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## The great diminishing reef

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**Warming of the oceans threatens the long-term survival of the Great Barrier Reef. Stephen Cauchi recently joined scientists for the natural wonder's annual check-up.**

It is 20 metres from the surface to the sea floor. Marine scientist Paul Marshall, who has spent much of his career snorkelling in these dazzling waters, plunges to the bottom, hunts around a bit and picks up a loose, brick-sized piece of coral. The specimen sums up the beauty of the Great Barrier Reef - and the problems it is facing. The top third is a bright shade of pink, indicating healthy coral. The middle third is bleached white - still alive, but very sick. The lower third is brown and cobwebbed with muck: stone dead.

The coral is a casualty of global warming. Climate change leads to warmer sea temperatures, with deadly side effects.

"What stresses the corals is when the water gets hotter than normal, hotter than what they're used to in that particular place," says Marshall, a specialist in climate change at the Great Barrier Reef Marine Park Authority, the Australian Government agency responsible for overall management of this World Heritage Area.

When the water becomes too warm, the algae that give the corals their colour and vigour flee and recovery becomes problematic.

"The coral becomes white not because it's dead, but because the tissue has no colour and you can see straight through the tissue to the skeleton underneath," Marshall says.



Paul Marshall and Pedar Lawrence, top, on Pelican 1. Bleached coral in the Keppel Islands.

Photo: *Sandy Scheltema*

"In a month, it's all over. They've either survived or they're dead. If the temperatures stay hot enough for three or four weeks, they'll die."

Marshall and a rotating roster of scientists have spent more than a month on the catamaran Pelican 1, cruising the entire 2000 kilometres of the reef from south to north to assess its health after the summer months, when waters were at their warmest.

*The Age* joined the voyage - billed as one of the most comprehensive bleaching surveys of the reef - at Cooktown for the final leg of the trip: a five-day jaunt to the reefs around Lizard Island, 240 kilometres north of Cairns.

Technology for monitoring the reef has never been better, with satellite imaging of sea temperatures, reef surveys carried out with pinpoint accuracy thanks to global positioning systems and underwater digital footage.

The reef is in fairly good health at present but marine scientists fear that all the hightech analysis will be for nothing unless the world can halt the global warming that is predicted to cause severe reef deterioration over the next century.

Climate-change models, such as done by CSIRO, predict that Australian air temperatures will warm between one and six degrees over the next century, with slightly less warming near the coast. Sea temperatures will, after a few decades' lag, match this rise. Part of Marshall's job is to investigate how this ocean warming will affect the reef in coming decades and what, if anything, can be done about it.

"People fear this catastrophe where you get the whole reef dying," he says. "That's possible - if we get a hot enough summer, you get catastrophic death of corals - but it's not so likely. What is more likely, almost certain, is that every couple of years now we'll have a bleaching event that kills a few per cent of the reef. It takes 10, 20 years to bounce back.

"You get 5 per cent plus 2 per cent plus per cent... all of a sudden you've lost half of the reef to coral bleaching. It's that sort of chronic degradation that I think we're going to be seeing in the future."

The first severe bleaching events, in 1998 and 2002, killed about a tenth of the reef in total, Marshall says, although the affected areas are slowly recovering.

The world's largest reef may be famous, but it takes a visit to really appreciate its beauty, a

stunning example of nature's handiwork. The stereotype - multicoloured corals and fish glowing under waist-deep water, tropical island nearby, all under a blazing blue sky - is somewhat different in reality.

During the wet season, the weather is a mix of overcast skies, sultry heat and tropical downpours, although there is the odd day of brilliant sunshine. The archipelago is highly visible but the reefs are mostly in deep water and, from the surface, their dark shapes could be mistaken for rocks or sandbars. Only in shallow water, or under water, can one glimpse their rich kaleidoscope of colours.

And, as so often in nature, beauty and danger are entwined. The signs in Cooktown warning of saltwater crocodiles in the mangroves are unnerving enough. In deeper waters, sharks and jellyfish lurk.

Pelican has a full complement: captain Garry McKechnie, a first mate, cook, four marine park authority scientists, four trainees from its indigenous program (the reef is Aboriginal sea country) and a diving instructor.

Bleaching this past summer has been particularly bad in the south, around Great Keppel Island, where entire reefs were turned a deadly shade of white. Bad though this is, says Marshall, it does not compare with 1998 and 2002, when the first alarm bells were triggered over the reef's future.

"1998 was, at that time, the worst we'd ever seen. Then 2002 came along and was actually a bit worse... (on each occasion) we lost about 5 per cent of the reef."

The Pelican travelled overnight on Monday from Cooktown to Lizard Island, where it shuttled from reef to reef until Thursday morning. While there is the odd bit of bleached coral around Lizard Island, the scientists say it is nothing compared with that around Keppel.

"Imagine a familiar landscape - it might be a rock garden or something like that - and then cover it with snow," says scientist Johnston Davidson. "It's that different, everything's bright white. It's very difficult to pick at particular detail because you lose contrast. It's just white and nothing."

The reef formed about 6000 years ago when the rising seas covered what had been dry land. Now, the water temperature is 29 to 30 degrees - not as warm as reefs in the Red Sea, where temperatures can reach 35.

If coral can survive to 35 degrees, you might think the reef's corals could adapt to the warmer waters expected this century. The problem, says Marshall, is that corals adapt to the local environment and they only bleach when waters warm compared with the average for that region, not an average in another part of the world. Corals can handle a small average rise in temperature, but not several degrees or higher.

"How long does it take for a coral evolved in 28 degrees to actually develop the genetic configuration to allow it to survive to 35 degrees? I suspect the answer to that is thousands of years," he says.

Even the lower end of the climate-change forecasts - a one or two-degree rise in ocean temperature - "is going to test the corals' ability to adapt... and that assumes it's going to happen across all species over the next 50 years. That's not going to happen."

The Great Barrier Reef is so vast - 2000 kilometres long, 3000 individual reefs, 1500 species of fish, 400 types of coral, 4000 types of molluscs - that a thorough bleaching assessment is impossible. The best that Marshall and other scientists can do is return to a few survey sites every year for a year-by-year comparison.

Around Lizard, the scientists film the reefs with underwater cameras and note, using underwater clipboards and pencils, the types and frequency of the corals.

Bad though the Keppel reef is, or the bleaching events of 1998 or 2002, reefs elsewhere in the world have had it worse. Caribbean reefs, for example, just had their worst summer ever. CNN reported in March that a third of the coral around Puerto Rico and the US Virgin Islands has died. This was because the sea temperature was the hottest recorded in 21 years of satellite monitoring.

US National Park Service fisheries biologist Jeff Miller told CNN it was an "unprecedented die-off". "These are corals that are the foundation of the reef... colonies that were here when Columbus came by have died in the past three to four months."

Other reefs have had it worse still. "We've seen other areas of the world where coral reefs have been devastated by coral bleaching - the Maldives, the Seychelles - where 70 to 80 per cent of the corals have died within months," says Marshall.

"If that did happen over the Great Barrier Reef, it would be an ecological catastrophe and an environmental catastrophe, there's no doubt about it."

The future of the reef, then, depends on whether the world has the will to control global warming, and how severe warming turns out to be over the next century.

Technology can do little except provide an accurate monitor of the reef's health. In January, the University of Queensland collaborated with NASA for satellite imaging of water temperature, colour, currents and phytoplankton concentrations. And the Pelican's voyage is made immeasurably easier by the use of global positioning systems, which allow it to pinpoint in seconds, in hundreds of square kilometres of ocean, the 5000 posts drilled into the sea floor that mark the survey points.

On Thursday morning we leave Lizard for Carter Reef, one of the most pristine, most beautiful places along the entire coast. "It's been closed to everyone for some years," says scientist Gillian Goby. "We have got a special permit to be here. We're one of the first boats in here for some time, which is great."

It is true that other factors can influence the health of coral reefs, says Marshall, particularly pollution and overfishing. But global warming remains the main factor.

"To my mind, the worst of all futures is if we were successful at reducing the amount of heating that is on the planet to a point that the corals could have survived, but we've actually stressed them out so much through other things, like water pollution or over-fishing, that they are unable to bounce back because of that," he says.

"Coral reefs are not going to disappear, but what we're talking about is significant deterioration. The things that make the reef so important to humans - its beauty, its productivity for fish and fishing, its appeal to tourism - all these things are going to deteriorate over the next 50 to 100 years."

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