

MEETING REPORTS

Coral Reefs and Global Change: Adaptation, Acclimation, or Extinction?

A symposium at a joint meeting of the Society for Integrative and Comparative Biology, the International Society for Reef Studies, and the Ecological Society of America, held at the Boston Marriott Copley Place, in Boston, USA, during 3–7 January 1998

The symposium was organized to provide review and input by the scientific community to the products of Working Group 104 of the Scientific Committee on Oceanic Research (SCOR), co-sponsored by the Land-Ocean Interactions in the Coastal Zone (LOICZ) – a core project of the International Geosphere-Biosphere Programme (IGBP), and with the support of the NOAA Coastal Ocean Program. This working group has been addressing the issue 'Coral reefs and global change: the role of adaptation' since 1994.

Total meeting attendance was approximately 1200, with participants in the coral reef invited and contributed paper sessions numbering in the hundreds. A majority of the registrants was from North America, but the symposium drew both speakers and attendees from Europe, the Western Pacific, the Caribbean region and the Middle East.

The symposium-related aspects of the general meeting consisted of one and a half days of contributed papers and posters (48 presentations), followed by two days of invited papers (18 presentations plus a discussion session); abstracts and titles were published in volume 37, number 5 of the journal *American Zoologist*. Symposium papers were broadly interdisciplinary, with contributions by biogeochemists, geologists, paleobiologists, climatologists, aquarists, geneticists, and organismal, ecological, and evolutionary biologists. Following the meeting, symposium participants and working group members met in a 3-day workshop to review and integrate the results of the presentations and discussions.

In keeping with the theme of the symposium, three major focal aspects emerged from the interdisciplinary presentations and discussions:

The calcification of corals, coralline algae, and coral-algal communities is dependent on the calcium carbonate saturation state of surface seawater, and is expected to be reduced by rising atmospheric carbon dioxide. This represents a global, systemic, climate-related threat to the functioning of reef ecosystems that will interact with the more immediate anthropogenic local stresses.

Coral reefs and communities are products of processes operating over a wide range of interacting time and space scales, with fundamentally different controls operating at different scales. While short-term responses will be controlled by local environmental conditions and biotic responses, the longer-term sustainability of a reef system depends on the recruitment, dispersal, persistence, and interactions of populations at larger scales.

Corals, and to some extent reef communities, possess numerous mechanisms for acclimatization and adaptation – diverse reproductive strategies, flexible symbiotic relationships, physiological acclimatization, habitat tolerance, and a range of community interactions. However, current understanding of these mechanisms, as

well as of the critically important calcification mechanisms, is inadequate to explain the past success of corals and reefs or to ensure their conservation for the future.

In view of the important, and in some cases largely unrecognized, implications of the conclusions for coral reef research, management, and conservation, symposium participants have agreed to make a concerted effort to publicize and interpret the results for the larger community. A more extensive report of the meeting and workshop may be found at <http://coral.aoml.noaa.gov/themes/coral-cg.html>. Proceedings of the symposium will be published as a dedicated issue of the journal *American Zoologist*.

ROBERT W. BUDDEMEIER
*Kansas Geological Survey
University of Kansas
1930 Constant Ave
Lawrence, KS 66047
USA
Tel: + 913 864 3965
Fax: + 913 864 5317
e-mail: buddrw@kgs.ukans.edu*

International Workshop: Planning for Climate Change Through Integrated Coastal Management

Held in Chinese Taipei, Taiwan, during 24–28 February 1997

The workshop was a follow-up to the World Coast Conference held in Noordwijk, the Netherlands, in November 1993, and provided an excellent opportunity to share new information and results on integrated coastal zone management, the coastal impacts of climate change, and the integration of adaptation strategies into national Climate Change Action Plans. A total of 122 representatives from 27 countries and four international organizations attended. Participants were asked to contribute a short overview on the progress their country has made in identifying coastal vulnerabilities and developing adaptation strategies, including the status of national integrated coastal management plans. The conference was supported by: Asian Foundation, Chinese Taipei Industrial Technology Research Institute, Japan Environment Agency, the Netherlands National Institute for Coastal and Marine Management, Chinese Taipei Environment Protection Administration, US National Oceanic and Atmospheric Administration, US National Academy of Sciences, and the US Country Studies Program.

The goals of the workshop were to:

- Update workshop participants on the latest developments from the IPCC (Intergovernmental Panel on Climate Change), including coastal findings, vulnerability assessment, response options, and adaptive measures.
- Review through country study experiences, common problems

with, management strategies for, and approaches to adapting to climate change.

- Exchange ideas for integrating strategies for adapting to the effects of climate change with those for managing other coastal problems and concerns – e.g. coastal pollution and habitat protection – within the framework of integrated coastal management (ICM), which is the IPCC's recommended approach to addressing current and long-term coastal management issues.
- Produce and adopt guidelines for incorporating principles and elements of ICM into national Climate Change Action Plans.

The workshop participants discussed and adopted a set of practical ICM guidelines for policymakers and coastal managers dealing with sustainable coastal area resource management and development. These guidelines were created to help industrialized countries, developing countries, and countries with economies in transition, to ensure that their national Climate Change Action Plans fully consider coastal resources and marine ecosystems. The guidelines are provided under the following headings:

- Principles for Integrated Coastal Management
- Improving the Scientific and Information Base for ICM
- Improving Institutional Capacities
- Participation and Consensus Building
- Education, Training, and Outreach
- Financing and Implementing Management Strategies.

A Summary Report of the Workshop is provided in Volume I of the Proceedings. The papers will be presented in Volume II, which will be published in early 1998. Copies of the ICM Guidelines may be obtained from: International Conference Secretariat, Attention Ms Lynne Mersfelder, N/EA, 1309 East-West Highway, #13336, Silver Spring, MD 20910, USA. Tel: +1 301 713 3078 ×172 Fax: +1 301 713 4263 e-mail: Lmersfelder@ocean.nos.noaa.gov

G. ROBIN SOUTH
Marine Studies Programme
The University of the South Pacific
PO Box 1168, Suva
Republic of Fiji
Tel: +679 305272 Fax: +679 301490
e-mail: SOUTH_R@USP.AC.FJ

Indirect Effects in Marine Ecosystems

A workshop held at the University of St Andrews, Scotland, during 18–19 September 1997

There is growing concern about the effect which commercial fisheries may be having on marine ecosystems, especially as there has been a marked trend for these fisheries to exploit progressively lower trophic levels (Pauly *et al.* 1998). Both the European Union and the Food and Agriculture Organization of the United Nations have recognized the need to incorporate ecosystem effects into future fisheries management policies. However, it is not clear how this can be achieved. Some insights can come from theoretical and empirical studies of food webs, where indirect effects (in which one species or species group can affect another through an intermediate species) are known to have important effects. In order to see whether this framework can provide an insight into multispecies management

problems, a group of 25, mainly British, ecologists took part in the present workshop supported by the Royal Society of Edinburgh. Kevin Stokes (CEFAS, Lowestoft) gave a brief presentation on the way fisheries are managed in the North Sea. Total Allowable Catches are set by the European Council of Ministers, acting on the advice of the International Council for the Exploration of the Sea (ICES). Most advice is given on a stock by stock basis, assuming that each species will be managed in isolation. ICES does make use of a multispecies version of conventional Virtual Population Analysis (VPA) to assess some ecosystem effects of different management actions, but there has been no instance since 1991 of the output from the Multispecies VPA being used to give advice for management. Nevertheless, ICES has moved a long way forward in providing advice to managers on the risks associated with particular management options.

Geoff Kirkwood (Imperial College, London) described the activities of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR). The Commission is required to manage the entire Antarctic marine ecosystem rather than just the individual exploited stocks. The system is dominated by krill, which is an important prey species for most of the higher predators and a potentially important species for commercial harvesting. A precautionary approach has been taken in setting catch limits for all species, in order to ensure that recruitment is stable, that ecological relationships are maintained, that depleted populations are allowed to recover, and to minimize the risk of potentially irreversible changes. The abundance and reproductive performance of a number of top predators which may act as indicators of krill abundance is monitored. However, the only well-documented long-term change in abundance of higher predators is the decline in abundance of a number of albatross species which is probably a result of their by-catch in long line fisheries (i.e. a direct, not an indirect, effect).

Nicholas Polunin (University of Newcastle, Newcastle upon Tyne) described his work on the management of fisheries on coral reefs. These systems are particularly amenable to study because the physical constraints are easily identified, there is high species diversity, the abundance of many species can be monitored by direct counting, and areas which are closed to fishing have been established in a number of countries. Although numbers of predatory species have been dramatically reduced in some systems, this has not often led to an increase in prey species abundance. There have been large scale changes in the species composition of reef communities following increases in fishing intensity, but it has been difficult to distinguish the effects of fishing from other anthropogenic activities such as increased nutrient inputs.

Peter Yodzis (University of Guelph, Canada) described his work using multispecies models of the Barents Sea and Benguela current ecosystems to investigate the effects of reducing the abundance of a top predator on fisheries yields, and to address the fundamental question of whether it was possible to identify discrete 'modules' within these systems. In these complex systems the median return to fisheries following a reduction in predator numbers was less than that predicted by a simple surplus yield calculation, and, in many cases, the probability of an increase in yield was no greater than that of a decrease. It was possible to remove the weakest 40% of the many thousands of links in the system without greatly affecting the predicted consequences of changes in predator numbers, but this still left a very complex system.

The workshop also discussed how the large industrial fisheries, mostly directed at sandeels and Norway pout (*Trisopterus esmarkii*), in the North Sea may affect higher predators. Adult sandeels are

confined to relatively well defined areas of sediment, but 0-group sandeels are pelagic and occur over a much wider area. It is this class of sandeel which is the major prey for fish and some seabirds. The sandeel fishery takes relatively few 0-group sandeels and, consequently, the impact of the fishery on recruitment is most likely to be through a reduction in the spawning stock. Sandeels in the North Sea are currently managed as a single stock, but recent research suggests there may be a number of reproductively isolated stocks. Other seabirds and marine mammals often predate age 1 and older sandeels. These are the same age classes which are taken by the sandeel fishery. Fishing for sandeels is concentrated on a small number of favoured banks, and this could have a direct effect on the availability of sandeels for predators using these banks.

Discussions in the workshop highlighted how difficult it is to develop models of indirect interactions in marine ecosystems which combine accuracy with utility. It was clear that much more work was required to determine whether there were identifiable modules within ecosystems which could be modelled effectively in isolation from the rest of the system, and to understand the way in which predators respond to changes in the relative abundance of their different prey species. In the meantime, simplified models, despite their many limitations, can be useful in demonstrating the way in which management actions based on single species models may have undesirable consequences as a result of indirect effects.

Reference

Pauly, D., Christensen, V., Dalsgaard, J., Froese, R. & Torres, F. (1998) Fishing down marine food webs. *Science* **279**: 860–3.

JOHN HARWOOD
School of Environmental & Evolutionary Biology
University of St Andrews
St Andrews
Fife KY16 9TS
Scotland, UK

Climate Change and Biological Diversity

A forum held at Kyoto, Japan, on 6 December 1997

One hundred and thirty participants representing a wide range of stakeholders, including governments, international institutions, and non-governmental organizations met in Kyoto, Japan, for a Global Biodiversity Forum. The forum was convened to coincide with the third meeting of the parties to the Climate Change Convention. The meeting was not intended to reach consensus but rather to raise the profile of forest and biodiversity conservation and to assess the opportunities to improve their prospects in the negotiations of the Kyoto Protocol. The World Conservation Union (IUCN) co-sponsors included the World Resources Institute, the World Bank, the Biodiversity Action Network (BIONET), the United Nations Development Programme, the World Wide Fund for Nature, the United Nations Environment Programme, the Royal Society for the Protection of Birds, the Nature Conservancy, the National Wildlife Federation, the Center for International Environmental Law, and the Union for Concerned Scientists.

A synthesis of the major points raised, includes:

1. The negotiations of the Framework Convention on Climate

Change have yet to directly address the serious threat that climate change poses to the diversity of life on Earth.

2. Governments should negotiate a climate change treaty which incorporates the effects of climate change on the world's wildlife, habitats and ecosystems; and recognizes that biodiversity loss is likely to accelerate because of climate change by exerting an additional stress to ecosystems already threatened by increasing resource demands, unsustainable management practices and pollution.

3. A growing body of research indicates that a clear and immediate danger now faces individual species and habitats as a result of climate change. Evidence that climate change may be affecting biodiversity creates the urgent need for a better understanding of the interactions between the biosphere and changes in climate.

4. More accurate predictions of the possible ecological responses to climate change are needed to facilitate the development of adaptation strategies to climate change. Assessments to determine the vulnerability of species and ecosystems to climate change are urgently needed, as are studies of the impact of climate change on protected areas and conservation planning.

5. Projects undertaken in the pilot phase of Joint Implementation under the climate treaty demonstrate that forest-based carbon sequestration projects can serve as a viable element of a climate change mitigation strategy. However, before such projects are allowed to be used for 'credit' under the treaty, an independent assessment to address ecological, social and methodological issues should be conducted. The lessons learned should be incorporated into the design of a future crediting scheme for projects implemented jointly between industrialized and developing countries.

6. Some JI pilot projects have demonstrated not only climate benefits, but also benefits to forest and biodiversity conservation. Projects implemented jointly could become a very important means for promoting forest conservation and management in the future. These opportunities should be explored in depth.

7. Provisions under the Kyoto Protocol such as the 'net' approach, emissions trading and the Clean Development Mechanism hold both promise and potential peril for achieving forest conservation objectives. Governments should pursue measures to incorporate forest conservation and management into the treaty so that these implementation mechanisms do not harm biodiversity.

8. The Conventions on Climate Change, Biological Diversity, and Desertification as well as the Rasmussen Convention should collaborate more closely in order to build synergies and strengthen their effectiveness in promoting sustainable development. At the same time, the United Nations should develop a more cohesive framework for addressing the linkages between these environmental agreements.

9. Governments, international financial institutions and non-governmental organizations should place a high priority on developing the institutional capacity to implement policies and actions which jointly address the problems of climate change and biodiversity loss.

BRETT ORLANDO
Program Associate
IUCN – The World Conservation Union
Washington Office
1400 16th Street, NW Suite 502
Washington, DC 20036
USA
Tel: + 202 797 5454
Fax: + 202 797 5461
e-mail: borlando@iucn.org