# PRESERVING THE WORLD'S CORAL REEFS

**LED BY PROFESSOR TERENCE HUGHES, RESEARCHERS AT THE ARC CENTRE OF EXCELLENCE FOR CORAL REEF STUDIES ARE PROTECTING JOBS, THE ECONOMY AND THE ENVIRONMENT WITH THEIR KEY FINDINGS ABOUT CORAL REEF MANAGEMENT**

Coral reefs are not only important for the environmental role they play, but for their social and economic value. Globally, the welfare of more than 200 million people is intricately linked to the goods and services provided by coral reefs. In Australia, tourism and fisheries on the Great Barrier Reef alone contribute A$6 billion annually to the nation's economy and provide employment for 60,000 people.

The ARC Centre of Excellence for Coral Reef Studies (CoECRS), led by director Professor Terence Hughes, is providing the scientific knowledge necessary to preserve the world's coral reefs. As a result, Australia has become an international leader is this field and is playing a key role in protecting reefs on a global scale.

## IN A NUTSHELL

* RESEARCH AREA: Coral reef management, reef fisheries management and systematic conservation planning
* PRIMARY AUTHORS: Professor Terence Hughes, Director, and Professors Garry Russ and Robert Pressey, ARC Centre of Excellence for Coral Reef Studies, James Cook University
* KEY OUTCOME AREAS: Economic; Environmental; Policy and administration

## THE PROBLEM OF 'PHASE-SHIFTS'

Reefs have long been under threat by fishing and pollution, but one of the biggest threats now is global warming. When water temperatures rise, coral bleaching occurs (a stress reaction that causes the coral to expel the algae that lives within its tissues) and the coral is overtaken by seaweed. "Once corals are replaced by weed – a process known as a 'phase-shift' – it is extraordinarily difficult, if not impossible, to bring them back again," says Hughes.

During a major heating event in the late 1990s, one-sixth of the world's corals were affected by coral bleaching, pointing to the potential scale of the impact of climate change on the natural environment. According to Hughes, it's only a matter of time before the next major bleaching event occurs. "For reefs to be able to withstand such events, they need to be resilient," he says. "A key focus of our work has been to determine ways of achieving this."

## FISH ARE VITAL

Hughes and his team conducted an experiment in the Great Barrier Reef and discovered that healthy fish populations are vital to successfully managing coral reef resilience.

"We followed the recovery of corals that had been severely damaged by bleaching," he explains. "The corals were on a reef where fish populations were very abundant. We also fenced the fish out of some areas, and compared coral recovery with and without lots of fish. The result was dramatic. The coral cover virtually doubled where the fish had access, while the fenced-off areas became overgrown with slimy weed and the corals failed to recover."

*Above: A Clown Anemonefish; healthy fish populations are vital to coral reef resilience.*
*Below: Coral reefs are threatened by global warming.*

The team discovered the larger herbivorous fish – such as parrot fish and surgeon fish – were particularly important. "Our experiment showed that one way to prevent a phase-shift from taking place is to have an intact population of herbivores ready to pounce on any weeds that may sprout before the corals can regenerate," says Hughes. "This research indicates it is important to avoid overfishing of these herbivores at all costs."

## BUILDING RESILIENCE

The team's findings have prompted reef management agencies around the world to build the resilience of reefs through initiatives such as 'no-take' zoning – the permanent closure of a designated marine area to all forms of extractive activity, including fishing – and policies for reducing water pollution.

It has also had an impact on policy and legislation worldwide. For example, in the US, Hughes was asked by Congressional advisors to provide a definition of 'coral reef resilience'. This has been incorporated into the *Coral Reef Conservation Amendments Act*, which was passed by Congress on 22 October 2007.

## REZONING THE GREAT BARRIER REEF

One of the most significant outcomes has been the rezoning of the Great Barrier Reef. In late 2002, Hughes convened an international working group of researchers and reef managers in Townsville, Queensland, to discuss ways to minimise the impact of climate change on coral reefs. In particular, participants provided scientific input into the public debate surrounding proposed legislative changes to the management of the Great Barrier Reef.

The group produced a major synthesis paper to develop the concept of ecological resilience, which was published as a cover article in *Science* in mid-2003. A press conference to release these findings was broadcast to more than four million viewers around Australia. The recommendations were further highlighted in a public meeting broadcast nationally by ABC Radio National.

"The dissemination of our results to managers and the media contributed to the emergence of a consensus that at least 30 per cent of the Great Barrier Reef should be designated as no-take," says Hughes, who has since also contributed to the rezoning of Ningaloo reef in Western Australia.

*The CoECRS team's findings have prompted reef management agencies around the world to build reef resilience through initiatives such as 'no-take' zoning.*

## REEF FISHERIES MANAGEMENT

No-take zones have also been important for reef fisheries management, another key focus of the CoECRS. Professor Garry Russ and his team have shown no-take reserves are critical for replenishing fish stocks, which in turn protects industry and the economy.

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"History has shown if we don't manage marine resources, we inevitably over-exploit them," says Russ. "But if you have a network of reserves where you can't go fishing, the fish build up in abundance in those areas, they spawn more effectively and tend to produce more larvae, and they export a lot of those new extra larvae out into the fished areas. So it's important for the conservation of the reef, but it's also important for the fisheries on the reef."

## NEW TAGGING TECHNOLOGY

Russ's colleague Professor Geoff Jones has developed a revolutionary new tagging technology for tracking larvae, which is helping to design more effective networks of no-take reserves. The tag – a chemical stain made from stable isotopes of barium – is injected into the female fish, passing through to the egg and then to the new babies.

"For the first time, this allows marine ecologists to track larvae from where they were spawned to where they end up," says Russ. "If you know how far the larvae go, you can then work out the best size, placement and spacing of the reserves, and you can start to design proper networks so that the reserves are doing the job you want them to do."

## SYSTEMATIC CONSERVATION PLANNING

The CoECRS also conducts research into the relatively new field of systematic conservation planning, and has produced a number of outcomes in this area. "Systematic conservation planning is a process of resolving conflicts between the conservation and use of natural resources," says Professor Robert Pressey.

In 1996, Pressey and his team developed a software tool called C-Plan, which allows practitioners to explore

different options for achieving conservation objectives. "The software shows them, on a map, the 'irreplaceability' of each area being considered," Pressey explains. "This is a measure of its relative importance for achieving objectives, or the number of other areas that could replace it. Effectively, this shows them where they have room to manoeuvre and where they don't. The system also allows them to develop alternative conservation and development scenarios, and to assess the trade-offs between them."

### WORLDWIDE INFLUENCE

C-Plan has been used by hundreds of people around the world for conservation planning in terrestrial, marine and freshwater environments. In Australia alone, it has led to the establishment of around one million hectares of new reserves in eastern New South Wales.

Pressey is also leading the development of a guide to conservation planning, which will be published by the International Union for Conservation of Nature (IUCN). "The motivation for the guide was to cut through the confusion produced by the many alternative approaches to conservation planning being developed and promoted," he says. "It will be distributed to hundreds of IUCN members around the world and therefore influence their thinking about conservation planning, lead to follow-up case studies and workshops, and generally lift the effectiveness of planning worldwide."

*The replenishing of fish stocks protects industry and the economy as well as the reef.*

## HELPING VILLAGERS IN THE PHILIPPINES

Professor Garry Russ's research into reef fisheries management has not only contributed to the establishment of no-take reserves in Australia, but also in small fishing villages in the southern Philippines. Since the early 1970s, he has collaborated with a local scientist, Dr Angel C. Alcala, to give the villagers some control over the way their marine resources are managed.

"Fisheries management used to be centralised in the big cities, so fishing companies would come to these villages, take all their fish and leave," says Russ. "Our work helped to set up no-take reserves and eventually led to legislation which gave villagers the power to co-manage their marine resources up to 15 kilometres from the shore."

Protecting the local coral reefs has also helped attract tourism, which is now bringing income into the villages. In a country where such a huge percentage of people live below the poverty line, this is of great economic benefit – an outcome of which Russ is very proud. "It's not often as a biologist that you get a chance to change the laws of a country for the benefit of local fishing communities and for the benefit of people who are disadvantaged," he says.

*For further reading*

*Bellwood, D.R., T.P. Hughes, C. Folke, and M. Nyström. 2004. Confronting the coral reef crisis. Nature 429: 827-833.*

*Alcala, A.C. and Russ, G.R. (2006). No-take marine reserves and reef fisheries management in the Philippines: A new people power revolution. Ambio 35(5): 245-254.*

*Pressey, R. et al. (2007). Conservation planning in a changing world. Trends in Ecology and Evolution 22: 583-592.*

*For a full list of published work, visit www.coralcoe.org.au*