



ARC Centre of Excellence  
**Coral Reef Studies**

ANNUAL REPORT 2005

ARC Centre of Excellence for Coral Reef Studies  
**Annual Report 2005**

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An underwater scene with several fish swimming in the upper half and a large, branching coral reef structure in the lower half. The background is a deep blue color. The text is overlaid on the upper left portion of the image.

## → Vision

To provide global leadership in the provision of scientific knowledge necessary for coral reef managers to preserve the world's coral reefs.

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## → Mission

To create a world-best integrated research framework that addresses regional and global issues and knowledge gaps in coral reef science and management.

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## Aims

### **1 Research**

Our research is world-best, innovative, and highly relevant to coral reef science and management.

### **2 Research Training & Professional Education**

We attract and train outstanding coral reef scientists at all stages of career, emphasizing practical outcomes and problem solving.

### **3 End-user linkages**

Our transfer of knowledge, technologies and research outcomes to end-users, industry and the wider community promotes co-operation and improves the management of coral reefs.

### **4 National and International linkages**

The Centre's networks and activities nationally and internationally represent a global hub for coral reef science collaborations.

### **5 Management and Governance**

Centre management is collaborative, co-operative, multi-institutional, communicative and continuously improving.

### **6 Commercialisation**

Commercialisation activities extend knowledge transfer, nationally and globally.

# Overview

The ARC Centre of Excellence for Coral Reef Studies was established in 2005 under the ARC Centres of Excellence program, with ARC funding of \$12m over five years from 2005 to 2010. This award, combined with cash and in-kind contributions from the Centre's partners in Australia and internationally, creates a \$40m investment in coral reef science over the next five years. The mission of the Centre is to be the world leader in providing the scientific knowledge necessary for improving coral reef management globally. Sustainability of coral reef resources is vital for economies and societies in tropical maritime

countries worldwide. Australia plays a vital role in the science that underpins coral reef management.

The ARC Centre is a partnership of James Cook University (JCU), the Australian Institute of Marine Science (AIMS), The Australian National University (ANU), the Great Barrier Reef Marine Park Authority (GBRMPA) and The University of Queensland (UQ) with formal collaborative links to twenty-four additional institutions in nine countries.

The Centre of Excellence creates multidisciplinary teams of leading scientists involving a balance of

University-based researchers, collaborating organisations and distinguished overseas partners, in addition to strong linkages with industry partners and end-users. The multi-institutional research teams have unprecedented access to the major tropical marine research infrastructure in Australia. Headquartered at James Cook University, at the gateway to the Great Barrier Reef World Heritage Area, the Centre offers unparalleled opportunities for co-ordination of research effort to provide world-best outcomes for coral reef science and research training that no existing program can replicate.

# Directors Report



Welcome to the inaugural report of the ARC Centre of Excellence for Coral Reef

Studies. In our first few months of operation, we have organized existing and new research projects into five major programs (page 11), and we have recruited so far nine new post-doctoral fellows. In 2005, the Centre produced over 100 publications, including eight papers in *Science* and *Nature*. Our publications in 2005 include co-authors from 90 institutions in 27 countries, a remarkable level of international linkage. According to ISI Essential Science Indicators, the Centre's publication profile in coral reef research in 2005 is of the highest international standard (page 41).

The ARC Centre's scale and critical mass are already beginning to consolidate innovative research. For example, in the field of genomics, work at the Centre investigating the responses of corals to climate change will use the largest expressed sequence tag (EST) library for a coral (developed at JCU), with an EST resource for algal symbionts (*Symbiodinium*; developed at UQ). By networking such resources into a national and international facility that transcends multiple

nodes, the Centre will provide the platform for truly comprehensive programs of research. Our global reach is further strengthened by the Centre's international graduate training program: At the end of 2005, the Centre's 19 Chief Investigators provided research training to 75 PhD, Masters and Honours students from Australia and overseas. Our cross-institutional projects and supervisory arrangements create a particularly vibrant and high quality training environment. In 2006, we are planning a number of national and international training and mentoring activities, including professional courses on climate-change biology and taxonomy, co-funded by our international partners. We have also initiated new industry-partnerships and a vigorous program of end-user engagement, both in Australia and internationally.

The Centre has featured widely in the national and international media in 2005, reflecting the public interest in our work on the Asian tsunami, global overfishing, climate change, and in coral reefs generally. We are fortunate to have secured Julian Cribb as the Centre's media consultant, whose efforts have further highlighted the Centre's work and its broad implications for policy and management of natural resources

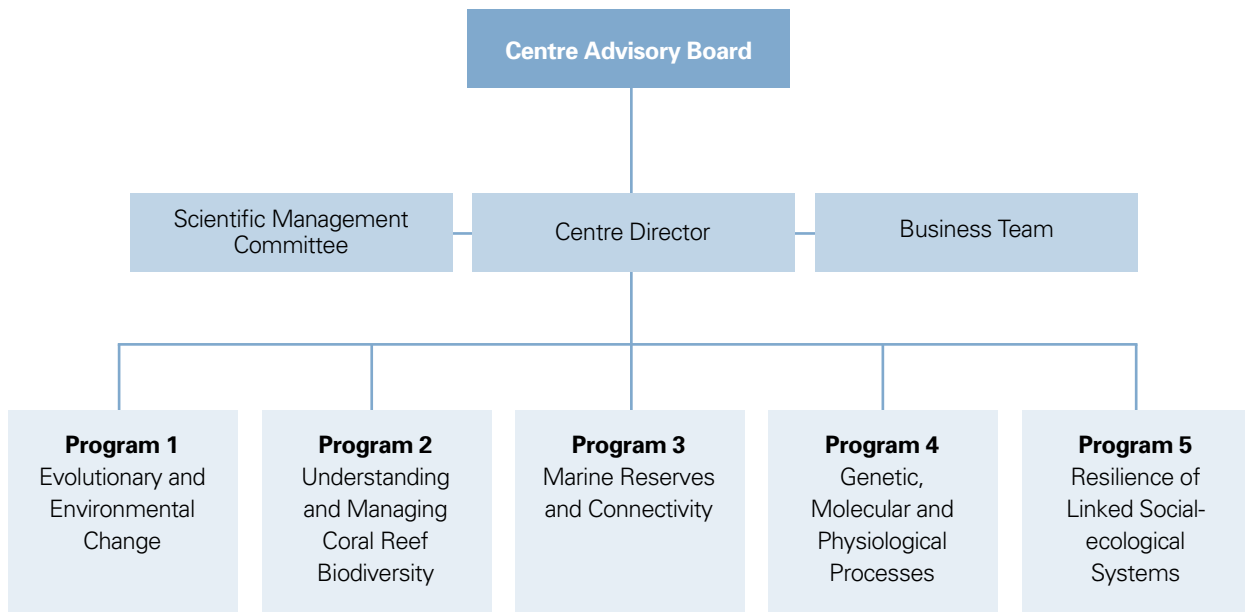
(see page 31). Our new website is already achieving over 12,000 hits per month.

This report covers only our first few months of activity, as we quickly gear up to full strength. In our first half-year we have secured almost \$8 million dollars in additional cash support for the Centre, beyond ARC's award of \$12 million. The State of Queensland and the collaborating universities have contributed a further \$8.5 and \$10.5 million, respectively, in in-kind contributions. The administering institution, James Cook University, has provided the Centre with a newly-renovated building, including a state-of-the-art videoconferencing facility which greatly facilitates communications across the Centre's nodes.

Finally, I would like to congratulate all of the Centre's personnel for a highly successful and productive year. In particular, I am grateful to the Centre's acting Chief Operations Officer, Jennifer Lappin, and our KPI Officer, Louise Taylor, for their Trojan efforts in establishing this unique, exciting and challenging enterprise.

**Terry Hughes**  
*Director*

# Management Structure



## Governance

A key goal of the Centre is to establish governance structures that engage stakeholders in planning and management processes and that provide easy access to emerging technologies, knowledge and information. The Centre is governed by a Centre

Advisory Board and a Scientific Management Committee. We are privileged to have access to the expertise and experience of university, industry and scientific leaders and we appreciate their contribution to the Centre. The major research and business

decisions are made by the Centre Director in consultation with the Chief Operations Officer and the Program Leaders. This group meets regularly to discuss the Centre's progress.

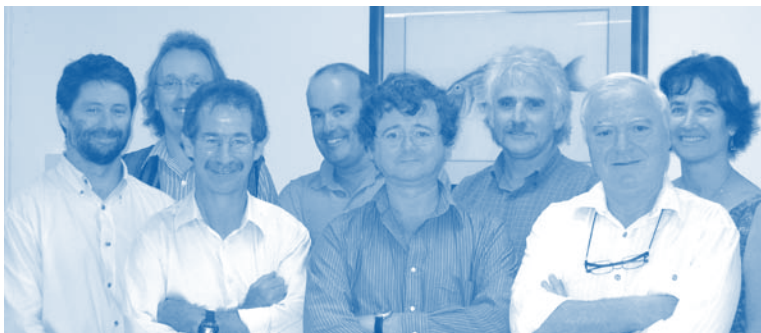
## Centre Advisory Board

The Centre Advisory Board contributes to the development of strategies and vision of the Centre and facilitates improved linkages between the Centre, industry, government and the wider community to facilitate uptake of research outcomes. The Board provides advice on research directions, centre structure membership and commercialisation strategies. The Centre Advisory Board will meet at least annually and is scheduled to have its inaugural meeting in early 2006.

Members are:

- **Professor Norman Palmer**  
Pro-Vice-Chancellor (Research and Innovation)  
James Cook University
- **Professor David Siddle**  
Deputy Vice Chancellor (Research)  
University of Queensland
- **Professor Lawrence Cram**  
Deputy Vice-Chancellor (Research)  
Australian National University
- **Dr Ian Poiner**  
Chief Executive Officer  
Australian Institute of Marine Science
- **Hon. Virginia Chadwick**  
Chair  
Great Barrier Reef Marine Park Authority
- **Professor Terry Hughes**  
Centre Director

## Scientific Management Committee



The Scientific Management Committee is responsible for the high-level operational management of the Centre and its scientific research program objectives and strategies. Members are:

- **Professor Yossi Loya** (Chair)  
Professor of Marine Biology  
The Raynor Chair for Environmental Conservation Research  
Department of Zoology  
Tel Aviv University Israel
- **Dr. David Wachenfeld**  
Director, Science Technology and Information Group  
Great Barrier Reef Marine Park Authority
- **Professor Malcolm McCulloch**  
Environmental Geochemistry and Geochronology  
Research School of Earth Sciences  
Australian National University
- **Professor Garry Russ**  
School of Marine Biology and Aquaculture  
James Cook University
- **Professor David Bellwood**  
School of Marine Biology and Aquaculture  
James Cook University
- **Professor Ove Hoegh-Guldberg**  
Centre for Marine Science  
University of Queensland
- **Professor Terry Hughes**  
Centre Director



# Membership

## Research staff

### Chief Investigators

- **Professor Terry Hughes**  
James Cook University
- **Dr Kenneth Anthony**  
James Cook University
- **Dr Andrew Baird**  
James Cook University
- **Professor David Bellwood**  
James Cook University
- **Dr Roger Bradbury**  
Australian National University
- **Dr Sean Connolly**  
James Cook University
- **Dr Sophie Dove**  
University of Queensland
- **Professor Ove Hoegh-Guldberg**  
University of Queensland
- **Professor Geoffrey Jones**  
James Cook University
- **Professor Michael Kingsford**  
James Cook University

### Students (see page 20)

- David Abrego
- Tracy Ainsworth
- Shelly Anthony
- Bridget Ayling
- Line Bay
- Victor Beltranramirez
- Rose Berdin
- Michael Berumen
- Teresa Bobeszko
- Lynda Boldt
- Daniel Breen
- Kate Bromfield
- Karin Buechler
- Samantha Burgess
- Neal Cantin
- Michael Cappel
- Timothy Cooper
- Melissa Cowlshaw
- Jo Davy
- Jeffry Deckenback
- Martial Depczynski
- Maria Dornelas
- Janelle Eagle
- Richard Evans

- **Dr Mark McCormick**  
James Cook University
- **Professor Malcolm McCulloch**  
Australian National University
- **Professor David Miller**  
James Cook University
- **Dr Philip Munday**  
James Cook University
- **A/Professor John Pandolfi**  
University of Queensland
- **Dr Morgan Pratchett**  
James Cook University
- **Professor Garry Russ**  
James Cook University
- **A/Professor Bette Willis**  
James Cook University
- **Professor David Yellowlees**  
James Cook University

### Partner Investigators

- **Professor Carl Folke**  
Stockholm University
- David Feary
- Paul Fisher
- Rebecca Fox
- Matthew Fraser
- Ashley Frisch
- Chris Fulton
- Monica Gagliano
- Naomi Gardiner
- Luis Gonzalez-Reynoso
- Andrew Halford
- Meegan Henderson
- Jean-Paul Hobbs
- Thomas Holmes
- Mia Hoogenboom
- Emily Howells
- Akira Iguchi
- Jacob Johansen
- Paulina Kaniewska
- Ailsa Kerswell
- Charlotte Kvennefors
- Angela Lawton
- Tove Lemberget
- Carole Loneragan
- Guy Marion
- Luiz Mendes de Gusmao
- Juan Carlos Ortiz

- **Professor Ronald Karlson**  
University of Delaware
- **Dr Janice Lough**  
Australian Institute of Marine Science
- **Dr Laurence McCook**  
Great Barrier Reef Marine Park Authority
- **Dr Mark Meekan**  
Australian Institute of Marine Science
- **Dr Serge Planes**  
University of Perpignan
- **Professor Robert Steneck**  
University of Maine
- **Dr Madeleine Van Oppen**  
Australian Institute of Marine Science

### Administrative Staff

- **Jennifer Lappin**  
Chief Operations Officer
- **Louise Taylor**  
Office Manager and KPI Officer

- Cathie Page
- Srisakul Piromvaragorn
- Dingchuang Qu
- Charmaine Read
- Ruth Reef
- Alejandro Reyes
- Zoe Richards
- Maria Rodrigues
- Christopher Ryan
- Armagan Sabetian
- Aleksey Sadekov
- Eugenia Sampayo
- Alison Sampey
- Francois Seneca
- Chuya Shinzato
- Luke Smith
- Meir Sussman
- Annamieke van den Heuval
- Ida Vincent
- Stefan Walker
- Merome White
- David Williamson
- Marian Wong
- Timothy Wyndham
- Siti Yaakub



## Research Program Leaders



Professor Malcolm McCulloch is one of the Centre's two Deputy Directors and Program Leader of Program 1: Evolutionary and Environmental Change. He is the Professor of Earth Environment, Research School of Earth Sciences, at The Australian National University, Canberra, and has held this position since 1999. His research interests focus on the modern part of the geologic record using isotopic and trace element geochemical methods to determine how climate and anthropogenic processes have influenced both past and present environments. Malcolm has received a number of awards, including Fellowships of the Australian Academy of Science (2004) and the American Geophysical Union (2002). His 184 scientific papers have been published in leading international journals including 18 in *Science* or *Nature*.



Professor David Bellwood is Program Leader of Program 2, Understanding and Managing Coral Reef Biodiversity. His research encompasses biogeography, paleoecology, biomechanics and behavioural ecology. His primary interests focus on the role of fishes on coral reefs and the relationship between species diversity and ecosystem function at global scales. He is particularly interested in the role of history in shaping the structure and functional characteristics of reef fish communities. After holding positions in the Ministry of Agriculture, Fisheries and Food (UK) and the Natural History Museum (London), he received his doctorate from James Cook University in 1985. Subsequently, he held postdoctoral positions at Silliman University, Philippines (1986) and at JCU (1987-1990). David joined the staff at JCU in 1991, where he now holds a Personal Chair in Marine Biology. He has published over 96 articles in leading international journals, including 6 in *Science* or *Nature*. He currently supervises an active research group of six graduate students and conducts collaborative projects with researchers in five countries.



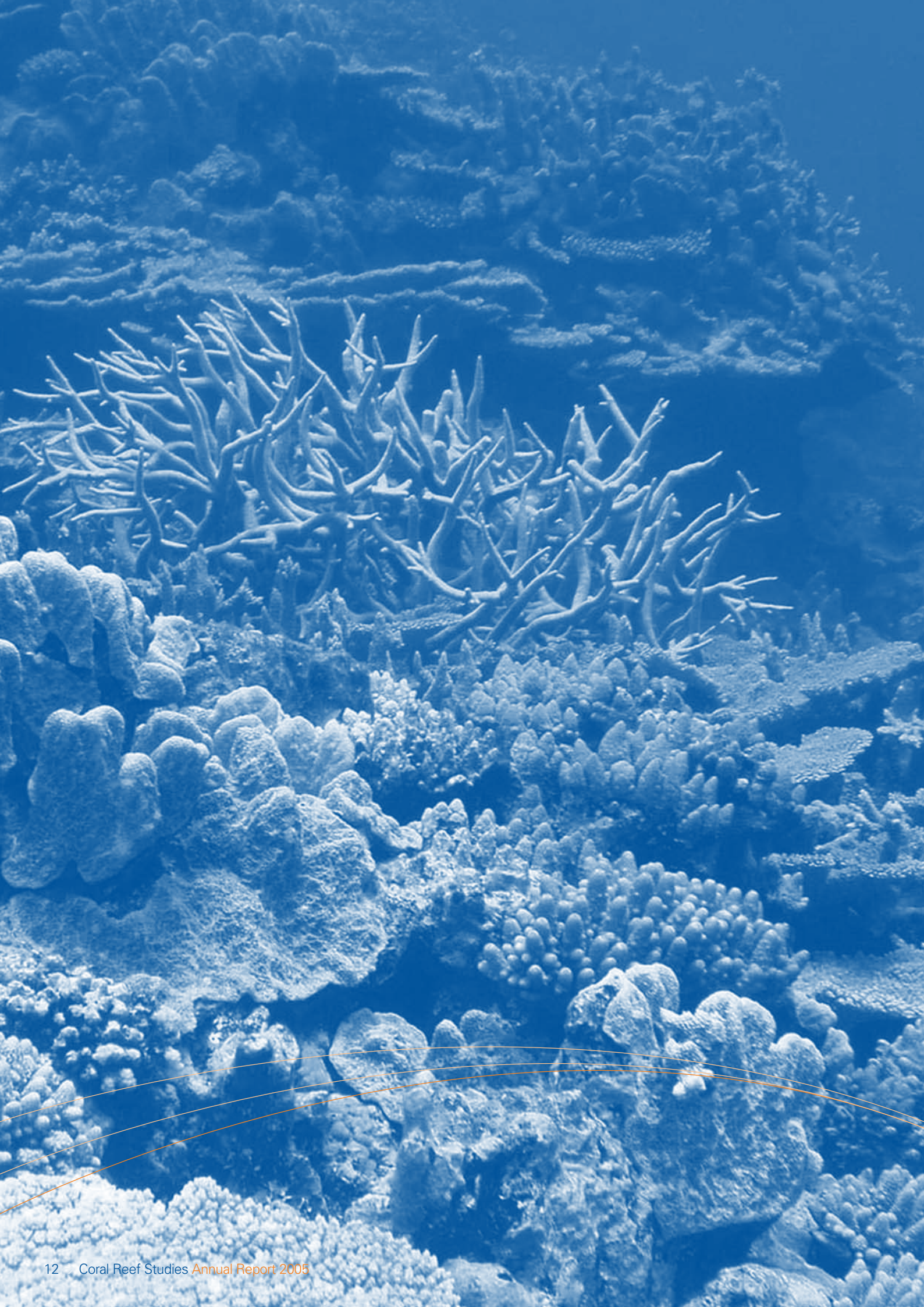
Professor Garry Russ is Program Leader of Program 3: Marine Reserves and Reef Connectivity. Garry studies the biology of reef fish of commercial and recreational fishing significance (mostly serranids, lutjanids and lethriids). A major area of research involves population and community dynamics of reef fish of commercial/recreational significance on coral reefs opened and closed to fishing. In Southeast Asia and Australia, he is undertaking long-term (15 year) monitoring of reef fish populations inside and outside marine reserves. Russ received his PhD from the University of Melbourne in 1981. He was a Queens Fellow at the Australian Institute of Marine Science from 1982-1986. He subsequently held a lectureship at the University of Sydney (1986-87). Garry moved to JCU 1988 where he is currently a Professor in Marine Biology. Garry has published over 45 papers in international journals. In 1999, he received a prestigious PEW Fellowship in Marine Conservation jointly with his long-time colleague Dr. Angel Alcalá.



Professor Ove Hoegh-Guldberg is the other Deputy Director and Program Leader of Program 4: Genetic, molecular and physiological processes. He is the Director of the Centre for Marine Studies at University of Queensland, and Director of the Stanford-Australia Program at UQ. His research interests span a broad range of topics including marine biology, evolution, physiology, biochemistry and molecular biology of plant-animal symbioses, co-evolution, coral bleaching and climate change. Ove is Chair of the GEF/World Bank Working Group on Coral Bleaching and Related Ecological disturbances, one of six expert groups within the IOC and World Bank Coastal Program's Global Coral Reef Targeted Research and Capacity Building Project. In the area of marine symbioses, he leads a large research group including 9 post doctoral fellows, 13 postgraduate and 3 Honours students as Senior Investigator with the Marine Animal and Plant Symbioses Laboratory at UQ. Ove has published over 80 papers, including 5 in *Science* or *Nature*.



Professor Terry Hughes is the Director of the ARC Centre of Excellence, the Centre's Federation Fellow (2002-2007) and Program Leader of Program 5: Resilience of linked social-ecological systems. He has broad research interests in ecology, marine biology and the dynamics of coral reefs. He received his doctorate in 1984 from Johns Hopkins University in Baltimore, Maryland, USA. From 1984-1990, he was a Postdoctoral and Research Fellow at the University of California, Santa Barbara. In 1990, Terry was recruited by JCU to develop and lead a program in coral reef ecology. He has published over 70 influential scientific papers on the biology and management of coral reefs, including 17 in *Science* or *Nature*. Professor Hughes was elected a Fellow of the Australian Academy of Sciences in 2001 in recognition of "a career which has significantly advanced the world's store of scientific knowledge". As Centre Director, Terry provides academic leadership and oversees the strategic development of the Centre. He currently supervises 6 graduate students and directs a very active field program of biogeographic-scale research in eight countries. In the past year he has worked closely on the socio-ecological resilience of coral reefs.



# Research

## Overview

The first six months of the Centre's operations has been an intensive and exciting period of research planning. Following the announcement of the Centre in June 2005, the inaugural Centre of Excellence planning meeting was held at James Cook University in early July. Chief and partner investigators from ANU, JCU, AIMS, GBRMPA and UQ presented their research interests, discussed the Centre's research programs and their role in each program. From July to December researchers in each of the research programs undertook intensive planning sessions to identify the key issues that will be the focus of the Centre's research and operational activities. These planning activities culminated in the Centre's Strategic Plan. The Centre of Excellence will focus initially on 5 research programs, each one under the stewardship of a Program Leader:

### **Program 1: Evolutionary and environmental change**

Knowledge of the past improves our ability to predict future influences of natural environmental variability, human impacts, and climate change on coral reefs. Centre researchers will use fossil and historical records to

develop novel methods to identify potential causes of global change in biodiversity and ecosystem function. Together with ecological studies, this broad array of work provides a unique perspective on community change that ranges from centuries to millennia.

### **Program 2: Understanding and Managing Coral Reef Biodiversity**

Though widely recognised as a critical factor for the maintenance of robust ecosystems, biodiversity at local and global scales is poorly understood. The Centre aims to understand the mechanisms and processes that maintain coral reef biodiversity by using a combination of mathematical modeling, field studies and phylogenetic analyses. This multi-disciplinary approach will improve knowledge-based management of biodiversity resulting in environmental, social and economic benefit to tropical maritime nations.

### **Program 3: Marine Reserves and Reef Connectivity**

Recent studies have highlighted the need for networks of marine reserves (no-take zones) to manage biodiversity and fisheries. Consequently, zoning for multiple levels of usage and protection is fast becoming the principal mechanism in the management

of maritime resources. An improved understanding of marine connectivity and barriers to dispersal is central to this endeavour.

### **Program 4: Genetic, molecular and physiological processes**

This diverse program seeks to understand coral reef processes at a molecular and physiological level to examine potential mechanisms for adaptation and acclimatization to environmental change. Specific areas of study include biochemical analysis of coral-zooxanthellae interactions, coral bleaching, physiology, sublethal stress indicators, energetic modeling, coral diseases and genomics.

### **Program 5: Resilience of linked social-ecological systems**

This novel program will provide new solutions to managing resilience and coping with change, uncertainty, risk and surprise in complex social-ecological systems. The ambitious objective is to improve the governance and management of natural systems and enhance their capacity to sustain human and natural capital. Innovative multi-disciplinary research will combine expertise on coral reef biology, management, governance, economics and social sciences.

## Program 1: Evolutionary and environmental change

### Researchers

Malcolm McCulloch (Program Leader)  
Roger Bradbury  
Sean Connolly  
Ove Hoegh-Guldberg  
Terry Hughes  
Michael Kingsford  
Janice Lough  
John Pandolfi  
Robert Steneck

Studies of coral reef systems and their environments prior to the impact of human civilisations provides a 'natural' baseline against which anthropogenic changes can be compared and assessed. Program 1 is developing novel methods for studying past environments and assessing rates of evolutionary changes in coral reefs. We are identifying the mechanisms via which local and global changes in the marine and adjacent terrestrial environments are causing reductions in coral reef biodiversity and ecosystem function. Together with our ecological studies (Programs 2, 3), this broad approach provides the Centre with a unique perspective on environmental change and how it impacts community structure and longer term evolutionary dynamics of coral reefs. Following a series of planning meetings in 2005, Program 1 has identified three major components:

**(a) Evolutionary dynamics of coral reefs:** Two sub-programs focus on (i) the fossil record and

morphometric and molecular-based phylogenies of functional groups of fishes, corals, coralline algae and zooxanthellae and (ii) the quaternary history of coral reef assemblages in the past 400,000 years (linked to Program 2).

**(b) Climatic variability, floods and terrestrial runoff:** This group applies cutting-edge isotope technologies to develop banded coral skeletons as proxies for paleoclimates and human impacts in Australia and overseas. This innovative approach enables understanding of global climate changes, rainfall variability and drought, and long-term trajectories of nutrient and sediment discharge onto the Great Barrier Reef.

**(c) Long-term records of human-coral reef interaction:** Data is being assembled from a range of sources from before the arrival of humans to the present (sources include Quaternary fossil deposits (past 2MA), coastal archaeological records (past 6000 years), historical documents, fisheries records and modern ecological studies) to quantify human impacts and explore management options (linked to Program 5). Locally, land use changes in river catchments, wetlands and estuaries is leading to increased supplies of sediment and nutrients to coral reefs, which together with pressures from activities such as trawling and overfishing, can lead to a trajectory that may ultimately result in abrupt

ecological phase shifts. On global scales, extreme climatic events caused by increased sea surface temperatures together with rising carbon dioxide levels from fossil fuel burning is resulting in an increased frequency of mass coral bleaching and a concomitant decrease in the rates of coral calcification. Understanding the processes that drive changes at both local as well as global scales is thus essential for the development of optimal strategies to ensure the long-term sustainability of coral reefs.

Research undertaken in this program in 2005 includes a focus on terrestrial impacts on coral reefs, particularly the Great Barrier Reef (GBR). A new postdoctoral position, co-funded by the ARC Centre and the Australian Institute for Marine Science, has been established in order to build capacity in this research area. In 2005-2006 we are focusing on the most highly impacted part of the GBR, where river discharge from the Russell-Mulgrave and adjacent rivers directly impacts the inshore corals of the Frankland Islands. Work is underway on coral cores from these sites with the flood record being documented, chronologies established and geochemical analyses undertaken. As part of the ARC Centre's international role, these new methodologies have also been applied by Malcolm McCulloch and his team to a coral reef off Kenya.

## Program 2: Understanding and Managing Coral Reef Biodiversity

### Researchers

David Bellwood (Program Leader)  
Andrew Baird  
Sean Connolly  
Terry Hughes  
Geoffrey Jones  
Ronald Karlson  
Philip Munday  
John Pandolfi  
Morgan Pratchett  
Robert Steneck

Around the globe, biodiversity is widely recognized as a critical factor for the maintenance of robust ecosystems. It underpins the provision of ecosystem goods and services upon which we all depend. Biodiversity has come to represent one of the central measures of the health of coral reef ecosystems. However, the mechanisms and processes that maintain local and global biodiversity are poorly understood. If societies are to effectively manage coral reef biodiversity and the inherent financial and World Heritage values that it represents then we must understand the nature of biodiversity, the factors that generate and maintain it, and the implications of biodiversity loss.

In 2005, the formation of the Centre presented the investigators in Program 2 with an unprecedented opportunity to expand the scope of our research. Our first goal was to identify the critical questions and then to establish new large scale collaborative research programs.

The three research goals which will be the focus of the Research Program over the next three years to four years are:

1. Understand how coral reef biodiversity is generated and maintained.
2. Quantify the relationship between biodiversity, community structure, and ecosystem function in reef systems. Does biodiversity really matter?
3. Determine how ecosystems and human activities can be managed to ensure biodiversity and critical ecosystem processes are sustained.

Program 2 lies at the heart of the Centre of Excellence, directly addressing the primary focus of the Centre: "sustainable management of coral reef biodiversity". It provides clear links between historical and physiological evidence in Program 1 and 4 and with the direct management approaches in Program 3 and 5. This cross-program multi-institutional collaboration will permit several exciting initiatives in 2006. It will:

1. provide a stronger integration of geological and climatological information with existing strengths in macro-ecology.
2. facilitate development of new advanced analytical approaches in biomolecular, paleontological and ecological fields.

3. permit substantial expansion and development of existing databases, and
4. provide strong links between international researchers and leading management agencies.

Our field work has been substantially expanded with planned sampling and censusing trips spanning the entire Indian and Pacific Oceans, and experimental studies stretching from the Great Barrier Reef to French Polynesia. In 2006, we plan to expand the analytical framework to incorporate process-oriented models in biogeography and instigate molecular analyses of the origins of Indo-Pacific reef biodiversity. We will explore the ecological and molecular evidence for the maintenance of species boundaries and will initiate research into the susceptibility of species boundaries to global warming and associated habitat change. Our research on biodiversity and ecosystem function will document the structure of ecosystems and the strength of ecosystem processes along biodiversity gradients using both direct and experimental approaches. One of the main goals will be to identify critical processes and functional groups for maintaining ecosystem function. In particular, we will focus on documenting novel phase shifts, identifying stable versus transitional states, biophysical thresholds and functional groups involved in reversing phase shifts on coral reefs (linked to Program 5).



## Program 3: Marine Reserves and Reef Connectivity

### Researchers

Garry Russ (Program Leader)  
Andrew Baird  
David Bellwood  
Sean Connolly  
Terry Hughes  
Geoffrey Jones  
Michael Kingsford  
Laurence McCook  
Mark McCormick  
Mark Meekan  
Philip Munday  
Serge Planes  
John Pandolfi  
Morgan Pratchett  
Garry Russ  
Bette Willis

The unifying theme of the Centre is the development of frontier technologies for management and sustainable use of the world's coral reefs. A major approach to management and sustainable use of renewable resources is spatial zoning for multiple levels of use and protection. A key aspect of this zoning approach is the establishment of marine no-take reserves, where all extractive practices by humans are banned permanently. Our recent studies have highlighted the need for networks of marine reserves for management of biodiversity and fisheries. Such zoning for multiple levels of use and protection is fast becoming a principal mechanism of management of Australia's marine resources. No-take reserves are often established to conserve species, communities, habitats, ecosystems and bioregions. They are increasingly also being advocated as a tool

for fisheries management. An improved understanding of marine connectivity (the flux of organisms, genes, nutrients, pollutants, diseases, etc., between locations) and barriers to dispersal is central to this endeavour. To date, some of the largest and most successful applications of marine no-take reserves have been on coral reefs e.g. Australia's Great Barrier Reef Marine Park, with a no-take area over 100,000 km<sup>2</sup>.

Research planning meetings with Chief and Partner Investigators held in the latter part of 2005 identified the following three goals as priorities in the Program's research plan for the next three to four years:

1. Assess the importance of marine reserves for fisheries management on coral reefs
2. Determine the optimal design of reserve networks for management of ecological resilience
3. Identify the levels of larval dispersal and connectivity within and between coral reef systems and marine reserve networks

Program 3 has already created research teams to work on key goals. In 2006, Geoff Jones and Garry Russ will start an innovative experiment to test if no-take zones in the Great Barrier Reef Marine Park export larvae of commercially- and recreationally-important reef fish to adjacent fished areas. This experiment will involve further development of cutting-edge larval marking techniques using

stable isotopes. This program will expand to include inputs from oceanographic and mathematical modellers, and larval biology specialists both within the Program and outside the Centre.

Considerable integration across Centre Programs has also begun. Program 3 has clearly defined and direct links to Program 1 (contemporary and historical fishing levels on the Great Barrier Reef), Program 2 (management of biodiversity within marine reserves), Program 4 (prevalence of coral diseases inside and outside marine reserves) and Program 5 (community-based management of marine reserves and its relationship to social and governance systems).

In addition to a focus on Australia's Great Barrier Reef, the Program has major research projects underway in Indonesia, Fiji, Papua New Guinea and the Philippines. The pending appointment in May 2006 of a Postdoctoral Fellow to work on larval dispersal and connectivity over the next 3 years will contribute considerably to further integration within the Program. The research will use the latest larval tagging technologies to investigate levels of potential export of larvae from no-take marine reserves in both Australia and in neighbouring Indo-Pacific countries. An international workshop on aspects of larval dispersal and connectivity within and between coral reef systems and marine reserve networks, is planned for mid-2006.

## Program 4: Genetic, molecular and physiological processes

### Researchers

Ove Hoegh-Guldberg (Program Leader)

Ken Anthony

Sean Connolly

Sophie Dove

David Miller

Madeleine van Oppen

Bette Willis

David Yellowlees

Program 4 draws on researchers across multiple nodes to understand coral reef organisms at a molecular and physiological level and to examine potential mechanisms of adaptation and acclimatization to environmental change. Genomics and microarray technologies will be integrated with physiological measurements and field experiments. These studies are providing novel tools for monitoring and predicting responses by corals to climate change and other stressors. Research planning undertaken in the latter half of 2005 identified four key focus areas for the next three years:

1. Biochemical analysis of coral-zooxanthellae interactions and coral bleaching. A key aim is improved understanding of the molecular relationship between symbiotic partners to predict responses to climate change and examine mechanisms for adaptation and acclimatization.
2. Coral diseases. The objective is to understand anthropogenic

and climatic drivers of coral diseases, to develop strategies for control and reduction of their economic impacts.

3. Coral and zooxanthellae physiology, sublethal stress indicators and energetic modeling. These studies will provide novel tools for monitoring and predicting responses by corals to climate change and other stressors.
4. Genomics. Comparative genomics of corals and zooxanthellae will be used to establish for the first time the molecular basis for symbiosis and calcification, of critical importance for growth of corals and healthy reef development.

Describing the mechanisms and processes that underpin corals and their symbiosis with dinoflagellates (*Symbiodinium*) is critically important to any comprehensive understanding of recent changes to the world's coral reefs. In addition to providing insight into why elements of coral reef ecosystems may be changing, an in-depth understanding of coral distress and disease will open the door to frontier technologies for use in the sustainable management of areas such as the Great Barrier Reef Marine Park. Program 4 will generate technologies that will range from bioinformatic tools to diagnostic arrays and genetic markers

and probes.

Program 4 will also link Australia's research strengths in coral reef molecular and physiological sciences into key international relationships and networks via the coral bleaching and disease components of the *World Bank - GEF Coral Reef Targeted Research Project*. Several common initiatives are being planned around collaborative workshops and field campaigns that will be held during the next five years, thereby creating synergies and further collaborations between the ARC Centre of Excellence and leading overseas institutions.

During 2005, a new postdoctoral fellow was recruited from Canada to pursue research into the processes underpinning the establishment and functioning of the symbiosis between corals and dinoflagellates *Symbiodinium*. A second fellow, co-funded by the ARC Centre and the Australian Institute of Marine Science, was recruited from the Smithsonian Institute to explore the heritability and evolution of stress resistant characters between generations of reef-building corals, beginning in mid-2006. Four additional postdoctoral appointments will be made to Program 4 over the next few months.

## Program 5: Resilience of linked social-ecological systems

### Researchers

Terry Hughes (Program Leader)  
Andrew Baird  
David Bellwood  
Roger Bradbury  
Carl Folke  
Ove Hoegh-Guldberg  
Laurence McCook  
John Pandolfi  
Garry Russ  
Robert Steneck

Conventional perceptions of the interactions between people and their environment are rapidly transforming. Old paradigms that view humans as separate from nature, natural resources as inexhaustible or endlessly substitutable, and the world as stable, predictable and in balance are no longer tenable. New conceptual frameworks are rapidly emerging, based on an adaptive governance approach that focuses on learning and flexible management in a constantly shifting social-ecological landscape. The overarching goal of this entirely new program is an improved integration of the scientific and social dimensions of natural resource management, to guide the evolution of improved multi-scale systems of governance that confront and cope with uncertainty, risk and change.

To date, the artificial separation between ecology, social sciences and economics continues to be a major impediment to achieving sustainable management of natural resources. The award of a Centre of Excellence enables us to recruit internationally-competitive post-doctoral Fellows to this program to provide value-adding skills across diverse disciplines, creating a unique world-class team with a broad, management-oriented focus. Beginning in 2006, Program 5 will interface with all of the Centre's other Programs, and will build on existing international

linkages with the *Beijer Institute for Ecological Economics*, in Stockholm, the *World Bank GEF Coral Reef Targeted Research*, the *Resilience Alliance*, and others. There will be two sub-programs:

### a) Learning, adaptive management & adaptive governance

A variety of individuals and organisations play functional roles in the adaptive governance of natural resources. This sub-program aims to investigate the social processes and mechanisms behind the 30-year evolution of management and re-zoning of the Great Barrier Reef. One component, in collaboration with CSIRO (*Water for a Healthy Country Flagship*) will address the issue of "mental models", i.e. the perception of individuals (and collectively, of institutions and societal groups) of the state of their environment and their interactions with it. The project will document how mental models vary among stakeholders (farmers, fishers, tourists, scientists, etc.), how these perceptions change over time (for example, as documented in annual reports of management agencies), and the role they play in adaptive management. A related project, to be led by Hughes, Folke and colleagues at the *Beijer Institute for Ecological Economics* in Sweden, will develop new theories and practical approaches to adaptive governance, also based on the recent transformation of the Great Barrier Reef social-ecological system.

In the context of the developing world, Program 5 will address how socioeconomic factors influence the ways in which human societies collectively manage reefs as common-pool resources - how resource use and governance systems are influenced by levels of economic development, social capital, and by local history and culture.

To date these issues have typically been the subject of anecdotal case studies or comparative studies with only a very limited geographic, social, and economic scope. Program 5 participants will develop and measure standardized socioeconomic indicators for 6 countries across South Asia and the Indo-Pacific, and rigorously relate them to corresponding ecological data (linking with Program 2).

### b) Operationalising a resilience approach

A major outcome of Program 5 will be developing information, guidelines and tools for coral reef managers and planners on climate change risks and adaptation options. The goal is to provide an essential link between theoretical concepts, scientific knowledge and the practical endeavours and challenges facing natural resource managers and practitioners. Building on Programs 1-4, Program 5 will lead the development of management protocols in collaboration with the *Resilience Alliance*.

Program 5 represents a major new portfolio of innovative multi-disciplinary research, which will combine and integrate expertise on coral reef biology, management, governance systems, and social sciences. The objective is to create and lead a new multidisciplinary team with members at JCU, ANU and CSIRO that will provide world-best outputs that no existing program in Australia or elsewhere can replicate. The proposed research will provide an ideal vehicle to cement closer links between marine biologists, social scientists, mathematicians and resource managers, facilitating the incorporation of research findings into management activities and environmental policy-development worldwide.



# Students

The ARC Centre of Excellence is the world's largest provider of graduate training in coral reef science. The Centre's goal is to attract and train outstanding coral reef scientists to improve and sustain expertise in coral reef research. The Centre provides a unique opportunity for Australian and non-Australian graduate students to receive research training (at the Honours, Masters and PhD level) in coral reef science, with opportunities for multi-disciplinary and multi-institutional supervision. Seventy-five students were supervised by Centre researchers in 2005. Students have access to leading tropical marine scientists, providing an exceptional intellectual environment. Graduate students form an internationally diverse student body with students from twenty-three countries currently completing their studies across the three university nodes of the Centre.

We emphasise a rigorous, quantitative approach, with well-designed sampling and experimental protocols, addressing questions that are important within

the broad context of ecological and evolutionary theory as well as for advancing our understanding of coral reefs. Students are trained and encouraged to publish their findings in international journals prior to submission of their thesis, generally as the sole or lead author, and to engage throughout with end-users of research.

The Centre actively involves students through a Student Committee. Some of the activities planned for 2006 include mentoring, a workshop series aimed at enhancing students' research and research management skills, open days, newsletters and cross-nodal development programs. We will also develop a program of funding opportunities and awards over coming months. In 2005, the student pages of the Centre's web site were established to feature each student and to showcase their work and achievements [www.coralcoe.org.au/people-students.html](http://www.coralcoe.org.au/people-students.html).

The Centre will facilitate joint training by funding exchanges between Centre nodes and by

working with the Great Barrier Reef Marine Park Authority and other end-users to ensure students and postdoctoral researchers develop generic skills relevant for end-users and stakeholders.

An ambitious postdoctoral recruitment program commenced in 2005. Nine positions have been filled, or will be taken up during early 2006, bringing the total number of postdoctoral fellows in the Centre to seventeen. The Centre has also committed to supporting the research cost of 7 Australian Postdoctoral Fellowships and Australian Research Fellowship applicants in the 2007 round of the ARC Discovery Program. The Centre's aim is to improve expertise and build capacity in coral reef research by recruiting a large body of highly qualified Postdoctoral Researchers particularly in disciplines that are not well developed in Australia. Fellows will be mentored through the Centre's programs to produce high-calibre publications and to engage in the multidisciplinary discourse of coral reef science.

## 2005 Student members of the ARC Centre of Excellence

Student	Country	Thesis Title	Centre Supervisor
<b>David Abrego (JCU)</b>	Mexico	Flexibility in coral algal symbioses: symbiont succession and physiological contributions of different algal partners. (PhD)	A.Prof B Willis Dr K Anthony Dr M van Oppen
<b>Tracy Ainsworth (UQ)</b>	Australia	Microbial communities associated with the coral holobiont during disease and stress. (PhD)	Prof O Hoegh-Guldberg
<b>Shelley Anthony (JCU)</b>	Australia	Coral disease in closed systems. (PhD)	A.Prof B Willis
<b>Bridget Ayling (ANU)</b>	New Zealand	Reconstruction of past interglacial climates using geochemical proxies in fossil <i>Porites</i> corals and giant <i>Tridacna</i> clams. (PhD)	Prof M McCulloch
<b>Line Bay (JCU)</b>	Denmark	The evolution of colour polymorphism in tropical reef fishes. (PhD)	Dr G Jones
<b>Victor Beltranramirez (JCU)</b>	Mexico	Molecular aspects of the coral-algal symbiosis. (PhD)	Prof. D. Miller
<b>Rose Berdin (ANU)</b>	Philippines	Late quaternary palaeoclimate history of the Northern Indo-Pacific warm pool from raised coral reefs in the Philippines. (PhD)	Prof M McCulloch
<b>Michael Berumen (JCU)</b>	USA	Demographic consequences of environmental gradients in chaetodontids. (PhD)	Dr G Jones Dr M Pratchett
<b>Teresa Bobeszko (UQ)</b>	Australia	The effects of different Ci concentrations on the photosynthesis of endosymbionts in scleractenian corals. (Hons)	Dr S Dove
<b>Lynda Boldt (UQ)</b>	Australia	Isolating photosynthetic genes in <i>Symbiodinium</i> sp. and determining how and through what mechanisms changing environmental factors affect symbiotic dinoflagellate photosynthetic processes. (Hons)	Dr S Dove
<b>Daniel Breen (JCU)</b>	Australia	Field and simulation studies in the design of programs monitoring tourist impacts on coral reefs. (PhD)	Dr G Jones
<b>Kate Bromfield (UQ)</b>	Australia	Faunal turnover in reef corals over the Miocene Pliocene boundary in the Indo-West Pacific. (PhD)	A.Prof J Pandolfi
<b>Karin Buechler (JCU)</b>	Switzerland	An evaluation of geographic variation in the life history and behaviour of anemone fishes: a common-garden approach. (PhD)	Dr G Jones
<b>Samantha Burgess (ANU)</b>	Australia	Geochemistry of high latitude environments using coral climate proxies.(PhD)	Prof M McCulloch
<b>Neal Cantin (JCU)</b>	Canada	the impact of photoinhibition on coral reproduction and the influence of genetically distinct <i>Symbiodinium</i> spp. on the physiology of the coral host. (PhD)	A.Prof B Willis

Student	Country	Thesis Title	Centre Supervisor
<b>Michael Cappo (JCU)</b>	Australia	Influences of habitat and ontogeny on composition and size structures of demersal fish communities on tropical shelves. (PhD)	Prof. M Kingsford Prof. G Russ
<b>Timothy Cooper (JCU)</b>	Australia	Physiological and ecological health/stress indicators of corals on nearshore reefs.(PhD)	Dr K Anthony Prof. M Kingsford
<b>Melissa Cowlshaw (JCU)</b>	Australia	Determinants of homerange and territory size in coral reef fishes. (PhD)	Dr G Jones Dr M McCormick
<b>Jo Davy (UQ)</b>	United Kingdom	Putative disease affecting the poritid corals. (PhD)	Prof O Hoegh-Guldberg
<b>Jeffry Deckenback (UQ)</b>	USA	Maturation, turn-over, oligomerization, and transport of Pocilloporins. (PhD)	Dr S Dove
<b>Martial Depczynski (JCU)</b>	Australia	The role of cryptobenthic fishes in coral reef ecosystem function. (PhD)	Prof D Bellwood
<b>Maria Dornelas (JCU)</b>	Portugal	Neutral coral community dynamics. (PhD)	Prof T Hughes Dr S Connolly
<b>Janelle Eagle (JCU)</b>	Australia	The influence of local scale hydrodynamics on food and larval supply to coral reef assemblages. (PhD)	Prof M Kingsford Dr G Jones
<b>Richard Evans (JCU)</b>	Australia	Effects of Great Barrier Reef Marine Park zoning on the reproductive potential of reef fishes. (MSc)	Prof. G Russ Dr G Jones
<b>David Feary (JCU)</b>	Australia	Response of tropical reef fish communities to live coral degradation. (PhD)	Dr G Jones Dr M McCormick
<b>Paul Fisher (UQ)</b>	United Kingdom	Investigating the photo-physiology of <i>Symbiodinium</i> and its relationship to coral bleaching. (PhD)	Dr S Dove Prof O Hoegh-Guldberg
<b>Rebecca Fox (JCU)</b>	United Kingdom	Quantifying the impact of herbivorous fishes on one of the inner shelf reefs of the GBR. (Hons)	Prof D Bellwood
<b>Matthew Fraser (JCU)</b>	Australia	Egg predation at spawning aggregation sites: trade-offs for fitness. (PhD)	Dr M McCormick
<b>Ashley Frisch (JCU)</b>	Australia	The regulation of sex-change in hermaphroditic fish. (PhD)	Dr M McCormick
<b>Chris Fulton (JCU)</b>	Australia	Wave energy and the role of swimming in reef fish ecology. (PhD)	Prof D Bellwood
<b>Monica Gagliano (JCU)</b>	Italy	The role of selective mortality in the early life history of coral reef fishes.( PhD)	Prof M Kingsford Dr M McCormick
<b>Naomi Gardiner (JCU)</b>	Australia	Influence of habitat structure on cardinal fish communities on coral reefs. (MSc)	Dr G Jones
<b>Luis Gonzalez-Reynoso (JCU)</b>	Mexico	The hormonal mechanisms of stress inhibition of reproduction in fish. (PhD)	Dr M McCormick
<b>Andrew Halford (JCU)</b>	Australia	The roles of recruitment and disturbance in assemblages of reef fishes in NW Australia. (MSc)	Dr G Jones

Student	Country	Thesis Title	Centre Supervisor
<b>Meegan Henderson (UQ)</b>	Australia	Microbial ecology of coral disease: the use of molecular techniques in understanding bacterial community shifts. (PhD)	Prof O Hoegh-Guldberg
<b>Jean-Paul Hobbs (JCU)</b>	Australia	Isolation, endemism and the structure of coral reef fish populations and communities (PhD)	Dr G Jones Dr P Munday
<b>Thomas Holmes (JCU)</b>	Australia	The selectivity of predation on newly-settled tropical reef fish. (PhD)	Dr M McCormick
<b>Mia Hoogenboom (JCU)</b>	Australia	Environmental stress, energy budgets, and demography of reef corals. (PhD)	Dr S Connolly Dr K Anthony
<b>Emily Howells (JCU)</b>	Australia	Fine-scale diversity of Zooxanthella populations in soft corals through space, time and early host development. (Hons)	A.Prof B Willis Dr M van Oppen
<b>Akira Iguchi (JCU)</b>	Japan	Fertilisation mechanism of Genus <i>Acropora</i> to clarify the relationship between fertilisation related genes and the speciation of Genus <i>Acropora</i> . (PhD)	Prof D Miller
<b>Jacob Johansen (JCU)</b>	Denmark	Swimming ability, refuging behaviour and habitat use of coral reef fishes. (MSc)	Prof D Bellwood
<b>Paulina Kaniewska (UQ)</b>	Sweden	The effect of light climate on Scleractinian coral morphology. (PhD)	Prof O Hoegh-Guldberg Dr K Anthony
<b>Ailsa Kerswell (JCU)</b>	Australia	Biogeography of benthic marine algae. (PhD)	Prof T Hughes Dr A Baird Dr S Connolly
<b>Charlotte Kvennefors (UQ)</b>	Sweden	Host-pathogen interactions and immunity in reef-building corals. (PhD)	Prof O Hoegh-Guldberg
<b>Angela Lawton (UQ)</b>	United States	Using oxygen microsensors to examine changes in the gross and net photosynthetic rates of corals under varying environmental conditions. (PhD)	Prof O Hoegh-Guldberg
<b>Tove Lemberget (JCU)</b>	Australia	Growth and body condition in a tropical larval fish and its importance to replenishment. (PhD)	Dr M McCormick Dr G Jones
<b>Carole Lonergan (JCU)</b>	Australia	The role of temperature in the disease of Montipora corals by <i>Vibrio coralliilyticus</i> . (Hons)	A.Prof B Willis
<b>Guy Marion (UQ)</b>	United States	The extraction and analysis of nitrogen isotopes (15N) preserved in long coral cores to trace river-born signals of fertilizers and urban pollutants entering the GBR lagoon since European-arrival (1860). (PhD)	Prof O Hoegh-Guldberg Prof M McCulloch A.Prof J Pandolfi
<b>Luiz (Felipe) Mendes De Gusmao (JCU)</b>	Brazil	The use of biochemical methods for the evaluation of zooplankton secondary production. (PhD)	Prof M Kingsford
<b>Juan Carlos Ortiz (UQ)</b>	Australia (Venezuela)	Ecological-dynamics of Heron Island coral communities: The roll of population size frequency distributions. (PhD)	Prof O Hoegh-Guldberg



Student	Country	Thesis Title	Centre Supervisor
<b>Cathie Page (JCU)</b>	Australia	Prevalence and biological impacts of coral disease on the Great Barrier Reef. (PhD)	A.Prof B Willis Prof T Hughes
<b>Srisakul Piromvaragorn (JCU)</b>	Thailand	Spatial patterns in coral communities and recruitment in the Gulf of Thailand. (PhD)	Prof T Hughes Dr S Connolly Dr A Baird
<b>Dingchuang Qu (ANU)</b>	China	Late Quaternary climate in the Indo-Pacific Warm Pool reconstructed from the raised coral reefs of Sumba, Indonesia. (PhD)	Prof M McCulloch
<b>Charmaine Read (JCU)</b>	Australia	Evolution of coral reef fishes and the origin of the Indo-West Pacific hotspot. (PhD)	Prof D Bellwood
<b>Ruth Reef (UQ)</b>	Israel	The effect of temperature on the accumulation and repair of UV damage in corals. (PhD)	Prof O Hoegh-Guldberg
<b>Alejandro Reyes (JCU)</b>	Colombia	The cellular mechanisms of coral calcification. (PhD)	Prof D Miller
<b>Zoe Richards (JCU)</b>	Australia	Age, genetic diversity and fitness of rare <i>Acropora</i> corals.(PhD)	Prof D Miller A.Prof B Willis Dr M van Oppen
<b>Maria Rodrigues (JCU)</b>	Mozambique	Effects of reduced herbivory on coexistence of corals and algae – an experimental approach. (PhD)	Prof T Hughes Dr A Baird
<b>Christopher Ryan (JCU)</b>	USA	Growth related sex change in reef fishes. (MSc)	Dr M McCormick Dr P Munday
<b>Armagan Sabetian (JCU)</b>	New Zealand	Parrotfish fisheries in tropical oceans; an ethnographic and demographic approach. (PhD)	Dr G Jones
<b>Aleksey Sadekov (ANU)</b>	Russia	Distribution of trace elements within foraminiferal tests as the proxy for paleoclimatology and foraminiferal biology. (PhD)	Prof M McCulloch
<b>Eugenia Sampayo (UQ)</b>	Netherlands	Genetic diversity of coral symbionts and whether this diversity is reflected in host-symbiont ecology. (PhD)	Dr S Dove
<b>Alison Sampey (JCU)</b>	Australia	Influence of environmental conditions on the growth and survival of tropical fish larvae from the North West Shelf of Australia. (MSc)	Dr M McCormick Prof M Kingsford
<b>Francois Seneca (JCU)</b>	Monaco	A study of cellular stress response in the scleractinian coral, <i>Acropora millepora</i> . (PhD)	Prof D Miller Dr M van Oppen
<b>Chuya Shinzato (JCU)</b>	Japan	The Sox genes functions in early coral development. (PhD)	Prof D Miller
<b>Luke Smith (JCU)</b>	Australia	Large-scale spatial and temporal variability in coral recruitment and factoring affecting subsequent survival. (PhD)	Prof T Hughes
<b>Meir Sussman (JCU)</b>	Israel	Pathogens, reservoirs and vectors for coral disease on the GBR: a microbial molecular approach. (PhD)	A.Prof B Willis Prof M Kingsford

<b>Student</b>	<b>Country</b>	<b>Thesis Title</b>	<b>Centre Supervisor</b>
<b>Annamieke Van den Heuval (UQ)</b>	Australia	The interaction of coral with their symbiotic dinoflagellates. (Hons)	Prof O Hoegh-Guldberg Dr S Dove
<b>Ida Vincent (UQ)</b>	Sweden	Historical ecology of Fiji. (Hons)	A.Prof J Pandolfi
<b>Stefan Walker (JCU)</b>	Australia	Experimentally isolating the interrelationships between population dynamics, social system and life history plasticity in reef fish. (PhD)	Dr M McCormick Dr P Munday
<b>David Williamson (JCU)</b>	Australia	Fishery effects and benefits of marine protected areas within the Great Barrier Reef Marine Park. (PhD)	Prof G Russ Dr G Jones
<b>Merome Wright (JCU)</b>	Australia	Effects of no-take marine reserves on the abundance and demography of an exploited reef fish	Prof G Russ
<b>Marian Wong (JCU)</b>	United Kingdom	The evolution of monogamy in coral reef fish. (PhD)	Dr G Jones Dr P Munday
<b>Timothy Wyndham (ANU)</b>	Australia	Geochemical tracers of environmental change in the nearshore Great Barrier Reef. (PhD)	Prof M McCulloch
<b>Siti Yaakub (JCU)</b>	Singapore	Hybridization in coral reef fishes: An example from <i>Thalassoma</i> (Family: Labridae) (Hons)	Prof D Bellwood



## End-User linkages

Our primary goal in the provision of end-user links is to promote cooperation between international governments, scientific experts, technological specialists, environmental managers, social planners and regional stakeholders, universities and research institutions. A key objective is the provision of data and information of relevance to managing the goods and services provided by coral reef biodiversity. We will achieve this through the Centre's governance structure, international and national networks, workshops for end-users and industry partners, via the media, and through the Centre's website. The Centre's website [www.coralcoe.org.au](http://www.coralcoe.org.au) was launched on 23 November 2005.

GBRMPA (the major federal agency responsible for reef management in Australia) is represented on the Centre Advisory Board by their Chair, Hon. Virginia Chadwick who provides direct linkage to a diversity of reef stakeholders (the tourist industry, fishing organisations, conservation groups, indigenous Australians) via the GBRMPA Consultative Committee. In addition, Dr David Wachenfeld, Director of GBRMPA's Science, Technology and Information Group is a member of the Centre's Scientific Management Committee. Following the announcement of funding for the Centre of Excellence, briefings were held

with GBRMPA in July and August to assess information needs, gaps and priorities to direct future research. GBRMPA has already committed \$195,000 in cash to Centre research projects over the 3 years 2006-2008 and over \$578,000 in in-kind contributions. James Innes, Manager Social Science, Research and Monitoring Coordination, GBRMPA had an active role in the Centre's successful bid for funding under JCU's Research Advancement Program and will continue to be involved in the development of this important research cluster. This project, *Adaptive Resource Management: Linking Ecology and Social Sciences* to be funded from 2006 to 2008 will extend the research cluster being developed under Program 5 and will represent a new portfolio of innovative multi-disciplinary research combining and integrating expertise on coral reef biology, management, governance systems and social sciences.

In 2005, additional outreach and community awareness activities were undertaken by Centre of Excellence researchers by presenting a number of public lectures and workshops. For example, Terry Hughes presented a public lecture on "A Resilience Framework for Managing Coral Reefs" to a variety of conservation groups at the Queensland Conservation

Conference in September. In December, Ove Hoegh-Guldberg presented a reef training program for Great Barrier Reef Research Foundation (GBRRF) and Comalco representatives.

In late 2005, the Centre lodged an Expression of Interest with the Marine and Tropical Sciences Research Facility of the Commonwealth Department of Environment and Heritage, for additional projects which will have a strong end-user and public-good focus. We plan to develop for the first time a program of reciprocal staff secondments and student placement, involving our university partners, AIMS, CSIRO, GBRMPA and other end-users. We will build also on a range of less formal channels for communication that already exist between Centre members and six Industry Partners.

The Centre will provide an ideal vehicle to cement closer links between scientists and resource managers, facilitating the incorporation of research findings into management activities and environmental policy development worldwide. *Resilience Alliance* meetings and workshops hosted by the ARC Centre in August 2005 led to the publication of a *Policy Forum* in *Science*, entitled "Globalisation, Roving Bandits and Marine Resources" which has generated enormous interest from international regulatory agencies.

# National and International Linkages

Nationally, the Centre's Chief Investigators are a key component of five ARC Networks, reflecting their broad range of expertise. The Centre is represented at the *Australian Academy of Sciences* by Hughes (JCU) and McCulloch (ANU). The three main University nodes (at JCU, ANU and UQ) are linked to research and industry partners throughout Australia (e.g. GBRMPA, CSIRO and AIMS research clusters in Townsville, Brisbane, Canberra, Darwin, Hobart and Perth). Co-funding agreements for postdoctoral fellows shared with the Centre are in place for initiation in 2005-2006 with both AIMS and CSIRO. Internationally, major developing linkages include *The Resilience Alliance*, *The Beijer Institute*, and *The World Bank Coral Reef Targetted Research Program*, which are described briefly below. In 2005, 60% of the Centre's publications included one or more overseas collaborators from 87 institutions in Austria, Brazil, Canada, China, Finland, France, French Polynesia, Germany, Indonesia, Ireland, Israel, Japan, Kenya, Mauritius, Mexico, New Zealand, Norway, Panama, Philippines, Russia, Singapore, Spain, Sweden, Taiwan, United Kingdom and United States of America, (see page 31).

## The Resilience Alliance

[www.resalliance.org](http://www.resalliance.org)

The ARC Centre of Excellence was formally recruited as a Member Organization of the *Resilience Alliance* (RA) in August 2005. The RA is a multi-disciplinary research group that explores the dynamics of linked

social and ecological systems in order to discover foundations for sustainability. It is an extensively networked organization, with 17 member organizations in Australia, Canada, France, the Netherlands, Sweden, Thailand, the USA and Zimbabwe. RA members are world-leaders in the ecological, mathematical, and social sciences, covering a broad range of disciplinary expertise. The ARC Centre is represented by Hughes on the RA's Board of Directors, and on the editorial board of their journal, *Ecology & Society*. In 2005, the ARC Centre sponsored two working groups in Stockholm and in Cairns to fast-track the development of closer linkages between the RA and the Centre. The Centre will host a third meeting in Australia in March 2006. The *Resilience Alliance* has also agreed to co-fund a postdoctoral position based at the Centre's Townsville node in 2006-2007. A series of joint research funding initiatives are also planned for 2006.

## The Beijer International Institute for Ecological Economics

[www.beijer.kva.se](http://www.beijer.kva.se)

The ARC Centre of Excellence's international profile in coral reef sustainability and management was recognized in 2005 by the appointment of the Centre's Director to the Board of Directors of the Beijer Institute (for 2006-2008). The Beijer Institute operates under the auspices of the *Royal Swedish Academy*, working at the interface of ecology and economics. It conducts research and training

internationally, funded by Swedish and international research councils. We are rapidly expanding a wide range of joint activities for 2006 onwards, including several shared research positions, following a successful trial-exchange of personnel between Townsville and Stockholm in 2005. We have also scheduled joint workshops in Australia, Sweden and elsewhere, with a key focus on graduate training and early-career researchers. A major outcome will be the development and application of policy guidelines and processes that further the global development of adaptive governance systems. *The Australian Academy of Science* has formally endorsed the ARC Centre's growing engagement with *Royal Swedish Academy*.

## Global Coral Reef Targeted Research Program

[www.gefcoral.org](http://www.gefcoral.org)

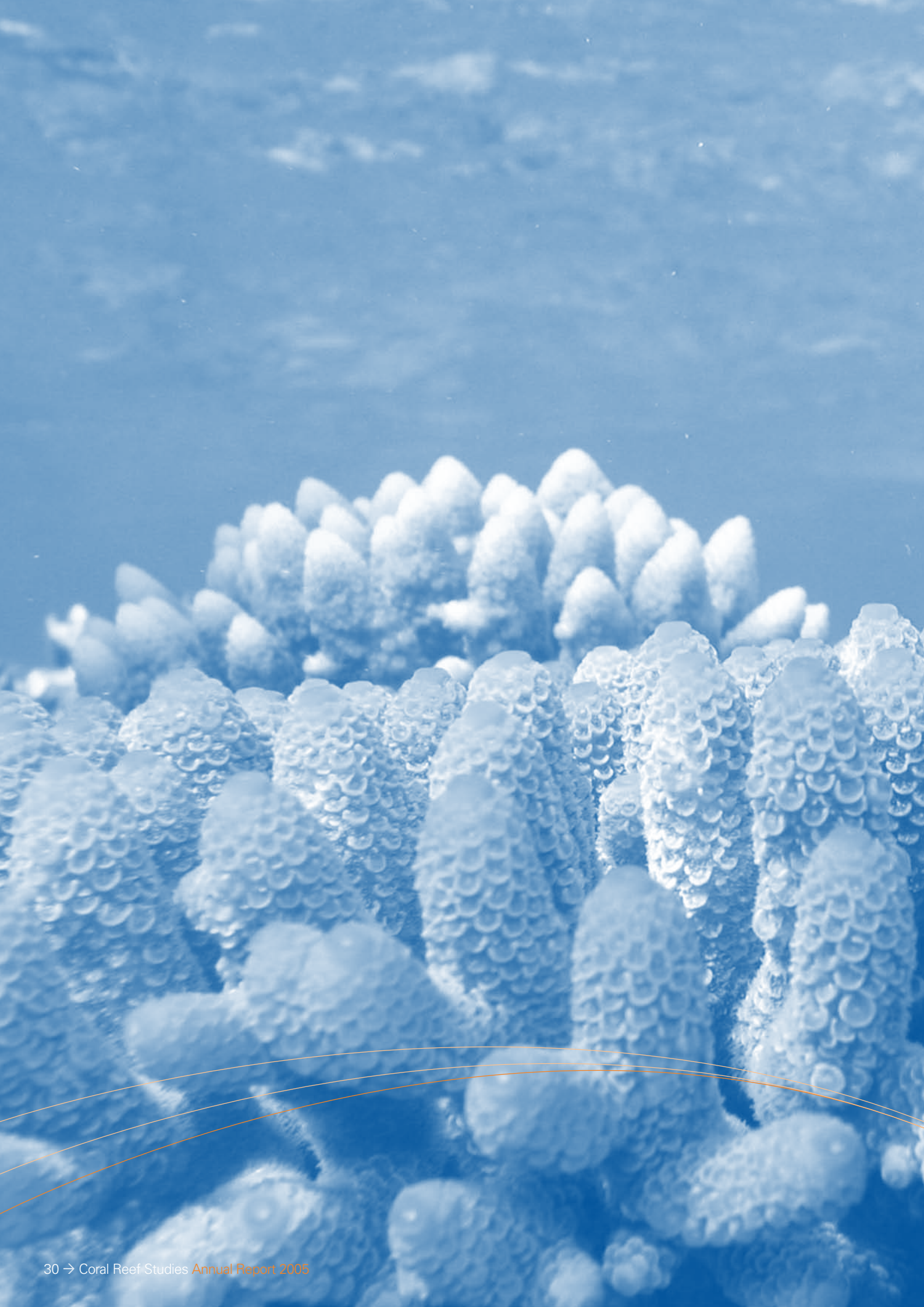
The ARC Centre of Excellence is one of the largest contributors of expertise to this global research partnership, which includes the World Bank, The Intergovernmental Oceanographic Commission, US National Oceanic and Atmospheric Administration (NOAA), the University of Queensland, and 60 other research groups. The consortium of researchers aims to conduct specific, targeted research to fill critically important information gaps in the fundamental understanding of coral reef ecosystems so that management and policy interventions can be strengthened globally. Five International Working Groups, each

with approximately a dozen leading researchers, form the scientific basis for the program. In 2005, the Centre is represented on four groups which dovetail well with Programs 3 and 4 of this proposal: (a) *Diseases Working Group*: Willis (Co-chair), (b) *Connectivity Working Group*: Jones, Planes and Steneck, (c) *Bleaching Working Group*: Hoegh-Guldberg, (Co-Chair), (d) *Modelling Working Group*: Bradbury (Chair). The distinguished Chair of the Centre's Scientific Management Committee, Professor Yossi Loya from Tel Aviv University, is also a Co-Chair of the *Bleaching Working Group*. In 2005, the Centre hosted two working group meetings in Brisbane and Townsville. Several further meetings and joint activities are planned for 2006.

Developing these and further international linkages is a key strategy for diversifying and augmenting the funding base of the Centre (e.g. through Packard, World Bank, etc.).

From July to December 2005, the Centre of Excellence hosted 25 international visitors.

- **Dr Tarik Meziane**  
Museum National d'Histoire Naturelle, Paris France
- **Dr Rod Dunbar**  
Stanford University, USA
- **Dr Adina Payton**  
Stanford University, USA
- **Dr Ken Calderia**  
Stanford University, USA
- **Dr Yossi Loya**  
University of Tel Aviv, Israel
- **Dr Maxime Aubert**  
Eau, Terre et Environnement, Institut National de la Recherche Scientifique, Québec University, Canada
- **Professor Gifford Miller**  
University of Colorado, Boulder, USA
- **Dr Ben Halpern**  
National Centre for Ecological Analysis and Synthesis, University of California, Santa Barbara, USA
- **Dr Rampal Etienne**  
University of Groningen The Netherlands
- **Dr Willem Renema**  
National Museum of Natural History, Leiden, The Netherlands
- **Dr Maoz Fine**  
University of Haifa, Israel  
Dr Davey Kline, Smithsonian Tropical Research Institute, Panama
- **Dr Per Olsson**  
Stockholm University, Sweden
- **Dr Fikret Berkes**  
Natural Resources Institute, University of Manitoba, Winnipeg, Canada
- **Dr Robert Steneck**  
School of Marine Sciences, University of Maine, Orono, USA
- **Dr Jim Wilson**  
School of Marine Sciences, University of Maine, Orono, USA
- **Professor Carl Folke**  
Centre for Transdisciplinary Environmental Research and Department of Systems Ecology, Stockholm University, Sweden
- **A/Professor Lance Gunderson**  
Emory University, Atlanta, USA
- **Dr Boris Worm**  
Biology Department, Dalhousie University, Halifax, Canada
- **Mr Robert Farhi**  
Science and Technology Attaché, Ambassade de France
- **Mr Frédéric Vanhove**  
Assistant to Science and Technology Attaché, Ambassade de France
- **Mr John Warner**  
Economic Officer, U.S. Department of State, U.S. Embassy
- **Dr von Nordheim and colleagues**, Federal Agency for Nature Conservation, Germany
- **Even Moland, Alf Pettersen and colleagues**, Government representatives, Norway



# Media Coverage

The ARC Centre of Excellence is committed to utilizing the media to increase public awareness of Australia's investment in coral reef science and management. We regard media uptake of the Centre's research outputs as an important performance indicator.

Research produced by the Chief and Partner Investigators of the Centre has been highlighted in local, national and international media such as the *BBC Worldwide*, *Der Spiegel*, *The Australian* and *The ABC*. In the latter half of 2005, in addition to the commentaries surrounding the announcement of the Centre, research outcomes were presented in over 100 newspaper and magazine articles, web online articles and in television and radio interviews. We expect to increase significantly the Centre's media presence during 2006 following the appointment of Julian Cribb and Associates as the Centre's media adviser. We plan to issue a minimum of 26 press releases in 2006 to promulgate our scientific outcomes and activities to the community. Additionally, the Centre's website will be further developed during 2006 to enhance public education and to disseminate the activities and outputs of the ARC Centre to a very general audience.

The largest single media event for the Centre in 2005 was the response to Dr Andrew Baird's paper *Acehnese reefs in the wake of the Asian tsunami* (Baird and Campbell *et al*), in *Current Biology*.

With his story on the Acehnese reefs, Dr Baird was cited or quoted in almost 20 different media sources in November.

Some highlights of the diversity and breadth of the Centre's media presence in 2005 include:

## Magazines

*Der Spiegel*, *Genetik- Komplexe Koralle*, David Miller, 15 December 2005.

*New Scientist*, *Lowly Sea Animals Boast World-class Genetic Armoury*, David Miller, 3 December 2005.

*SuperScience*, *Coral Reef Devastation*, John Pandolfi, 15 December 2005.

## Newspapers

Press Release, Dr Brendan Nelson, Australian Government Minister for Education, Science and Training, *\$122 million for New Leading-Edge Research Centres*, 15 June 2005

*Malaysian Star*, *Global Warming Damages Reefs*, Terry Hughes, 24 June 2005.

*West Australian*, *Dampier in Real Deal in Reefs*, Terry Hughes, 2 July 2005.

*Courier Mail*, *Townsville the Big Fish of Reef Research*, Terry Hughes, 13 July 2005.

*Cairns Post*, *Call to Cushion Tsunami Effect*, Terry Hughes, 17 August 2005.

*Sydney Morning Herald*, *Acehnese reefs in the wake of the Asian tsunami*, Andrew Baird, 8 November 2005.

*The Australian*, *Humans Worse than Tsunami on Reefs*, Andrew Baird, 8 November 2005.

*Gladstone Observer*, *Reef research gets a \$1m bonus*, Ove Hoegh-Guldberg, 9 November 2005.

*The Age*, *Humans Cause more Reef Damage than Tsunamis*, Andrew Baird, 9 November 2005.

*The Adelaide Advertiser*, *Coral Destroyed*, Andrew Baird, 9 November 2005.

*Herald Sun*, *Human Wave Wrecks Reefs*, Andrew Baird, 9 November 2005.

*Daily Advertiser*, *Human Most Destructive*, Andrew Baird, 9 November 2005.

*Australian Financial Review*, *Global Effort to save our Coral*, Ove Hoegh-Guldberg, 14 November 2005.

*Courier Mail*, *Reef Damage*, Andrew Baird, 16 November 2005.

*The Age*, *Great Barrier Reef*, Ove Hoegh-Guldberg and Terry Hughes, 17 November 2005.

*Daily Mercury*, *Barrier Reef under the Threat of Wipeout Because of Climate Change*, Ove



Hoegh-Guldberg,  
30 November 2005.

The Canberra Times, *Reef May be History by 2050 Expert Says*, Ove Hoegh-Guldberg, 30 November 2005.

Herald Sun, *Reef Set for Grief*, Ove Hoegh-Guldberg, 30 November 2005.

The Age, *Barrier Reef given a 2050 Death Sentence*, Ove Hoegh-Guldberg, 30 November 2005.

Gladstone Observer, *Reef Tourism Under Threat*, Ove Hoegh-Guldberg, 4 December 2005.

Sunday Telegraph, *Threat to Reef*, Ove Hoegh-Guldberg, 4 December 2005.

## Radio

Townsville, 4TO FM Talkback, *Centre of Excellence Announcement*, 15 June 2005.

ABC Radio, *Role of Climate Change on Western Australian Coral Reefs*, John Pandolfi, 15 July 2005.

The World Today BBC World Service, *Acehnese Reefs in the Wake of the Asian Tsunami*, Andrew Baird, 8 November 2005.

Radio National News, *Acehnese Reefs in the Wake of the Asian Tsunami*, Andrew Baird, 8 November 2005.

Earthwatch Radio interview- "Rich Hoops" *Acehnese Reefs in the Wake of the Asian Tsunami*, Andrew Baird, 8 November 2005.

ABC Central Queensland Radio, *Great Barrier Reef Funding*, Ove Hoegh-Guldberg, 8 November 2005.

2CC Mike Welsh live interview, *Acehnese Reefs in the Wake of the Asian Tsunami*, Andrew Baird, 9 November 2005.

## Television

7.30pm Report, *Scientists Divided Over Coral Reef Protection*, Terry Hughes, 28 June 2005.

Seven local television news, Townsville, *Climate Change and Coastal Development Major Threats to GBR*, Terry Hughes, 15 September 2005. Also Bundaberg, Cairns and Mackay.

Seven News, *Role of Fishes on the Great Barrier Reef*, David Bellwood, 29 August 2005.

Seven Sunshine News Mackay, *\$1m Comalco Funded Research Program on Global Warming*, Ove Hoegh-Guldberg, 8 November 2005.

Seven Cairns TV, *Research on Box Jelly Fish*, Ove Hoegh-Guldberg, 30 November 2005. Also Mackay Sunshine TV.

Sunday Business Television, *Saving Paradise*, Ove Hoegh-Guldberg, 30 November 2005.

Cairns WIN TV, *Support for the Great Barrier Reef*, Ove Hoegh-Guldberg, 8 December 2005.

## News Online

MPA News Interview, *The role of MPAs in protecting against Coastal Disasters*, Terry Hughes, 17 September 2005. <http://depts.washington.edu/mpanews/MPA67.htm#Hughes>

EurekaAlert, *Acehnese Reefs in the Wake of the Asian Tsunami*, Andrew Baird, 9 November 2005.

ABC Science Online- News in Science, *People, not Tsunami, Damaged Reef the most*, Andrew Baird, 8 November 2005. [www.abc.net.au/science/news/stories/s1499488.htm](http://www.abc.net.au/science/news/stories/s1499488.htm)

Marine and Coastal Conservation Network, *People, not Tsunami, Damaged Reef the Most*, Andrew Baird, 8 November 2005. [www.mccn.org.au/article.php/id/840/#a1](http://www.mccn.org.au/article.php/id/840/#a1)

Seaspan Marine Newsletter, *New Coral Reef Research Confirms Need for Regional MPA Networks*, Terry Hughes, 17 September 2005. <http://listserv.miami.edu/scripts/wa.exe?A2=ind0509&L=seaspan&O=A&P=186>

# National Benefit Case-Study

Human populations are concentrated along coasts, and consequently coastal ecosystems are some of the most utilized and altered worldwide. These areas are also sensitive to many hazards and risks, from floods to disease epidemics. In August 2005, the ARC Centre of Excellence published two high profile studies in *Science* (Adger et al. 2005) and in *Current Biology* (Baird et al., 2005), which address how a better understanding of the linkages between ecosystems and human societies can reduce vulnerability and enhance resilience of coastal settlements and economies. The articles focus specifically on disaster management, following an *Australian Academy of Science* forum on the Asian tsunami (and the response of Australia's scientific community to it) held earlier in March 2005 in Canberra.

Both articles argue that effective multilevel governance systems are critical for building capacity to cope with climate change, disease

outbreaks, hurricanes, global market demands, and other large-scale perturbations. The societal challenge is to enhance adaptive capacity to deal with disturbance and to build preparedness for living with change and uncertainty. The *Science* article states that "social resilience, including institutions for collective action, robust governance systems, and a diversity of livelihood choices are important for buffering the effects of extreme natural hazards." We concluded that the hidden success story of the Asia tsunami was the prevention of widespread secondary mortality of injured and traumatized victims from infection and disease, due in large part to the unprecedented scale of international responses. Both publications have been widely cited by NGO and government personnel and agencies, particularly in Indonesia, providing an excellent example of how Australian science and National Priority Areas also resonate regionally.

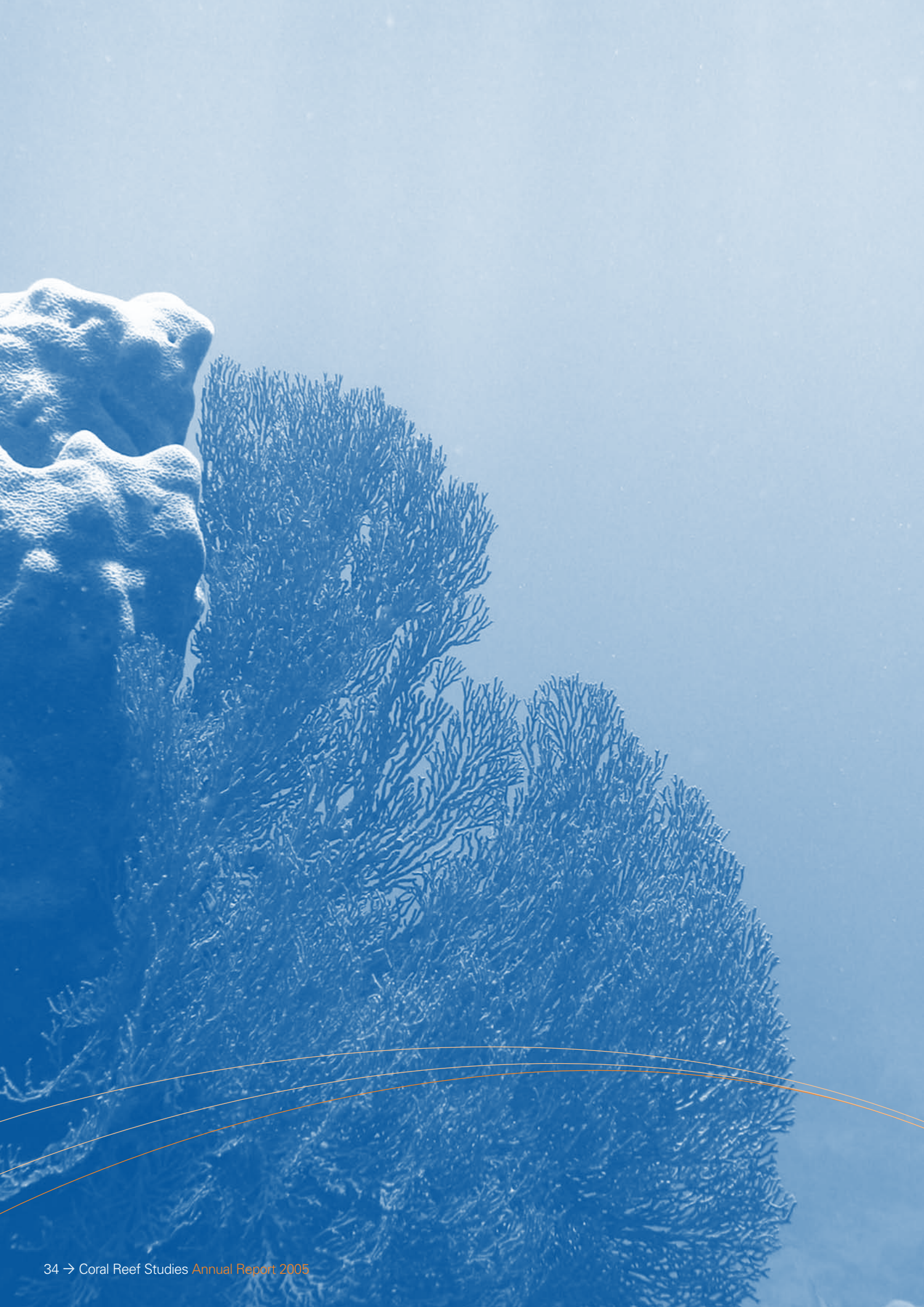
The studies involved two Chief Investigators at the Centre of Excellence, as well as a dozen well-respected co-authors in Indonesia, Sweden, the UK and the USA. Both publications received extensive media attention in Australia and internationally. The Centre of Excellence authors provided over 25 media interviews over a two week period.

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## Aceh, Indonesia – Lhoknga road to beach





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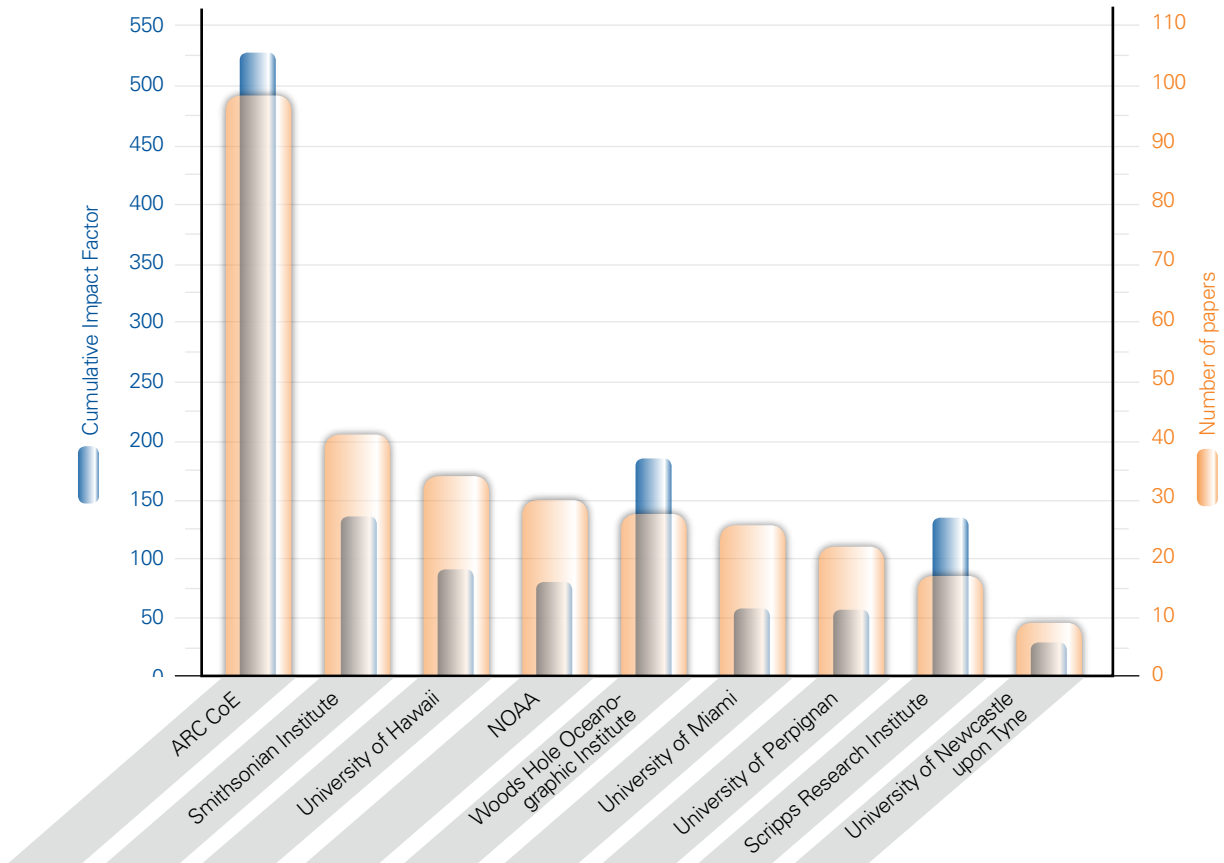




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# Performance Measures

The Centre of Excellence for Coral Reef Studies is a world leader in Coral reef science, with more publications in this discipline than other internationally renowned research institutes, such as the Scripps Institute of Oceanography, Woods Hole Oceanographic Institute and Smithsonian Tropical Research Institute.



**Comparison of 2005 journal publications in coral reef disciplines with Benchmark Institutions.**

Graph compares the total number of publications in Coral Reef Science and the total Impact Factor of those publications. Output was determined by searching ISI Web of Science for Coral\* and the Institution's name. Note the high Impact Factor relative to the number of publications for the ARC Centre of Excellence, Scripps Research Institute and Woods Hole Oceanographic Institute.

Centre researchers are the first, third and fifth most published Australian authors in *Nature* and *Science* in any field over the last five years, with 7 Centre researchers in the top 20. In 2005, ARC Centre of Excellence researchers produced 103 publications. Of these, 28 were published in high impact journals

(ISI impact factor >4). Centre researchers were cited over 3600 times in 2005. Cross institutional collaborations resulted in 62 joint publications representing 90 institutions from 27 countries.

Members of the Centre received recognition in 2005 for the quality of their research through awards

and "league table" success. Madeleine van Oppen received the Australian Academy of Science Dorothy Hill award which recognizes research excellence in reef science by female researchers under 40 years. Sean Connolly was awarded the JCU Early Career Research Excellence award.

League table achievements include:

**Connolly, S.R., T.P. Hughes, D.R. Bellwood, R.H. Karlson.** (2005). Community structure of corals and reef fishes at multiple scales. *Science* 309, 1363-1365. (ranked by the Faculty of 1000 ([www.f1000biology.com](http://www.f1000biology.com)) as an **Outstanding Publication**).

**Bellwood, D.R., T.P. Hughes, C. Folke,** and M. Nyström. (2004). Confronting the coral reef crisis. *Nature* 429: 827-833. (Invited major review and cover article, identified by Thompson ISI as a **Hot Paper** in the top 0.01% of citations among papers published in the past 2 years, ([www.in-cites.com/hotpapers/2005/september05-env.htm](http://www.in-cites.com/hotpapers/2005/september05-env.htm)).

**Hughes, T.P., A.H. Baird, D.R. Bellwood,** M. Card, **S.R. Connolly, C. Folke,** R. Grosberg, **O. Hoegh-Guldberg,** J.B.C. Jackson, J. Kleypas, **J.M. Lough,** P. Marshall, M. Nyström, S.R. Palumbi, **J.M. Pandolfi,** B. Rosen, J. Roughgarden. (2003). Climate Change, Human Impacts, and the Resilience of Coral Reefs. *Science* 301, 929-933. (Major review and cover article, identified by Thompson ISI as one of the **Top 3 Hot Papers in Environment/Ecology** published globally in the past 2 years, [www.in-cites.com/hotpapers/2005/september05-env.htm](http://www.in-cites.com/hotpapers/2005/september05-env.htm))

Jackson, J.B.C., M.X. Kirby, W.H. Berger, K. Bjorndal, L.W. Botsford, B.J. Bourque, **R.H. Bradbury,** R. Cooke, J. Erlandson, J.A. Estes, **T.P. Hughes,** S. Kidwell, C.B. Lange, H.S. Lenihan, **J.M. Pandolfi,** C.H. Peterson, **R.S. Steneck,** M.J. Tegner, R.R. Warner. (2001). Historical overfishing and the recent collapse of coastal ecosystems. *Science* 293: 629-638. (Major review and cover article for *Special Issue on Ecology through Time*. Identified by ISI Essential Science Indicators as a **Current Classic** ([www.in-cites.com/currentclassics/july2005.htm](http://www.in-cites.com/currentclassics/july2005.htm)).

## Research findings

Measure	Target for July-December 2005 <sup>1</sup>	Outcome in 2005 <sup>2</sup>
Number of publications	25	<b>51</b> 1 Book chapter, 46 articles in scholarly refereed journals, 1 journal article-letter, 2 Major Reviews, 1 Conference paper- fully refereed
Publications in Journals with an Impact Factor > 4	2	<b>14</b>
Number of citations	125	<b>1823</b>
Invitations to address and participate in international conferences	2	<b>6</b>
Invitations to provide review articles	2	<b>7</b>
Number and nature of commentaries about the Centre's achievements	25	<b>109</b> (see page 31) 39 newspaper articles 40 web online articles 3 magazine articles 18 television interviews 9 radio interviews
Level of recognition	1	<b>6</b> (see page 41)

## Research training and professional education

Measure	Target for July-December 2005	Outcome in 2005
Number of postgraduates enrolled	50 over 5 years	66 (see page 20)
Number of postgraduate completions	50 over 5 years	4
Number of Honours students	50 over 5 years	9 (see page 20)
Number of professional workshops	1	3
Participation in professional workshops	1	5
Number and level of graduate student courses and workshops in the priority area(s)	3	6

<sup>1</sup> Targets for 2005 have been halved to represent the 6 months from 1 July.

<sup>2</sup> Estimated by halving the total for 2005.

## International, national and regional links and networks

Measure	Target for July-December 2005	Outcome in 2005
Number of international visitors	5	25 (see page 28)
Number of national and international Working Groups	1	13 Centre investigators participated in 3 international and 5 national working groups.
Number of visits to overseas laboratories and research facilities	6	12
Nature and extent of international engagements	3	21 Invitations to membership of national and international boards and advisory committees
Number of cross-institutional authorship of publications	5	62
Number of multi-institutional supervisory arrangements of graduate students	2	29
Number & nature of contractual arrangements (commercialisation and consultancies). Aims to: <ul style="list-style-type: none"> <li>■ increase the level of internationally funded students</li> <li>■ increase level of consultancies and contract research</li> </ul>	10 over 5 years  1	16  8 Contract research contracts with industry
Number of government, industry and business briefings	2	9 industry briefings 8 government briefing
Number of Centre trained/ing personnel in knowledge / technology transfer and commercialization	1	0
Number and nature of Public Awareness programs <ul style="list-style-type: none"> <li>■ Website</li> <li>■ Public awareness presentations</li> </ul>	2000 hits/ month  1	Website established 11361 hits in December 3 public awareness events (Details on page 27)

## Organisational support

Measure	Target for July-December 2005	Outcome in 2005
Annual cash contributions from Collaborating Organisations	<b>\$1,115,000 in year 1</b>	Collaborating organisations have met their 2005 cash contribution commitments. Other cash contributions for year 1 will be provided in 2006
Annual in-kind contributions from Collaborating Organisations	<b>\$1,873,122 in year 1</b>	Collaborating organisations have met their 2005 in-kind contribution commitments. Other in-kind contributions for year 1 will be provided in 2006
Number of new Organisations recruited to or involved in the Centre	<b>4 in year one, increasing by 2 per annum</b>	<b>8</b> New collaborations established with the Beijer Institute, University of Adelaide, CSIRO Sustainable Ecosystems, University of Maine Orono, University of Dalhousie, Emory University, Wageningen University, and the Centre for Transdisciplinary Environmental Studies
Level and quality of infrastructure provided to the Centre	For year 1, the value of infrastructure provided to the Centre from collaborating institutions totals <b>\$878,843</b> .	Collaborating institutions have provided access to infrastructure for the Centre exceeding their commitments.
Annual cash contributions from other new organisations	Additional funding of <b>\$100,000</b> in year 1	Additional funding of <b>\$100,000</b> received from CSIRO Sustainable Eco-systems

## Governance

Measure	Target for July-December 2005	Outcome in 2005
Breadth and experience of the members of the Advisory Board	Senior representation from all nodes. Representation of eminent international researchers. Members with commercial and business links. Representation of a broad spectrum of interests with strong participation from end users	Centre Advisory Board and Scientific Management Committee established. Membership details on page 6
Frequency and effectiveness of Advisory Board meetings	Annual face-to face meeting attended by entire Centre Advisory Board. Face-to-face meeting of entire Scientific Management Committee twice per year.	Inaugural Scientific Management Committee meeting in February 2006. Inaugural Centre Advisory Board meeting scheduled for early 2006. 2 Program leader meetings held in 2005.
Quality of the Centre strategic plan	The Centre's progress against the plan will be formally reported to the Advisory Board and be renewed in light of outcomes.	Draft Strategic Plan developed and presented to Scientific Management Committee. To be reviewed by business, science and university leaders and presented to inaugural Centre Advisory Board.
Effectiveness of arrangements to manage Centre nodes	The nodes will communicate through: 1) Meetings of the Scientific Management Committee where each node and program is represented 2) monthly nodal leader phone or video conferences 3) Annual rotational visits to the nodes 4) Annual research retreats for all Centre participants 5) Annual research planning meetings of Programs with cross-nodal attendance	1) All nodes and research programs represented at Scientific Management Committee meetings. 2) Monthly nodal and program leader meetings held 3) In 2005 management meetings held at each of the 3 nodes 4) In 2005 research planning meetings held for Centre and each research program 5) Cross nodal attendance at all research planning meetings
The adequacy of the Centre's Key Performance Measures	1) International benchmarking to research in top international marine research centres.	The Centre has outperformed benchmarked institutions. (See page 41)

# National Benefit

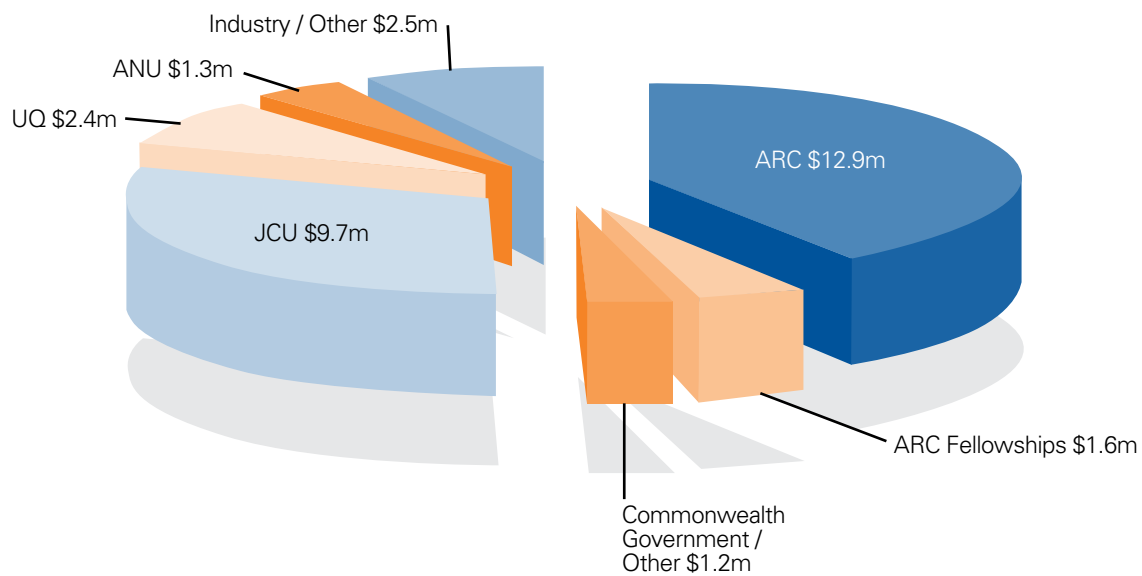
Measure	Target for July-December 2005	Outcome in 2005
Measures of expansion of Australia's capability in the priority area(s)	1) A growth trajectory of 10% in citations and Publications from 2000-2004 as the benchmark. 2) 5 briefings to government, business and industry groups per annum in year 1 increasing to 10 by year 5. 3) 10 cross institutional co-authored publications in year 1 increasing to 30 by year 5.	16%  17 briefings  14 Publications co authored by researchers in different nodes of the Centre
Case studies of economic, social, cultural or environmental benefits	1 to be highlighted in the annual report and distributed to media agencies Target of 1 for July-Dec 2005	(See page 33)



# Financial Status

The operating cash and in-kind operating budget for the Centre of Excellence for 2005-2010 currently totals \$31.6m. The chart below indicates the budgeted level of funding from the various funding sources.

**Cash & Inkind Operating Budget 2005-2010**



# University Partners





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**Coral Reef Studies**

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