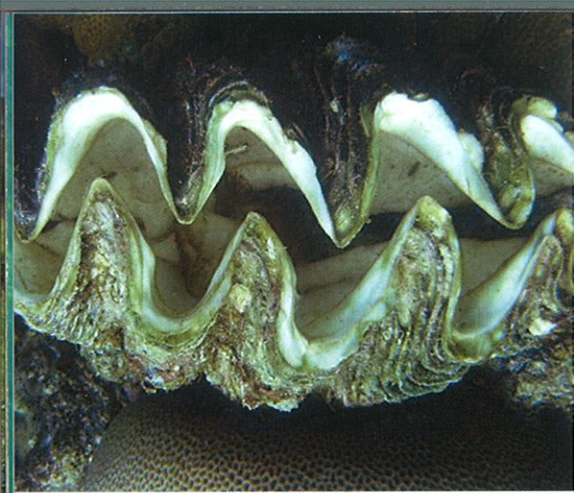
to form its skeleton. It appears that this acidification is now taking place over decades, rather than centuries as originally predicted.

### **WA coral reefs**

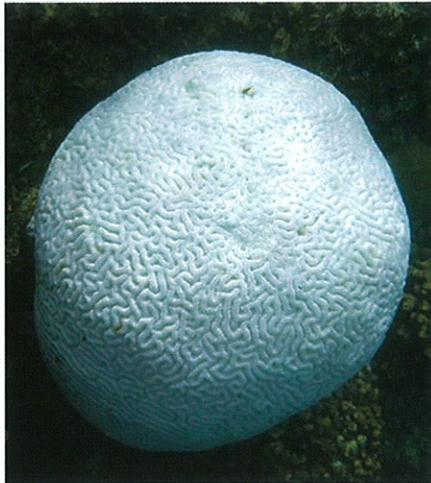
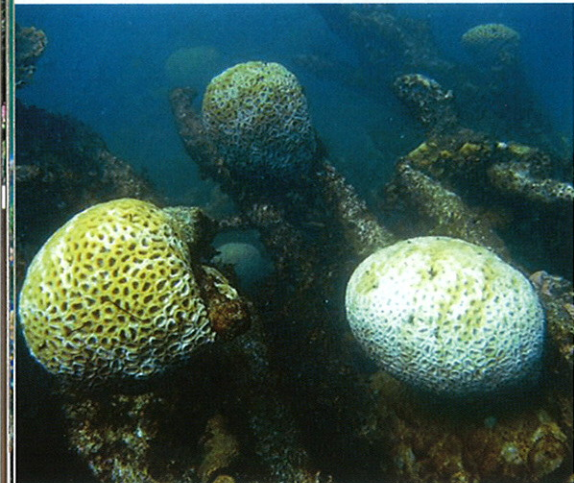
So how will climate change impact on WA corals? Coral reefs in the Ningaloo Marine Park, Rowley Shoals Marine Park, the Dampier Archipelago (likely to be declared a marine park later this year), the Montebello-Barrow Islands marine reserves, the Arolhos Islands and many other areas are all likely to be affected.

The effect of climate change on Australia's marine areas was a major theme of the Australian Coral Reef Society Conference held in Fremantle in October 2007. According to keynote speaker Professor Charles Sheppard, from the University of Warwick in the UK, coral bleaching in the 1998 and 2002 events has already had a terrible human cost, with uncounted numbers of people from subsistence, fishing-based economies dying and suffering food shortages as a consequence of climate change. Coral reefs in many parts of the Indian Ocean—such as along the eastern coast of Africa—that were subject to major pressures from overfishing and pollution could not recover from coral bleaching and died. Significantly, Professor Sheppard said coral reefs were best able to survive such severe coral bleaching where they were





**Left** Bleaching can also occur due to factors other than thermal stress. For example, when mass coral spawning occurs in certain weather conditions, the spawn can be pushed into bays and lagoons, deoxygenating the water and killing corals, fish and other animals.  
*Photos – Claire O'Callaghan/DEC*



not suffering from other pressures. Coral may become stressed from ecosystem pressures due to anchor damage, overfishing, dredging, reduced water quality and associated diseases, thereby reducing its ability to withstand heat stress associated with climate change.

Establishing a comprehensive, adequate and representative network of marine parks is extremely important because, where marine environments are well managed, this contributes to the resilience of marine ecosystems and helps them more easily weather severe environmental stresses such as coral bleaching and other effects of climate change.

### **What can be done?**

Most marine scientists believe the only real solution to coral bleaching is to significantly reduce global carbon emissions that are linked to global warming. It will be important for national and international collaboration to occur and will rely on direct contributions from individuals, industry and governments to reduce carbon emissions and address climate change issues.

Halting climate change will only be accomplished through concerted global action to increase energy efficiency,

adopt renewable energy options, reduce greenhouse gas emissions through a range of technological innovations and minimise land clearing.

The WA Government is committed to reducing greenhouse gas emissions. For example, by 2010 the public sector will be buying at least 20 per cent of its energy from renewable sources. The WA Government has almost doubled the length of Perth's rail system—taking about 25,000 cars off our roads every day. It has also established a website ([www.actnow.wa.gov.au](http://www.actnow.wa.gov.au)) to help the public take steps towards a greener future.

Specific actions to protect the marine environment and help make WA's marine ecosystems more resilient to climate change include plans to expand the number of marine parks in WA, with four new reserves expected in 2008. These measures will increase the area protected in marine parks to 14 per cent of our waters.

Marine park management practices, such as the establishment of sanctuary zones and public moorings, all help to increase the resilience of WA's marine parks to bleaching events by reducing or removing additional pressures on coral. Over the past few years the WA Government has

significantly increased the amount of funding to manage existing and new marine parks.

It has also committed \$21 million over five years from July 2006 to establish the Western Australian Marine Science Institute (WAMSI). WAMSI contributes funding to research by CSIRO, the Australian Institute of Marine Science (AIMS), the Department of Environment and Conservation (DEC) and local universities into WA's marine biodiversity and the impacts of climate change on the State's marine areas.

WAMSI and CSIRO, in collaboration with DEC, are developing a model that will predict the likely effects of different climate change scenarios on Ningaloo Marine Park and which will help manage the impacts of human use of the reef. This model will also apply to the conservation of other coral reefs in WA in relation to climate change.

### **Marine park management**

In late 2007, two DEC marine park management staff attended a workshop at Lady Elliot Island in the Great Barrier Reef Marine Park on managing coral reefs in response to climate change.

Ningaloo Marine Park Coordinator, Roland Mau, and West Kimberley District Marine and Coastal Reserves Officer, Fiona Galloway (who manages the Rowley Shoals Marine Park), attended the workshop with 21 other government and non-government representatives from Indonesia, Malaysia, the Philippines, Thailand, Hawaii, Australia's Great Barrier Reef Marine Park Authority and other Commonwealth marine reserves.

Led by Paul Marshall and Heidi Schuttenberg, trainers from Australia and the USA's National Oceanic and Atmospheric Administration (NOAA) presented an intensive five days of



**Background right** Healthy corals in the proposed Dampier Archipelago Marine Park.

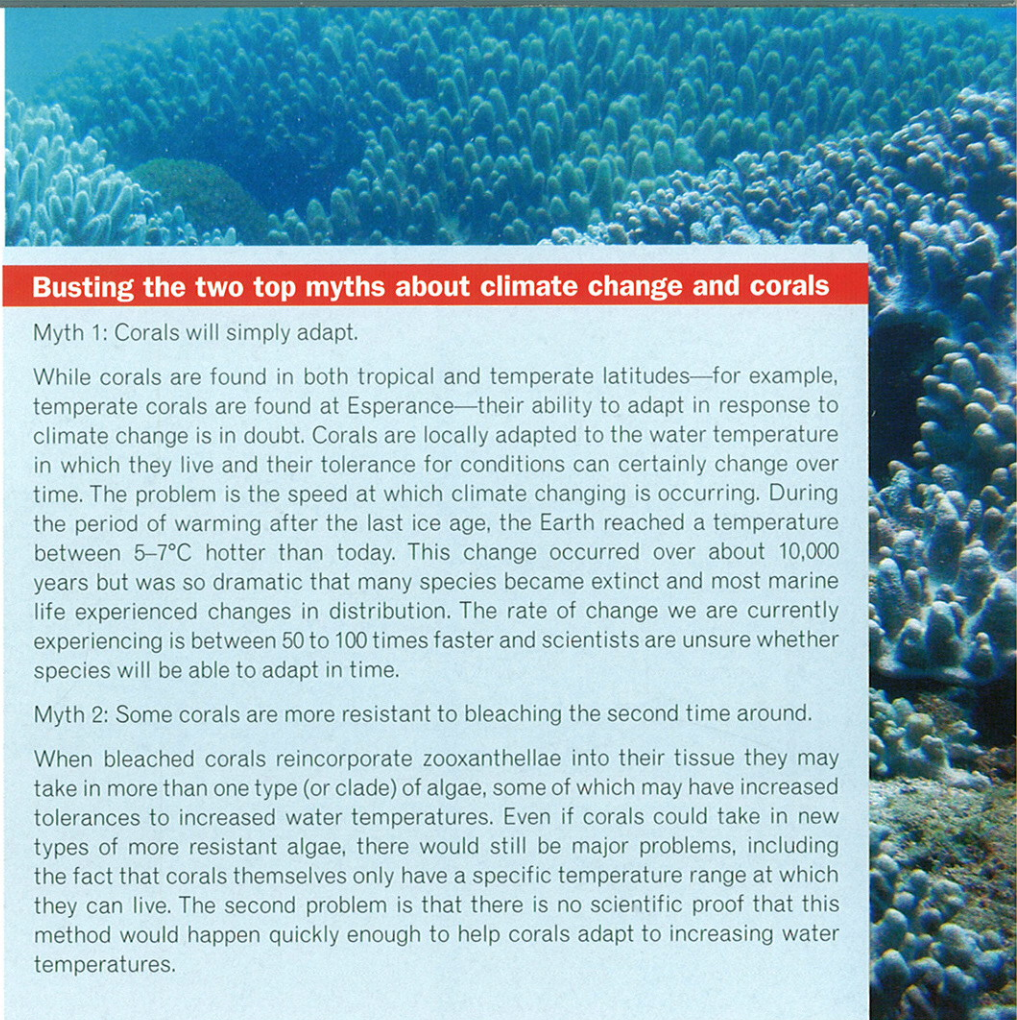
**Below** Yellow boxfish in a staghorn coral. Not only corals, but the animals which depend on them, need our help.

*Photos – Suzanne Long/DEC*

lectures and field exercises to increase capacity for planning, monitoring and responding to climate change and bleaching events in coral reefs.

Topics covered management issues such as developing response frameworks, coral reef resilience, social and economic impacts, interpreting remote sensing data, management interventions, and the development of bleaching response plans.

WA's Ningaloo Marine Park and Scott Reef are already 'virtual' stations for which automated email alerts are issued to Western Australian coral reef managers when NOAA satellite observations indicate that water temperatures are rising beyond critical limits. Roland and Fiona nominated additional locations off the Pilbara and Kimberley coast that will become part of the NOAA's worldwide coral bleaching early warning system ([www.coralreefwatch.noaa.gov/satellite](http://www.coralreefwatch.noaa.gov/satellite)). These include the Montebello Islands Marine Park, Rowley Shoals Marine Park and Montgomery Reef, which lies on the Kimberley coast just offshore from the proposed Walcott Inlet National Park.



## Busting the two top myths about climate change and corals

Myth 1: Corals will simply adapt.

While corals are found in both tropical and temperate latitudes—for example, temperate corals are found at Esperance—their ability to adapt in response to climate change is in doubt. Corals are locally adapted to the water temperature in which they live and their tolerance for conditions can certainly change over time. The problem is the speed at which climate changing is occurring. During the period of warming after the last ice age, the Earth reached a temperature between 5–7°C hotter than today. This change occurred over about 10,000 years but was so dramatic that many species became extinct and most marine life experienced changes in distribution. The rate of change we are currently experiencing is between 50 to 100 times faster and scientists are unsure whether species will be able to adapt in time.

Myth 2: Some corals are more resistant to bleaching the second time around.

When bleached corals reincorporate zooxanthellae into their tissue they may take in more than one type (or clade) of algae, some of which may have increased tolerances to increased water temperatures. Even if corals could take in new types of more resistant algae, there would still be major problems, including the fact that corals themselves only have a specific temperature range at which they can live. The second problem is that there is no scientific proof that this method would happen quickly enough to help corals adapt to increasing water temperatures.

Since Roland and Fiona's return, a discussion forum has been held through DEC's Marine Science Program to raise the issue of coral bleaching and its implications for Western Australian coral reefs. Further discussions on relevant management actions are planned for 2008.

DEC will continue to monitor the health of coral communities in WA's marine parks and reserves as part of its long-term monitoring programs. The public can help by reporting any observations of coral bleaching to DEC's

Marine Science Program or to the department's Exmouth District office.

### Sentinels of the sea

Like other important environmental indicators on land, such as frogs, which are the first animals to disappear or show stress when things start to go wrong, coral reefs are the sentinels of the sea. The International and Coral Reef Initiative has declared this year the International Year of the Reef—time for us all to reflect on how our specific actions can have an impact on our oceans.



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