Implications for Coral Reef Management and Policy:

Relevant Findings from the 9th International Coral Reef Symposium

Edited by

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Cover Photos (clockwise):

Cleaning ornamental shells in Cebu, Philippines – Barbara Best
Great Barrier Reef, Australia – Great Barrier Reef Marine Park Authority
Great Barrier Reef, Australia – Great Barrier Reef Marine Park Authority
Bleaching Reef at Reunion Island, April 2001 – M. Rard/ECOMAR
Dynamite blast-fishing – Reef Check

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Organization Profiles

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Preface

Call for Actions to Protect and Conserve Coral Reef Ecosystems

CORAL reefs constitute one of the earth's most complex, beautiful and biologically diverse ecosystems. These unique ecosystems benefit people directly by supplying a vast array of goods and services such as food, medicine, recreation, and coastal protection, as well as aesthetic and cultural benefits. Coral reefs occur in over 100 countries. According to one estimate, coral reefs provide over US $375 billion worth of goods and ecosystem services to humans. The economies of many countries, especially small island nations, are highly dependent on the goods and services that coral reefs provide. In addition, coral reefs are intimately associated with mangrove forests and seagrass meadows and form a broader tropical coastal ecosystem upon which more than a billion people depend.

Photo: Roger Steene

Coral reef with rocky island in Calamianes Islands, Philippines

Unfortunately, many coral reefs around the world are in serious decline. According to the recent report *Status of Coral Reefs of the World: 2000* by the Global Coral Reef Monitoring Network, one quarter of the world's reefs have already been lost and another one-third may disappear within the next 30 years. Coral reefs are threatened both directly and indirectly from a variety of human activities. These threats include coastal development, overexploitation and destructive fishing practices, diseases, land-based pollution and erosion, marine-based pollution, and global climate change. In addition, the recent global impacts of catastrophic events, such as widespread coral bleaching and mortality and increased storm intensity, compound the more localized human impacts that place reefs at risk. There is an urgent need to respond to these threats facing coral reefs at local, national, regional, and global levels in order to address biodiversity loss, food insecurity, loss of economic livelihood, and loss of development potential.

In response to these threats facing coral reefs, the organizers of the 9th International Coral Reef Symposium (ICRS) incorporated strong management and human or socio-economic dimensions into the symposium, expanding their usual biological and ecological emphasis. Over 1500 scientists, managers, resource users, government officials, journalists and others interested in coral reef studies and management gathered in Bali, Indonesia in October of 2000. The overall theme of the meeting was the *World Coral Reefs in the New Millennium: Bridging Research and Management for Sustainable Development.* To intervene effectively, we need to view and understand coral reefs in multiple dimensions – human, socio-economic, biological, and ecological.

The 9th ICRS continues a process begun in 1969 at the first ICRS – bringing together those interested in coral reef studies and management to share, debate and learn from each other, and to set a course of action to conserve and sustain the coral reefs. Organized into five broad themes: "State of Knowledge;" "Resource Management;" "Socio-economic Values;" "Assessment, Monitoring, and Rehabilitation;" and "The Future of Coral Reefs," over 1400 papers were presented orally in 58 mini-symposia, and more papers were presented in poster sessions.

The purpose of this report is to synthesize some of the best scientific and management information presented at ICRS for use by those in positions to conserve, protect and rehabilitate coral reefs – policy-makers, managers and the public-at-large. Session convenors, collaborators and colleagues were asked to prepare short syntheses of relevant sessions and/or topics for coral reef management and policy. Each topic area is meant to be a stand-alone piece that can be used separately from the whole report. Some topics relate directly to one or more sessions, while other topics were dispersed throughout many sessions. We extend our sincere thanks and gratitude to Dr. Anugerah

Nontji and his Indonesian colleagues for hosting a wonderful Symposium, and to those session convenors and colleagues who responded to our requests for contributions to this report. The success of this project is due to their dedication and assistance.

Although efforts must be made by all parties on all issues, some of the more important recommendations from the 9th ICRS are the following:

For Policymakers

- reduce greenhouse gases and address climate change
- address threats from invasive species and coral diseases
- strengthen law enforcement
- reduce land-based sources of marine pollution
- expand and strengthen marine protected areas
- enhance communication of scientific information to the general public

For Researchers

- encourage research targeted to management needs
- conduct valuation studies of coral reefs
- increase monitoring studies for more informed management

For Managers

- implement co-management approaches
- implement ecosystem level management
- make more use of socioeconomic information in management
- promote stakeholder participation and participatory decision-making in management
- exercise vigilance and precautionary approaches in all coral reef fisheries
- prohibit destructive fishing practices – such as explosives, cyanide and other poisons, dredging, and trawling

We must now utilize the information available to us to conserve and protect the world's coral reefs, in conjunction with a precautionary approach to management. We must also develop policy and management actions that reflect the multiple dimensions of coral reef ecosystems – human, biological and ecological.

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Long Term Coral Reef Monitoring Programs: Working Towards a Synthesis of Science, Management, and Policy

Brian N. Tissot [1] and Deborah M. Brosnan [2]

Statement of the Issue

CORAL reefs are complex ecosystems threatened globally with a variety of natural and anthropogenic factors. Scientific monitoring is the primary source of information on reef biology and status. However, monitoring is both a scientific endeavor and a decision-making management tool. As a result, this dual nature leads to controversy and there is considerable debate among scientists about the design and methodology of these programs. Thus, although monitoring programs are often focused on important biological questions, they may have weak links to management and environmental policy. These links need to be strengthened for effective management and intervention.

This paper is a synthesis of presentations and discussions that took place both during and after the 9th ICRS, and included scientists, reef managers and policy-makers. Several major coral reef monitoring programs in the Atlantic, Caribbean, and Pacific, and their relationship to management and policy issues at both the local and national levels, were reviewed.

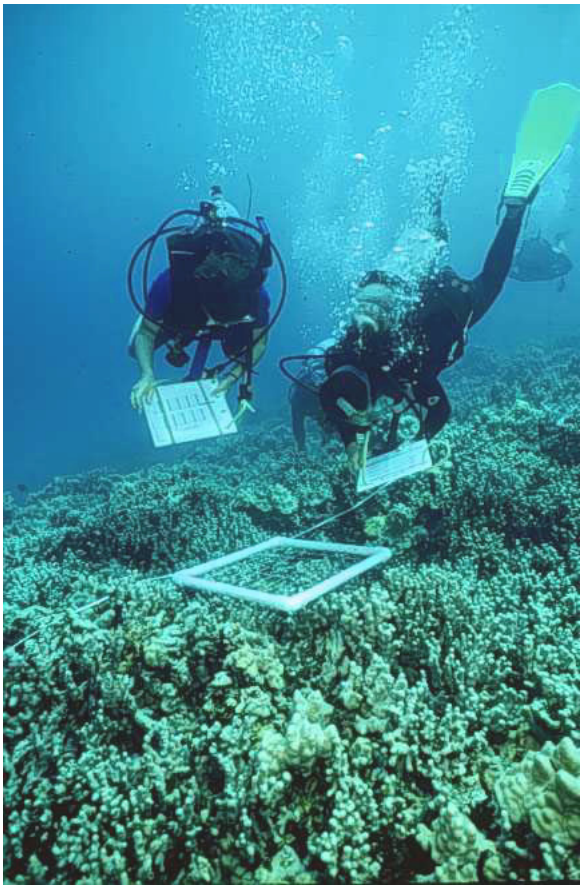

Photo: Brian Tissot

Monitoring in Mahikona, Hawaii

State of Knowledge

Careful Design, Integration and Cooperation are Important

Although monitoring questions are often based on simple scientific principles and methods, it is a challenge to distinguish natural from human-induced variation. Careful attention to the types of data collected, including indicator species such as benthic algae and temporal patterns in the distribution and abundance of recent and old dead coral, can provide important information on population dynamics.

Monitoring programs require a substantial amount of energy to be established and maintained, and there are institutional barriers to establishing long-term programs. Monitoring is undervalued in comparison to experimental science, and it is difficult to sustain funding over the time scales needed to detect meaningful change. Moreover, holistic approaches that integrate both the causes and effects of human impacts on reefs often require interdisciplinary cooperation, which clash with traditional disciplinary boundaries and funding sources.

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Formulate Realistic Targets

Another important issue is the statistical rigor of monitoring programs. To be efficient, monitoring programs need to be focused on specific testable hypotheses or questions. However, question-driven programs are based on specified experimental designs that require specific target levels of accuracy and statistical error rates. Due to substantial (and non-linear) trade-offs between accuracy and effort, formulating realistic target levels is critical to program design and success. Unfortunately, many monitoring programs are not based on the needs of reef managers and may be overly accurate and thus inefficient with limited financial resources. Statistical rigor can also be increased by using paired control-impact designs, habitat-based stratified approaches and by methods that increase replication or reduce measurement error.

Role of New Technologies

One of the most important long-term drivers of monitoring programs is likely to be changes in technology. Thus, research exploring new methodology is important and rigorous monitoring programs should be adaptive to new methods as they emerge. Increases in the resolution of remote sensing combined with increasing scales of underwater survey work are beginning to provide large-scale data for ecosystem management. However, efficient management at the ecosystem level will require better integration of state and federal policy and cooperation and collaboration among a wide variety of stakeholders.

Relevant Actions Being Taken and Management/Policy Implications

There is a strong need for scientists and resource managers to collaborate when developing and implementing long-term monitoring programs. Reef managers need to develop the specific questions and criteria they need to be effective managers and scientists need to link their experimental designs to these questions. Moreover, policy makers need to use language detailing specific terms and/or outcomes from programs that link science and management issues together. A good example of this type of monitoring program is the West Hawaii Aquarium Project (WHAP). WHAP is run by a consortia of academic scientists working with Hawaii resource managers and biologists to measure the effectiveness of marine reserves created to evaluate the policy-mandated "effectiveness" of the reserves to increase the productivity of an aquarium fishery. WHAP is cost-efficient because it uses highly-trained undergraduate students generated from the QUEST coral reef monitoring workshop to conduct reef surveys (see references).

There is also a need to develop a question-driven decision tree. That is, given a specific management question what monitoring programs and methods are good models. The development of this tool would help facilitate collaboration between scientists and managers and reduce the amount of controversy around methodological and statistical issues. The decision-tree should also include a framework for integrating ecological concepts (for example, disturbance) with the appropriate methodology so there is consistency both within and among programs.

The creation of a question-driven decision tree can be facilitated by developing standards through a national and/or international coral reef monitoring program that all programs could build on and provide a central clearinghouse for data, metadata and survey methodology. Good examples of international monitoring programs exist in the GCRMN/Reef Check model and the ReefBase database. At the National level the USA Coral Reef Conservation Act offers an opportunity to mesh state and federal policy and establish a national coral reef monitoring program. However, to develop an efficient, effective and sustainable monitoring program there is a need to conduct a comprehensive review and synthesis of existing long-term programs and identify gaps in information and methodology.

Specific Recommendations for Action

- Monitoring programs need to be designed with strong links to reef management issues;
- Reef managers need to develop specific questions and criteria and collaborate with scientists;
- Policy should address realistic and measurable scientific/management questions;
- A question-driven decision tree needs to be developed to guide the experimental design of monitoring programs;
- Research on new survey methodology should be ongoing and monitoring programs should be flexible and incorporate new methods;
- There needs to be greater coordination among monitoring programs at the national and international levels and the development of a central clearinghouse for data and methodology.

Useful References and Resources:

This paper was prepared from presentations and discussions at the 9th International Coral Reef Symposium, with special emphasis on Mini-Symposium D2 "*Central Questions, Experimental Design, and Methods of Long Term Monitoring Programs: A Synthesis of Ecological Concepts and Data.*" Authors and titles of presentations can be found at: www.nova.edu/ocean/9icrs/

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