Proc 8th Int Coral Reef Sym 1:323–328. 1997

THE EVOLVING WESTERN INDIAN OCEAN CORAL REEF PROGRAMME

R.V. Salm[1], N. Muthiga[2] and C. Muhando[3]
[1] IUCN Eastern Africa Regional Office, Box 68200, Nairobi, Kenya
[2] Kenya Wildlife Service, Box 82144, Mombasa, Kenya
[3] Institute of Marine Science, Box 668, Zanzibar, United Republic of Tanzania

ABSTRACT

The coral reefs of the western Indian Ocean (WIO) share a pool of species that are endemic to the whole region. This suggests a series of processes that link these reefs into a discrete biogeographic region. These broad linkages also suggest the need for regional collaboration in coral reef management among the 10 WIO states.

Reef management is not well developed in the WIO, and is focused at the site rather than national or regional level. Poorly regulated fisheries and coastal development linked burgeoning populations and tourism are major contributors to reef destruction. This is ironic as both fisheries and coastal tourism are heavily dependent on coral reefs and are major contributors to the economies of most states in the region.

The principal reef management activity is the establishment of marine protected areas mainly for tourism purposes, and little is being done to safeguard reefs for biodiversity or fisheries conservation. Although progress is being made in collaborative reef management at the community-government level, there is the need for collaboration among the WIO states to safeguard reefs. This will enable sharing of successful approaches for management problems that are common to the region, use of a standard methodology and database for reef assessments to facilitate data sharing and analysis, understanding of processes sustaining the regional linkages, and will facilitate regional collaboration.

INTRODUCTION

The western Indian Ocean (WIO) region extends between 11°54′ North and 28°30′ South from the coast of Africa to 65° East. The States of the region are Somalia, Kenya, Tanzania, Mozambique and South Africa along the mainland coast, and the island States of Comoros, Seychelles, Mauritius, Madagascar, and Mayotte and La Réunion (France).

The region includes both tropical and subtropical waters influenced by the northeast to northwest monsoon that blows intermittently from November to April, and the southwest to southeast monsoon that blows steadily between June and October. Tropical cyclones occur south of the equator, mainly during the northern monsoon. The South Equatorial Current flows westwards across the region throughout the year at about 12°S. On reaching the African coast it divides and is deflected into the southerly Mozambique Current and the northerly East African Coastal Current. During the northern monsoon the Somali Current flows southward and meets the East African Coastal Current off the north coast of Kenya, giving rise to an equatorial counter current, which flows eastward across the centre of the region. During the southern monsoon the East African Coastal Current flows northward to meet the north-flowing Somali current, giving rise to upwelling off the coast of northern Somalia (Bryceson et al. 1990). The dominant current off the Maputaland coast of South Africa is the warm Agulhas current, flowing southwards from Mozambique (UNEP/IUCN 1988: 317).

Sea surface temperatures rarely fall below 20°C, except off the coast of northern Somalia during upwelling and off the South African coast. Maximum sea surface temperatures are about 29°C for offshore waters, but shallow inshore lagoons with limited water exchange may experience higher temperatures (Bryceson et al. 1990).

Well developed fringing reefs and patch reef complexes occur between 5°N and 20°S along the fairly narrow continental shelf of Somalia, Kenya, Tanzania and northern Mozambique, around the offshore islands, and are the most common reef type in the WIO (Salm 1983). On the mainland, they are broken only by large river outflows, and are most extensive where the shelf broadens around islands. The southernmost corals reefs of the region are at Inhaca Island in Mozambique (Salm 1976b), just north of the border with South Africa, although coral communities are found off the Maputaland (Tongaland) coast of South Africa. Madagascar and the Comoros have some well-developed reefs, including barrier reefs off Toliara on the southwest coast of Madagascar and around Mayotte in the Comoros Archipelago. The Seychelles Bank supports the reef-fringed granitic islands of Seychelles. Also part of the Seychelles are the patch and fringing reefs around the coralline islands of the Amirantes Bank, and the region's only and superb examples of both sea-level and raised atolls (Salm 1983). The Saya de Malha Bank, Nazareth Bank and Cargados Carajos Shoals are large, partly or completely submerged, limestone plateaux, where reef structure and coral fauna remain largely unknown, although some of them, notably the Cargados Carajos Shoals, have exceptionally large algal ridges. In the Mascarene Islands, lying to the south and separated from each other by deep water, reef development decreases from east to west; Rodrigues and Mauritius have fairly extensive reefs unlike La Réunion. The scattered islands of Tromelin, Europa, Bassas de India and Juan de Nova are little known but have some reef development. In the Indian Ocean, coral diversity decreases to the west along the equatorial belt from Australasia, the area of highest coral diversity. However, this decrease is offset by high degrees of endemism among the corals of the western Indian Ocean (Salm 1995).

The threats to coral reefs and their associated ecosystems vary widely between countries in this region, as do national actions and capacities to address these threats. This paper addresses issues and approaches to management applicable to the region in general.

THREATS TO CORAL REEFS AND ASSOCIATED ECOSYSTEMS

The threats to coral reefs and their associated ecosystems in the WIO region fall into the following four main groupings (described in greater detail by Salm 1996):

Resource extraction related activities:
- overexploitation of living resources
- destructive exploitation of living resources, including dynamite fishing
- coral and sand mining for construction purposes.

Poorly controlled development:
- poor land use practices leading to erosion and sedimentation
- dredging and/or filling operations
- tourism related activities.

Pollution related activities:
- pollution from land-based activities
- pollution from maritime transport.

Natural disasters:
- tropical storms
- coral bleaching
- *Acanthaster planci* outbreaks.

The principal underlying causes for those problems that are linked directly to people are rooted in poverty linked to the lack of suitable income generating opportunities. Lack of or inadequate planning frameworks, lack of institutional will or capability to implement suitable guiding policies and regulations, and civil disturbances leading to large scale displacement of populations into coastal areas have aggravated the coral reef management problems (Salm 1996). In the long term, it is these underlying causes that will need to be addressed to achieve sustainable conservation of coral reef resources.

CORAL REEF MANAGEMENT IN THE WESTERN INDIAN OCEAN: THE CHALLENGE

State of Knowledge

Oceanic current patterns and monsoon seasons have a major influence on the biogeography and biodiversity of the region. Currents carry larvae, migratory species, nutrients and pollutants from one coastal area to another, and across national or subnational boundaries. Destruction of one reef, which is a source of larvae, may impoverish another located down current. A clear understanding of these source-sink relationships is essential for long term management of coral reef ecosystems in the region. This understanding currently does not exist. At the national level, marine protected areas are more likely to be located according to the needs of the tourism industry than the needs of interacting reef systems. Reliable measurements of concentration and circulation of pollutants and their effects are also inadequate at national and regional levels (Bryceson et al. 1990).

Successful reef management requires information on reef species and distribution, their uses and threats, and the processes sustaining them locally, nationally and regionally. The links between coral reefs, mangroves, lagoons and seagrass beds have yet to be determined in the region. There is also a fundamental need for community involvement in reef management and the incorporation of knowledge of traditional management systems, user rights, and socially acceptable alternatives to reef-based fisheries (Salm 1994a).

Capacity for Research and Training

National capacities for applied marine scientific research in the region are limited. In the 1960s, the interest in the marine environment of the WIO region came mainly from international scientists with little interaction with national researchers. There are now many more competent nationals of the region. Unfortunately, this increase in trained scientists has not been accompanied by the necessary increase in funding, equipment and infrastructure for national research institutions. As countries in the region continue to struggle with the economic burdens of development, national funding for research is likely to decrease (UNESCO 1993). Budgets for many national research institutions barely cover salaries. The ultimate goal for applied marine research in the region should be sufficient capacity in all countries to conduct the research necessary for sound management. In the short term, donors and nationals alike should seek regional collaboration to maximize the effects of the limited resources available. Donors should strive to engender research partnership between international and national scientists, and to ensure that national scientists trained in developed countries have expertise relevant to their national contexts, and return to their national institutions with equipment essential for their continued research, and able to train other nationals (UNESCO 1993). In addition to marine science capacity, countries in the region require the capacity to adopt a multidisciplinary research approach involving ecological, economic and other social sciences to address management problems holistically in coastal areas.

Approaches to Conservation of Coral Reefs and Their Associated Ecosystems in the Western Indian Ocean Region

The traditional approach to coral resources conservation in the WIO region has been through village imposed closed seasons or areas, such was done for octopus and certain finfish around Zanzibar and the mainland Tanzania coast. These traditional approaches have been eroded in recent times and replaced by the establishment of marine protected areas.

Protected areas ca be valuable management tools as, if properly managed, they provide a haven for marine organisms and help to balance the effects of exploitation elsewhere. They may even contribute to improved fishing yields. The status and needs of marine protected areas in the region are addressed by Salm (1994b), and in the recently concluded global review of marine protected areas (Kelleher et al. 1995).

Marine protected areas alone are not adequate for long term management of coral reefs and their associated ecosystems. They seldom address threats to these ecosystems from land-based activities. Without community involvement, protected areas may not resolve user conflicts nor address the resource needs of communities living at the coast. The survival of the region's coral reef resources will require an integrated, cross-sectoral approach to management that includes land use planning, pollution reduction, fisheries management, user conflict resolution, environmental education, protected area management and capacity to respond to environmental disasters. In addition, management will require a multilevel approach: regional-level coordination to safeguard circulation of larvae, nutrients and migratory species, and to maintain water quality; national decision maker collaboration to ensure that activities in different sectors serve the needs of sustainable management; community participation to relieve pressure on reefs imposed by burgeoning populations (Salm 1994a), and to ensure that quality of life is not jeopardized by conservation needs. This community-based approach to coastal resource management is the focus of increased attention in Kenya, Zanzibar and Tanzania mainland, and the main thrust of IUCN and WWF programmes. Cross-sectoral approaches to management are particularly challenging where different jurisdictions are involved. Development activities may be the mandate of one institution, agricultural practices another, and protected areas a third. Long term management will require collaboration between subnational, national and regional institutions.

NATIONAL CORAL REEF MANAGEMENT PROGRAMMES

Somalia

Off the northeastern and Gulf of Aden coasts of Somalia reef growth is inhibited by seasonal cold upwelling. Fringing reefs stretch from between 500 and 1,500 metres offshore from Adale south to the Kenyan border, reaching to within a few metres of the shore near Kismayo. South of Kismayo to the Kenyan border reefs are again 500-1,500 metres from the shore and are broken by the coral islands and reef flats of the Bajuni Archipelago. The only major break in the reef barrier is off Mogadishu (ESCWA *et al.* 1987a,b). Around Mogadishu corals are limited to patch reefs interspersed with seagrass beds (UNEP/IUCN, 1988).

The coral reefs, related fauna, and associated habitats of Somalia are the least well known in the region. There are no marine protected areas, and currently no activity to safeguard coral reefs. However, two initiatives are worth mentioning as they will lead to reef related conservation activities in the near future.

Somalia Community Services, a Somali NGO concerned with resettlement of Somali refugees in the southeast of Somalia, has approached IUCN for assistance with conservation activities in the area, particularly in the region of the Bajuni Islands, an area rich in coral reefs. Options for pursuing this activity are under consideration, possibly under a partnership agreement with the Commission of the European Community Delegation for Somalia.

Kenya

Kenya has fringing reefs along most of its coastline, and its marine protected areas system is one of the best in the region. Kenya has four marine national parks and six marine national reserves in five sites, all of which contain coral reefs. Extractive activities are prohibited in parks, though some tourist activities are allowed in certain areas. In marine reserves only traditional fishing by approved methods is permitted. All marine parks and reserves are administered by the Kenya Wildlife Service which, under the *Coastal Conservation Project* of the *KWS-Netherlands Wetlands Conservation & Training Programme*, is actively pursuing improved management of these sites. Kenya is moving increasingly toward a process of direct community participation in marine protected area management.

WWF and KWS are collaborating to enhance management of Kiunga Marine Reserve, a Biosphere Reserve off the north coast of Kenya. This activity, which began in January 1996, focuses on safeguarding the outstanding biodiversity, natural

resources, and ecological processes of the reserve through a consensus-based management plan that is prepared with the full participation of local communities, and which aims to improve the livelihoods of the reserve neighbours and users.

The Coral Reef Conservation Project, an activity of Wildlife Conservation International (New York Zoological Society) conducts research in collaboration with scientists of KWS and KMFRI on the status of, and threats to, coral reef ecosystems, including threats associated with fishing and shelling (for example: McClanahan 1994; McClanahan and Mutere 1994; McClanahan and Obura 1994; McClanahan and Shafir 1990).

Muthiga (1995) gives further details on the relevant coral reef research and management activities in Kenya.

Tanzania

About two thirds or 600 kilometres of Tanzania's shelf are covered with coral reefs. Fringing and patch reefs predominate and are restricted to a fairly thin band near shore due to the narrowness of the continental shelf. Patch reefs are often extensions of fringe reefs and arise from the sea floor on most parts of the shelf away from river mouths. The continental islands of Mafia, Zanzibar and Pemba and numerous other small and largely uninhabited islands are surrounded by fringing reefs (UNEP/IUCN 1988). The Department of Fisheries regulates all fishery activities, but has been notably unsuccessful at controlling dynamite fishing and destructive forms of seine netting.

Tanzania has a number of marine protected areas gazetted in 1981 that exist on paper only. However, the Institute of Marine Science, WWF and Frontier have assisted the Tanzanian authorities and Mafia Island communities with studies and workshops relevant to design and development of Mafia Island Marine Park, the first of its kind in Tanzania established under the recently gazetted *Marine Parks and Reserves Act, 1994*. The Mafia Island area has some of the finest surviving coral reefs off the Tanzanian coast. The Fisheries Division and WWF are actively involved with establishment of the park and development of an appropriate management regime in which there is strong community participation, and which directly benefits the island's communities.

The Department of Environment, in collaboration with the Institute of Marine Science and Sub-commission of Fisheries, has actively promoted reef management by dependent communities on Zanzibar, such as at the Fumba Peninsula, and is currently seeking support to develop this successful concept for application at other sites. Management of the recently gazetted Chumbe Island Reef Sanctuary by a private company is another experiment in reef management that is currently underway in Zanzibar. With the support of WWF, government and local communities have initiated the establishment of a multiple-use, community-managed marine conservation area in Menai Bay, southwest Zanzibar. The Kunduchi Marine Biological Station has had a programme of research in coral reef based fisheries.

The Swedish Agency for Research Cooperation in Developing Countries (SAREC) is supporting a national programme of coral reef surveys and research through the Institute of Marine Science on Zanzibar, and the Swedish International Development Agency (SIDA) is in the process of initiating an integrated coastal zone management programme for the Kunduchi area of Dar es Salaam on the Tanzania mainland that would need to address the critical reef pollution and dynamite fishing management issues there.

In Tanga, the northeastern administrative province of Tanzania, the Regional and District Government Authorities are implementing a programme of integrated coastal zone management which has a strong focus on coral reef restoration and community-based management. IUCN helped design this project, which is funded by Irish Aid, and is providing supportive technical assistance. The programme is proving a test case of community-based coral reef management and restoration and control of destructive fishing, particularly the use of dynamite and weighted seine sets.

Mozambique

Reef development off Mozambique is limited by freshwater influx and siltation from the many river systems. Reefs are found at Inhaca Island, near the South African border; the Bazaruto Archipelago; and the Primeira and Segundo Islands. Fringing reefs are found close to shore from Macambo Bay to the Tanzanian border.

Two protected areas in Mozambique include significant coral reefs. These are the Ilhas da Inhaca e dos Portuguesas and the Bazaruto National Park. WWF has had a long association with Bazaruto, and is supporting the community-based management of Bazaruto National Park with funding from the European Union. This activity, which began in 1989, is now in its third phase. This phase continues the development of the management plan and expands the emphasis on community-based resource management to achieve the conservation of the fragile Bazaruto Archipelago ecosystem and improvement of the socioeconomic conditions of island communities.

The Oceanographic Research Institute in Durban, South Africa, is conducting a coral reef survey around Bazaruto Island, contributing to the Park management plan, and preparing a handbook on the natural history of the island. ORI has been contracted by the World Bank to undertake a detailed study of marine resources along the southern Mozambique coast. This will complement an assessment of the southern Mozambique coastal zone undertaken through IUCN (Hatton n.d.).

South Africa

Coral communities off the Maputaland (KwaZulu/Natal) coast of South Africa are protected in the St Lucia Marine Reserve. The main area of concentration of coral is contained in a 40 mile stretch of coral-covered rocky reefs between Ponto do Ouro on the Mozambique border and Cape Vidal. These reefs are largely unspoiled, being situated well away from the main South African industrial areas and to the north of the area influenced by run-off from Natal's rivers.

The reserve system off the Maputaland coast of South Africa includes the best examples of these extreme southern Africa coral communities. Although intensively used by recreational divers, the area is well managed by Natal Parks Board and is being studied by a team of scientists from the Oceanographic Research Institute (ORI) in Durban.

ORI, in collaboration with the University of Tel Aviv, has studied species composition and community structure of these coral communities, environmental factors which influence their distribution, and has assessed reef damage caused by human use and other disturbances (including monitoring of a small crown-of-thorns outbreak). Based on their findings and the opportunities for ecotourism in the area, ORI has recommended a system of classification and zonation for long term reef use that will rationalise use of the reefs and reduce diver damage. Artisanal fishing is permitted in much of the reserve and local communities are gaining increased benefits from ecotourism through direct employment and the development of secondary industries.

Aliwal Shoal is an island community of corals and associated fauna off the south coast of KwaZulu/Natal that is used by anglers and spearfishermen, and is also a premier dive site. A process is underway to formulate a management plan for the shoal.

Seychelles

The Seychelles have 115 islands scattered over 1,374,000 square kilometres of ocean (Shah 1995). Fringing reefs are the dominant reef type among the central granitic islands. The outer banks support numerous patch reefs and coral islands, and the Seychelles have a range of raised and sea level coral atolls, all with well developed coral reefs. These remoter reefs have been little studied.

Seychelles has a comprehensive system of marine parks and reserves that include coral reefs, one of which, aldabra Atoll, is a World Heritage Site. Recognizing the need for increased effort to manage these protected areas, The Division of Environment has designed and is implementing two projects: Rehabilitation of Curieuse Marine National Park (with funding from France), and a country-wide biodiversity conservation and national parks programme (funded by the European Union). Both these projects have a focus on coral reef conservation, and have technical assistance provided by IUCN.

Legislation protecting coral falls under the Fisheries Act 1986 and Fisheries Regulations 1987 prohibit blasting, spearfishing and fishing with dynamite. The Seychelles Fishing Authority is responsible for the control and development of fisheries and the enforcement of the Fisheries Act.

Following a training course provided by SAREC and a mission coordinated by the Great Barrier Reef Marine Park Authority to set up a reef monitoring programme, the authorities are well placed to implement a programme of reef monitoring.

Through the Indian Ocean Commission project, a coral reef activity in Seychelles is being implemented that aims to:

- provide a bibliography of all information prepared on Seychelles coral reefs
- identify sensitive coral reef areas subjective to degradation around Mahé, and establish a monitoring programme with regional data sheets (the rapid assessment methodology being developed by IUCN will be applied)
- identify additional coral reef areas around the inner granitic islands suitable for protection status
- identify suitable sites for restoration.

Comoros

The Comoros archipelago comprises four isolated volcanic islands. Fringing reefs are found around Grand Comores, Anjouan and Moheli. Mayotte (France), the oldest island in the chain, has a substantial barrier reef. The Banc de Geyser lies in international waters. It is a large, horseshoe-shaped reef, submerged at high tide, that is notoriously dangerous to shipping. Its isolation has preserved it from human damage.

There are no marine protected areas in the Comoros, and one fishing reserve in Mayotte lagoon.

The European Union is financing a project on the development of artisanal fisheries which includes introduction of fish aggregating devices and motorisation of fibreglass boats to disperse inshore fishing pressure to the continental shelf (Youssouf, pers. comm.).

At the request of the Comorian Government, and on the basis of the National Environment Action Plan, which was approved by donors in November 1994, UNDP is supporting formulation of a national biodiversity conservation strategy that would include coral reef management actions. There is the requirement to produce a management plan for the Nioumachoua Marine Reserve which, although established principally to conserve marine turtle nesting beaches, includes good examples of coral reefs.

Madagascar

Reefs are numerous and extensive around Madagascar. The reefs on the east coast are the least known ad includes fringing reefs near Antseranana to the Iles de Leven; fringing coral growth around Nosy Borah (Ile Saint-Marie); and a submerged, fragmented barrier reef off Toamasina, with a reef flat covered by seagrasses. The west coast has more than 1000 kilometres of reefs, located in the northwest and southwest (UNEP/IUCN 1988).

There is one marine park (Nosy Atafana Marine Park) and one special reserve (Nosy Mangabe Special Reserve) that include coastal areas, but neither are effectively managed (Kelleher et al. 1995). Most marine conservation effort is currently going into the Grand Recif at Toliara.

Considerable research was undertaken on the reefs of Madagascar by French scientists in the 1960s through the mid-1970s. In 1992, local scientists supported by WWF surveyed the Grand Récif at Toliara and made recommendations for its conservation (Cooke 1993a,b; Cooke 1994). Currently, the Universite de Toliara is active in marine research and has participated in multidisciplinary reef survey work (Cooke, pers. comm.).

As part of the WWF strategy for marine and coastal conservation in the Africa and Madagascar region, development of a marine programme in Madagascar has been identified as a priority (WWF 1996). The WWF programme includes coastal surveys in 1996 and provisions for assisting the Malagasy authorities to develop a comprehensive system of coastal and marine reserves that would include coral reefs among other environments as part of a strategic framework for marine conservation activities in the country.

The WWF programme would complement the Unesco project to manage the extensive Grand Récif coral reef system at Toliara off the southwest coast, which is scheduled to become a protected area and biosphere reserve.

Mauritius

Mauritius is the central island in the Mascarene group, and is almost entirely surrounded by fringing reefs. Sheltered fringing reefs border channels within the peripheral fringing reefs or protected bays. Patch reefs are found within the lagoon (UNEP/IUCN 1988). Rodrigues is the oldest island with the best developed coral reefs (200 square kilometres) among the Mascarene group, and Cargados Carajos Shoals has about 190 square kilometres of reefs and a massive algal ridge - possibly the largest in the Indian Ocean (Kelleher *et al.* 1995).

The reefs off Mauritius have been badly affected by overfishing, tourism and development activities, and reef management action has been late in coming. In recognition of this, the Mauritian authorities have been implementing a joint project with the University College of North Wales to classify and map the coral reefs, and plan to establish two marine reserves for coral reefs that were proposed for protection in 1974 (Salm 1976a; Procter & Salm 1975).

Other work relevant to coral reefs and their associated ecosystems includes time series transects of reefs to provide a basis for management, replanting of mangroves and establishment of nurseries, and studies of physical, chemical and biological parameters of lagoon waters influenced by sewage and industrial discharges. A Marine Environment management Plan is being prepared by the Ministry of Fisheries and Marine Resources. The Ministry is also undertaking ecosystem monitoring activities and is establishing two marine parks. Additional measures being implemented to safeguard reefs include:

- a ban on the removal and sale of shells and corals whether live or dead
- a ban on spearfishing
- tight control on the use of explosives
- closed seasons for seine net fishing
- establishment of fishing reserves.

Baseline data collection on coral reefs and water quality has been carried out between 1991 and 1994 at several sites around the island, and lagoon water circulation patterns were studied at Albion as an example of coastal oceanographic processes within reef lagoon systems. Studies relating to lagoonal and coral reef systems, among other related subjects, will be implemented with technical assistance from Japan through the fully equipped Marine Conservation Centre at Albion.

La Réunion

Réunion is the youngest and highest of the Mascarene islands, with relatively little reef development. The island dependencies of Réunion are spread over a wide area of the Indian Ocean and the Mozambique channel: Tromelin (north of Réunion), the atolls Europa and Bassas de India in the Mozambique Channel, Juan de Nova off the west coast of Madagascar, and the Iles Glorieuses to the north of Madagascar. They are coralline islands with some reef development, and all are declared protected areas with Juan de Nova replaced by Bassas de India under later legislation (Kelleher et al. 1995). Réunion has ratified the Nairobi Convention.

The Laboratoire d'Ecologie Marine of the Universite de la Réunion has had an active coral reef research programme since the 1970s that focuses research on populations and processes of coral reef ecosystems, and related studies on the management and exploitation of reefs and their resources (Chabanet & Letourneur 1995; Guillaume 1994; Letourneur 1993; Letourneur & Chabanet 1994; Letourneur et al. 1993; Rouyer 1988). There is a strong element of research focused on anthropogenic impacts on coral reefs, especially as these affect water quality in inshore waters and coral calcification rates (Chabanet *et al.* 1995; Cuet 1994; Cuet & Naim 1994; Cuet *et al.* 1988; Montaggioni et al. 1994; Naim 1988, 1993, 1994).

INTERNATIONAL AND REGIONAL CORAL REEF PROGRAMMES IN THE WIO

The International Coral Reef Initiative ran a regional meeting for WIO states in March 1996. This meeting offered the first opportunity to draw the states of the region and the many different national and regional activities into a coherent programme. A Strategy for coral reef management in the WIO is currently being finalised as a result of the ICRI meeting.

Ongoing regional activities that incorporate or focus directly on coral reefs include a range of activities undertaken through the UNEP Eastern Africa Regional Seas Programme, the Indian Ocean Commission (which focuses on the island states), WWF, IUCN, Irish Aid, the Swedish International Development Agency (together with the University of Stockholm), the Netherlands Indian Ocean Programme and other bilateral activities, USAID in partnership with the Coastal Resources Center of the University of Rhode Island, Unesco IOC, and the Western Indian Ocean Marine Science Association (a regional NGO that supports grants for coral reef research).

REFERENCES

Bryceson, I., T.F. de Souza, I. Jehangeer, M.A.K. Ngoile and P. Wynter. 1990. *State of the marine environment in the Eastern African Region.* UNEP Regional Seas Reports and Studies No. 113. Nairobi, Kenya: 46 pp

Chabanet, P. and Y. Letourneur. 1995. Spatial pattern of size distribution of four fish species on Réunion coral reef flats. *Hydrobiologia* 300/301: 299-308

Chabanet, P., V. Dufour and R. Galzin. 1995. Disturbance impact on reef fish communities in Reunion Island (Indian Ocean). *J. Exp. Mar. Biol. Ecol.* 188: 29-48

Cooke, A. 1993a. *Coral reefs and coastal zone of Toliara - Conservation and development through eco-tourism.* Project report. WWF International, Gland, Switzerland: 235 pp.

Cooke, A. 1993b. Madagascar's Great Barrier Reef - Recent Developments. *Reef Encounter* 13: 14-15

Cooke, A. *Toliara Coral Reef Expedition, Madagascar - 1993. Rapport Final.* With Cellule des Oceanographes de l'Universite de Toliara: 206 pp

Cuet, P. 1994. Sources et conséquences de l'enrichissement en sels nutritifs de l'écosysteme récifal a la Réunion. Pp. 105-110 in Coudray and Bougherra (eds). *Environnement en milieu tropical.* Estem, Paris

Cuet, P. and O. Naim. 1994. Analysis of a blatant reef flat degradation in La Réunion Island (l'Etang-Salé fringing reef). *Proc. 7th Int. Coral Reef Symp. Guam*: 313-322

Guillaume, M. 1994. La croissance du squellete de *Porites lutea*, scléractiniaire hermatypique, sur le récif frangeant de La Saline, Ile de La Réunion, Océan Indien. *Bull. Soc. Zool. Fr.* 119(1): 75-83

Kelleher, G., C. Bleakley, and S.M. Wells (eds). 1995. *A Global Representative System of Marine Protected Areas.* A Draft Report to the World Bank Environment Department. IUCN/GBRMPA, Gland, Switzerland and The World Bank, Washington DC, USA

Letourneur, Y. 1993. Dynamique des peuplements ichtyologiques des platiers récifaux de l'ile de La Réunion (Résume de these). *Cybium* 17: 175-176

Letourneur, Y. and P. Chabanet. 1994. Variations spatio-temporelles de l'ichtyofaune de platiers récifaux a La Réunion. *Cybium* 18(1): 25-38

Letourneur, Y., M. Marmelin-Vivien and R. Galzin. 1993. Impact of Hurricane Firinga on fish community structure on fringing reefs of Reunion Island, S.W. Indian Ocean. *Environ. Biol. Fih.* 37(2): 109-120

McClanahan, T.R. 1994. Kenyan coral reef lagoon fish: effects of fishing, substrate complexity, and sea urchins. *Coral Reefs* 13(4): 231-241

McClanahan, T.R. and J.C. Mutere. 1994. Coral and sea urchin assemblage structure and interrelationships in Kenyan reef lagoons. *Hydrobiologia* 286: 109-124

McClanahan, T.R. and D. Obura. 1994. Status of Kenyan coral reefs. In: Ginsburg, R.N. (compiler). *Proceedings of the Colloquium on Global Aspects of Coral Reefs: Health, Hazards and History, 1993*: 392-396

McClanahan, T.R. and S.H. Shafir. 1990. Causes and consequences of sea urchin abundance and diversity in Kenyan coral reef lagoons. *Oecologia* 83: 210-218

Montaggioni, L.F., P. Cuet, and O. Naim. 1994. Effect of nutrient excess on a modern fringing reef (Reunion Island, western Indian Ocean). Geological implications. In: Ginsburg, R.N. (compiler). *Proceedings of the Colloquium on Global Aspects of Coral Reefs: Health, Hazards and History, 1993*: 397-403

Muthiga, N. 1995. *Coral reefs of Kenya: A review of past and current research activities and priorities.* Background paper presented at the ICLARM Workshop, Cairo, Egypt (22-27 September, 1995): 12 pp

Naim, O. 1988. Bilan de sante des platiers recifaux a la Reunion. *La Journal de la Nature* 1(1):69-73

Naim, O. 1993. Seasonal responses of a fringing-reef community to eutrophication (Reunion Island, Western Indian Ocean). *Mar. Ecol. Progr. Ser.* 99: 137-151

Naim, O. 1994. Structure des communautés benthiques et eutrophisation en milieu corallien. Pp. 99-104 in Coudray and Bougherra (eds). *Environnement en milieu tropical.* Estem, Paris

Procter, J. and R.V. Salm. 1975. *Conservation in Mauritius. A report to the Government of Mauritius.* IUCN/WWF, Morges: 138 pp

Rouyer, P. 1988. Les recifs coralliens des Comores. *Le Journal de la Nature, Bourbon Sciences* 1(1):14-23

Salm, R.V. 1976a. The structure and successional status of three coral reefs at Mauritius. *Proc. Roy. Soc. Arts Sci. Mauritius* III (2): 227-240

Salm, R.V. 1976b. The dynamics and management of the Ponta Torres coral reef, Inhaca Island - Mozambique. *Mems. Inst. Invest. Cient. Mocamb.* 12 Serie A: 25-40

Salm, R.V. 1983. Coral reefs of the Western Indian Ocean: a threatened heritage. *Ambio* XII(6): 349-353

Salm, R.V. 1994a. Coral's hidden riches. *People & the Planet*, 3(1): 19-21

Salm, R.V. 1994b. *Marine Protected Areas in the Western Indian Ocean: Status and Needs.* Case Study Paper presented at the African Heritage 2000 CNPPA Africa Region Working Session, Kruger National Park, 11-17 October 1994: 21 pp

Salm, R.V. 1995. Marine Biodiversity of the Western Indian Ocean. Status and Conservation Framework. Pp. 101-130 in Linden, O. (ed.) *Proceedings of the Arusha Workshop and Policy Conference on Integrated Coastal Zone Management in Eastern Africa including the Island States.* SAREC Marine Program, Coastal Management Center, Manila, Philippines: 371 pp

Salm, R.V. 1996. *The status of coral reefs in the Western Indian Ocean with notes on the related ecosystems.* Working Paper 1, ICRI Western Indian Ocean Regional Workshop Seychelles: March 29th to April 2nd 1996: 27 pp

UNEP/IUCN. 1988. *Coral reefs of the world. Volume 2: Indian Ocean, Red Sea and Gulf.* UNEP Regional Seas Directories and Bibliographies. IUCN, Gland, Switzerland and Cambridge, U.K./UNEP, Nairobi, Kenya: 389 pp

UNESCO. 1993. *SAREC-IOC Workshop on donor collaboration in the development of marine scientific research capabilities in the Western Indian Ocean region.* Organized in cooperation with and supported by the Flemish Government. Brussels, Belgium, 23-25 November 1993. Intergovernmental Oceanographic Commission, Workshop Report No. 95

WWF. 1996. *WWF Strategy for Marine and Coastal Conservation in the Africa and Madagascar Region 1995-2005.* WWF International, Gland, Switzerland: 53 pp