

Cambridge University Press
978-0-521-67145-3 - Coral Reef Conservation
Edited by Isabelle M. Cote and John D. Reynolds
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Coral Reef Conservation

Coral reefs are the 'rainforests' of the ocean, containing the highest diversity of marine organisms and facing the greatest threats from humans. As shallow-water coastal habitats, they support a wide range of economically and culturally important activities, from fishing to tourism. Their accessibility makes reefs vulnerable to local threats which include over-fishing, pollution and physical damage. Reefs also face global problems, such as climate change, which may be responsible for recent widespread coral mortality and increased frequency of hurricane damage.

This book summarizes the current state of knowledge about the status of reefs, the problems they face and potential solutions. The topics considered range from concerns about extinction of coral reef species to economic and social issues affecting the well-being of people who depend on reefs. The result is a multidisciplinary perspective on problems and solutions to the coral reef crisis.

ISABELLE M. CÔTÉ is a professor at Simon Fraser University, Vancouver, Canada where she leads the Tropical Marine Ecology Group.

JOHN D. REYNOLDS is a professor at Simon Fraser University, Vancouver, Canada where he holds the Tom Buell Chair in Aquatic Conservation.

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Conservation biology is a flourishing field, but there is still enormous potential for making further use of the science that underpins it. This new series aims to present internationally significant contributions from leading researchers in particularly active areas of conservation biology. It will focus on topics where basic theory is strong and where there are pressing problems for practical conservation. The series will include both single-authored and edited volumes and will adopt a direct and accessible style targeted at interested undergraduates, postgraduates, researchers and university teachers. Books and chapters will be rounded, authoritative accounts of particular areas with the emphasis on review rather than original data papers. The series is the result of a collaboration between the Zoological Society of London and Cambridge University Press. The series editors are, Professor John Gittleman, Professor of Biology at the University of Virginia, Charlottesville, Dr Rosie Woodroffe of the University of California, Davis and Dr Guy Cowlislaw of the Institute of Zoology, Zoological Society of London and Professor Michael Samways, Stellenbosch University, South Africa. The series ethos is that there are unexploited areas of basic science that can help define conservation biology and bring a radical new agenda to the solution of pressing conservation problems.

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ISABELLE M. CÔTÉ
JOHN D. REYNOLDS
Simon Fraser University



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CONSERVATION AND FISHERIES, UK

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Contributors

ANGEL C. ALCALA
 Silliman University–Angelo King Center
 for Research and Environmental
 Management (SUAKCREM)
 Silliman University Marine Laboratory
 Dumaguete City 6200
 Philippines

RICHARD B. ARONSON
 Dauphin Island Sea Laboratory
 101 Bienville Boulevard
 Dauphin Island, AL 36528
 USA

RICHARD BOAK
 Water Management Consultants Ltd
 23 Swan Hill
 Shrewsbury SY1 1NN
 UK

KATRINA BROWN
 School of Development Studies
 University of East Anglia
 Norwich NR4 7TJ
 UK

LISA J. BROWNING
 Reefology
 39 Brompton Road
 Southsea PO4 9AJ
 UK

EMILY CORCORAN
 Coral Reef Unit
 c/o UNEP–World Conservation Monitoring
 Centre
 219 Huntingdon Road
 Cambridge CB3 0DL
 UK

ISABELLE M. CÔTÉ
 Department of Biological Sciences
 Simon Fraser University
 Burnaby, B.C. V5A 1S6
 Canada

DEOLALL DABY
 School of Science
 University of Mauritius
 Reduit
 Mauritius

RICHARD E. DODGE
 Nova Southeastern University
 Oceanographic Center
 8000 North Ocean Drive
 Dania Beach, FL 33004
 USA

R. ANDREW O. FINLAY
 Atkins Water
 Woodcote Grove
 Ashley Road
 Epsom KT18 5BW
 UK

LORNA R. E. FOX
 Reefology
 39 Brompton Road
 Southsea PO4 9AJ
 UK

TOBY A. GARDNER
 Centre for Ecology, Evolution and
 Conservation
 School of Environmental Sciences
 University of East Anglia
 Norwich NR4 7TJ
 UK

JENNIFER A. GILL
 Centre for Ecology, Evolution and
 Conservation
 School of Biological Sciences
 University of East Anglia
 Norwich NR4 7TJ
 UK

DAVID GILLIAM
 Nova Southeastern University
 Oceanographic Center
 8000 North Ocean Drive
 Dania Beach, FL 33004
 USA

STEFAN HAIN
 Coral Reef Unit
 c/o UNEP–World Conservation Monitoring
 Centre
 219 Huntingdon Road
 Cambridge CB3 0DL
 UK

ALASTAIR R. HARBORNE
 Marine Spatial Ecology Laboratory
 School of Biosciences
 University of Exeter
 Exeter EX4 4PS
 UK

EMILY HARDMAN
 Marine Science Laboratories
 University of Wales at Bangor
 Menai Bridge LL57 5AB
 UK

JULIE P. HAWKINS
 Environment Department
 University of York
 York YO10 5DD
 UK

J. HAROLD HUDSON
 Florida Keys National Marine
 Sanctuary
 PO Box 1083
 Key Largo, FL 33037
 USA

DAVID J. HUTCHINSON
 School of Biological Sciences
 University of Liverpool
 Liverpool L69 7ZB
 UK

WALTER C. JAAP
 Florida Fish and Wildlife Research Institute
 100 8th Avenue SE
 St Petersburg, FL 3370
 USA

GUY JOBBINS
 SEAM Programme
 Egyptian Environmental Affairs Agency
 30 Misr Helwan al Zerae
 Maadi
 Cairo
 Egypt

REBECCA KLAUS
 Marine Science Laboratories
 University of Wales at Bangor
 Menai Bridge LL57 5AB
 UK

NANCY KNOWLTON
 Center for Marine Biodiversity and
 Conservation–0202
 Scripps Institution of Oceanography
 University of California at San Diego
 La Jolla, CA 92093
 USA

TIM McCLANAHAN
 Wildlife Conservation Society
 Coral Reef Conservation
 Bamburi, Kenyatta Beach
 Mombasa
 Kenya

PETER J. MUMBY
 Marine Spatial Ecology Laboratory
 School of Biosciences
 University of Exeter
 Exeter EX4 4PS
 UK

PORTIA NILLOS
 Silliman University–Angelo King
 Center for Research and Environmental
 Management (SUAKCREM)
 Silliman University Marine Laboratory
 Dumaguete City 6200 Philippines

WILLIAM F. PRECHT
 PBS&J
 Ecological Sciences Program
 2001 NW 107th Avenue
 Miami, FL 33172
 USA

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[More information](#)

x List of contributors

JOHN D. REYNOLDS
 Department of Biological Sciences
 Simon Fraser University
 Burnaby, B.C. V5A 1S6
 Canada

CALLUM M. ROBERTS
 Environment Department
 University of York
 York YO10 5DD
 UK

GARRY R. RUSS
 School of Marine Biology and Aquaculture
 James Cook University
 Townsville 4811
 Australia

RICHARD SHAUL
 Sea Byte, Inc.
 P. O. Box 14069
 Bradenton, FL 34280
 USA

CHARLES SHEPPARD
 Department of Biological Sciences
 University of Warwick
 Coventry CV4 7AL
 UK

JAMES SPURGEON
 Jacobs Babbie
 London Road
 Reading RG6 1BL
 UK

JOHN R. TURNER
 Marine Science Laboratories
 University of Wales at Bangor
 Menai Bridge LL57 5AB
 UK

AMANDA C. J. VINCENT
 Project Seahorse
 Fisheries Centre
 University of British Columbia
 Vancouver, B.C. V6T 1Z4
 Canada

ANDREW R. WATKINSON
 Centre for Ecology, Evolution and
 Conservation
 Schools of Biological and Environmental
 Sciences
 University of East Anglia
 Norwich NR4 7TJ
 UK

SUE WELLS
 56 Oxford Road
 Cambridge CB4 3PW
 UK

CLIVE WILKINSON
 Global Coral Reef Monitoring Network
 c/o Australian Institute of Marine
 Science
 P. O. Box 772
 Townsville 4810
 Australia

Foreword

The world's coral reefs are vitally important for their biodiversity value, including the large range of goods and services that they provide to people who have few alternative resources available. Coral reefs support 10% of the world's fishing harvest, provide vital coastal protection, and harbour a third of the world's marine species.

Yet, as this volume makes clear, coral reefs and the livelihoods they support are under grave threat from a range of competing pressures. These include coastal development, unsustainable fishing practices, pollution, the growth of tourism and the consequences of climate change. These pressures threaten around half of the world's reefs.

The United Kingdom has a particular responsibility towards helping to solve the problems facing the world's coral reefs. Through our Overseas Territories, we are ranked 12th among the world's nations for tropical reefs under our jurisdiction. Furthermore, recent research has shown that we also have significant areas of cold-water reefs off our shores, which harbour unique species assemblages that are under threat, principally from fishing trawlers. The UK has used the Common Fisheries Policy to protect cold-water corals such as the Darwin Mounds.

Coral reef conservation is also a key part of our wider international agenda, which seeks to promote sustainable development and poverty reduction while safeguarding the biodiversity that is crucial to people around the world. The recent report by the Royal Commission on Environmental Pollution, *Turning the Tide*, underlines ongoing degeneration of the marine environment. The sustainable management of our seas is an enormous environmental challenge.

To meet the challenge of solving the coral reef crisis we need to be strategic and flexible in developing our responses, recognizing that we often need to follow different tracks simultaneously. We need to keep up the pressure on tackling climate change by reducing greenhouse gases. The coral reef community can play a vital role in helping to secure international action

by publicizing the findings reported in this volume, of extreme sensitivity of coral to increases in sea temperatures, which has severe implications for coastal communities.

As we tackle climate change, we need to mainstream coral reef conservation management approaches into national sustainable development and investment strategies, as well as those of international agencies and programmes, donors and financial institutions. We need countries and organizations to change their thinking and adopt integrated marine and coastal management strategies.

We also need to apply more specific measures that address sectoral threats directly. We need to focus on tackling excessive and destructive fishing; we need networks of marine protected areas; and we need appropriate regulatory action to control land-based pollution.

To deliver these policies and measures effectively, we also need to improve the way we work together and take forward our policies. This means effective partnerships embracing governments, agencies, inter-governmental bodies, non-governmental organizations (NGOs) and the private sector, which enable decisions and implementation to be undertaken at the local level wherever possible. In short, we need improved governance based on stronger participation by all interested parties.

An excellent example of international coordination is provided by the International Coral Reef Initiative (ICRI). We are delighted to have shared responsibility for ICRI over the last two years with the Government of Seychelles and with the assistance of the UNEP World Conservation Monitoring Centre in Cambridge. This has been a significant undertaking in our Department of Environment, Food and Agriculture, which has contributed some £200 000 to run ICRI during our stewardship, including helping to deliver some tangible outcomes under a small grants programme.

We feel that ICRI has established a sense of an international coral reef community, providing a strong voice in international environment and development decisions. This has strengthened the hand of coral reef conservation when decisions taken by countries are translated into actions on the ground. At the recent Small Island Developing States Conference in Mauritius (January 2005), ICRI joined with governments, NGOs and agencies in a major initiative to help develop marine protected areas throughout the Small Island regions over the coming years.

The last element I would draw attention to in building a strategic approach to coral reef conservation is the need for increased funding of assessment and science. I am delighted that the conference that led to this book included the UK launch of the 2004 Status of Coral Reefs of the World

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report. I commend this as an excellent piece of work by the Global Coral Reef Monitoring Network.

Some of the messages in the Report and amplified in this book are stark, but it is not all bad news. It is heartening to be able to point to cases where effective management has shown that coral reef degradation can be stopped and reversed. This underlines the importance of our devising effective strategies which centre on conservation of the resources on which communities depend, and which demonstrate long-term commitment by all parties.

Ben Bradshaw, MP
Minister for Nature Conservation and Fisheries, UK

Preface

Coral reefs are found in the waters of more than 100 countries in tropical regions of the world, and provide food, income and cultural benefits to hundreds of millions of people. They cover a mere 0.1% of the ocean surface, yet they host a disproportionate amount of biodiversity, including nearly one-third of the world's marine fish species.

Coral reefs are under threat around the world. Recent estimates suggest that approximately 20% of the world's coral reefs have been destroyed and show no immediate prospect of recovery. Of those remaining, one-quarter are under imminent risk of collapse and another quarter face a long-term threat of collapse. For example, a recent comprehensive survey from the Caribbean found that since 1977, live coral cover across this region has decreased from 50% to 10%. This 80% decline in 25 years exceeds the rates of loss for any biome, including tropical forests. Equivalent measures of coral loss are not yet available for other regions, though 80–95% of coral cover was lost throughout large tracts of the Indian Ocean during the 1998 coral bleaching event, and there has been little recovery from many of these sites.

The main causes of coral reef degradation clearly originate from human activities, driven by growing human populations in coastal areas and lack of effective management of reef resources. They include over-fishing, which can damage reefs directly and also through the removal of herbivores that keep macroalgae in check, pollution and sedimentation due to coastal development and runoff from deforested lands, and warming of oceans due to climate change. There are no easy solutions to any of these problems. Climate change is particularly worrisome, with its links to coral bleaching and mortality. Future projections of rises in sea temperatures are bleak, and the problem can only be combated with concerted global efforts, which are difficult to muster.

The implications of coral reef deterioration for loss of biodiversity are profound. Governments of the world are committed to the target of the

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World Summit on Sustainable Development, set in Johannesburg in 2002, for a reduction in the rate of loss of the world's biodiversity by 2010. With the marine habitat that holds the highest diversity of species per unit area under such threat, this target will be very difficult to achieve.

The loss of the world's reefs also has profound implications for the millions of people who depend on them for food and income. Healthy reefs are estimated to provide up to US\$375 billion per year in goods and services globally. These benefits include fisheries, tourism, protection of coastal developments against storms, generation of beach sand, sources of pharmaceuticals, and the provision of key biogeochemical services (i.e. nitrogen fixation, waste assimilation, detoxification of hydrocarbons, oxygen production and sequestration of carbon).

This book stems from a conference that we organized in London in December 2004. The meeting was sponsored by the Zoological Society of London and by the Fisheries Conservation Foundation, to whom we are extremely grateful. Prominent speakers from a wide range of disciplines were asked to help place the coral reef crisis in context of the implications for both biodiversity and loss of ecosystem services that are vital to people's livelihoods. The meeting also served as the UK launch point for the biennial *Coral Reefs of the World Report* (2004) by the Global Coral Reef Monitoring Network.

In Part I, 'Setting the stage', Clive Wilkinson begins with a sobering review of the state of the world's coral reefs. Although some of the reefs affected by the 1998 mass bleaching event have recovered, many have not. Recovery has been better in more remote areas unaffected by severe anthropogenic impacts, but coral reefs of the world continue to decline under a mix of predominantly human stresses. How extraordinary these changes are can only be understood when placed in a historical context. William Precht and Richard Aronson offer such a perspective for Caribbean coral reefs and suggest that the unprecedented convergence of coral community compositions across reefs of the region began in the very recent past and was initiated primarily by disease outbreaks and bleaching episodes. The changes occurring on coral reefs can also not be appreciated in an ecological vacuum. Peter Mumby and Alastair Harborne demonstrate elegantly the connectivity and interdependence of coral reefs, mangroves and sea-grasses and argue convincingly for a seascape perspective. Finally, Emily Corcoran and Stefan Hain shatter the myth of corals as exclusive denizens of warm, tropical waters and review the distribution and only recently realized plight of cold-water corals. Anyone who needs to be convinced that there is indeed something very special 'down there' need only look at

Plate 4.4! The authors note that a key difference between temperate and tropical reefs is the fact that the former face a single predominant threat: trawling, giving some hope for effective management.

Coral reefs are exploited for the resources they contain. The impacts of this exploitation are reviewed in Part II, *Uses and abuses: ecological and socio-economic issues*. Tim McClanahan considers the challenges to achieving sustainability in coral reef fisheries. These include managing a highly species-rich catch, targeted by varied and overlapping gear owned by a large number of people wholly dependent on this activity for their livelihood. Tim's review of food fisheries is complemented by Amanda Vincent's chapter, which provides the most comprehensive review to date of the trade in live fish and non-food items extracted from coral reefs. She points out the increasingly global reach of the trade in reef products, and the depletions of some species such as groupers and large wrasses that ensue. For other species, her review highlights concerns about the lack of information on population impacts of extractive activities. Guy Jobbins shows that tourism can be a mixed blessing for coral reefs. Tourism brings in much-needed revenues and incentives to protect reefs. However, the infrastructure required by tourists, and the actions of the visitors themselves, can threaten the very ecosystems that drew people to a given area. Guy illustrates these trade-offs using the South Sinai as a case study and suggests non-intuitive links between destination marketing, visitor 'quality' and coral reef degradation.

We have included human alteration of the global climate among the many abuses sustained by coral reefs. Although the direct impacts of climate change on reefs, such as the incidence of coral bleaching caused by elevated sea temperatures, are well documented, the longer-term impacts of bleaching-induced coral mortality are less often considered. Charles Shepard shows that these effects can be far ranging, from shifts in coral community composition as a result of differential mortality among species, to increases in wave energy reaching the shoreline, and accelerated beach erosion, resulting from the impaired protective function afforded by eroding dead coral.

In Part III, various authors explore *The way forward*. Their chapters cover three general topics: developing or strengthening assessment methods, involving communities in conservation, and rethinking management strategies. Assessing what we have lost and what we have left is not as straightforward as it seems. Isabelle Côté and colleagues propose a new and statistically robust method of estimating the rate of ecological change on coral reefs. This method generates hard-hitting figures of coral loss, which are useful for lobbying for action and for gauging how far we are from

meeting the 2010 biodiversity objective. We have spared the reader yet another review of the importance of marine protected areas (MPAs). Instead, Sue Wells tackles a neglected but important aspect of coral reef MPAs: how to assess the effectiveness of their management. She emphasizes how we should adopt business-like criteria to assessing MPA management effectiveness. John Turner and colleagues show how careful environmental impact assessment can reduce or mitigate some of the more damaging effects of coastal development on coral reefs. They offer a new method of impact assessment which calls for continuous monitoring of reefs during construction and responsive feedback action by developers. Another form of assessment is reviewed by James Spurgeon, who points toward the next generation of economic models to improve our estimates of the value of coral reefs. He argues that the omission of the intrinsic value of reefs from previous approaches has led to a gross undervaluation of these ecosystems.

It is widely acknowledged that community support is crucial to the success of all conservation endeavours. The veracity of this statement is tested quantitatively by Angel Alcalá and co-authors. They compare the outcomes of coral reef MPAs with and without community-led management and find that, although both types of MPAs have equal success in enhancing fisheries, those involving local communities experience fewer conflicts with stakeholders. Engaging communities in coral reef conservation is clearly desirable, but sometimes difficult to achieve. Education offers an important means to raise awareness of the importance of reefs and instil a sense of pride and ownership. Lisa Browning and colleagues review the positive impacts of education programmes associated with coral MPAs. On the strength of this evidence, they make the case that education should be an integral part of coral conservation effort and not a poorly planned afterthought, as is often currently the case. Bottom-up approaches to community involvement are necessary, but are not enough without a change in top-down influences. Kate Brown highlights the key reasons why stakeholders are seldom involved in coral reef conservation, and shows why a full understanding of the social and political contexts is vital for success in reef management. Anyone who thinks that better studies of conservation biology alone will turn things around should take a close look at her Fig. 15.2, which shows that in Tobago, taxi drivers have the same perceived influence over the local marine park as conservation organizations!

Two chapters on coral reef management address opposite extremes of spatial scale. Walt Jaap and colleagues examine coral reef restoration techniques, which are usually applied to small areas of reef after damage from

ship groundings and other physical impacts. There seems to be little that cannot be fixed nowadays, given sufficient time and money. High-tech restoration is a luxury that few countries can currently afford, but we can expect a growing demand for use of the simpler techniques amid increasing human activities around reefs. At the other end of the spectrum, Callum Roberts and co-authors propose a radical shift in the scale at which coral reef conservation efforts should be aimed. Marine reserves are still the best tool we have to protect reefs, but their so-far haphazard establishment must be transformed into a spatially coherent regional network to preserve and enhance key processes of reef recovery, such as recruitment, which occur at large geographic scales.

The concluding chapter could easily have been a sad goodbye to coral reefs, an obituary to a much admired old friend, but it is not. Nancy Knowlton offers us instead a cautiously optimistic credo, highlighting evidence of recovery here and positive human action there as small rays of hope. Indeed it isn't all gloom and doom. We hope that the contributions of the 39 authors in this book will help consolidate the knowledge base from which people can move forward in their efforts to restore the world's coral reefs and the vital resources that they contain.

Isabelle M. Côté
and
John D. Reynolds
Vancouver, January 2006