WORKSHOP ON INTEGRATED REEF RESOURCES MANAGEMENT IN THE MALDIVES

BOBP/REP/76

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BAY OF BENGAL PROGRAMME

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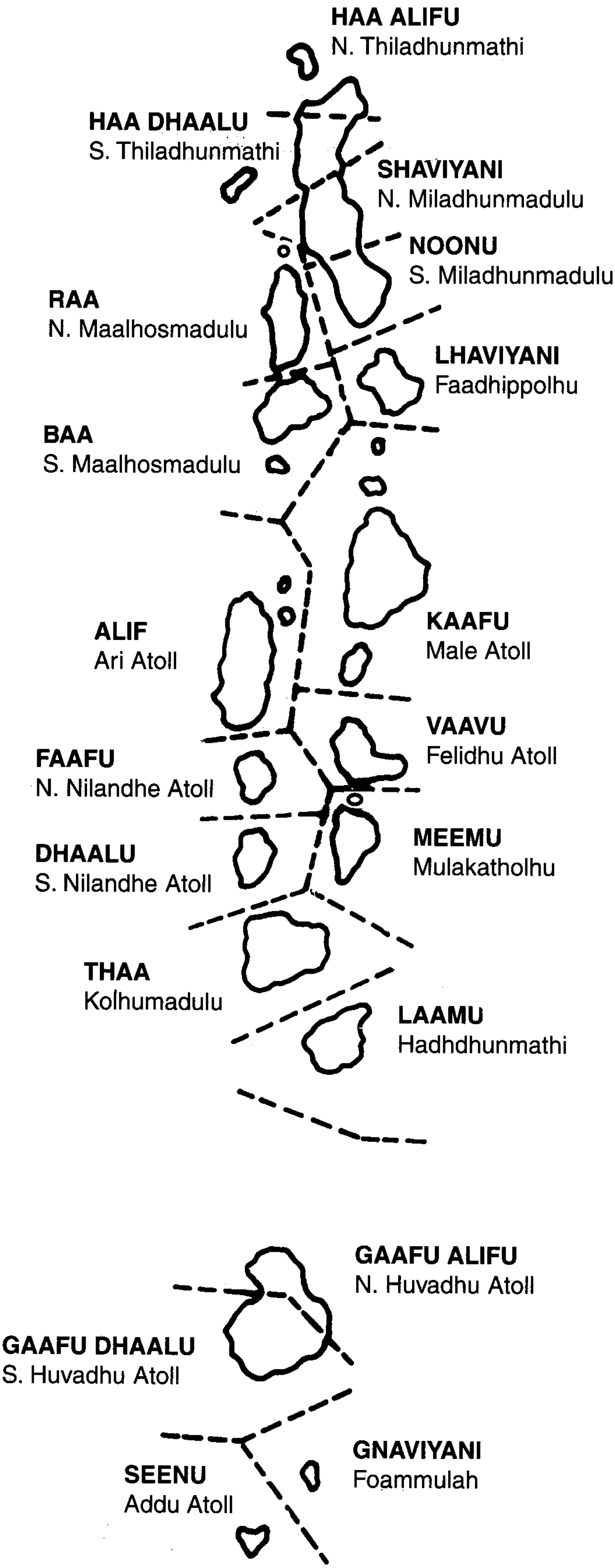
MAP OF THE MALDIVES



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WORKSHOP ON INTEGRATED REEF RESOURCES MANAGEMENT IN THE MALDIVES

Male, Maldives
16-20 March, 1996

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BAY OF BENGAL PROGRAMME
Madras, India
1997

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This document is the report of a national workshop on Integrated Reef Resources Management in the Maldives. It was held in Male, Maldives from 16 March to **20** March, 1996.

The document contains the recommendations of the workshop, as well as technical papers presented.

The workshop was sponsored jointly by the Ministry of Fisheries and Agriculture, Government of Maldives, and the FAO's Bay of Bengal Programme (BOBP). It was attended by 26 delegates from various departments and ministries in the Maldives plus 20 observers and 30 students. Ms. Sana Mohamed was the Technical Secretary. Half a dozen international experts served as resource persons.

The Bay of Bengal Programme (BOBP) is a multiagency regional fisheries programme which covers seven countries around the Bay of Bengal - Bangladesh, India, Indonesia, Malayasia, Maldives, Sri Lanka, Thailand. The Programme plays a catalytic and consulative role in developing coastal fisheries management in the Bay of Bengal to help improve the conditions of small-scale fisherfolk in member-countries.

The BOBP is sponsored by the governments of Denmark and Japan. The executing agency is the FAO (Food and Agriculture Organization of the United Nations).

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ABSTRACT

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For much of the world's tropical population, coral reefs are synonymous with reef fish and edible marine invertebrates. Reef-related fisheries are important to small-scale fisherfolk, as a source of both protein and livelihood security for local coastal communities.

In all of Asia, coral reef resources play a role in the food and livelihood security of coastal communities. Perhaps nowhere in Asia in this role more important than in the Maldives. As a student working group in the Workshop put it, "The whole livelihood of the Maldivians depends on the reef resources."

The Republic of Maldives initiated IRRM to improve the management of its reef resources. IRRM is supported by BOBP and combines scientific and fisherfolk knowledge with the expertise and input of all Ministries with jurisdiction in areas impacting reef resources. Issue areas for management under IRRM include (1) Reef fishery (2) Bait fishery for the tuna pole and line fishery (3) Coral mining (4) Tourism and fishery interactions and (5) Legal and institutional aspects of IRRM.

The IRRM Workshop was convened to share scientific and socio-economic information on the five issue areas and to obtain a common understanding and agreement among the many government agencies, public interest groups and the private sector on the objectives and vision of the IRRN Programme. Participants examined the five issue areas and arrived at a consensus on recommendations to address each issue area. The Report and Proceedings contain the recommendations and the papers presented at the Workshop.

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FOREWORD

Coral reefs everywhere are a feast to the eye and mind, a magnificent repository of resources, a treasure-house of wealth, a testament to bio-diversity. In the Maldives, coral reefs play an even more important role, because they provide the living base for this SIDS (small-island developing state) which comprises a thousand coral islands.

The economy of the Maldives depends to an appreciable degree on the exploitation of its marine resources. Till the 1970s the nation's reef resources were largely untapped. Since the 1980s a new fishery targeting reef species has emerged. High export demand, a small resource base, and lack of management measures have combined to impose severe pressure on this fishery.

The Integrated Reef Resources Management Programme (IRRMP), launched by the Government of Maldives, responds to this pressure. It is a holistic approach to reef management that seeks to combine fisherfolk knowledge, scientific studies of reefs and the expertise of all Ministries in the reef areas.

The BOBP is proud to support the IRRMP which tackles live key issues: the reef fishery; baitfishery for tuna pole and line; coal mining; tourism-fishery interactions; and comprehensive resource management. The IRRM Workshop helped create a forum for a common understanding on these issues. It brought together several Ministries and numerous departments, scientists, officials, fisherfolk, even students. In fact, it is a matter for delight that students contributed usefully to the Workshop with a thoughtful statement and a list of recommendations.

We congratulate the organizers of the Workshop on their sincere and painstaking efforts. We share the feeling of a "a sense of achievement" as the Hon Minister for Fisheries and Agriculture, Mr Hassan Sobir, put it, about the Workshop's successful conduct and conclusion. It has helped develop an implementation strategy for a more holistic approach to reef management.

Thanks to the Workshop and the implementation of its recommendations, coral reefs may continue to delight and benefit the people of the Maldives, and visitors from everywhere, for a long time.

Kee-Chai CHONG
Programme Coordinator, BOBP.

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ABBREVIATIONS AND ACRONYMS

BOBP	Bay of Bengal Programme
COT	Crown of Thorns
CSD	Commission on Sustainable Development
EDC	Educational Development Centre
FAO	Food and Agriculture Organization of the United Nations
FM	Frequency Modulation
ICOD	International Center for Ocean Development
IRRM	Integrated Reef Resources Management
IRRMP	Integrated Reef Resources Management Programme
ITF	Institute for Teacher Education
MOFA	Ministry of Food and Agriculture
MPHRE	Ministry of Planning, Human Resources and Environment
MRS	Marine Research Section
MSY	Maximum Sustainable Yield
ODA	Overseas Development Authority
SEAFDEC	South East Asian Fisheries Development Center
TCO	Technical Corporate Officer
UNDP	United Nations Development Programme
VOM	Voice of Maldives

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Technical Papers

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RECOMMENDATIONS OF THE INTEGRATED REEF RESOURCES MANAGEMENT WORKSHOP

1. INTRODUCTION

Reef resources have traditionally been exploited at a very low level in the Maldives, where the oceanic tuna fishery was for centuries the major economic activity. In recent years, however, the use of reef resources has increased dramatically with the growth of the tourist industry, the development of new export markets for reef fishery products, and the growth of the Maldivian population. The consequences of this increased reef resources usage include: overt fishing of some reef resources (with resultant loss of income to fishermen and the country as a whole); increased reef degradation (with resultant losses to some fishery stocks, and increased island erosion); and an increase in conflicts between reef resource users.

Healthy coral reefs are vitally important to the two major industries of the Maldives: tourism and fisheries. Recognizing this, and the need to address the problems resulting from increased reef resource usage, the Government of Maldives is promoting a policy of Integrated Reef Resources Management (IRRM). IRRM aims to involve all reef users from both government and private sectors in the process of collaborative reef management. As an early step in this process, the Ministry of Fisheries and Agriculture (MOFA), with some assistance from the Bay of Bengal Programme (BOBP), has developed an IRRM Programme. Under this Programme four central atolls (Vaavu, Meemu, Faafu and Dhaalu) have been identified in which trial IRRM activities will be undertaken, before being spread to the rest of the country.

Also under this Programme, Workshop was held in Male in March 1996, to identify key issues and objectives for the IRRM process, and make recommendations for its implementation.

The National Workshop on Integrated Reef Resources Management was held 16 - 20 March, 1996 at the Maldives Center for Social Education, Male. Issues were discussed under four main resource headings: reef fisheries; the livebait fishery; coral mining; and tourism reef resource interaction. Specific recommendations arising from these discussions are listed in Sections 2 to 5. Recommendations apply to the general IRRM process and are relevant to all resource headings listed below.

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During the workshop, the mornings were spent mainly presenting the papers, while the afternoon sessions were devoted to working groups. Students' working groups were conducted separately while national delegates, observers as well as international experts formed working groups to discuss the major issues outlined.

The Ministry of Fisheries has presented the following recommendations passed by the workshop to the Fisheries Advisory Board, in order to initiate implementation of the Integrated Reef Resources Management Programme in the Four Selected Atolls: Vaavu, Meemu, Faafu and Dhaalu. The recommendations were endorsed by the FAB in 1996.

Overall recommendations for IRRM

- Initiate a collaborative, participatory reef resources monitoring and management program involving people directly concerned with reef resource utilization (e.g. fisherfolk, the tourism industry, coral miners etc), as well as Government, relevant NGOs and other stakeholders. This will require the development of a mechanism for coordination and cooperation among all parties in order to develop strategy and to implement recommendations and identified actions. A commitment to change is required from all parties if the aims of the IRRM process are to be achieved.

- Introduce pilot-scale IRRM programmes on an atoll by atoll basis, working through existing Atoll Development Committees and Island Development Committees (and fisheries subcommittees if present). One option would be to introduce Reef Resources Committees in Male and the Atolls. The Committees would help to guide monitoring and research and to manage resources. The Committees should represent a full cross-section of interests.

- Increase awareness of the fishing community in particular and the public in general on issues relating to reef resources management, such as the dangers of overfishing, advantages of sustainable resource use, the impacts of coral mining and the benefits of using alternatives to coral rock for construction. Mechanisms for increasing awareness include: the use of print media (local news sheets as well as national newspapers). the use of radio (atoll based FM radio if/when available, as well as the national Voice of Maldives); and the development of links between environmental clubs / school groups in Male and in the atolls.

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- Develop a plan of phasing out coral mining in the current National Development Plan, working backward from a total ban in 2005 AD

- Give priority to enforcing existing laws and regulations concerning reef fisheries and other reef resources more effectively.

- Promote reefresources management on an atoll scale. Recognizing that people of one atoll would have little or no incentive to conserve “their” reef resources if there was open access to people of all atolls, it is recommended that there be some regulation, requiring fishermen from all atolls to conform to the management measures in place in any atoll.

- Establish a network of marine protected areas, designed to act as harvest refugia and to protect breeding stocks and biodiversity, covering approximately 20% of the total atoll area and including representative samples of all major habitats.

Document existing local knowledge of marine resources and management systems, in order to provide a sound foundation for IRRM.

3. CORAL REEF FISHERIES

The Maldivian fishery has traditionally concentrated on oceanic tunas, so reef resources were barely exploited until fairly recently. In recent years a number of export-oriented fisheries have developed, including those for beche-de-mer, giant clam, aquarium fish and live grouper. These commercial reef fisheries are in most cases based on limited natural stocks, and can be rapidly over-exploited if the fisheries are not properly managed. Poor management also leads to conflicts among resource users.

Objectives

- Develop a collaborative IRRM strategy for the sustainable and equitable utilization of reef fishery resources.

- Improve coordination and cooperation among exporters, Customs, Ministry of Trade and Industries, Ministry and Fisheries and Agriculture, Ministry of Atolls Administration, NGO’s and other relevant bodies in managing and enforcing regulations of fisheries.

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- Increase awareness of the fishing community in particular and the public in general on reef fishery management issues.

Recommendations for IRRM

Recommendations for monitoring and research

- Estimate potential fishery yield targets for different fisheries for each atoll.

- Compile information available from other parts of the world on reef resources stock assessment and other biological studies, in order to make the IRRM process more cost effective.

- Identify potential fishery targets, carry out market research on them, and disseminate the resulting information to the public.

- Engage suitable fishermen on targeted islands to monitor reef fisheries using logbooks. Species composition data, size frequency data, and also catch and effort data should be collected.

- Conduct short research projects to obtain information on specific topics as required.

- Establish a fisheries unit within Customs, in order to monitor fisheries exports more effectively. Provide training in fisheries product monitoring to Customs in order to facilitate this process.

- Develop a mechanism for monitoring the activities of foreign vessels entering the country to buy or load live fish.

- Set size limits on commercially important species.

Recommendations for management

- Concentrate initial community based monitoring and management activities on the grouper fishery in view of its current importance.

- Take strong action to prevent poisonous fishing materials, such as the use of cyanide.

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= Enforce the existing regulation requiring the registering of any new fishery with the Ministry of Fisheries and Agriculture, before fishing activity commences.

= Impose size limits on commercially important species.

= Ban fishing during breeding season where appropriate (e.g. on spawning aggregations of groupers).

= Control fisheries in each atoll by limiting the catch and/or fishing effort.

= Enforce existing regulations concerning foreign vessels fishing in territorial waters (e.g. grouper).

= Impose a moratorium on fisheries that are severely overfished in order to allow stocks to recover (eg. sea cucumber).

= Ban the use of small mesh in gillnets in view of the damage they can do to reef resources.

= Prohibit the use of compressed air diving (both SCUBA and surface supply) for commercial fishing, except in cases where diving is the only practical method of fishing (e.g. aquarium fish).

4. TUNA LIVEBAIT FISHERY

The livebait fishery is the reef-related component of the important tuna fishery. The livebait fishery has been in existence for hundreds of years, and it remains the most important reef fishery. The scale of the livebait fishery has increased greatly in recent years, leading to concern about the sustainability of fishing on some livebait stocks. Tuna fishermen have traditional rights to fish for livebait on any reef in the country. Conflicts of interest have occurred between livebait fishermen and other, non-traditional, reef resource users.

Objectives

- Increase public awareness about management issues associated with the livebait fishery.

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- Increase coordination among the responsible authorities to ensure transfer of timely information about the fishery, and prompt management action when required.

- Increase awareness among school children as a long term objective for proper management of the fishery

- Ensure that, if scuba diving for baitfishing is to be allowed, then fishermen are adequately trained to enable them to dive and to work underwater safely.

Recommendations for IRRM

Recommendations for monitoring and research

- Carry out research in order to assess the status of livebait fish stocks and their sustainable yields. This research should incorporate local knowledge in addition to appropriate scientific studies.

- Initiate a baitfishery data collection system

Recommendations for management

- Establish better mechanisms for enforcing laws and regulations.

- Prepare fishery information packages for school teachers.

- Increase coordination between VOM and MOFA to ensure the timely transfer of information to be distributed through VOM to the fisherfolk.

- Introduce legislation to ban the use of destructive livebait collecting methods, especially the use of sticks and heavy chains/weights, to drive livebait out of their refuges by breaking corals.

- Establish a regulatory body to establish minimum safety and training standards for diving fishermen, if SCUBA diving for baitfish collection or other fisheries is allowed.

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5. CORAL. MINING AND RELATED ACTIVITIES

Coral mining is a traditional activity in the Maldives that supplies the only indigenous rock for construction. In the past coral mining was a small-scale and sustainable activity. However, demand has increased greatly in the last couple of decades and coral mining at current levels is no longer sustainable. Associated activities include sand mining, dredging, reclamation and the building of coastal structures. All of these activities lead to reef degradation, adverse effects on fisheries and increased erosion.

Objectives

= Phase out coral mining, and to the extent possible other related activities, since they are highly destructive of the reef and island environment.

= Identify measures to achieve preservation of coral reefs through research and management.

= Identify changes taking place in the reef environment.

= Identify economic, institutional and cultural mechanisms that can be implemented to make alternatives to coral rock attractive throughout the country.

= Develop public awareness on the adverse impacts of coral mining **and** the benefits of use of alternative building materials.

Recommendations for IRRM

Recommendations for monitoring and research

= Initiate and develop a participatory reef monitoring program involving Island and Atoll Development Committees, Women's Committees, NGOs and other stakeholders.

= Monitor coral reefs in order to identify changes taking place in the reef environment, and where appropriate to suggest remedial action.

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Recommendations for management

- Establish and implement mechanisms to make alternatives to coral rock socially acceptable in the country and encourage the use of alternatives in maritime structures.

- Develop a plan for phasing out coral mining in the context of the current national development plan, working backwards from a total ban by 2005 AD.

- Develop and conduct training courses in the making of concrete blocks, as an alternative to coral rock for construction.

- Develop criteria and procedures for definition of boundaries for house reefs of tourist and inhabited islands and zones designated for different uses.

- Develop atoll area management plans based on community participation and cooperation.

- Minimize incidence and impacts of dredging and reclamation.

6. TOURISM AND REEF RESOURCES INTERACTIONS

While the very existence of the Maldives is based on coral reefs there are three main economic activities directly involved in reef resource utilization: fisheries, coral mining and tourism. Although some tourist activities can impact reefs adversely (e.g. reef walking, sewage disposal, dredging) the tourist industry often uses reef resources in a non-extractive manner (e.g. diving, snorkeling). In contrast, fisheries are entirely extractive. These contrasting patterns of resource utilization can give rise to user conflicts. In addition coral mining can adversely affect both tourism and fisheries. The Integrated Reef Resources Management program aims to find ways in which extractive and non-extractive resource users can coexist in harmony.

Issues within the tourism sector:

= Heavy demand by tourists for reef souvenirs.

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- Tourists impact the reef flat by walking during low tide on the reef flat, and by novices in diving grabbing at coral in strong currents.

- Tourists impact fish ecology and behavior by feeding fish.

= The tourism lifestyle creates heavy amounts of waste that must find oulets of disposal.

- Reclamation and destruction of reef areas by dredging and other land-use changes from resort development.

Issues between the tourism/fisheries sectors:

= Bait fishing areas near resorts — these inhibit some tourists

- Multi-use conflict with aquarium fishing.

- Mining impacts tourism and fisheries, through coastal erosion and destruction of fish habitats.

= No clear definition of reef boundaries exists for those islands that are developed for both tourism and industry.

- Although some dive sites are established, additional reefs are used for both diving and fishing.

Objectives

- Resolve user conflicts in a balanced and equitable manner.

- Build on the positive influence of tourism to protect the reef resources.

Recommendations for IRRM

Recommendations for research and monitoring

- Provide incentives for the tourism industry to support marine related research relevant to them and education programs for both locals and visitors.

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= Compile and integrate results of research related to management of marine resources.

Recommendations for management

- Determine limits for expansion of number of tourism islands based on criteria which include impacts, logistics, costs, benefits to tourist industry and other sectors of society.

- Develop a network of marine protected areas.

- Minimize incidence and impacts of dredging and develop strategies to deal with wastes.

- Develop atoll area management plans based on community participation.

- Develop criteria and procedures to define boundaries of house reefs of tourist islands and zones designated for different uses.

- Develop a licensing system for tourism and fisheries based on personal transferable licenses. Licenses should be issued on the basis of carrying capacity of both industries.

7. STUDENTS' RECOMMENDATIONS

7.1 IMPORTANCE OF REEF RESOURCES

Introduction

Resources are vital to a country like the Maldives. The very livelihood of Maldives depends on its reef resources. The two main income generating industries (tourism and fisheries) are heavily dependent on the reef environment. Outside all this the reef acts as the main barrier, protecting low lying islands from the dangers of the sea that surrounds it.

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Coral Mining

Though coral from our fragile reefs provides the main building blocks for our construction industry, builders should be discouraged from using coral for construction. Alternate materials like imported sand and granite can be made available at a cheaper price by the government. These could be made more readily available to all the islands throughout the Maldives. Courses on making cement bricks could be conducted by the construction ministry both in the island and in Male. Cement bricks which could be used as an alternative for coral during construction.

Tuna Fishery

Tuna is the main source of protein for all Maldivians. A large percentage of our tuna is exported, earning much-needed foreign exchange for the country.

Though at present there is no indication that the tuna stocks in Maldivian waters are being overfished, it is of great importance that Maldivians initiate a research project to estimate the existing stock and determine a MSY value for this fishery.

Sea Birds

Sea birds play an important role in locating fishing grounds. Many of these birds are being caught by fishermen and kept in their homes as pets. Some of these birds are now seen very rarely.

The government should impose a total ban on the capture of sea birds and should take strong action to prevent destruction of their habitats.

Bait Fishery

The live bait fishery is of great importance for the pole and line fishery. Precautions must be taken by the government to protect these bait fishing grounds. Laws and regulations should be enforced to ensure that little or no damage is done to the reef when taking bait.

Permanent anchors at these sites should minimize the damage done by anchoring boats. A total ban on coral mining in these areas will ensure that the habitat is little affected by human interaction.

Fishermen should be made aware of existing problems in catching live baitfish. They should be encouraged not to exceed a fixed amount of baitfish capture even when bait is abundant. They should also be advised to put the excess bait back on to a reef and not into the open ocean.

Specialized boats for bait fishing can be introduced to meet the ever increasing demand for baitfish. These vessels could then provide the needed live baitfish for pole and line fishermen.

Aquarium Fishery

Capture of aquarium fish is another developing fishery that needs to be expanded. Better markets for exporting aquarium fish need to be looked at, and laws and regulations should be made to ensure the sustainable development of this fishery.

7.2 HUMAN INTERACTION ON CORAL REEFS

Introduction of a tax on mined coral

Concerned
— about the destruction of coral reefs by human impact.

Noting
— that coral mining causes mass destruction of coral reefs.

Recalling
— that a law is already implemented, banning coral mining on house reefs.

Urges
— the government to take firm actions against destruction of coral reefs.

Decides
— to levy a higher tax on mined coral.

Ways of Taxation
— to have a fixed price for the first 100 cubic feet.

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double the price for the second 100 cubic feet and triple the price for the next 100 cubic feet and so on.

- permission for mining should be granted by the MPHRE.

Introduction of school-based environment groups to deal with environmental problems in the islands.

Concerned

- about the destruction of coral reefs by human impact.

Noting

- that dumping of cans and other non-biodegradable' materials on to the reef destroys the reefs, and that school-based environment groups can play a significant role in protecting the environment.

Recalling

- that already in most islands, sites are allocated for dumping garbage on the island.

Urges

- the government to take firm action against those who dump garbage outside allocated sites.
- the government to introduce facilities for collecting cans and plastics throughout the Maldives.

Decides

- to introduce machines to incinerate the collected cans and plastics.

Suggested ways to carry out the task

- cans and plastics may be collected by students from the environment club.
- once a large amount of cans and plastics are collected, they can be taken to the island where they can be incinerated.
- a small price may be paid for each kilo of can or plastics, to encourage the students .

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Creating awareness

Noting

– that gradual long-term destruction of coral reefs is due to the lack of knowledge on coral reefs.

Recalling

– that there are already programmes to create awareness among the public on ways in which people interact with the environment.

Urges

– the government to expand these existing programmes.

Decides

– to use media to create awareness.
– to send qualified environment field officers to various islands to create awareness among the island communities.
– to organise lectures for students.

7.3 EDUCATION IN CORAL REEF RESOURCE MANAGEMENT

Respective delegates, observers and ladies and gentlemen. Good morning. It is a great privilege for me to speak on behalf of our group. We discussed the role that we could play in educating the community in reef resource management.

Information on coral reefs and its resources is available only to students of secondary school, through a subject called Fisheries Science. In most island schools, very few students reach the level of secondary education. And many island schools do not offer secondary education at all. As a result, most students completing studies at island schools hardly know anything about the coral reef and its vulnerability. We as students strongly feel that Fisheries Science should be introduced to students at a lower level in the existing curriculum. May be at the primary or middle school level.

I also note that although the existing Fisheries Science curriculum has a practical component in it, it is hardly practised. Though Fisheries Science curriculum strongly encourages active learning, many of the practical activities indicated in the Fisheries Science Activity workbooks are not carried out by the teachers.

We on behalf of all Fisheries Science students recommend that the government take appropriate steps to ensure that more activities be carried out by the Fisheries Science teachers. I'm sure this will encourage more students to take Fisheries Science, thus creating more awareness among the students about the reefs.

We would also like to note that all teachers of Fisheries Science are expatriates. These expatriates have very little practical experience on coral reefs. This may be why they are so reluctant to take the students out to the reef.

Therefore we strongly suggest to the responsible government authorities to train Maldivians to teach Fisheries Science at the schools.

Field trips to observe coral reefs could be organised at least once a year by the appropriate ministries for the students of both Male schools and island schools.'

Lectures for graduates should be organised to provide information on career opportunities relevant to coral reefs.

Lectures, video shows and slide shows could be organised by various departments to create awareness among students about the fragile environment that surrounds us.

Radio programmes and documentaries shown on the National TV can provide a lot of information to the public.

In addition, debates and quizzes could be organised among schools by various departments regarding the coral reefs environment.

Poster competitions could be organised nationwide. The best 10 posters could be mass produced and distributed throughout the country.

Environment clubs in schools could be given the responsibility of designing leaflets which could be mass produced and distributed. Schools could take turns in designing leaflets.

Huge billboards could be put up at different locations of the island. Again, students from various schools could help paint these boards.

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Draft Collaborative IRRM Plan

Chapter 1

Five Key Issues

Issue Areas for Management

Issue areas for management in the IRRM are unique to the Maldives but have implications for other countries for management of relatively untapped but fragile reef ecosystems, This present phase (1994- 1998) programme has identified Five Key Issues:

1) Reef Fish Fishery

The main area of concern will be the export-oriented Grouper and Marine Aquarium Fish Trade.

2) Baitfishery for Tuna Pole and Line Fishery

This is the reef-related component of the tuna fishery.

3) Coral Mining

The main areas will include impacts due to coral and sand mining, dredging and reclamation.

4) Tourism/Fishery Interactions

This issue is included mainly due to the fact that this is an issue in the project area. In addition, IRRM will observe the interactions among interests within each sector, before analysing the interactions between sectors.

5) Comprehensive Management of the Resources.

This issue is mainly concerned with the legal and institutional aspects of IRRM.

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Chapter 2

Objectives for Management

The Objectives for Management are to identify a suitable IRRM Strategy in the overall Atolls (Administration) National Development Programme and at the same time carry out intensive monitoring as well as in-house training programmes to develop an IRRM Programme for the project areas of Vaavu, Dhaalu, Meemu, and Faafu Atolls that:

- Spells out collaborative, participatory reef resources monitoring and management activities and programs involving people directly affected by reef resource utilization (e.g. fisherfolk, the tourism industry, coral miners, etc), as well as Government, relevant NGOs and other stakeholders.
- Includes the development of a mechanism for coordination and cooperation among all parties in order to implement recommendations and identified actions. Consideration will be given to introduce Reef Resources Committees in Male and the Atolls. The Committees would help to guide monitoring and research and to manage resources. The Committees should represent a full cross-section of interests. A commitment to action and change is required from all parties if the aims of the IRRM process are to be achieved.
- Promotes reef resources management on an on an atoll by atoll basis, to help eliminate the current open access to resources. Introduces pilot scale IRRM programmes, working through existing Atoll Development Committees and Island Development Committees and fisheries subcommittees if present.
- Develops a strategy to increase awareness of the fishing community in particular and the public in general on issues relating to reef resources management, such as the dangers of overfishing, advantages of sustainable resource use, the impacts of coral mining and the benefits of using alternatives to coral rock for construction.
- Develops a plan of phasing out coral mining in the current National Development Plan, working backward from a total ban of 2005 AD.
- Details the enforcement of existing laws and regulations concerning reef fisheries and other reef resources including environment more effectively.
- Establishes a network of marine protected areas, designed to act as harvest

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refugia and to protect breeding stocks and biodiversity, covering approximately 20% of the total atoll area and including representative samples of all major habitats.

= Documents and builds on the existing local knowledge of marine resources and management systems, in order to provide a sound foundation for IRRM.

The Workshop advised that leadership for executing the specific activities to implement IRRM be assigned to relevant management levels: National; Atoll; and Island. These management levels have been recommended according to the functions described in Chapter 5 'Coordinating and Implementation Mechanism'. Recommended actions are listed below by issue and lead responsible management level.

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Chapter 3

Strategies and Recommendations to Solve Issues

Reef Fish Fisheries Recommendations

It was found during the IRRM Workshop that the objectives and recommendations for addressing the 'Live Bait Fishery for Tuna Pole and Line Fishery' issue were also appropriate and often the same for solving the 'Coral Reef Fisheries' issue. Therefore, the recommendations for these two issues are combined under a single 'Reef Fish Fisheries' Strategy or set of recommendations, below. The Atoll Area Management Plan for each Atoll would likely need to have separate committees devoted to each fishery, to carry out the details of these recommendations. In addition, the awareness building solutions and approaches needed for each issue area are the same, only the content of the materials developed would differ for each issue, and could often be combined into one campaign material.

In addition, two 'key' solutions for all the issues, and particularly the Reef Fish Fisheries and Tourism and Reef Resources Interactions issues are the development and implementation of an Atoll Area Management Plan for each Atoll, and the establishment of a network of marine protected areas. While the former is dealt with in detail in this section, the network of marine protected areas is more fully described under the solutions for Tourism and Reef Resources Interactions.

Recommendations are set out by issue area where appropriate — for example under the Marine Research Section, and as specific considerations for the Atoll level management framework to develop into management measures.

Objectives

= Promote reef resources management on an atoll scale. Recognizing that people of one atoll would have little or no incentive to conserve 'their' reef resources if there was open access to people of all atolls, it is recommended that there be some regulation, requiring fishermen from all atolls to conform to the management measures in place in any atoll.

= Take strong action to prevent the establishment of fishing using any poison, such as cyanide.

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- Increase awareness of the fishing community in particular and the public in general on issues relating to reef resources management, such as the dangers of overfishing, advantages of sustainable resource use.
- Increase enforcement of existing regulations.
  Increase institutional coordination in fisheries management.

- Recommendations

1. **National Level Actions**

- Support a diverse set of approaches for building awareness of the fishing community as the target audience, and the public in general on issues relating to reef resources management. Approaches could include but not be limited to the following:
  - Develop links between environmental clubs and school groups in Male and in the atolls.
  - Use print media (local news-sheets as well as national newspapers); and radio (atoll based FM radio if/when available, as well as the national Voice of Maldives) as frequent and informal means to exchange information.
  - Documentaries shown on the National TV.
- Introduce fisheries science to students at a lower level (ie, primary or middle school) in the existing curriculum with an active field studies component, to create more awareness among the students about the reefs and the organisms in it. In addition, debates, poster competitions and quizzes among the schools could be organized by various departments regarding the coral reefs environment
- Give environment clubs in schools the responsibility of designing leaflets which could be mass produced and distributed. Schools can take turns in designing leaflets.
- Support the enforcement and technical coordination of measures and actions developed under the Atoll area management plans.

Coral Reef Fisheries

- Establish a fisheries unit within Customs, to monitor fisheries exports more effectively. Provide training in fisheries product monitoring to Customs to facilitate this process.
- Develop a mechanism for monitoring the activities of foreign vessels entering the country to buy or load live fish.

- Increase enforcement of the existing regulations concerning foreign vessels fishing in territorial waters (e.g. grouper).
- Increase enforcement of the existing regulation requiring the registering of any new fishery with the Ministry of Fisheries and Agriculture, before fishing activity commences.
- Ban the use of small mesh in gillnets in view of the damage they can do to reef resources.
- Ban fishing during breeding season where appropriate (e.g. on spawning aggregations of groupers).
- Impose a moratorium on fisheries that are severely overfished in order to allow stocks to recover (eg. sea cucumber)
- Prohibit the use of compressed air diving (both SCUBA and surface supply) for commercial fishing, except in cases where diving is the only practical method of fishing (e.g. aquarium fish).

Baitfishery for Tuna Pole and Line Fishery

- Establish a regulatory body to establish minimum safety and training standards for diving fishermen, if SCUBA diving for baitfish collection or other fisheries is allowed.
- Apply the results of MRS impact analysis of livebait collecting methods to consider introducing legislation to ban the use of destructive livebait collecting methods.
- Consider banning the capture of sea birds and take strong action to prevent destruction of their habitats. Sea birds play an important role in locating fishing grounds. Many of these birds are being caught by fishermen and kept in their homes as pets. Some of these birds are now seen very rarely.

2. Atoll Level Actions

- Develop an Atoll Area Management Plan for each Atoll in the project area based on Island community participation and cooperation. Components of the Plan would consider and lay out the details of management measures for the export-oriented grouper and marine aquarium fish trade, and the live bait fishery for tuna pole and line fishery to:
    - Ban fishing during breeding season where appropriate (e.g. on spawning aggregations of groupers).

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- Control fisheries in each atoll by limiting the catch and/or fishing effort.
- Ban the use of small mesh in gillnets in view of the damage they can do to reef resources.
- Develop mechanisms for increasing awareness in cooperation with national efforts and also geared towards local level concerns within the issue areas. In addition, develop mechanisms for disseminating contents of management measures developed for further public input throughout the process.
- Impose a moratorium on fisheries that are severely overfished in order to allow stocks to recover (eg. sea cucumber).

3. Local Community Level Actions

- Participate in the development of Atoll Area Management Plans.
- Work together with MRS to:
  - Document the existing local knowledge of marine resources and management systems, in order to provide a sound foundation for IRRM.
  - Estimate potential fishery yield targets for different fisheries for each atoll.
  - Identify potential fishery targets and help to set size limits.
  - Monitor reef fisheries using logbooks. Species composition data, size frequency data, and catch and effort data should be collected.
  - Concentrate initial community based monitoring and management activities on the grouper fishery in view of its current importance.

4. Marine Research Section Support to IRRM Process

- Work with the island communities to document existing local knowledge of marine resources and management systems, in order to provide a sound foundation for IRRM.
- Conduct short research projects to obtain information on specific topics as required.
- Provide the technical direction and information for radio programmes and documentaries shown on the National TV to help disseminate information to the public.
- Estimate potential sustainable yield targets for all fisheries in the Atoll project area:
- Compile information available from other parts of the world on reef resources

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stock assessment and other biological studies, in order to make the process more cost effective.

Coral Reef Fisheries

- Engage suitable fishermen on targeted islands to monitor reef fisheries using logbooks. Species composition data, size frequency data, and also catch and effort data should be collected.

Baitfishery for Tuna pole and line Fishery

- Carry out research in order to assess the status of livebait fish stocks and their sustainable yields. This research should incorporate local knowledge in addition to appropriate scientific studies (working with local communities).
- Initiate a baitfishery data collection system (working with local communities).

Coral Reef Fisheries

- Carry out market research on the coral reef fisheries, and disseminate the resulting information to the public.
- Provide information to Atolls and Island Communities to help set size limits on commercially important species as part of the Atoll Area Management Plan.
- Concentrate initial community based monitoring and management activities on the grouper fishery in view of its current importance.
- Help organize and participate in lectures for school leaders to provide information on career opportunities for students taking subjects relevant to coral reefs.

Baitfishery for Tuna pole and line Fishery

- Fishermen should be made aware of the existing problems in catching live baitfish. They should be encouraged not to catch an exceeding amount of bait fish even when bait is abundant. They should also be advised to put back the excess bait back on to a reef and not into the open ocean.
- Prepare fishery information packages for school teachers.
- Introduce specialized boats for bait fishing to meet the ever increasing demand for baitfish. These vessels then could provide the needed live baitfish for the pole and line fishermen.

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- Increase coordination between VOM and MOFA to ensure the timely transfer of information to be distributed through VOM to the fisherfolk on live bait issues.
- Analyze the impacts of destructive livebait collecting methods including the use of sticks and heavy chains/weights to drive livebait out of their refuges by breaking corals. This information will be used by MOFA and other relevant Ministries to consider a ban on certain livebait collection methods.

Coral Mining and Related Activities Recommendations

Objectives

- Develop a plan for phasing out coral mining in the context of the current national development plan, working backwards from a total ban by 2005 AD.
- Increase awareness of the fishing community in particular and the public in general on the impacts of coral mining and the benefits of using alternatives to coral rock for construction, and other alternatives that promote sustainable resource use.

Recommendations

1. **National Level Actions**

- Establish and implement mechanisms to make alternatives to coral rock socially acceptable in the country and encourage the use of alternatives in maritime structures, This could include but not be limited to:
  - economic incentives that subsidize alternative materials like imported sand and granite to all the islands throughout the Maldives
  - setting a higher tax levy on mined coral: fixed price for the first 100 cubic feet; 100% on the second 100 cubic feet; and 200% next incremental cubic feet, etcetera
- Consider assigning MPHRE as the approval authority for coral mining permits. Develop and conduct training courses in Male and the Atolls, in the making of concrete blocks, as an alternative to coral rock for construction.
- Develop in cooperation with the Atoll Committee framework, criteria and procedures to define boundaries for house reefs of tourist and inhabited islands and zones designated for different uses.

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- Minimize incidence and impacts of dredging and develop strategies to deal with wastes.

2. Atoll Level Actions

- As part of the Atoll Area Management Plan..
  - Initiate and develop a participatory reef monitoring programme involving Island and Atoll Development Committees, Women's Committees, NGOs and other stakeholders. The monitoring programme will observe changes in the reef environment to help determine probable cause and effect of changes. Results will be used to guide future solutions or remedial actions.
  - Develop criteria and procedures for definition of boundaries for house reefs of tourist and Inhabited islands and zones designated for different uses.

3. Local Community Level Actions

- Participate in the design and implementation of the following actions as part of the Atoll Area Management Plan:
  - reef monitoring programme involving Island and Atoll Development Committees, Women's Committees, NGOs and other stakeholders.
  - develop criteria and procedures for definition of boundaries for house reefs of tourist and inhabited islands and zones designated for different uses.

4. Marine Research Section Support to IRRM Process

- Provide the technical direction and oversight for the following actions as part of the Atoll Area Management Plan:
  - participatory reef monitoring programme. The monitoring programme will observe changes in the reef environment to help determine probable cause and effect of changes. Results will be used to guide future solutions or remedial actions.
  - development of criteria and procedures for defining boundaries for house reefs of tourist and inhabited islands and zones designated for different uses.

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Tourism and Reef Resources Interactions

Objectives

- Observe the interactions within the two major use sectors; tourism and fisheries.
- Observe and resolve the user interactions between tourism and fisheries in a balanced and equitable manner.
- Build on the positive influence of tourism to protect the reef resources, and promote sustainable livelihood of the fisheries sector.
- Develop a network of marine protected areas.

Recommendations

1. **National Level Actions**

- Provide incentives for the tourism industry to support marine related research relevant to them and education programs for both locals and visitors.
- Determine limits for expansion of number of tourism islands based on criteria which include impacts, logistics, costs, benefits to tourist industry and other sectors of society.
- Develop a network of marine protected areas, particularly to protect the livebait fishery. The live bait fishery is of great importance for the pole and line fishery. Precautions must be taken by the government to protect these bait fishing grounds. However, to ensure that little or no damage is done by to the reef when taking bait, permanent anchors at these sites should minimize the damage done by anchoring boats. A total ban-on coral mining at these areas again will ensure that the habitat is little affected by human interaction. Participation from the Atoll Committee frameworks and technical assessments of MRS should be incorporated to help determine areas most appropriate for designation as marine protected areas. The fifteen established dive sites could be the basis for the network, and additional areas established under IRRM would build on this foundation.
- Develop a licensing system for tourism and fisheries based on personal transferable licenses; licenses should be given based on carrying capacity of both industries.
- Initiate an interdisciplinary effort (ITE, EDC, and MRS as lead agencies) to expand on the existing government programmes to create awareness about our fragile environment, using the media as a key tool, and sending qualified environment field officers to various islands to create awareness among the island community.

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- Minimize incidence and impacts of dredging from tourist resorts and develop strategies to deal with wastes from tourism.

2. Atoll Level Actions

- As part of the Atoll Area Management Plan:
  - provide input and advice to the national level to help determine limits for expansion of number of tourism islands based on criteria which include impacts, logistics, costs, benefits to tourist industry and other sectors of society.
  - help identify areas for protection as part of the network of marine protected areas.
  - develop criteria and procedures for definitibn of boundaries of house reefs of tourist islands and zones designated for different uses.
  - provide input and advice to the national level to help develop a licensing system for tourism and fisheries based on personal transferable licenses; licenses should be given based on carrying capacity of both industries. Introduce school-based environment groups to collect cans and plastics. Once a large amount of cans and plastics are collected it can be taken to the island where they can be incinerated. A small price can be paid for each kilo of can or plastics so the students will be encouraged to carry out the task.

3. Local Community Level Actions

- Participate in the design and implementation of the following actions as part of the Atoll Area Management Plan.
  - develop a licensing system for tourism and fisheries based on personal transferable licenses; licenses should be based on carrying capacity of both industries.
  - develop criteria and procedures for defining boundaries for house reefs of tourist and inhabited islands and zones designated for different uses.

4. Marine Research Section Support to IRRM Process

- Compile and integrate results of research related to management of marine resources. Provide technical assessments to help determine area for inclusion in the network of marine protected areas.

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- Provide information to support the Atoll and Islanders in developing:
    - criteria and procedures for defining boundaries of house reefs of tourist islands and zones designated for different uses.
    - a licensing system for tourism and fisheries based on personal transferable licenses; licenses should be based on carrying capacity of both industries.
- Support school based environment groups campaigns in collecting cans and plastics. Once a large amount of cans and plastics are collected it can be taken to the island where they can be incinerated. A small price can be paid to each kilo of can or plastics so the students will be encouraged to carry out the task.
- Support an interdisciplinary effort (ITE, EDC, and MRS as lead agencies) to expand on the existing government programmes to create awareness about our fragile environment, using the media as a key tool, and sending qualified environment field officers to various islands to create awareness among the island communities.

Chapter 4

Coordinating and Implementation Mechanism

The boxes below describe the IRRM implementation frameworks, and the coordination between the Atoll, National and local community levels, and the MRS.

IRRM Implementation Framework

National

1. Interagency coordination **and** commitment
2. Ensures legislative enactment of atoll and island recommendation
3. Assist in locating financial support for local actions. -

Atoll

1. Coordination of community level activities
2. Forum for exchanging information on solutions, issues and ideas between communities
3. Forum for decision-making on integrated issues vis-a-vis inter-relationship of issues and impacts.

M.R.S.

1. Technical advisory support to national, atoll & local communities
2. Coordination of overall management process, technical information exchange, in particular with the local community level, between MRS scientists and fisherfolk, to assist in the development of IRRM solutions & management measures.

Local Community

1. Help identify, develop and implement management solutions
2. Exchange information with MRS
3. Bring measures and issues forward to atoll level for action.

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Chapter 5

High Priority Actions over the Next Year to Follow-up on Workshop Recommendations

IRRM WORKPLAN
1996 Activities

Preparatory Activities for IRRM Atoll and Island Level Implementation

1) Consider focusing activities in Vaavu Atoll, as a pilot project for the first six months of the Programme. A strong Programme in Vaavu Atoll can then be a model for Memu, Faafu, and Dhaalu Atolls, and trained community leaders from Vaavu will help transfer the concepts to the other Atolls.
2) identify key leaders in Vaavu Atoll to help implement the Programme. (Abdul Majeed, Atolls Office, Vaavu).
3) Finalize the Workshop Recommendations.
4) Translate IRRM background materials into Dhivehi, including: Workshop Recommendations; IRRM Implementation Framework.
5) Reprint Reef Resources Management Handbook.

Atoll and Island Level Implementation

6) Field trip (multi-sectoral: MRS, ITE, EDC, MT, MPHRE, Atolls) to help establish IRRM process and approach.
   a) Conduct informal meetings in Atoll and Islands to reach consensus on a management framework for IRRM which is adaptive to the ideas and needs of Vaavu communities.
   b) Establish membership of management committees, roles and responsibilities for individuals within the community and Atoll
   c) Atoll and Island community prioritize recommendations for implementing IRRM.
   d) Arrange schedule of prioritized actions, and commitment of funding to implement actions.
   e) Develop strategy for involving the continued participation of local level government officials and islanders and bridging the gap between government and stakeholders.
7) Document existing local knowledge of marine resources and management systems, in order to provide a sound foundation for IRRM.

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Appendix B

Workshop Prospectus

Background

The Maldives is a nation of over one thousand small coral islands spread over ninety thousand square kilometers in the Western Indian Ocean. It is not surprising that this small island nation is dependent on its marine and coastal resources for its livelihood. Tourism and Fisheries are the two highest foreign exchange earners, and are equally dependent on the high environmental quality of the reef and marine resources. While the tourism industry has grown in the last decades to become the highest foreign exchange earner, fisheries and fisheries-related industries have traditionally provided the primary source of employment and protein in the Maldives, especially to the rural or island population. In addition to being dependent on the same resource, these two foreign exchange earners are also economically interdependent. Part of the experience of being a tourist in the Maldives is enjoying the fresh fish products, and the fisherfolk have benefited from this additional market primarily for reef fish.

Fisheries in the Maldives has historically targeted the pelagic tuna resources and the livebait fishery. However, since the early 1980's, the Maldives has seen the emergence of new fisheries targeting reef species. These fisheries can be largely grouped into the export-oriented grouper fishery, the marine aquarium fish trade, the beche-de-mer fishery and the giant clam fishery. A high export market demand coupled with a small resource base and lack of management measures has created severe pressure on these fisheries. As part of the solution, the Government of the Maldives is developing mariculture pilot projects to help offset the intensive effort and catch in the beche-de-mer, grouper and giant clam fisheries.

To respond to these recent changes in the fishery uses of its reef resources, trends in the tourism industry, and concern among the stakeholders of the sustainability of the reef resources, the Government of Maldives has initiated an Integrateh Reef Resources Management Programme (IRRM) which will build on the successful results of earlier efforts. In fact, the IRRM has been established from the recommendations following the unusual storm-surge incidence of 1987.

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Through the ODA/TCO Programme, the Government of Maldives has conducted research on tuna as well as reef degradation and its impact on the reef fishery. Recommendations made for the establishment of a Coral Reef Research Unit have been assisted by the ICOD/Canada. Additional funding for Reef monitoring, COT Awareness campaign, One Day Seminars with the Tourist Industry and the concerned government departments, as well as training assistance has been sought from the World Bank, ODA, ICOD, and SEAFDEC.

Through assistance from the Scandinavian Countries, UNDP, FAO/BOBP, Government of Japan, Australia and India, an Extension Programme was conducted during the period 1989 - 1993. This Extension programme consisted of a series of consultations, workshops, seminars and training programmes in Vaavu and Meemu Atolls. Two substantive outcomes of this programme include a Reef Resources Management Handbook designed to be used by everyone with an interest in living marine resources, from tourists and fisherfolks, to research scientists, and the printed booklet "Our Living Reefs" that has been used by the community schools within the project area.

The Maldives has a strong international commitment relating to coastal and marine resources management in Agenda 21. The Maldives is on the forefront of implementing recommendations under Agenda 2 l, Chapter 17, which calls for the development of an integrated approach to the management of coastal and marine resources with particular reference to the protection of coral reefs as areas of high biodiversity and global importance.

The IRRM programme will develop a management model for the Vaavu, Meemu, Faafu and Dhaalu Atolls, using a participatory approach with the fisherfolk to improve the welfare of the fisherfolk communities and the sustainability of the reef fishery resources. A more holistic approach to reef management which combines fisherfolk knowledge with the results of scientific characterisation of the reef fisheries resources, and the expertise and input of all Ministries with jurisdiction in the areas impacting the reef resources, will ensure that management solutions will be comprehensive and sustainable.

An integrated approach which considers the cultural and scientific aspects of management will open doors to our understanding of coral ecosystems and the fisherfolk communities that depend on them. Activities conducted by the Marine Research Section (MRS) in the targeted Atolls have prepared the conimunities for

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participation in the IRRM Programme. These earlier efforts have also helped to identify issue areas for the management of the resources.

Issue Areas for Management

Issue areas for management in the IRRM are at once unique to the Maldives and will have implications to other countries for management of relatively untapped but fragile reef ecosystems. This present phase (1994 - 1998) programme has identified Five Key Issues:

1. **Reef Fish Fishery:** Main area of concern will be export-oriented Grouper and Marine Aquarium Fish Trade.

2. **Baitfishery for Tuna pole and line Fishery:** Reef related component of the tuna fishery.

3. **Coral Mining:** Main areas will include impacts due to coral and sand mining; dredging as well as reclamation.

4. **Tourism/Fishery Interactions:** Mainly due to the fact that this is an issue in the project area. In addition, IRRM will observe the interactions among interests within each sector, before analysing the interactions between sectors.

5. **Comprehensive Management of the Resources:** Mainly concerned with the legal and institutional aspects of IRRMP.

Main Objective:

To identify a suitable IRRM Strategy in the overall Atolls (Administration) National Development Programme; at the same time carry out intensive monitoring as well as in-house training programmes to develop an IRRM Programme for the project area.

Goal:

To develop an IRRM Policy Guideline for all the Administrative Atolls by the year 2000.

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Workshop Objectives:

- Obtain a common understanding and agreement among participants of the general objectives and vision of the IRRM Programme and explore and develop approaches for implementing the Programme.

- Share scientific and socio-economic information currently developed on the five issue areas, and develop draft approaches for their assessment and application to the IRRM decision making process.

Expected Outputs:

- Consensus-building on the general objectives and vision of the IRRM Programme, and recommendations for strategy options for IRRM implementation.

- Proceedings published in English and Dhivehi..

Workshop Methodology:

The workshop will be organised around the identified issue areas as discussed above, and will serve as a forum to apply the perspective and experience from a variety of disciplines to these issue areas to improve understanding of these issues and review alternative options for management. Participants arc expected to number approximately one hundred with the plenary session open for observers. Morning sessions will be for the presentation of resource papers at the plenary, while the afternoon sessions will be limited to the invited delegates, divided into five working groups.

The first day of the Workshop will focus on the status of the reef resources largely from a scientific perspective.

The second day will apply the science and issue identification to explore potential institutional frameworks for information and dissemination from the perspective of steps already accomplished in the Maldives and other countries

The third day will discuss management approaches.

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The fourth day will give the international experts an opportunity to visit Tourist Resort installations and Fishing villages, while the Secretariat prepares the working documents as well as the working group recommendations to facilitate concluding discussions on the final day.

The final day of the Workshop will be used to consolidate the discussions and to arrive at recommendations for IRRM.

Who Will Attend:

Delegates and Observers will include representatives from all fisheries, tourism and reef related industry professions and associated groups interested in the sustainable reef resources development and management within the Private and the Public Sectors.

Invited Internntionnl Experts:

Dr. R. E. Johannes
R. E. Johannes Pty Ltd.
8 Tyndall Court
Bonnet Hill
Tasmania, 7053
Australia

Dr. Terry. Done
Australian Institute of Marine Sciences
PMB 3 Townsville
Queensland 48 10
Australia

Dr. Alasdair J. Edwards
Centre for Tropical Coastal Management Studies
Department of Marine Sciences and Coastal Management
University of Newcastle
Newcastle upon Tyne NE 1 7RU
United Kingdom

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Dr. Alan T White
Coastal Resources Management Project
No. 1 Gower Street
Colombo 5
Sri Lanka

For further information contact:
Director General of Fisheries and Agriculture, Ghazee Building, Male 20-05
Tel: 322625, Cable: Fisheries Telex: 77033 Facsimile: (960) 326558

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Appendix C

AGENDA

Day 1
16 March, 1996: Saturday

<u>Morning Session</u>

8:30 - 9:00 Registration

9:00-1 0:00 Opening Ceremony

Recital from Quran

Introductory remarks	*Mr. Jadhulla Jameel* *Director General, Ministry of Fisheries & Agriculture*
Welcome Address	*Hon. Hassan Sobir* Minister of Fisheries and Agriculture
Inaugural Address	*Hon. Ismail Shafeeu* Minister of Planning Human Resources and Environment
Statement of Objectives of the Workshop	*Mr Maizan Hassan Maniku* Director General, Fisheries R & D.

10:30 -11:00.	Paper 1: Status and Trends of the Tuna Livebait Fishery. *Robert Charles Anderson*
11:00 - 11:30	Paper 2: The Aquarium Fishery of the Maldives. *Mohamed Shiham Adam*
11:30-12:00	Paper 3: Ekploitation of Reef Resources: Grouper and other food fishes. *Hassan Shakeel*

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12:00-12:30	Paper 4: Exploitation of Reef Resources: Beche-de-mer, Reef Sharks, Giant Clams, Lobsters and others. *Hudha Ahmed*

Afternoon Session

14:00--16:00	Working Groups *Concurrent sessions* Discussion Leaders: *Munro, Johannes, Ruddle, Done, White* Reporters: *Shakeel, Shiham, Anderson, Naseer, Hudha, Simad, Firaag*
16:30-17:30	Working groups in plenary

Day 2
17 March, 1996; Sunday

Morning; Session

9:00-9:30	Paper 5: Status of Coral Mining in the Maldives: Impacts and Management Options. *Abdulla Naseer*
9:30-10:00	Paper 6: Tourism and the Environment: Current issues for Management. *Ismail Firaag*
10:00-10:30	Paper 7: Status of the Communities in the four Atolls: Their perceptions, problems, and options for participation. *Ahmed Thasmeen Ali*
10:30-11:00	Coffee Break
11:00-11:30	Paper 8: Environmental Changes in the Maldives: Current Issues for Management. *Mohamed Khaleel & Simad Saeed*
11:30-12:00	Paper 9: Existing Legal Systems and Institutional Structure as Opportunities and Gaps for Coordination in IRRM in the Maldives. *Maizan Hassan Maniku.*

Afternoon Session

14:00-16:00	Working Groups *Concurrent sessions* Discussion Leaders: *Munro, Johannes, Rtrddle, Done, White* Reporters: *Shakeel, Shiham, Anderson, Naseer, Hudha, Simad, Firaag*
16:30-17:30	Working groups in plenary

Day 3
18 March, 1996; Monday

Morning Session

9:00 - 9:30	Paper 10: Four Performance Indicators for Integrated Reef Resources Management. *Terry Done*
9:30-l0:00	Paper 11: Collaborative and Community-based Management of Coral reef Resources: Lessons from Sri Lanka and the Philippines. *Alan T. White*
10:30-11:00	Paper 12: Traditional Management Options and Approaches for Reef Systems in Small Island Nations. *Robert E. Johannes*
11:00 - 11:30	Paper 13: Aspect of Appraisal, Assessment and Monitoring of Reef fish Resources. *John L. Munro*
11:30- 12:oo	Paper 14: Traditional Marine Resources Management Systems in the Asia - Pacific Region: Design Principles and Policy Options. *Kenneth Ruddle*

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Afternoon Session

14:00-16:00 Working Groups
Six concurrent sessions
Discussion Leaders: *Munro, Johannes, Ruddle, Done, White*
Reporters: *Shakeel, Shiham, Anderson, Naseer, Hudha, Simad, Firaag*

16:30-17:30 Working groups in plenary

Day 4
19 March, 1996; Tuesday

Free for the workshop participants. Field trip for the International Experts. Dinner hosted by the Minister of Fisheries and Agriculture.

Day 5

20 March, 1996; Wednesday

Morning Session

Plenary

09:00-11 :00	Working Group Presentations	
11:30 - 12:30	Introduction	*Mr Maizan Hassan Maniku* Workshop Chairman
	Experts Concluding Remarks	International Expert
	Concluding Speech	*Hon. Ibrahim Hussein Zaki* Minister of Tourism
	Vote of Thanks	*Mohamed Khaleel* Deputy Director, MPHRE

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Appendix D

LIST OF DOCUMENTS

1. Status and Trends of the Tuna Livebait Fishery. *Robert Charles Anderson* **IRRM/ NW/01**

2. The Aquarium Fishery of the Maldives. *Mohamed Shiham Adam* **IRRM/NW/02**

3. Exploitation of Reef Resources: Grouper and other food fishes. *Hassan Shakeel* **IRRM/NW/03**

4. Exploitation of Reef Resources: Beche-de-mer, Reef Sharks, Giant Clams, Lobsters and others. *Hudha Ahmed* **IRRM/NW/04**

5. Status of Coral Mining in the Maldives: Impacts and Management Options. *Abdulla Naseer* **IRRM/NW/05**

6. Tourism and the Environment: Current issues for Management. *Ismail Firaag* **IRRM/NW/06**

7. Status of the Communities in the four Atolls: Their perceptions, problems, and options for participation. *Ahmed Thasmeen Ali* **IRRM/NW/07**

8. Environmental Changes in the Maldives: Current Issues for Management. *Mohamed Khaleel & Simad Saeed* **IRRM/NW/08**

9. Existing Legal Systems and Institutional Structure as Opportunities and Gaps for Coordination in IRRM in the Maldives. *Maizan Hassan Maniku* **IRRM/NW/09**

10. Four Performance Indicators for Integrated Reef Resources Management. *Terry Done* **IRRM/NW/10**

11. Collaborative and Community-based Management of Coral reef Resources: Lessons from Sri Lanka and the Philippines. *Alan T. White* **IRRM/NW/11**

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12. Traditional Management Options and Approaches for Reef Systems in Small Island Nations. *Robert E. Johannes* **IRRM/NW/12,**

13. Aspects of Appraisal, Assessment and Monitoring of Reef fish Resources. *John L. Munro* IRRM/NW/13

14. Traditional Marine Resources Management Systems in the Asia - Pacific Region: Design Principles and Policy Options. *Kenneth Ruddle* **IRRM/NW/14**

15. Workshop Agenda **IRRM/NW/15**

16. Agenda for Inaugural and Closing Session **IRRM/NW/16**

17. List of Documents **IRRM/NW/17**

18. List of Participants **IRRM/NW/18**

19. Opening Remarks **IRRM/NW/19**

20. Welcome Address **IRRM/NW/20**

21. Inaugural Address **IRRM/NW/21**

22. Final Report **IRRM/NW/22**

23. Statement of Objectives ***IRRM/NW/23***

Appendix E

INTRODUCTORY REMARKS

by **Mr. Jadhullah Jameel,**
Director-General, Ministry of Fisheries and Agriculture, Maldives

Chief Guest, Ministers, distinguished guests, colleagues, ladies and gentlemen.

Assalaam alaikum.

Maldive islands have existed for thousands of years providing a safe habitat to numerous terrestrial and marine lives because of the wonderful reefs surrounding its islands and atolls. The reef has been a part and parcel of the life of the people of the Maldives from time immemorial. It has been protecting our homes. It has been a source of income. It has been a place of recreation.

The existence of these wonderful reefs which we have taken for granted has been threatened during the last 25 years due to large scale coral mining, overfishing of some commercially valuable reef fishes and the use of reefs for Tourism and Fisheries in some areas resulting in erosion of islands, depletion of marine lives and creation of conflicts among users of reefs. Though reef resources management attempts are not entirely new in this country and regulations to solve these problems are in place, this is the first time a workshop is being organised at the national level to identify a suitable integrated reef resources management strategy. However, such a strategy will be successful and achieve the desired goals only with the acceptance of such a strategy, co-operation by all resource users and continued hard work by government and the public. Scientists and the international community also have a significant role to play in this task.

I would like to congratulate my colleague Maizan Hassan Maniku, Director General of the Ministry of Fisheries and Agriculture, who has played a key role in organising this workshop with the assistance of number of people. He always plays an important role in all marine-related research and projects with assistance within and outside Maldives. During the entire life of the Marine Research Section of our Ministry, he has headed the section in the right direction and has achieved much. I would also like to thank all the Ministers including the present Minister of Fisheries and Agriculture Hon. Hassan Sobir for their encouragement and guidance without which the work for sustainable use of our reef resources would not be successful

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Last but not least, I would like to express our gratitude to His Excellency President Maumoon Abdul Gayyoom for his untiring efforts to preserve the beautiful environment of our country for the benefit of present and future generations.

I wish you all well.

Thank you.

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Appendix F

WELCOME ADDRESS

by **Mr. Hassan Sobir,**
Minister of Fisheries and Agriculture

I am very pleased to welcome you all this morning.

As the Minister of Fisheries and Agriculture, I clearly remember a year ago when our research team brought this matter up to discuss the workshop with me and my own suggestions as to how it could be managed and funded. It has taken almost a year for the workshop to materialize.

Seeing you all today, I cannot but feel elated that the workshop is now a reality, and we are about to begin four days of discussions on how we can best share one common resource and our most important resource — the coral reefs.

Organising a workshop of such high scientific quality is a complex activity, involving several different groups of people. A higher level of interaction is required among various groups of people, specially in trying to coordinate a group of international experts to assist us in this exercise.

I myself shared in turn their excitement, frustration and problems in getting the workshop organised and I am now experiencing with them a sense of achievement for having you here together at last. I should congratulate the secretariat therefore, for a job very well done.

The moving spirit behind the secretariat has been the close cooperation among the staff of the Marine Research Section, of my Ministry and the Bay of Bengal Programme, in developing the concept and the guidelines for the secretariat to implement.

To all the agencies who have helped: Ministry of Planning, Human Resources and Environment, Ministry of Atolls Administration, Ministry of Tourism and the Attorney General's Office, I would like to express my gratitude for their cooperation and unstinting support for this undertaking. I would also like to thank the all the private individuals, as well as the tourism industry, for having responded to our requests for assistance.

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Lastly, I would like to congratulate the International Experts, for having come all the way to the Maldives, to share their experiences, from different regions of the world sharing similar ecosystems. I have no doubt that this workshop will generate new knowledge and will greatly assist the government in establishing a well structured policy for an Integrated Reef Resources Management Programme.

To all those who will be participating in this four day workshop, I wish you all success in this concerted effort in making this workshop a great contribution to the process of managing our reefs in a sustainable manner.

I bid you a warm welcome.

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Appendix G

Inaugural Address

by **Mr. Isamail Shafeeu,**
Minister of Planning, Human Resources & Environment

Minister of Fisheries and Agriculture, Honorable Hassan Sobir, Director General Jadulla Jameel, Director General Hassan Maniku, distinguished participants, Ladies and Gentlemen.

Assalaam Alaikum

It is a great pleasure for me to be here this morning, to participate in the opening session of this workshop on integrated reef resources management. This workshop is an important step forward, in our efforts to sustainably and equitably manage our reefs. These reefs have sustained the island communities of this country from time immemorial, and with foresight and planning, are capable of sustaining the many generations to come.

There is no doubt that all citizens of this nation are entitled to work towards a better quality of life and share in the benefits of development. However, we have increasingly come to realize that some processes and by-products of our pursuit of a better life have serious adverse impacts on our resources and consequently on future development. Though our beautiful reefs are rich in biodiversity and thriving well, there is no doubt that they have taken a number of punches in the rounds of development. In particular, as competition among multiple users of reef resources intensifies, so will the degradation of reef resources; and the management options open to us will then increasingly diminish. This situation is increasingly becoming apparent in parts of the country which have had the most investments and the highest growth.

Maintaining the biological diversity, the condition, the resources and values of coral reefs requires a multi-stakeholder perspective at national and local level. We have only achieved partial success in the past when individual sectors took unilateral control measures. It has become very clear that only joint concerted action can resolve the issues. As well, the need has become deeply felt for dialogue and cooperation between different economic and social sectors, for common solutions transcending the different sectors and for fulfilling responsibility. Multi sectoral, multi disciplinary forums such as this workshop are the ideal means to discuss the issues at hand and to identify comprehensive strategies.

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Ladies and Gentlemen,

We must be clear in our minds about what we are addressing at this meeting. We are not talking only about conservation of resources, nor of protection alone. We are addressing the issues of management of reef resources that include sustainable multiple use of resources, protection of critical habitats, maintenance of biological diversity, conservation of rare or endangered species and stewardship of the whole reef ecosystem.

As Agenda 2 1, the action plan of the Earth Summit recognizes, sustainable development of resources is only possible through a viable partnership between government, industry and civil society. In this regard, the government is committed to developing national strategies, plans and policies. This workshop is such an initiative. The active involvement of private stakeholders and community organisations is critical in the formulation of strategies. and policies for sustainable reef management. It is indeed encouraging to see representatives from the industries, NGOs and the media present in this opening session. It is my sincere hope that all of you would be able to participate throughout the workshop and make useful contributions to **this** very important initiative.

Ladies and Gentlemen,

Many a seasoned and jaded global traveller has been inspired and excited and refreshed by the richness and exuberance of Maldivian reefs. However, this situation may not endure for long if present trends continue unabated. Over-exploitation of living reef resources, illegal trade of endangered species and their products, irresponsible coral mining, destructive fishing practices are real dangers that our reefs face:Only a practically oriented management system can ensure that such destructive activities do not have a place in the Maldives.

The government has taken a number of measures to manage reef resources in a responsible and sustainable manner. Destructive fishing practices have been banned, the export and exploitation of certain marine products have been prohibited or controlled, zoning has been introduced for coral mining, market incentives introduced to promote import of construction materials, and very recently marine protected areas have been designated. To achieve sustainable tourism development, the Ministry of Tourism with the cooperation of Maldivian Association of Tourism Industry has introduced a number of regulatory measures and appropriate technologies.

However, we should never be complacent in this matter. There should be no doubt in our minds that our survival as a nation is intimately linked to our coral reefs. We thus need to constantly build on the policy and regulatory framework. In particular, we need holistic policies and strategies that provide a clear sense of purpose and the direction to follow in the years ahead. We need to develop policies directed at the relevant stakeholding sectors who should take full responsibility.

We also need to further develop comprehensive working management systems, with consistent and enforceable legal instruments for control, along with market mechanisms for promotion of certain measures. A research agenda needs to be developed and facilitated for areas where there are gaps in information or where no information is available. Provisions for information availability, institutional coordination, education, training, and public awareness should become part of the management system.

Ladies and gentlemen,

In developing our policies for the future, there are a number of questions that need answers. Are resources being over-exploited ? Do we need ceilings on exploitation of a resource ? Do we have enough information to set such ceilings ? What is the maximum sustainable yield ? What is the best method for controlling regulation or market mechanisms ? What is the best institutional structure? And so on.

Additionally, in this context, we need to also continually assess the effectiveness of ongoing measures : we recently designated marine protected areas. Does this designation meet our overall objective? How can we manage the protected areas? What kind of guidelines need to be developed? Can we generate adequate financial resources for the proper management of these areas?

The question of property right is also a major issue to be addressed. Who owns the resources? Who should have accessibility ? What kind of policy and legal instruments are needed to avoid conflicts in resource utilization? The questions go on. We need answers to these questions and we need them soon. I hope that you have place in your deliberations for such questions.

Distinguished Participants,

Coral reef protection was accorded a high priority in Agenda 21, Chapter 17, on "Protecting and Managing the Oceans". We would be thus well advised to develop an agenda that we could put in front of UN agencies, convention secretariats and multilateral and bilateral donors. This has to be an agenda in which our priorities are clearly set out, which outlines what can be accomplished by ourselves and which describes what assistance we require in terms of financial resources and technology.

I believe that this is very timely workshop. We have just started the process of developing a local agenda 21. Last December, in association with the Ministry of Health and Welfare, an inter sectoral consultation on health and environment was held. This would culminate with a situation analysis and action plan for health and environment. Now the critical issues in reef resource management are being addressed.

It would also be useful to bear in mind that the 1996 sessions of the Commission on Sustainable Development with its focus on Chapter 17 of Agenda 2 1 will deal with coral reef and related ecosystems. I hope that the results of this workshop could form a critical part of the Maldivian input into the deliberations of the CSD.

Ladies and Gentlemen,

Before concluding I would like to welcome the distinguished resource persons who have brought here with them their knowledge and experiences. Their contributions will be of great help in workshop deliberations. I wish you a pleasant stay in the Maldives.

I would also like to congratulate the Minister of Fisheries and Agriculture Mr. Sobir and his staff at the Ministry and at the Marine Research Section on developing this initiative. It would also not be unfair to anyone to make special note of the catalytic role played by the Director General Hassan Maniku in this process.

My final appeal is to the participants: please approach this workshop with the intention of identifying workable options that are socially, economically and ecologically viable and which are respectful of the role of the reefs. With some compromise and some sacrifice by the different stakeholders, I believe that much is possible.

Thank you.

Appendix H

STATEMENT OF OBJECTIVES OF THE WORKSHOP

by **Maizan Hassan Maniku,**
Director-General of Fisheries Research & Development

Good Morning.

Let me first of all express my heartfelt thanks to Honorable Minister of Planning, Human Resources and Environment, Mr. lsmail Shafeeu, for inaugurating this important workshop; and to all those who have accepted our invitation, while fulfilling a very busy schedule.

My intervention here is not to bore you with the technical details of the workshop. However, before I outline briefly the statement of objectives of this workshop on Integrated Reef Resources Management, as befits my present state of life and career, I will use this opportunity to take you with me in tracing some of the main events in utilizing the reef resources in the Maidives, and express some views on the present challenges with these perspectives in mind; in order to place the workshop in the present context of development. My hope would be that this exercise will contribute to the background and to the important discussions of current problems in managing and developing the reef resources.

Physically the country owes its existence to the coral reefs which provide the living base on which these fragile islands are established. In an Atoll environment, the Ocean and Reef Resources underpin the traditional lifestyle and the development of a cash economy. The modern economy of these island communities has to depend on a narrow resource base, dependent on the direct exploitation of its marine resources, both the extractive and non-extractive, for its livelihood.

Maldives have been lucky to be situated in a unique ocean space in the Indian Ocean, which has provided cultural contacts with the Indian Ocean rim islands dating back many thousands of years. These contacts influenced greatly those communities that began to emerge with collective ideas as well as arts and craft transforming them to be adaptive to the local environment. The famous cowrie trade which presumably was initiated during the 9th century flourished until the British victory in Bengal in 1757. This could be considered the most radical change in the Indian Ocean trade history. For the Maldives this led to the end of a long period of affluence and it

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became one of the lost islands of the Indian Ocean, its existence almost forgotten, mainly because of the fact that the reefs have lost its significance, not due to depletion of stock, but a change in the trading system that emerged after the collapse of the Dutch.

With the introduction of Tourism in the 1970s, the Maldives have become one of the most demanding destinations for the international traveller offering again the reef environment but in a totally different context.

Maldives have never utilized the reef resources to any major degree of sophistication until the beginning of the '70s. However, over the past 20 years, rapid progress through increased earnings have focused people's attention to the only resource base available, the reef resources.

The rapid development that took place over this period has placed the reef resources under heavy stress. The recent developments in the Fisheries and the Tourism sector, coupled with the high growth rate, have placed a higher demand for coral mining as well as deepening the harbors and extra demand for space.

Thus a management strategy had to evolve, that would not jeopardize any of these activities which have become the most important economic activities throughout the nation. The use of the marine environment and its resources have taken an intersectoral perspective. There can never be one single national authority dealing with the marine affairs, in the present context.

The concept of an Integrated Reef Resources Management evolved during an Extension program carried out during the period 1989 - 1993. National Workshops conducted on the sustainable use of marine resources during the National Year of Productivity, as well as the recent Atoll Chiefs' Conferences, have continued to highlight the issue of managing the reef resources.

Five issue areas for developing an Integrated Reef Resources Management were thus identified. These five key issue areas are:

1. **Reef Fish Fishery:** Main concern being the export oriented Grouper and Marine Aquarium Fish Trade.

2. **Bait Fishery for Tuna Pole and Line:** reef related component of the tuna fishery

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3. **Coral Mining:** areas including coral and sand mining, dredging and reclamation.

4. **Tourism/Fishery interactions:** Interactions within the sectors as well.

5. **Comprehensive Management of Resources:** mainly concerned with the legal and institutional aspects of IRRMP.

While the Maldives is trying to establish an Agenda within its own waters, the international community is trying to find solutions to the problems of the high sea fisheries, which has a direct bearing on the most important resource the country has traditionally being involved in - the Tuna resources.

An important advance of the Law of the Sea Convention was also that it set out generally accepted standards for the exploitation of fishery resources, but still left the coastal states a fair degree of freedom to pursue national objectives in their fisheries policies.

However, according to the Framework laid in Agenda 2 1 Chapter 17 for the oceans and island states in implementing the Bio-diversity Convention, nations have been entrusted with a critical role to play in the development of scientific knowledge concerning the coastal zone and its resources, in order to maintain the diversity of its living resources.

The national workshop that we are initiating today needs to take into account all these aspects. Thus the main objective of the workshop is to develop a research agenda for the scientists, the economists, the politicians, the NGOs as well as the business sector in developing an IRRM strategy for the country at large.

The outcome of this workshop would assist the IRRMP which is being developed for Vaavu, Meemu, Faafu and Dhaalu atoll to test the hypotheses, in order to achieve the goal of developing an IRRM Policy Guideline for all the Administrative Atolls by the year 2000.

The workshop will run for 3 consecutive working days, with the papers presented at the plenary, which would also be open to interested parties, on a first come first served basis. While the afternoon sessions will be mainly for the delegates and observers divided into smaller working groups which would take place concurrently. Before the days session ends, the final hour will be spent in consolidating the working group deliberations at the plenary.

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The final session will be on the 5th day of the workshop, when the group findings will be discussed in the plenary, followed by the closing ceremony just before mid-day.

A concurrent working session for school children participating in the workshop has also been organized, to identify issues among themselves, coordinated by resource persons from the Ministry of Planning Human Resources and Environment, Ministry of Tourism and the Ministry of Fisheries and Agriculture.

Lastly, I would like to mention that we have been very lucky to have some of the internationally recognized reef scientists among us here today to assist us in developing a more focused agenda for developing the IRRMI? I would like to thank them on behalf of all those who are here today. My only hope is that the delegates and observers will take four days off their busy schedule to assist us as well as you all in consolidating a research agenda which we all can use to maximize the benefits, from our reef systems.

Thank you.

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Appendix I

CONCLUDING REMARKS

by **Mr. Ibrahim Hussain Zaki,**
Minister of Tourism

Minister of Fisheries and Agriculture, Honorable Hassan Sobir, Honorable Ministers, Director General of Fisheries Research and Development Mr. Hassan Maniku, Resource persons and participants.

Ladies and Gentlemen,

It is indeed a privilege for me to able to make a statement on this important occasion – the closing ceremony of the Integrated Reef Resources Management Workshop. It is a workshop that will assist to establish a management system for a resource that we all depend on. This workshop, Ladies and Gentlemen, is important not only for those directly involved in harvesting the reef resources, but for all.

As none would dispute, our livelihood is entirely dependent on the reef resources. It not only provides the required resources for our existence and development but protects our islands from adverse weather conditions and supplies the sediments to replenish our shores. It is the support and protection of these reefs that enable habitation of these islands it enabled the birth of a nation with a distinct culture and tradition and gave us the identity we now possess.

Though the importance of it is evident to all, people often fail to recognize it. This may be because the importance of a resource like the reefs will be felt when it ceases to exist. We often realize the value of an environmental resource when its potentiality to serve us deteriorates. But, Honorable Minister, your decision to hold this workshop is a clear manifestation of your foresight and concern for the sustainability of this vitally important resource.

Even though I was unable to attend the workshop I monitored the proceedings and recommendations, and I am very pleased with its outcome. Mr. Minister, your research team, under the leadership of your Director General has done an excellent job. Its benefits are not only limited to the fisheries industry, but to all users of the reefs. Recommendations of this workshop, reached after much deliberations, would be the cornerstone to develop an integrated system for reef resources management.

When I initially heard about this workshop, I thought it would be a highly scientific and technical workshop, whose recommendations would be understood only by

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intellectuals of the field. But I am glad it has not been so. The papers presented were diverse and even covered areas like institution and legislation in this area. Participants of the workshop were well represented of the sectors - almost all involved from the private and the public sector were present. Therefore armed with relevant information, guided by experts in the field, this diverse group of participants were able to suggest very practical and constructive recommendations. However, the benefits of these kind of exercises will depend on the willingness on the part of the actors to implement them. There is no doubt that this well planned consultative process will facilitate it.

Ladies and Gentlemen,

Though our traditional occupations and life style were in harmony with the environment, they are more environmentally demanding now. More and more economic activities are being based on our limited resources. This is because then we depended entirely on the tuna fishery for our living, and due to the very nature of this fishery, the role of the reefs was to supply bait fishes. Because the tuna fishery was relatively small then, the need for reef resources management was less. But today, Ladies and Gentlemen, the tuna fishery has emerged. In addition, a new industry - tourism, which relies largely on the beauty of these reefs has developed, and our dependence on this industry is progressively increasing. Above all others, it depends primarily on conserving the reefs, as it is the main trading asset.

Distinguished delegates,

These developments call for better management practices and institutional arrangements, if we are to sustainably use this resource. It is very important that mechanisms are put in place for the development and growth of all these new economic activities. By no means should one develop at the cost of the other, as from a national point of view it is important that our economy is diverse. My belief is that though resource uses of tourism and fisheries differ, they can co-exist. They are not conflicting economic activities, but can complement each other. This exercise is of vital importance to attain these goals. I am confident that as a result of this workshop, a unified integrated reef resource management process will be developed and assist effective implementation of our plans.

I thank the Hon. Minister of Fisheries and Agriculture Mr. Hassan Sobir for giving me this opportunity to conclude this valuable exercise. I would also like to thank the Director General of Fisheries Research and Development, Mr. Hassan Maniku, and his research team and the consultants who have made this workshop a success.

Thank you.

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Appendix J

Vote of Thanks

by Mr. Mohammed Khaleel,

Director of Environment, Ministry of Planning, Human Resources & Environment

Minister of Tourism Honorable Ibrahim Hussain Zaki, Minister of Fisheries and Agriculture, Honorable Hasssan Sobir, Ministers, Ladies and gentlemen

It is a privilege and a great joy for me to extend a vote of thanks to all those who have contributed in one way or the other to make this workshop a success.

Ladies and Gentlemen, the Director General of Fisheries Research and Development, Mr. Maizan Hassan Maniku, has been the driving force behind this whole process. His vision, interest and hard work has once again culminated in another success story. I wish to thank him for the efforts he has put into developing this new research agenda for integrated reef resource management.

The staff of the Ministry of Fisheries and Agriculture, especially those at Marine Research Section, have worked extremely hard, both in the foreground and background. Organizing a five day workshop with international experts, government organizations, NGOs, stakeholders and other professional bodies is not at all an easy task. You deserve congratulations for a job well done.

The Bay of Bengal Programme provided part of the financial resources for organizing this workshop which ensured smooth running of this workshop. I wish to thank them for their assistance and acknowledge the support rendered by their Programme Officer, Ms Donna Nickerson.

The international resource persons have brought here with them and shared with us their knowledge and experiences. You have guided us in the right direction and we appreciate that. We understand that you have taken time out of your very important schedules to contribute to this workshop, and some of you have even traveled at very short notice. Thank you for your invaluable contribution.

I also acknowledge the contributions of all those who have presented papers at this workshop.

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The non-governmental organizations, professional bodies and representatives from the industries have participated actively throughout the workshop. It is what was expected and we would like to see this kind of close co-operation in the implementation of the strategies that have come out as well.

I also wish to thank the students who have attended this workshop and expressed your thoughts. What is decided here would have direct implications for your future and the interest and enthusiasm you have shown is indeed a good sign for the future.

Before concluding, let me express our sincere gratitude and appreciation to the Guest of Honor Honorable Ibrahim Hussain Zaki and the ministers who have raised this occasion with their presence here today.

Finally, let me put on record our tributes to the Minister of Fisheries and Agriculture Honorable Hassan Sobir for his guidance and encouragement.

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Technical Papers presented at the Workshop

PAPER 1

THE MALDIVIAN TUNA LIVEBAIT FISHERY — STATUS AND TRENDS

BY

R. Charles Anderson
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Ministry of Fisheries and Agriculture
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ABSTRACT

The Maldivian livebait fishery is a traditional one that has been carried out for centuries. It is practiced throughout the country, and is the most important reef fishery in the Maldives. Current catches are of the order of 10,500t of livebait per year, which are used to catch almost 100,000t of tuna. Major management issues include livebait habitat destruction by coral mining, black coral collecting and as a result of livebait collection itself; the reportedly negative effects of reef fish fishing; the use of SCUBA diving gear and lights for livebait collection. There has been no concerted stock assessment, so the status of the Maldivian livebait resource is poorly known.

INTRODUCTION

Tuna pole and line fishing is the most important fisheries activity in the Maldives. It is a traditional activity, which has been carried out on a large scale for centuries. The great Arab traveller Ibn Battuta gives a clear account of the importance of tuna in the Maldives at the time of his visits in 1343-44 and 1346 (Gray, 1889). There is also evidence that tuna fishing was carried out in the Maldives before the conversion to Islam in 1153.

The livebait pole and line fishery has traditionally been the major source of employment, the major and preferred source of animal protein, and the major source of export earnings for the entire Maldives. With the development of tourism, of new fisheries, and other economic activities, the relative importance of the tuna fishery has declined over the last two decades. Nevertheless, the fishery remains of crucial importance. In 1994 some 96,800t was caught by pole and line, which was 93% of the total recorded fish catch (MOFA, 1995). Pole and line fishing is carried out from local wooden fishing vessels of some 10-l 5m LOA, known as *masdhonis*. The entire *masdhoni* fleet was mechanized in the late 1970's.

The pole and line fishery in fact comprises two separate fisheries: an offshore one for tunas and an inshore one for livebait. Without livebait there would be no pole and line tuna catch. It is no exaggeration to say that the well being of the Maldives depends on the success of the pole and line tuna fishery. The success of this fishery depends in turn on the availability of livebait. Tuna livebait are therefore the most important reef fish resource in the Maldives.

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Overview of previous studies

Despite the importance of the Maldivian livebait fishery, there has not been a comprehensive study of the fishery and its resource base. However, several smaller studies have been undertaken. A number of early descriptive accounts of the Maldivian fishery included some information on livebait (Jonklaas, 1967; Munch-Petersen, 1980). Accounts of livebait fishing methods are given by Anderson (1983 & 1995), Liews (1985) and Waheed and Zahir (1990). The major livebait varieties used are described by Anderson and Hafiz (1984). A brief review of the Maldivian livebait fishery was provided by Anderson and Hafiz (1988), and later reprinted in a revised form (Maniku, Anderson and Hafiz, 1990). The biology of some Maldivian livebait species (including information from studies of reproduction, growth and predation) is discussed by Blaber et al. (1990) and Milton et al, (1990a & 1990b). Seasonal, regional and interannual variations in the utilization of livebait within the Maldives are described by Anderson and Saleem (1994 & 1995); the data sheets prepared for these studies have been bound and stored at MRS (Anon, 1995a). Estimates of the size of the Maldivian livebait fishery are provided by Anderson and Hafiz (1988) and Anderson (1994). Management issues are discussed by Anderson and Hafiz (1988), Wright (1992) and Anon (1994 & 1995b). A summary of research on livebait undertaken by the Marine Research Section is given in MRS (1995). Dhivehi translations of some of this information have been provided by Hafiz (1985 & 1995).

The Maldivian livebait fish and fishery show many similarities with those in the Indian Lakshadweep Islands to the north. In fact the people of the southernmost island of the Lakshadweep group, Minicoy, speak Dhivehi and have traditionally had a pole and line tuna fishery as in the Maldives. The livebait fishery of Lakshadweep has been studied by several authors, including Jones (1958 and 1962), Kumaran et al. (1989), Madan Mohan and Kunhikoya (1985), Pillai et al. (199 1) and Thomas (1962).

THE LIVEBAIT CATCH

Species composition

The Maldivian livebait fishery is a multispecies one. Small species (i.e. about 3-10cm in length) that school close to reefs are targeted. The major varieties used are listed in Table 1. More information on the species used is given by Anderson and Hafiz (1984 & 1988). Average species composition of the total Maldivian catch has been roughly estimated by Anderson (1994) and is summarized in Table 2.

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Table 1. The main livcbait varieties used in the Maldives

Local Name	*Species*	*English Name*	*Family*
Rehi	*Spratelloides gracilis*	Silver Sprat	Clupeidae
Hondeli	*Spratelloides delicatulus*	Blue Sprat	Clupeidae
Miyaren	*Encrasicholina heteroloba*	Shorthead Anchovy	Engraulididae
Thaavalha	Various species	Silversides / Hardyheads	Atherinidae
Boadhi	Varoius species	Cardinalfishes	Apogonidae
Muguraan	Various species	Fusiliers	Caesionidae
Nilamehi	*Chromis viridis*	Blue Damselfish	Pomacentridae
Bureki	*Lepidozygous tapeinosoma*	Fusilier Damselfish	Pomacentridae

Table 2. Average composition of the Malclivian livebait catch

Species / Family	*Local Name*	*Percentage*
Spratelloides gracilis	*Rehi*	38 ± 10 %
Caesionidae	*Muguraan*	37± 9%
Apogonidae	*Boadhi & Fatha*	10 ± 3%
Engraulididae	*Miyaren*	7± 2%
Spratelloides delicatulus	*Hondeli*	5± 1%
Atherinidae	*Thaavalha*	1 %
Pomacentridae	*Bureki & Nilamehi*	1 %
Others	—	0.2 %

It should be emphasized that there are considerable fluctuations in the availability of different varieties from year to year (Anderson and Saleem, 1995). For example, Cardinalfish abundance and utilization was unusually high in 1993-94. There are also considerable regional and seasonal variations in livebait availability (Anderson and Saleem, 1994). Regarding regional variation, in the southern Maldives (i.e. south of the Kudahuvadhoo Channel at about 02°40'N) livebait species composition is very different from that in the north and centre of the country, and livebait species diversity is greater (see Fig. 1 for location map). Regarding seasonal variations, there appear to be three main patterns of variation in livebait abundance and utilization in the Maldives:

1. Common on the east coast during the Northeast Monsoon season (December to April), and on the west coast during the Southwest Monsoon (June to October). Examples include Blue Damselfishes, Silversides, and to a large extent Fusiliers.

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2. Common on the east coast during the Southwest Monsoon season, and on the west coast during the Northeast Monsoon. Examples include Silver Sprats and Blue Sprats.

3. Common during the intermonsoon periods. For example, Anchovies.

Catch size

The Maldives has an excellent fisheries statistics system for tuna catches, but not for livebait utilization. However, some information on the major varieties of livebait used by *masdhonis* on a number of islands is collected by MOFA field officers and MRS tuna research project samplers. This information for 1994 has been summarized in Table 3, and is used as a basis for the estimation of the national livebait catch for 1994. Note that data for Male are from Anon (1995a); data for G.Dh.Thinadhoo from the same source have been supplemented with additional data collected by the MOFA field officer on the island.

Anderson and Saleem (1994) note that the livebait species composition in the south of Maldives is very different from that in the north and centre. Livebait utilization data presented in Table 3 are assumed to be representative for the two regions. It is recognized that this may well not be the case (especially as the data are dominated by Male catches) and that in future much more sampling of livebait utilization should be carried out.

Following Anderson (1994), it is assumed that the average daily catch of Sprats and Anchovies is 60kg, while that of other varieties is 45kg. Sprats and Anchovies are rather delicate and can only be used on the day of capture. Other varieties are more hardy and can be kept from one day to the next if they are not used. Therefore, number of days utilization will be less than the number of catches. To try to account for this Anderson and Hafiz (1988) and Anderson (1990) assumed that the number of days on which hardy livebait species are fished is 5% less than the number of days on which they are used. Anderson, Hafiz and Shiham (1996) noted that poor estimation of the frequency of livebait reuse may be a major source of error in estimating total livebait catch. Therefore, in 1995 MRS initiated some sampling of livebait reuse, using MRS tuna research project field officers. The results are summarized in Table 4:

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Table 3. Reported livebait utilization during 1994 at selected islands in the Maldives (Reported numbers of days used by masdhonis)

Atoll	Island	Months	Silver Sprat	Blue Sprat	Fusilier	Cardinalfish	Anchovies	Damselfish	Silversides	Others	Total
H.Dh.	Kulhudhoofushi	Jan-Dee	0	0	112.5	23	0	0	0	0.5	136
N.	Manadhoo	Sep-Nov	5	0	196.7	17.5	0	1.3	0	3.5	224
R.	Alifushi		0	0	18.5	4.5	0	0	0	0	23
R.	Ungoofaru	Feb	8	0	2	9	0	0	0	0	19
K.	Male	Jan - Dec	3586.5	9.5	817.5	2321.5	0	0	1	0	6736
M.	Maduveri	Jan - Dec	11	10	138	55	50	0	3	0	257
Dh.	Kudahuvadhoo	May - Nov	0	0	41.5	6.5	0	0	0	0	48
Subtotal North & centre			3610.5	19.5	1326.7	2437	50	**1.3**	4	4	7443
L.	Maamendhoo	Jan-Dee	2	0	38	55	0	**0**	0	1	96
G.A.	Villingili	Feb-Dee	7	0	38.8	84.4	0	7.8	0	1	139
G.Dh.	Thinadhoo	Jan-Dee	199	107.8	296.8	373	3.4	0.5	11.5	14	1006
Subtotal South			208	107.8	373.6	512.4	3.4	8.3	11.5	16	1241
TOTAL			3818.5	127.3	1700.3	2949.4	53.4	9.6	15.5	20	8684

Table 4. Summary of frequency of reuse of delicate and hardy livebait varieties

	Number of days used as livebait				*Total days*
	Sprats & Anchovies		*Hardy species*		*used*
Used on day of capture	130	(100%)	220	(73%)	350
Reused on subsequent day	0	(0%)	80	(27%)	80
Total	130	(100%)	300	(100%)	430

It thus appears that livebait utilization data may overestimate hardy livebait catches by as much as 27%. However, there is reason to suspect that this figure may be too high. From the log sheets filled by the field officers it is sometimes not possible to distinguish days on which only baitfishing was carried out from those on which baitfishing was carried out followed by unsuccessful tuna fishing. The true rate of reuse of hardy livebait varieties may therefore be something between 27% and 5%. As a rough estimate an intermediate figure of 15% is used here, although it is recognized that further sampling will be required to refine this estimate.

In 1994 a total of 223,095 days fishing by mechanized *masdhonis* and 1138 days fishing by sailing *masdhonis* was recorded (MOFA, 1995). Although the great majority of *masdhonis* go for pole and line tuna fishing, an unknown minority do not. Furthermore, there is some under-reporting of tuna catches (Parry and Rasheed, 1995; Anderson and Hafiz, 1996) and presumably also of tuna fishing effort. As an approximation it is assumed that the recorded fishing effort by mechanized *masdhonis* is a good estimate of the actual pole and line fishing effort.

Of the 223,095 days fishing recorded by mechanized *masdhonis* in 1994, 161,565 were recorded from the northern and central atolls, and 61,530 from the southern atolls. Given the estimated species composition from each region (Table 3), the average catch weight of hardy and of delicate species, and the estimated frequency of reuse of hardy species, the following national catches are estimated:

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Table 5. Estimated Maldivian livebait catch by variety during 1994

	Livebait Variety	Estimated Catch
Silver Sprats	*Rehi*	5330 ± 1330
Cardinalfishes	*Boadhi*	2980 ± 750
Fusiliers	*Muguraan*	1830 ± 460
Blue Sprats	*Hondeli*	330 ± 80
Anchovies	*Miyaren*	80 ± 20
Silversides	*Thaavalha*	25 ± 10
Damselfishes	*Nilamehi & Bureki*	1.5 ± 10
Others		30 ± 10
Total		10620 ± 2660

Following Anderson and Hafiz (1988) and Anderson (1994) a confidence interval of 25% is assigned to these estimates. This is an arbitrary figure, which is intended mainly as a reminder of the considerable uncertainties associated with these estimates.

Catch trends

The total annual catches of livebait were estimated for 1978-8 1, 1985-87 and 1993 by Anderson and Hafiz (1988) and Anderson (1994). These estimates used a figure of 5% for the frequency of reuse of hardy livebait varieties, rather than the 15% used here. The quantities of livebait used have been recalculated using a reuse rate of 15% (which results in a decrease of about 6% in estimated total livebait catch), and are summarized in Table 6:

Table 6. Revised estimated quantities of livebait used annually in the Maldivian pole and line tuna fishery

Time Period	Livebait Used	Modified From
1978-1981	3000 ± 800 t	Anderson and Hafiz (1988)
1985-1987	4800 ± 1200 t	Anderson and Hafiz (1988)
1993	10500 ± 2600 t	Anderson (1994)
1994	10600 ± 2700 t	This study

It should be noted that there are considerable uncertainties associated with these estimates. Despite this it is clear that there has been a major increase in livebait catches in recent years. In part this can be explained by the steady increase in fishing

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effort over the last 15 years (Fig. 2). The period 1978-81 marked the low point of pole and line fishing effort, and therefore of livebait utilization, during the transition of the fleet from sail to engine power. There has also been an increase in the quantity of livebait used per day. This is largely due to an increase in average size and associated fishing power of pole and line vessels in recent years (Anderson, 1994). The quantity of livebait used per day by pole and line vessels is roughly estimated as follows:

Table 7. Estimated daily livebait utilization by Maldivian pole and line vessels

Note: Fishing effort data from MOFA; data for 1978-81 include both sailing and mechanized *masdhonis,* while in other years only mechanized *masdhonis* are included.

Time Period	*Livebait Used (t)*	*Mean number days fished*	*Livebait used per day (kg)*
1978-81	3000 ±800 t	101,400	30kg
1985-87	4800 ±1200 t	161,042	30kg
1993	10500 ±2600 t	222,548	47kg
1994	10600±2700t	223,095	48kg

Catch per unit bait

There may well be significant regional differences in livebait utilization. For example, fishermen from Lhaviyani Atoll are reported to use particularly large amounts of bait while those in Addu Atoll have to make do with much smaller quantities. Furthermore, there are undoubtedly periods in every atoll when livebait is scarce, and has to be used sparingly. Nevertheless, average tuna catch per unit bait (CPUB) does give a useful index of the effectiveness of livebait utilization.

Table 8. Estimated average tuna catch per unit bait in the Maldives.

Note: Tuna catch data from MOFA; data for 1978-81 include catches by both sailing and mechanized *masdhonis,* while in other years only mechanized *masdhoni* catches are included.

Time Period	*Livebait Used*	*Annual Tuna Catch*	*Catch per unit bait*
1978-81	3000 ±800 t	24,097 t	8.0 kg tuna / kg bait
1985-87	4800 ± 1200 t	50,997 t	10.6 kg tuna / kg bait
1993	10500 ± 2600 t	76,735 t	7.3 kg tuna / kg bait
1994	10600±2700 t	87,293 t	8.3 kg tuna / kg bait

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Maldivian tuna catch per unit bait is comparable to CPUB rates in the central and eastern Pacific (Sakagawa, 1987) but rather low compared to CPUB rates from the western Pacific (Sakagawa, 1987) and very low compared with estimated rates in Lakshadweep (Pillai, 1991). Reasons for this include the Maldivian fishermen's profligate use of livebait when it is available in abundance, and the fact that total livebait catch has been estimated in the Maldives not the quantity actually used as is apparently the case elsewhere.

Status of livebait resources

There has been no livebait stock assessment. It is therefore not possible to comment on the status of Maldivian livebait resources with any confidence. Anecdotal evidence might suggest that there are some problems, since fishermen regularly complain about lack of livebait and consistently state that baitfishing was better in previous years than it is now. However, closer questioning usually reveals that fishermen believe that any livebait shortage is likely to be a short-term, seasonal problem. Furthermore, in a bait fishing log book survey carried out by MRS in 1987, lack of bait was cited as the reason for not going tuna fishing on only one out of 389 days during which no fishing was carried out. A similar survey was carried out in 1993-95 (Table 9). MOFA field officers on three islands (N.Manadhoo, R.Ungoofaru and G.Dh.Thinadhoo) completed baitfishing logsheets, on which were recorded reasons for not going tuna fishing. Lack of livebait was the least important reason for not going tuna fishing (although it should be noted that Addu Atoll, where baitfishing is poor but tuna fishing is good, was not included in this survey).

Table 9. Reasons for not going pole and line tuna fishing cited by fishermen.

Reason for not fishing	No. days recorded	% days recorded
Fridays	222	38.2
Religious festivals	2.5	4.3
Community work	52	9.0
Personal work	50	8.6
Vessel maintenance	79	13.6
Engine repairs	30	5.2
Lack of crew	20	3.4
Disputes	9	1.5
Poor weather	48	8.3
Poor tuna fishing	42	7.2
Poor bait fishing	4	0.7
Total	581	100

Source: MRS logbook survey.1993-95.

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THE LIVEBAIT FISHERY

Livebait catching

Traditionally livebait fishing was carried out using a hand made cotton lift net, deployed over the side of the sailing *masdhoni* using four long poles (Fig. 3a). Fish paste was used to attract livebait over the net. This paste would be smeared on the end of a fishing pole and deposited above the net with a sharp jabbing motion. Coconut oil would be flicked on to the sea to improve through-surface visibility.

A major change that occurred during the 1950's was the introduction of nylon bait nets to replace the traditional cotton ones (Anderson and Hafiz, 1988). The new nets were lighter and could be made much larger, They were also cheaper, easier to maintain, and longer-lasting. Subsequently, over the last two decades a number of other improvements to livebait catching have been introduced. These include:

- The use of diving masks. These were introduced to the Maldives on a large scale following the start of organized tourism in 1972. Their use spread rapidly throughout the country. Masks make it much easier for fishermen to locate bait schools on the reefs, and to catch them once they have been located. The use of snorkels and fins is becoming more common now, but they are still not universally used.

- The use of swimmers to deploy the bait net. This development followed the introduction of diving masks, which allowed fishermen to see what they were doing and encouraged them to enter the water. The bait net is now deployed without the use of poles, but with lines tied to each corner (and sometimes in the middle of the sides as well). The corners of the net are weighted with coral or concrete blocks (Fig. 3b). When fish paste is used to attract the livebait it is deposited over the net by a swimmer.

- Use of SCUBA diving equipment. This is a very recent development, and its use is still not widespread but largely confined to the Male area. There have, however, also been a number of recent reports of fishermen using diving gear for livebait catching in Addu Atoll. The use of diving equipment is apparently particularly helpful in catching deep swimming varieties such as Cardinalfishes.

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All of these developments have made livebait catching much easier than it was in former times. At the same time masdhonis have been getting larger. As a result daily livebait catch per *masdhoni* has increased (Table 7).

Livebait maintenance and utilization

When a haul of livebait is made the fish are flicked in to the flooded hold of the *mnsdhoni.* Fresh seawater,is allowed into the hold through holes in the hull. Circulation used to be maintained by hand bailing. With mechanization of the *masdhoni* fleet in the late 1970's the main engine was used as a pump to maintain circulation. In the early 1980's the use of large holes in the hull was introduced; angled plastic pipes inserted in these holes are used to maintain circulation while the *masdhoni* is underway.

The chummer (Dhivehi: *enkeyolhu)* stands over the baitwell, just astern of the mast. When a tuna school is spotted, livebait are scooped up from the hold and thrown out to either side of the stern of the masdhoni to draw the tunas towards the stern fishing platform. At the same time, water is sprayed from the stern of the *masdhoni.* This not only helps to hide the fishermen from the tuna but also creates the impression of many small fish jumping at the surface. Traditionally the splashing was done by hand, with two crew members assigned to the task. The use of mechanical pumps for spraying started in 1990 and quickly spread throughout the country (Anderson and Waheed, 1990). Petrol pumps have been widely used, but diesel pumps were introduced in 1995. Two crew members can be replaced by the use of a mechanical water sprayer, a major consideration for boat owners now that obtaining sufficient crew is a major problem in many islands.

At the end of the day's fishing, any remaining livebait may be either discarded or kept overnight (if they are of hardy species and tuna fishing is planned for the next day). Livebait were traditionally kept overnight in slatted wooden bait boxes (Dhivehi: *lahari, enkoshi* or *masge)* moored in the lagoon. These have now been replaced with net enclosures. Sometimes a special cage with net walls is used. Other fishermen use the bait net, rigged in a wooden frame, either floating in the lagoon or suspended from the side of the *masdhoni.* A few fishemen in the south do not use a separate container at all, but moor their *masdhonis* in exposed positions and rely on the rolling of the vessel and the large holes in the bait well to maintain adequate overnight circulation.

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Remuneration for livebait catching and utilization

It has long been the tradition in Maldives that at the end of the day's fishing the tuna catch is divided between the boatowner, the crew, and any others who have contributed to the success of the fishing operation. In the old days, maintaining the cotton baitnet was a laborious task that might take several hours of work in the evening. The bait net owner was therefore entitled to a share of the tuna catch. Similarly, the bailing of the livebait hold to maintain circulation was a demanding job that was rewarded with an extra share. With the introduction of cheap nylon nets and mechanical pumps these extra shares are no longer paid. However, swimmers now make a major contribution to bait catching and so they often receive an extra share. The chummer, **as** always, receives an extra share or half share for his efforts.

MANAGEMENT ISSUES

Stock assessment

As noted above, there has been no stock assessment, so the status of livebait stocks is unknown. In general it is believed to be rather difficult to overfish stocks of small, highly fecund pelagic fishes such as the Sprats on which the Maldivian livebait fishery heavily depends. There are no clear signs of overfishing so far, and it is far from obvious what management measures could realistically be introduced if overfishing were to occur.

Nevertheless, given the enormous importance of the livebait fishery, it would be prudent to initiate stock assessment activities. At present lack of catch and effort data is a major constraint which needs to be overcome. The current system of data collection is inadequate. It is therefore recommended that consideration be given to incorporating livebait catches in MOFA's existing tuna catch statistics forms.

Coral mining

Coral mining is widespread in the Maldives, and perhaps the major cause of reef degradation. Since most coral mining takes place on reef flats, while most baitfishing takes place on reef slopes, the effects of coral mining on the baitfishery have not been too severe. There is an exception to this generalization: Damselfishes such as the Blue Chromis (nilamehi) and Fusilier Damselfish (bureki) are associated with reef flat corals. Coral mining is known to reduce reef flat fish populations (Dawson Shepherd et al., 1992) and the abundance of these Darnselfish species may have been adversely affected by coral mining.

Anderson and Hafiz (1988) suggested that some 140t Damselfishes were used annually as livebait in the Maldives during 1985-87, which was something of the order of 3% of all bait used. Anderson (1994) suggested that some 120t of Damselfishes were used in 1993, which was about 1% of all livebait used. It is therefore possible that there has been a decline in the utilization of these species, and further that this decline may be associated with habitat destruction caused by coral mining. However, there are considerable sources of error associated with these estimates, so this interpretation may not be correct.

Comprehensive regulations for the control of coral mining have recently been developed. However, coral mining was already banned on major livebait fishing reefs, following a President's Office decree of September 1990, promulgated by the Ministry of Atolls Administration (circular number B-90/3). Lack of effective data collection and monitoring makes it very difficult to assess the impact of coral mining on the livebait fishery.

Black coral collecting

Many tuna fishermen say that the collecting of black coral (Dhivehi: endheri) reduces the abundance of some varieties of Cardinalfishes (boadhi) which swarm by day among the branches of the black coral trees. In earlier times black coral was presumably abundant on Maldivian reefs. However, over the last two decades large quantities were removed, to make jewellery and other souvenirs for tourists. From 1 January 1995 a ten year moratorium on the collecting of black coral in the Maldives was introduced by the Ministry of Fisheries and Agriculture.

Destructive livebait collection methods

Baitfishing itself can cause damage to the coral reefs. The collection of species, such as Cardinalfishes and Damselfishes, that are closely associated with the corals can be particularly destructive. In such cases the net may be spread over the corals with which the livebait are associated. Any livebait remaining under the net may be chased out using poles, or a 'scarer' (such as a palm frond or a steel chain) on the end of a rope. The livebait are then chased back onto the net. This can result in much coral damage, and in particular branching corals in which livebait shelter may be smashed. In the case of essentially pelagic varieties such as Fusiliers, Sprats and Anchovies the net is generally kept off the bottom, and the livebait are lured into the required position with fish paste, so reef damage is minimal.

Another cause of reef degradation associated with baitfishing is anchor damage. Each pole and line vessel deploys at least two heavy steel anchors while baitfishing. Vessels may move positions several times during the course of one baiting operation. Depending on wind and current directions, the anchors may be deployed on the sandy lagoon bottom or on the coral reef itself. The extent of damage caused in such cases is unknown. However, sometimes many boats from a single island concentrate on one reef to collect bait over a period of days or even weeks. At such times anchor damage must be significant. Since tuna fishing is becoming concentrated on fewer islands, and vessels are getting larger, this problem may be getting worse.

Traditionally, Maldivian fishermen used locally made coral and stick anchors (fanaa) for anchoring while baitfishing. Although these anchors were relatively small and light, it is not clear that they would have caused less damage than the steel anchors now used, because they cannot grip on sand and have to be deployed on a rocky (i.e. coral) bottom. *Fanaa* were used in the past because steel anchors were expensive and difficult to make. The use of fanaa was largely phased out during the 1970s.

There is a need for greater awareness among tuna fishermen about the potentially damaging effects of their livebait fishing activities. Radio broadcasts by the Ministry of Fisheries and Agriculture discussing the problem would be an excellent first step. In the longer term, the effects of the more destructive means of catching Cardinal fishes and Damselfishes should be investigated, to assess the damage and to suggest options for resolution of this issue.

Reef fish fishing

Reef fish fishing was traditionally not an important activity in the Maldives. In recent years, however, it has increased greatly in importance, largely as a result of the development of new domestic and export markets. The great majority of the reef fish species taken are carnivores. Intuitively it seems obvious that the removal of increasing numbers of potential predators from the reefs should be beneficial for baitfish populations. In practice things do not seem to be so simple. First, many of the reef fish species caught do not appear to be major consumers of tuna baitfish (Blaber et al., 1990).

Secondly, many Maldivian tuna fishermen say that reef fishing harms baitfishing because predatory reef fishes tend to keep the baitfish in tight, stationary schools. If predatory reef fish are removed the schools tend to disperse, and baitfish are difficult to catch. This is said to apply to many reef fish species, including groupers and sharks (particularly the whitetip reef shark, *Triaenodon* obesus). Tuna fishermen also say that shark nets deployed on or near reefs tend to cause bait schools to disperse.

A somewhat different problem connected with the development of reef fisheries relates to the size of the fishing population. Although the population of Maldives as a whole is increasing rapidly, the population of active fishermen is stable. As a result the proportion of fishermen in the population is decreasing, largely because of their low socio-economic status. As new fisheries develop fishermen are attracted to them by the opportunity of high earnings. In consequence the number of fishermen available for the livebait tuna fishery is reduced. There has been enormous Government investment in infrastructure for tuna exports over the last decade. In order to service these investments there must be a large and active fishing population. To achieve this there is a need to make fisheries in general, and tuna fishing in particular, more attractive to young people.

Utilization of livebait species for other purposes

Relatively small quantities of some bait species, notably *Spratelloides gracilis* and adult Fusiliers, are used for human consumption in the Maldives. Some tuna fishermen believe that this will harm baitfish stocks, but the quantities involved are relatively small so this seems unlikely. A few bait species, notably *Chromis viridis* (Adam, 1995) but also some other Damselfishes and Cardinalfishes, are taken by aquarium fish collectors for export. Again, the quantities involved are very small.

The Ministry of Fisheries and Agriculture recognizes the importance of the baitfishery, and the potential damage that might be done if an export market were developed for any of the livebait species. Therefore, as a precautionary measure, the export of any bait used for pole and line fishing has been banned by MOFA.

Conflicts with tourism

Tuna fishermen sometimes visit the house reefs of resorts or diving sites to collect livebait. Tourists and dive operators object to this, saying that anchoring destroys the corals and that bait fishing removes many attractive schools of fish from the reefs. It is widely accepted in Maldives that tuna fishermen have a right to take livebait from anywhere. In recognition of this right, livebait fishing is the only fishing activity allowed on the 15 marine protected areas (dive sites) declared in June 1995. At present fishermen are not supposed to fish on the house reefs of uninhabited islands (a definition that includes resorts) without permission of the leasee/owner. In practice there is a lot of confusion over this regulation and it is often ignored. Greater public awareness (among both tourists/divers and tuna fishermen) would go a long way towards minimizing conflicts between these two groups.

The use of SCUBA diving equipment

As mentioned above, the use of SCUBA diving equipment during livebait fishing operations has recently started around Male, and in Addu Atoll. There have been some complaints from other fishermen that this reduces their bait catches. A more serious consideration is likely to be the health and safety of divers. Fishermen who using diving equipment without adequate training are at a very high risk of suffering a serious diving accident. There are now two diving schools in Male offering training to Maldivians. Consideration should be given to banning the use of diving equipment for livebait fishing and/or setting minimum legal standards for fishermen-divers.

The use of lights for livebait fishing at night

Maldivians are unusual among pole and line fishermen in that they catch their livebait during the daytime. Most other pole and line fishermen catch livebait at night, using powerful lights to attract the livebait to their nets. The reasons for this difference may be historic: in the old days in Maldives it would have been very difficult to operate sailing boats among the reefs at night particularly on moonless nights when livebait catches are best, and also there would have been no suitable source of artificial light. This tradition has been continued right up to the present day, and in fact the use of lights for livebait fishing at night is prohibited under a legal notice from the Ministry of Fisheries issued in 1987 (MF-B/34/87/27). This ban was introduced following complaints from fishermen not using lights about other fishermen who were using lights and allegedly affecting livebait catches on subsequent days. There is, however, still some night livebait fishing being carried out in Addu Atoll, where livebait is notoriously scarce.

There is a need for a review of the current extent of night livebait fishing and catches, and of its effects on daytime catches of livebait, in order that rational management options can be formulated.

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Utilization of Silversides

Silversides or Hardyheads *(thaavalha)* are seasonally very abundant. They are also relatively easy to catch, and are particularly hardy. However, they are not used very often by fishermen as tuna livebait. The reason for this is their poor chumming ability. Although fishermen usually get a good initial chumming response with *thaavalha,* especially on drifting objects when the tunas may be particularly hungry, the tuna soon stop feeding and disperse. There are two explanations for this. First, some fishermen say that *thaavalha* swim down and away from the fishing vessel, leading the tunas behind them. The second, and far more prevalent explanation is that the hard scales and ‘stony’ head of this bait make it very difficult for the tunas to digest. As a result the tunas stop feeding after an initial strong chumming response.

Whatever *the* reason for *thaavalha*'s poor chumming ability, its use is strongly opposed by some fishermen. If one tuna fishing vessel is using *thaavalha* as a bait it may cause the school to disperse, resulting in poor fishing for any other Vessels fishing on the same school. This is sometimes a source of conflict between fishermen. In 1993 Laamu Atoll Development Committee banned the use of *thaavalha* for pole and line fishing around fish aggregating devices (FADs) near Laamu Atoll (Anderson and Saleem, 1994). Naeem and Latheefa (1994) noted that the use of *thaavalha* (which they called ‘silverline’) near an FAD in the Watteru Channel between Vaavu and Meemu Atolls apparently reduced tuna catches there.

The Ministry of Fisheries and Agriculture has made radio broadcasts about this issue to fishermen, in order to increase their awareness.

Dumping excess livebait at sea

AL the end of the day’s tuna fishing, fishermen are sometimes left with some unused livebait, especially if tuna fishing has been poor. This livebait may be kept for use on the next day. However, if there is no fishing planned for the next day (for example if it is a Friday), or if the livebait are thought to be in poor condition, the excess livebait will be dumped at sea. There are no estimates of the quantity of livebait wasted in this way, but it may amount to several hundred tonnes per year. The Ministry of Fisheries and Agriculture has made several radio broadcasts to fishermen asking them to dump excess livebait close to a reef rather than in the open ocean, in order to minimize theselosses.

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Figure 2. Annual Maldivian pole and line fishing effort and estimated livebait utilization

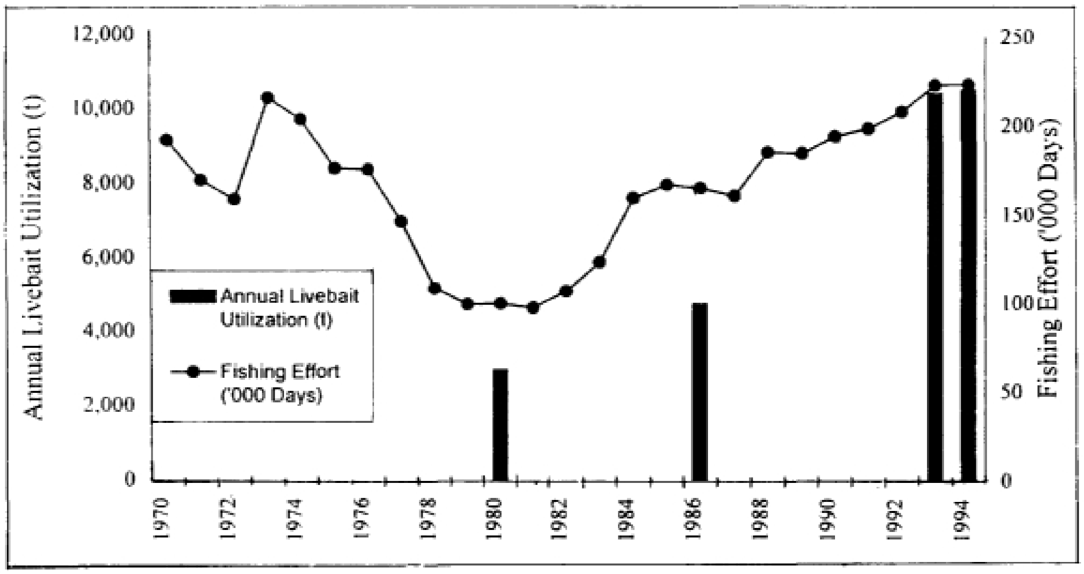

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Figure 1. Location map of the Maldives showing places mentioned in the text

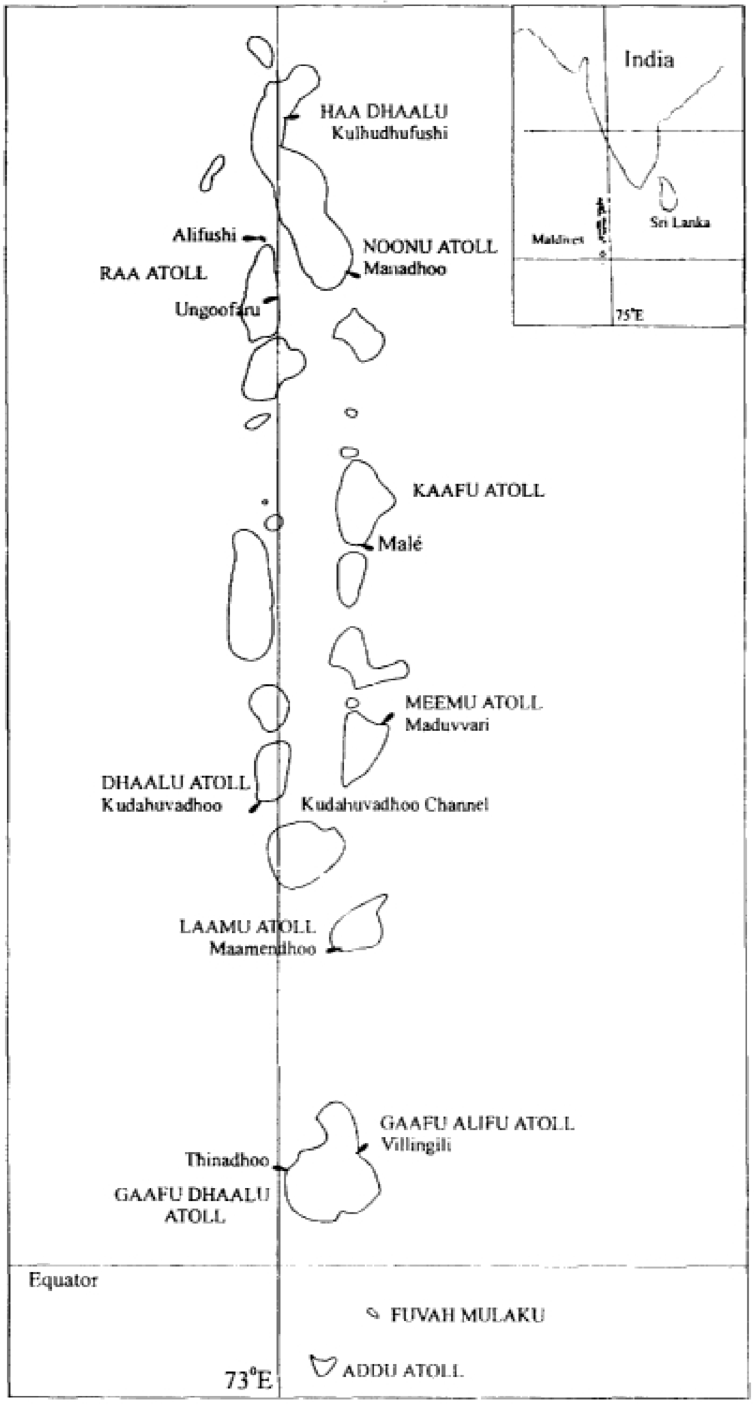

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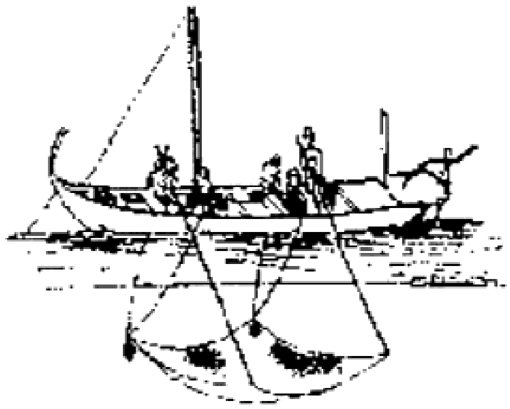
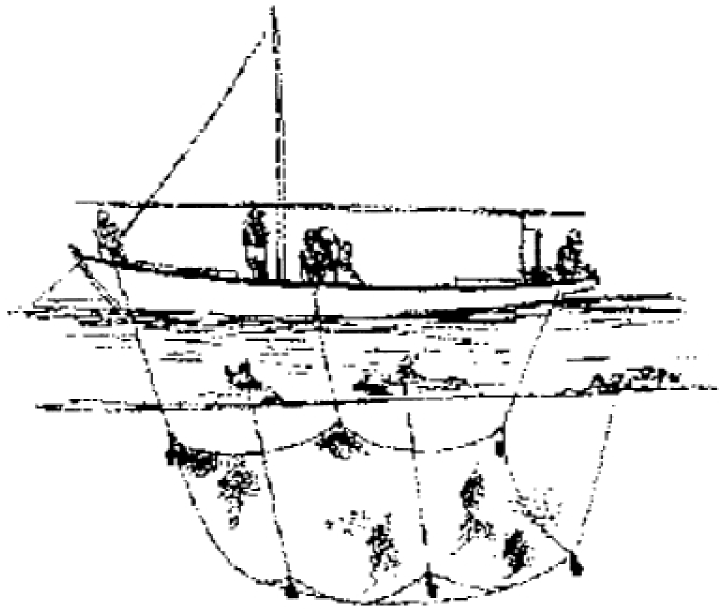
Figure 3. Sketch diagrams of Maldivian livebait fishing activities (original drawings by Hussein Zahir)



a. Livehait flshing c.1975. Long poles arc used to spread the net.



b. Livehait fishing c. 1995. The net is much bigger and is spread by swimmers in the *water.*

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PAPER 2

THE AQUARIUM FISHERY OF THE MALDIVES

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ABSTRACT

The aquarium export fishery started in 1979 exporting mainly to Sri Lanka at the time. At present the fishery is centered around the International Airport where the fish are air freighted to Sri Lanka, Europe, USA and the Far East. In 1994 more than 300,000 fish were exported earning more than MRf. 7 million. About 100 species of fish are now being exported, with 20 species comprising over 75% of the trade. Some of the species exported are very rare in the Maldives and are very vulnerable to overexploitation. The fishery is reviewed and management issues are discussed. The options for monitoring and regulations are also discussed.

1. INTRODUCTION

The aquarium fishery appears to have started in 1979, mainly exporting to Sri Lanka at the time. At present there are 17 licensed exporters. More than 100 species of fish are being exported, which includes species that are very rare in the Maldives and are very vulnerable to over exploitation. The tourism and fishing industries provide perhaps more than 70% of the total government revenue, and both depend heavily on coral reefs. Tourism which is the most important source of foreign exchange earnings has a major attraction for the coral reefs and its associated colourful fishes which are exported in the aquarium fish trade. The pole and line tuna fishery, which exploits surface swimming tunas requires a daily supply of livebait fish, some of which arc exploited in the aquarium fish trade.

Since its inception, the aquarium fish trade has been monitored by the Government. Exporters are required to have an export license issued from the Ministry of Trade and Industries. Export statistics are collected by the Customs and compiled by Ministry of Fisheries and Agriculture. Based on a study carried out by Edwards (1988) blanket quota of 100,000 fish were set for 1985 and 1989 by the Ministry of Fisheries. However, the quota seems to have not been implemented effectively. A species based quota was also set for certain species that were thought to be subjected to local over exploitation or were close to maximum sustainable level of exploitation at the time. Although these quotas were in place since 1988, they were not being properly reviewed and the quotas were not adequately implemented, largely due to lack of coordination among the responsible authorities.

The aquarium fish industry has expanded during recent years and companies have started to spread out around Male and even to nearby atolls. Conflicts between tourist dive operators and collectors often arise when collectors collect aquarium fish from popular boat dive sites. Until June 1995 aquarium fish could be collected from any reef except from the tourist resort "house reefs". Aquarium fish collection is now also prohibited from the 15 protected marine areas proclaimed in June 1995,

2. STATUS OF THE TRADE

Even though there are 17 licensed companies in the export business a great majority of the aquarium fish are exported by only two companies. In 1993 these two companies exported about 60% of the aquarium fish and earned over 70% of the total revenue (Adam, 1995).

Relatively few people are employed in the aquarium fish export business. The majority of the work force are Sri Lankan expatriates working mainly as divers. It is estimated that at present about 80- 100 people are employed in this industry. These include fish collectors, boat handlers, aquarium staff and managerial staff. From an economic point view aquarium fish exports accounts about 1.6% of the total marine export value at present (see Table 1). The value of aquarium fish exported in 1994 was 7.03 million Rufiyaa. In 1994 major exports were to Sri Lanka (65.2%) followed by Europe (17.4%), USA (10.6%) and the Far East (6.4%) (see Fig. 2 and Table 6). Exports to Sri Lanka are mostly re-exported to more lucrative markets of Europe, American and Far East, to which there are good flight connections.

2.2. Recent Trends in the Trade

The quantity of fish exports has risen steadily since 1980 except for the late 1980's. The decline in the export in these years could be due to the political problems in Sri Lanka which may have made it difficult for easy export to Sri Lanka. From 1980 to 1994 a seven fold increase in the quantity of fish exported and 45 fold increase in the export value has occurred (Table 1 and Figure 1). In 1994 a record level of 3 12,483 fish were exported which was about 70% more than the amount in 1993. It is expected that more than 400,000 fish will be exported in 1995.

At the start of the business in the early 1980's exports were mainly to Sri Lanka. Edwards and Shepherd (1992) noted that from 1983-l 986 about 83% of the fish were exported to Sri Lanka followed by Europe (13.3%) and small numbers were also exported to USA, Japan and Singapore. Maldives now exports to more than 20 countries around the world but the majority of countries take less than 1% of the total. The most important markets are Sri Lanka, UK, Netherlands, Germany, Belgium, Japan and USA. Figure 2 gives a year-wise breakdown of the quantity exported and their FOB values to major destinations for 1989-1994. Table 6 and 7 give country-wise breakdown of the quantity exported and their values for 1989- 1994.

Unlike the situation in mid 1980's, it appears that the situation had changed in the late 1980's. In 1989 the majority of fish were exported to Europe (70.12%) earning about 80% of the total value. From 1989-1994, even though the annual quantity exported to Europe increased (largely due to increase in the volume exported by the companies), the quantity in terms of percentage however, have declined. Figures for Sri Lanka shows a dramatic increase in 1993 and in 1994 (Fig. l and Tables 5 and 6). The explanation for this rapid increase could be recent increase ofnew comers to the business who are exporting mainly to the easily accessible Sri Lankan market. In recent years the USA and Far Eastern markets have become important destinations. In 1994, 33,023 fish were exported to USA alone (10.6% of total) earning MRf. 831,341 (11.8%).

The unit prices for aquarium fish exports by major destinations for 1989-l 994 are given in Table 2. The average unit price per fish offered for European markets were in the range of MRf. 25- 44, the highest were during 1991 with an average of MRf. 43.76. Average prices for Sri Lanka remained more or less same throughout the period, but showed an increase in 1994. The highest prices offered were from the Far Eastern markets, notably by the Japanese buyers.

2.3. Methods of Collection

Aquarium fish collection is carried out by snorkeling and using SCUBA. Most collectors are from Sri Lanka. They are often paid on piece rate basis and are employed directly by the company. Fish are normally collected using hand nets. When collection is carried out using SCUBA, each diver carries a small net (about 10cm mouth diameter) and a large net (about 50 cm in the mouth diameter). Mesh sizes may vary from 3-S mm. Fish arc driven in to which ever net is the most appropriate. As the fish are collected they arc transferred to a plastic bag secured at the diver's waist. When fish arc collected by snorkeling, a large plastic container is towed behind the divers to which the collected fish are transferred. The container is holed. and has a rubber tyre attached mid-container to keep it upright and afloat. More valuable fish are kept in polythene bags secured to the snorkeller's waist. Sessile organisms and invertebrates are taken by hand, ifnecessary being prized apart or dug out in the case of soft coral and sea anemones.

Recently some companies started using “moxy” nets, a new technique that is being introduced to the Maldives by Sri Lankan divers. This cone shaped net (more like the traditional cast net *Laandhaa)* is closed at the top. The bottom is about a metre or more in diameter. A float is attached on the top and lead weights are fastened around the perimeter of the base. Moxy nets are often used on shallow reef tops by snorkelers. The net is spread on top of coral heads where the fish take refuge. Fish are then chased out by banging the coral heads with a tickler stick until they are caught in the net. Fish caught using this technique are severely stressed and more often die in the first few days of capture than fish caught by hand nets. It is thought the use of this method of collection now is only minimal after the Ministry sent a circular to all exporters discouraging its use.

2.4. Holding facilities

Most holding facilities have purpose-built concrete holding tanks but a few have large plastic tanks. The tanks are piped with compressed air which is centrally connected to an electric blower. Water in the tanks are renewed weekly or as often as required depending on the numbers of fish in the tanks and quantity of through put. Most companies have semi-open systems where by overflow water is thrown out as required and replaced by fresh sea water. Operators who use complete open systems have sand filters and paper cartridges attached to the incoming pipe line to filter debris and bacteria. One company (the largest) has a modern central circulatory filtration system whereby the overflowed water from the tanks is skimmed to remove nitrogenous waste and then is filtered through an ultra violet sterilization system before the water goes to the tanks again. All the facilities have smaller glass tanks and plastic containers for keeping aggressive species in isolation. At the holding facility fish are generally not fed. They may sometimes be fed lobster eggs if they were to stay longer periods before being exported.

Recently some companies have started to extend the area of collection to nearby atolls. As a result they have started using holding cages at the out stationed collection sites. Once enough fish are collected, they are packed and brought back to the central holding facility (located close to airport) for conditioning before being exported. These cages which are framed in PVC pipes (2.5” and 1.5” dia.) are about 1 0’x5’x5’ in size, rigged with plastic netting. The air tight PVC piping help the cages to keep afloat.

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Conditioning of fish at the holding facilities prior to export is a general practice carried out by all exporters. Most companies collect fish to meet a specific requirement for a client. Few companies collect fish routinely and stock them at holding facilities. The companies that do this appear to be exporting mainly to Sri Lanka where the importers have no particular preference of species.

2.5. Packaging and Exporting

Fish are starved for about 2-3 days before being exported. A small amount of fresh water is added to the packing water and chemicals may be added to tranquilize for longer journeys. Packing starts just in time for the flight. Fish are packed with oxygen and a little water singly in double polythene bags to ensure that fish are not stranded without water should one bag be holed. Polythene bags are packed in cardboard boxes for short journeys (mainly to Sri Lanka). For European and other long haul journeys they are packed in Styrofoam boxes with some ice to keep the temperature down. Layers of paper may be inserted between plastic bags in the box to avoid catching sight of aggressive species. Packaging methods have improved considerably over the years mainly due to feed back from the customers and many exporters now guarantee almost 100% survival for most destinations provided that good connecting flights are available.

2.6. Species Composition in the Trade

Customs require that all export shipments have detailed packing lists, including value and destination of export. Some companies provide the detailed list of species, its quantity and value, while others provide only the number of boxes and quantity of fish in each box. In every case the exact number of fish in each shipment, the destination and its value are known,

From a sample of 29 invoices picked at random from the available detailed packing lists, estimates have been made on the quantity of fish exported by species for 1993 (Adam 1994). A great difficulty was faced in sorting out proper species names as companies have their own trade names. About 100 species of fish and invertebrates from 23 families were exported. Commonest ones include of wrasses (Fam: Labridae, 20 species), butterflyfish (Fam: Chaetodontidae, 17 species), damselfishes (Fam: Pomacentridae, 7 species), and angelfishes (Fam: Pomacanthidae, 8 species).

Exported species are listed in Table 3 along with the number of each species in the sample of 29 packing lists and estimates of numbers (to nearest fifty) exported in

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1993 and 1994. Among the 14,645 “fish” in the sample were 143 invertebrates. Most of these were sea urchins (Echinodemrata: Echinoidea), starfish (Echinodermata: Asteroidea) which includes *Linkia, Fromia* and *Culcita* and sea anemones (Class Anthozoa, *Radianthus* and *Stoichactis)*

3. STOCK ASSESSMENT

Little work has been done on the biology of the aquarium fish in the Maldives. Crude estimates of potential yield for 65 species within a radius of 7 nautical miles (13 km) around Male were made by Edwards and Shepherd (1992). They used underwater visual assessment count data from virgin fish populations to translate the abundance to maximum potential yield in a given area of reef using the equation of Gulland (197 1). Their results showed that some species were locally overexploited or were close to maximum sustainable yields. Calculations of Edwards and Shepherd (1992) have been extended by Adam (1995) for North and South Male Atolls and Vaavu Atoll based on the assumption that only 15% of the reef area is exploited by the collectors. Present levels of exploitation is no way near to the estimated amount.s from these three atolls. However, as collection effort is not evenly spread out, local overexploitation may occur in some places as observed by Edwards and Shepherd (1992).

4. MANAGEMENT lSSUES

4.1. Monitoring of the Trade

From the beginning ofthe aquarium fish trade, the government authorities have closely monitored the levels of export. The Customs authorities collect the information from the export invoices and are sent to the Economic, Planning and Coordination Section (EPCS) of the Ministry of Fisheries and Agriculture (MOFA). The data are compiled by the EPCS and annual summaries are published in the “Basic Fisheries Statistics” booklet.

Recently MOFA has initiated aprogramme for strengthening the data collection system based on the studies of Edwards and Shepherd (1992) and Adam (1995). One major difficulty in getting reliable information is the lack of proper identification guides for the Customs officers and for the exporters. At present, information on species level data is poor as exporters use more than one name for several species. MRS is preparing a catalogue of the aquarium fishes which will be made available to Customs officials and exporters.

Since the beginning of the aquarium fish trade, hand nets have been used for collection of the aquarium fish. This method of collection does not appear to have a detrimental impact to the reef habitat as these nets do not get caught up in the corals. Recently, however, some companies have started using moxy nets for collection which not only damage the reef habitat but also causes heavy mortality to the captured fish. MOFA has recently issued a circular to all exporting companies informing of the destructive nature of this collection method and urging them to stop or discourage the use of such destructive method by their collectors. The response appears to have been positive as many exporters have dismissed the collectors who happen to be using these destructive methods.

4.2. Regulation of the Trade

Ministry of Trade and Industries (MTI) is the government body responsible for regulation of the export trade. MTI issues export licenses which are based on export value. These licenses are generally valid for one year and the value of fish exported under the license should not exceed the export value of the license (generally in the range of 200-300 thousand Rufiyaa). The export value is determined by the exporters themselves. A nominal charge of MRf. 1/- in the form of revenue stamp is levied for each MRf. 1 000/- worth of exports. This system of licensing has been misinterpreted as an export quota by Edwards (1988) and Edwards and Shepherd (1992).

In response to the findings of a preliminary report by Edwards (1988) on the aquarium fish trade, MOFA set a blanket quota of 100,000 fish for export in 1988. At the same time a species quota was introduced based on the findings of Edwards and Shepherd (1992). However, there appear to have been no change brought to the regulatory system to enforce the 100,000 fish quota. But since then MTI have issued a list of the species subject to quota and the allocated number for export with every new license issued. In allocating the quantity of species quota, due consideration is given to the numbers of people applying for export licenses and the export volumes of the companies. Customs offtcials were to keep running totals of the quota species and stop any exports of that species when the allocated amount have been reached. However, that the blanket quota and the species based quota were not enforced or reviewed adequately.

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To overcome the problems of data collection and timely monitoring of the trade, it has been suggested to introduce "Proforma Aquarium Fish Export Forms" and "Daily Log Forms" which have to be filled by the exporters. Profroma aquarium fish export forms will have the names of all fish species that are likely to be exported. The exporter will have to write the corresponding numbers and their prices of the fish. This will be used as the packing list. Day forms will have the information on collection sites, numbers collected, time spent on collection, etc. which are vital information to detect early symptoms of overexploitation. It is thought that these improvement on the data collection system will be introduced soon.

4.3. Potential conflicts

As a general rule it is prohibited to carry out any form of fishing on the house reefs of tourist resorts and these areas are protected from any such activities. Both tourism and aquarium fish export business require the close proximity of an international airport and therefore it is not surprising that most of the holding facilities are centered close to the airport and in the tourism zone. At present most collection occurs in north and south Male Atolls, where the highest concentration oftourists also occurs. Conflicts occur when aquarium fish collectors happen to collect fish from a popular boat dive sites. In the recent past there have been such conflicts between dive operators and the aquarium fish collectors. It is likely this problem will be exacerbated in the future if the necessary regulatory measures are not taken now. 15 popular dive sites have been declared in June 1995 as protected marine areas, banning all forms of fishing activities except bait fishing.

Pole and line tuna fishing requires a daily supply of small reef fish which are collected from the reef. Even though the export of bait varieties are banned, one species of bait which is of minor importance is being exported in the aquarium fish trade. This is the Pomacentrid, *Chromis viridis* which is of minor importance as a bait (Anderson and Saleem, 1994). It is estimated about 0.5% of the total live bait requirement is of this species, which is estimated as under 100 tonnes per year (Anderson and Saleem, 1994; Anderson, 1994). 10,000 individuals collected in 1994 in the aquarium export business constitute an insignificant number compared to this quantity.

Edwards and Shepherd (1992) note five species of edible reef fish of minor importance which are also being collected by the aquarium fish exporters. *These are Plectorhincus orientalis, Chelinus trilobatus, Cephalopholis miniata, Parupaneus cyclostomus* and *Variola louti.* The amount collected by the aquarium fish collectors is very small compared to the quantity of fish species landed in Male and therefore should not be problem.

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4.4. Regulation of the Holding Facilities

Regulating the standards of the holding facilities and of standards of packing is important to ensure minimum mortality of fish at holding facilities and in transport. At present there is no official requirement for a standard of the holding facilities. Preliminary findings in 1994 shows that few facilities are not adequately maintained (Adam 1995). Mortalities rates at collection and at the holding facilities are poorly known. However, interviews with the exporters and collectors indicate that at both these stages mortality may be as little as 3-5%. (Adam 1994). Compared to the mortality figures for Sri Lanka these are quite low (Wood, 1985). She estimated mortalities before arrival in the. country of destination approached 25% with 15% dying at holding facilities in the country of origin and 10% dying during transport. Fortunately the fish collected from the Maldives do not require long domestic transport times as in Sri Lanka as the collecting areas and the airport are very close to the holding facility.

4.5. Endemic and Rare Species

Aquarium fish collection is a selective exploitation process of well sought after species that fetch high prices in the market. Of the 100 or so species exported in the trade, 20 species make more than 75% of the total numbers exported.

Some of the species that are being exported are quasi-endemic with only limited geographic distribution, Maldives being the centre of abundance. Therefore, these populations are extremely important reserves for maintaining biodiversity. One of the species commonly exported in the Maldives is the Clown Fish *(Amphiprion nigripes)* which fits well under this category. Although this species occurs in the neighboring Sri Lanka and Laccadives, it is considered rare in these areas. Anemone fish have only limited larval dispersal and as a result show the phenomenon of local endemism. For this reason anemone fish are particularly susceptible to local over exploitation. In 1994 it is estimated that about 8000 Maldives Clown Fish and about 500 anemones were exported.

There may be several other species which are rare in the Maldives which warrant strict control on numbers collected. The recently "discovered" angel fish, *Apolomithchthys armitagei* is also very rare in the Maldives and should be included in the species quota list. It is thought that some species of Wrasses (fam: Labridae) and Gobies (fam: Gobiidae) that are popular among the collectors are not fully described from the Maldives and therefore the extent of the distribution or abundance

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in Maldives are not known (R.C. Anderson, pers. comm.). One way to avoid heavy exploitation of deep sea wrasses may be to have maximum collection depth, that is to have a strict rule maximum dive depth. This may also prevent serious dive accidents that have happened in the past.

4.8. Economic Considerations

The management of the aquarium fish trade should not be taken only from a biological point of view. Economic considerations should also be taken in to account when rules and regulations are being made to manage the fishery. In 1994 the export business earned about US$ 0.67 million which is about 1.6% of the total marine exports value. It is worth noting that from 1989-l 994 the value of total export earning increased 1.7% where as in the same period the value of aquarium fish export earnings increased almost 65% (Anon, 1994). The aquarium fishery in the Maldives could be expanded without potential conflict among other reef resource users. Collection areas have to be widened to include other atolls. To avoid conflict with the tourist dive operators, area restrictions can be enforced in the tourism zone.

It has been recommended that when developing and expanding the aquarium fishery, consideration should be given (together with biological and environmental points discussed) to the relatively large capital cost required to setup the holding facility, the ongoing costs of packaging and the necessity of competitive freight charges for the consignment. For the exporting companies which have invested large amounts of capital in terms ofholding facilities, collecting gear and transport vessels, a restrictive quota system may discourage them. If more "small timers" were to enter the business the quota has to be distributed among all parties reducing the numbers that can be allocated for exporters with considerable capital tied up in their business. Therefore, it has been suggested that in the future, consideration may be given to licensing of the exporters and assigning designated areas for collection which could be closely monitored.

The costs of packaging are high, especially for the European markets and USA markets. Packaging requires Styrofoam boxes, oxygen, high quality polythene bags which all have to be imported for re-exportation within a very short period. A sample of invoices with full information (i.e. with breakdowns of packaging and freight costs) for 1993 shows that packaging costs about 11% of the total for Sri Lanka and about 6% for Europe. However, the average packaging cost per box is about a dollar more for the European market (Table 5).

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Waiving of import duties on these exported items of packaging would partly solve the high packaging cost problem. Alternatively, Styrofoam box manufacturing could be started in Male. The demand for Styrofoam boxes is high at the moment as many of the reef fish exporters use them. One major Singapore: manufacturer considers that this could be manufactured in the Maldives quite cheaply.

Freight cost also takes a considerable amount of the total FOB value. Average freight costs for Europe are in the range of 38% and that of Sri Lanka is about 21%. Exporters claim that freight charges are not very competitive due to limited choice they have. As the chartered flights which fly direct to Europe do not carry any consignments they are limited to only few air lines. It is thought that special discounted rates from the air lines may be bargained for through an Exporters Association. But it appears that freight charges will come down as more air lines start to operate and direct connections to European destinations improve.

At present about 63% of the total exports are being exported to Sri Lanka gaining only 40% of the total value. These figures are likely to go higher in the future as new exporters join the industry. The new comers often do not have access to European markets and their exports are mainly to Sri Lanka. MOFA with close collaboration with the proposed Aquarium Fish Exporters Association can play an active role in trade promotions and finding new markets (e.g. by participating in international trade fairs such as the Aquarama and Interzoo held annually). It is estimated that if the 1994 Sri Lankan exports had been exported to European markets there would have been a gain of extra 43% of the total export value.

5. SUMMARY OF RECOMMENDATIONS

Following is a summary of the recommendations that have been made by Edwards and Shepherd (1992) and Adam (1995):

1. Use of destructive methods of fish collection should be completely banned.

2. The present system of value based quotas should be abolished and quotas based on numbers should be introduced.

3. Coordination between MOFA, Customs Authority and Ministry of Trade and Industry should be strengthened in order to better regulate the fishery.

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4. Proforma Aquarium Fish Export Forms should be introduced as soon as possible in order to monitor the numbers of fish exported by species. This will considerably ease the burden of monitoring exports and provide systematic information on the trade.

5. Collection of rare and quasi-endemic species should be banned or controlled.

6. The present list of species subjected to quota should be reviewed urgently. The list should include rare and quasi-endemic species and species that survive poorly in aquaria.

7. Daily Log Forms of aquarium fish collection should also be introduced to obtain detailed information on collection areas, hours spent on collection etc. The data generated by this form will be vital in detecting the symptom of overexploitation at an early stage.

8. Assigning of designated areas for aquarium fish collection should be initiated in consultation with the aquarium fish exporters, MAT1 and relevant government authorities.

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Table 1. Quantity of live tropical fish exported and their FOB value (1980-1994).

Year	*Nos. of Fish Exported*	*FOB Value* (MRf.)	*FOB Value* (US$)	*% Tot. Mar Exp. Value*
1980	42,128	153,958	d a	0.53
1981	43,929	214,607	n/a	0.78
1982	38,322	242,014	n/a	0.96
1983	44,921	372,699	53,243	0.75
1984	37,255	296,823	42,102	0.50
1985	65,065	555,290	78,231	0.50
1986	86,312	805,078	112,587	0.69
1987	69,216	902,758	97,882	0.52
1988	68,102	1,589,212	180,909	0.60
1989	53,925	1,312,037	145,124	0.42
1990	54,572	1,216,000	127,873	0.35
1991	112,918	3450,000	336,500	0.92
1992	161,918	3,156,000	298,603	0.95
1993	184,233	3,746,171	341,901	1.19
1994	312,483	7,028,295	606,630	1.65

*Note: Annual average exchange rates obtained from the Statistical Year Book of Maldives, 1995.
Source: Customs, Complied by EPCS/MOFA

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Table 2. Average Unit Prices for aquarium fish offered for major destination (prices in MRf.)

Destinations	*1989*	*1990*	*1991*	*1992*	*1993*	*1994*
Europe	27.82	28.14	43.76	26.66	25.73	30.52
Sri Lanka	11.63	11.56	12.40	9.41	13.11	15.75
Far East	30.75	39.90	46.68	42.47	96.91	66.16
USA	27.60	67.74	18.95	47.54	—	25.17
Others	–	—	—	—	—	9.09

Source: Customs, Compiled by EPCS/MOFA

Table 3. List of species exported in the trade with estimated numbers (nearest 50) exported in 1993 and 1994.

Column A = number of species in the sample of 29 packing lists picked at random from detailed invoices.

Species	*Local name*	*A*	*1993*	*1994*
CHAETODONTIDAE, Butterflyfishes				
Chaetodon auriga	Threadfin	173	2150	3700
C. collare	Collare or Pakistani	27	350	600
C. falcula	Saddleback	426	5350	9100
C. guttatissimus	Spotted	135	1700	2900
C. kleinii	Klein's or Sunburst	141	1750	3000
C. lunula	Racoon	8	100	150
C. madagascariensis	Madagascar or Pear Scale	38	500	800
C. melannotus	Black-backed	163	2050	3450
C. meyeri	Meyer's	32	400	700
C. unimaculatus	Teardrop	26	350	550
C. xanthocephalus	Yellowhead or Goldring	265	3350	5650
Forcipiger spp.	Long-nosed	73	900	15'50
Hemitaurichthys zoster	Pyramid	10	150	200
Chaetodon mitratus	—	72	900	1550
Chaetodon lineolatus		7	100	150
Chaetodon bennetti	—	7	100	150
Chaetodon oxycephalus		83	1050	1750
POMACANTHIDAE, Angelfishes				
Apolemichthys trimaculatus	Flagfish	32	400	700
Centropyge multispinis	Bluefin Dwarf	75	950	1600

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Pomacanthus imperator	Emperor	86	1100	1850
P. xanthometopon	Yellow-faced	1	<50	<50
Pygoplites diacanthus	Royal	321	4050	6850
Cen tropyge spp.	—	11	150	250
Apolemichthys xanthurus	—	47	600	1000
A. armitagei	—	2	50	50
SCORPAENIDAE, Lionfishes				
Dendrochirus brachypterus	Shortfin	2	50	50
Pterois antennata	Broadbarred Firefish	23	300	500
P. miles	Devil Firefish	20	250	450
P. radiata	Radial Firefish	179	2250	3800
Dendrochirus zebra	—	1	<50	<50
GOBIIDAE, Gobies				
Gobiodon citrinus	Poison or Yellow Goby	1346	16900	28700
Paragobiodon microlepis	Green Goby	5	50	100
Nemateleotris magnifica	Fire (tail) Goby	28	350	600
Valenciennea strigata	Watchman Goby	11	150	250
Nemateleotris decora	Decora	199	2500	4250
Fusigobius spp.	—	8	100	150
Unspecified gobies	—	30	400	650
BLENNIDAE, Blennies				
Cirripectes stigmata	—	3	50	50
Unspecified blennies	—	8	100	150
POUACENTRIDAE, Damselfishes				
Amphiprion nigripes	Maldives Clown	358	4500	7650
A. clarkii	Sebae Clown	54	700	1150
Clown Fish	Clown Fish	263	3300	5600
Chromis viridis	Green Damsel	451	5650	9600
Dascyllus aruanus	Three-stripe Damsel	673	8450	14350
Pomacentrus pavo	Jade Damselfish	385	4850	8200
MONACANTHIDAE, Filefishes				
Oxymonacanthus longirostris	Longnose	479	6000	10200
CIRRHITIDAE, Hawkfishes				
Cirrhitichthys oxycephalus	Coral Hopper	2	50	50
Oxycirrhites typus	Longnose Hawkfish	17	200	350
Unspecified hawkfishes	—	2	50	50

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SERRANIDAE, Anthias, groupers				
Pseudanthias dispar	Longfin Wreckfish	373	4700	7950
I? evansi	Purple Wreckfish	1200	15050	25550
P. kashiwae	Silver-streak Goldie	80	1000	1700
Nemanthias carberryi	—	304	3800	6500
Variola Iouti	Lyretail Grouper	16	200	350
Anthias sp.	—	678	8500	14450
BALISTIDAE, Triggerfishes				
Balistoides conspicillum	Clown Trigger	37	450	800
Rhinecanthus aculeatus	Picasso	511	6400	10900
ACANTHURIDAE, Surgeonfishes				
Acanthurus leucosternon	Powder Blue	1347	16900	28700
Naso Iituratus	Lipstick or Orangespine	31	400	650
Paracanthurus hepatus	Regal Blue	2	50	50
Zebrasoma scopas	Brown Sailfin	163	2050	3450
Z. veliferum	Sailfin	992	12450	21150
Naso valmingii	—	18	250	400
Naso spp.	—	134	1700	2850
Acanthurus tennenti	—	76	950	1600
—	Yellow eye surgeon	56	700	1200
Ctenochaetus striogosus	—	1	<50	<50
LABRIDAE, Wrasses + SCARIDAE, Parrot fishes				
Anampses lineatus	Leaf or Deep-sea Wrasse	114	1450	2450
A. meleagrides	Marble or Yellowtail	43	550	900
Bodianus axillaris	Polkadot	18	250	400
Coris formosa	Red Wrasse	1	<50	<50
Gomphosus caeruleus	Green Birdmouth	81	1000	1750
Halichoeres lcucoxanthus	Yellow Wrasse	8	100	150
Labroides bicolor	Yellow Diesel, Cleaner	231	2900	4900
L. dimidiatus	Blue Diesel, Cleaner	223	2800	4750
Macropharyngodon bipartitus	Rare Wrasse	259	3250	5500
Novaculichthys taeniourus	Dragon Wrasse	224	2800	4750
Pseudocheilinus hexataenia	Pyj ama	32	400	700
Bodianus bimaculatus	—	20	250	450
—	Blue Wrasse	36	450	750
—	Blue Parrot	14	200	300
Coris spp.	—	81	1000	1750
—	Parrot fish	56	700	1200

Halichoeres cosmetus	—	2	50	50
—	Bicolor Parrot Fish	1	<50	<50
—	Commet Wrasse	10	150	200
Parachelinus mccoskeri	—	20	250	450
TETRAODONTIDAE, Pufferfishes				
C. valentini	Saddleback	59	750	1250
Arothron spp.	Puffer Fish	73	900	1550
OSTRA CIDA E, Boxfishes				
Ostracion cubicus	Yellow Boxfish	48	600	1000
DIODOATIDAE, Porcupinefshes				
Diodon liturosus	Shortspine Porcupine	12	150	250
MULLIDAE, Goatfishes				
Parupeneus cyclostomus	Yellow Goatfish	23	300	500
HEAMULIDAE, Sweetlips				
Plectorhinchus spp.	Oriental	5	50	100
CALLIONYMIDAE, Dragonets				
Synchiropus stellatus	Starry Dragonet	3	50	50
INVERTEBRATES				
	Pink star	4	50	100
	Red Star Fish	48	600	1000
	Anemone	40	500	850
	Sea Urchin	51	650	1100

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Table 4. Commonest 20 species of fish exported in the trade and the estimates (nearest 50) of quantity exported in 1994

Species	*Local Name*	*Export nos.*
Acanthurus leucosternon	Powder Blue	28,700
Gohiodon citrinus	Poison or Yellow Goby	28,700
Pseudanthias evansi	Purple Wreckfish	25,550
Zebrasoma veliferum	Sailfin	21,150
Anthias sp.	Anthias	14,450
Dascyllus aruanus	Three-stripe Damsel	14,350
Rhinecanthus aculeatus	Picasso	10,900
Oxymonacanthus Iongirostris	Longnose	10,200
Chromis viridis	Green Damsel	9,600
Chaetodon falcula	Saddleback	9,100
Pomacentrus pavo	Jade Damselfish	8,200
Pseudanthias dispar	Longfin Wreckfish	7,950
Amphiprion nigripes	Maldives Clown	7,650
Pygoplites diacanthus	Royal	6,850
Nemanthias carberryi	Anthias	6,500
Chaetodon xanthocephalus	Yellowhead or Goldring	5,650
Clown Fish	Clown Fish	5,600
Macropharyngodon bipartitus	Rare Wrasse	5,500
Labroides bicolor	Yellow Diesel, Cleaner	4,900
Novaculichthys taeniourus	Dragon Wrasse	4,750
	Total of 20 Common Species	236,250
	Total exported in 1994	312,483
	Per cent of 20 Commonest	76

Table 5. Comparison of packaging and freight costs for a sample of live tropical fish exports to Sri Lanka with those of Europe (Belgium, England, Netherlands, Switzerland, Germany, France) for 1993.

Destination	*Number of* Boxes	*Number of* Fish	*Packaging* costs US$	*Total FOB* [US$]	*% Total in packaging*	*Packaging* cost/box US$
Sri Lanka	1767	41260	8173	77281.60	10.58	4.63
Europe	1772	44745	10470	183945.95	5.69	5.91

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Destination	*Number oj Boxes*	*Number of Fish*	*Freight costs* US$	*Total FOB* [US$]	*% Tolal in freight*	*Freight cost / box US$*
Sri Lanka	1767	41260	16446.45	7728 1.60	21.28	9.31
Europe	1772	44745	70871.70	183945.95	38.53	40.00

Source: Customs

Table 6. Quantity of aquarium fish (nos.) exported from the Maldives by country from 1989-1994

Country / Region	1989	1990	1991	1992	1993	1994
EUROPE						
United Kingdom	i9938	7506	23262	25127	32059	29706
Italy	1771	381	7329	13808	4554	6486
Germany	3453	3107	6170	10177	6935	5973
Austria	0	0	927	0	0	445
Switzerland	189	605	224	5597	337	297
France	3029	1960	1538	5179	1380	770
Netherlands	942 1	12655	10470	21083	15210	10666
Spain	9	0	0	0	0	0
Belgium	0	1681	4343	5034	2749	0
Denmark	0	0	1021	155	0	0
Sub Total	37810	27895	55284	86160	63224	54343
SRI LANKA	11940	21025	46308	71586	114643	203587
FAR EAST						
Thailand	0	0	0	0	0	338
Hong Kong	0	0	0	0	330	7500
Singapore	517	4	1673	29	88	704
Japan	1401	4890	7219	2483	5984	11196
Australia	51	19	0	0	0	0
Taiwan	0	450	0	0	0	180
Sub Total	1969	5363	8892	2512	6402	19918
OTHER COUNTRIES						
India	0	0	0	0	0	65
Bahrain	0	0	0	0	0	1410
U.A.E.	0	0	0	0	0	68
South Africa	0	0	0	0	0	69
Sub Total	0	0	0	0	0	1612
U.S.A.	2206	289	2214	1660	0	33023
GRAND TOTAL	53925	54572	112698	**161918**	184233	312483

Source: Customs, Compiled by EPCS/MOFA

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Table 7. Value of aquarium fish (in MRf.) exported from the Maldives from 1989-1994

Country / Region	1989	1990	1991	1992	1993	1994
EUROPE						
United Kingdom	455755	176100	583316	544 179	76552 1	831298
Italy	59492	13236	225049	364067	125992	221443
Germany	67996	61158	1085083	275852	164512	240028
Austria	0	0	16927	0	0	14949
Switzerland	5498	21248	5117	166319	15354	7108
France	104890	59843	65861	185222	53381	6801
Netherlands	357355	417806	315109	603330	439564	336918
Spain	830	0	0	0	0	0
Belgium	0	35464	86590	151289	62430	0
Denmark	0	0	35989	6646	0	0
Sub Total	1051816	784855	2419041	2296904.	1626754	1658545
SRI LANKA	138804	242989	574449	673325	1502780	3205986
FAR EAST						
Thailand	0	0	0	0	0	27965
Hong Kong	0	0	0	0	284724	853973
Singapore	8268	3093	78493	2146	9730	30568
Japan	51359	194978	336607	104537	322482	396480
Australia	915	1591	0	0	0	0
Taiwan	0	14333	0	0	0	8789
Sub Total	60542	213995	415100	106683	616936	1317775
OTHER COUNTRIES						
India	0	0	0	0	0	2650
Bahrain	0	0	0	0	0	10207
U.A.E.	0	0	0	0	0	655
South Africa	0	0	0	0	0	1139
Sub Total	**0**	**0**	**0**	**0**	**0**	14651
U.S.A.	60876	19576	41959	78911	0	831341
GRANDTOTAL	**1261415**	**3450550**	**3155824**	**3746471**	**7028295**	

Source: Customs, Compiled by EPCS/MOFA

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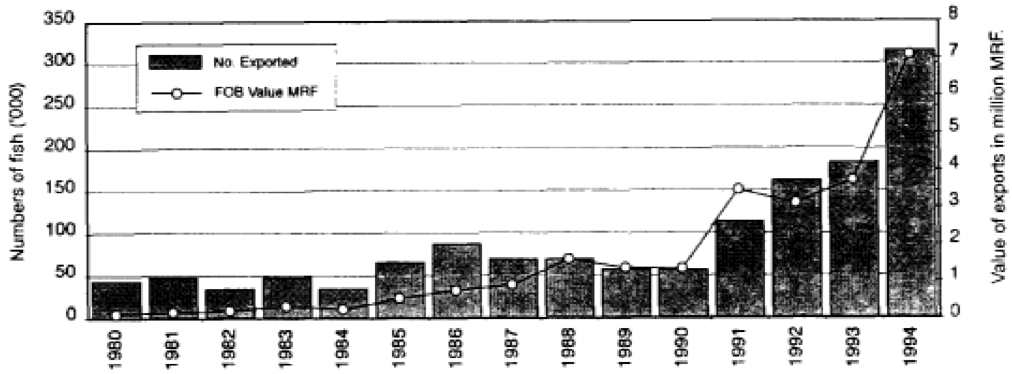
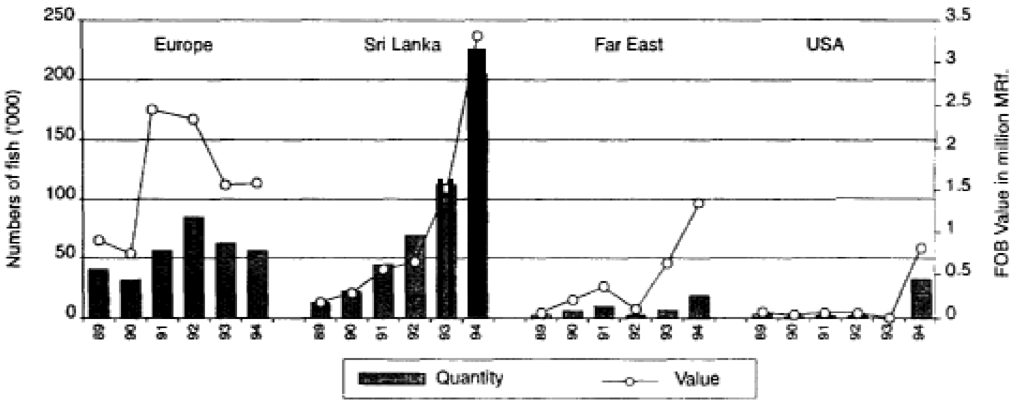
Figure 1. Export ot aquarium fish (nos.) and
their export value in MRF (1980-94)



Source. Customs, compiled by MOFAIEPCS

Figure 2. Aquarium fish exports by
major destinations (1989-94)



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PAPER 3

EXPLOITATION OF REEF RESOURCES: GROUPER AND OTHER FOOD FISHES

BY

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ABSTRACT

Exploitation of reef resources in the Maldives has become an important component of the country's fisheries sector. Two forms of reef fish fisheries are recognised: the general reef fish fisheries, targeting at a large number of different commercial species; and grouper fishery, targeting at commercial grouper species. Both of these fisheries are expanding today.

The developing new fisheries pose two main threats: over exploitation of resources and conflicts among resource users. To address the consequences of fisheries diversification, intensification, and interactions with other resource users, fisheries management has become a necessity.

The total annual yield of all commercially valuable reef fish from the Maldives has been estimated at roughly 30,000t ± 13,000t. The estimated fish catch was 14,000t in 1994. The reef fish resources, therefore, seemed to be underfished. The maximum sustainable yield of grouper has been estimated at 1,800t/year.

To come up with recommendations for developing and managing reef fish fisheries, the available qualitative and quantitative information has been analysed in the present scenario of expanding reef fish fisheries, and increasing competition for the reef resources among different interest groups. For the general reef fish fisheries, it has been recommended to inform Ministry of Fisheries and Agriculture when starting new commercial fisheries, increase awareness of fishermen on the environment, identify the allowable gear for reef fishing, enforce the existing rules and regulations, and review the customary management laws. For the grouper fishery it has been recommended to impose a minimum commercial size limit of 12 inches and 16 inches for the medium and large size groups of fish, maintain the fishery below the maximum sustainable yield, keep some areas temporarily closed and open for fishing, and do experimental aquaculture of groupers. Improving the collection of statistics is a common recommendation for both fisheries.

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I. INTRODUCTION

Exploitation of marine resources has intensified in the Maldives in the last ten years. Tuna still being the dominant fishery, other existing fisheries have increased in scale and new ones have started. In addition to fish, other reef organisms are also being commercially exploited. Reef fish fishery, which remained subsistence for a long time, has now developed to a commercial scale. A recent development is fishing for some species of grouper to export them live or fresh.

Today, marine resources are being shared by two important economic sectors, fisheries and tourism. The investment of private sector on small scale fisheries is increasing, particularly on the exploitation of reef fish. These small scale fisheries, which are supplementary to tuna fishery, have considerable social and economic benefits. These activities provide additional employment for the fishermen during tuna fishing off-season or when tuna fishing is poor. If the supplementary opportunities are not there, fishermen have to look for non-fishery employment during such times, often at heavily populated Male. As the exploitation of reef resources is expanding both in terms of variety and quantity, reef-based tourism is also developing bringing a considerable amount of foreign currency into the country. Diving, snorkeling and fishing on reefs have become major tourist attractions. Thus fisheries and tourism - the two most important economic sectors - have to make compromises for their development.

The developing new fisheries pose two main threats: over-exploitation ofresources and conflicts among resource users. Coral reef habitats in the Maldives are rich in variety, but poor in abundance of individual species - a characteristic common to many tropical habitats. Hence a commercial fishery wholly based on the natural stocks will soon be under the threat of over- exploitation, if the fishery is not being properly managed. Poor management also leads to conflicts among different interest groups or economic sectors sharing the common resources. Tourists do not like fishing from dive sites. On the other hand, fishermen believe that diving is a problem for baitfishery as baitfish get scared and scattered because of divers. Fishermen also hold the belief that removing groupers from reefs has negative impact on the baitfishery. As in the fisheries sector. within the tourism sector also there are antagonistic interest groups -such as divers and night fishing tourists.

To address the consequences offisheries diversification, intensification and interactions with the tourism sector, fisheries management has become a necessity. Fisheries management calls for collaborative efforts on the part of policymakers, researchers, administrators and island communities. In formulating management strategies,

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consideration has to be given to the fact that fisheries management involves imposing some form of restriction or the other on the age-old free access to resources, dealing with antagonistic interest groups, causing a possible imbalance to the livelihood of the people. The aim of this paper is to analyse the status of reef fish fisheries and suggest recommendations to develop and manage them.

2. METHODS

To come up with recommendations for developing and managing reef fish fisheries, the available qualitative and quantitative information has been analysed in the present scenario of widening reef fish fisheries, and increasing competition for the reef resources among different interest groups.

The source of fisheries catch statistics was the Economic Planning and Co-ordination Unit of Ministry of Fisheries and Agriculture, MOFA (1995)

Total stock assessment of reef fish presented in this paper was done following an exploratory fishing survey carried out in the Maldives in two phases: phase I, during 1987-1988 (Van der Knaap et al., 1991); phase II, during 1989-1991 (Anderson et al., 1992). The stock figures given for groupers were calculated by Shakeel(1994), based on the results of the exploratory survey.

The maturity lengths of groupers were established assuming that a fish gerally spawns for the first time at half the maximum length it attains (Maicev et al., 1981). The maximum total lengths of groupers as reported by Heemstra and Randall, (1993) were used to estimate the theoretical maturity lengths. The theoretical maturity lengths of grouper species were compared with the actual lengths of the smallest matured individuals (Female, maturity stage[3]) caught during the exploratory fishing survey (Table 4). The length at maturity was assumed as minimum size that can be caught in commercial fishing as this size will allow the fish to gain considerable biomass and spawn at least once in its life. Groupers recorded from Maldives were catogarised into small, medium, large and extra-large size groups; and for each group, the average maturity length was calculate to suggest it as the minimum commercial size. for the group members. When grouped like this, all commercial and few non-commercial species fell into the medium and large size groups.

Fishermen will be able to distinguish the members of one commercial group from those of the other, making clear distinction between the two groups. Having minimum

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number of groups easily distinguishable commercial groups is an important condition if a size-limited fishery is to be practically carried out.

3. REEF FISH FISHERIES

3.1 General Reef Fishery

For Maldivian fishermen, reef fishing often means fishing for any fish other than tuna. This traditional definition of reef fishing arose as a result of the ever dominating nature of the tuna fishery. Tuna has always been the major export product, and once it was the only major source of income generation through out the country. Therefore, tuna catch was reserved for sale as Maldives fish, and other fish were used for family consumption. Thus, based on the way the end products were used, two major fisheries were recognised: fishing for tuna for export and fishing for other fish for domestic non-commercial consumption. As the bulk of domestic consumption constituted mainly reef, fishing for domestic consumption and fish caught in this fishery began to be called reef fishing and reef fish respectively, although the catch of the fishery contained offshore fish and inshore pelagic fish. When an oceanic species, for example dolfinfish, is referred to as a reef fish, the meaning is not that it lives in the reefhabitat, but that it belongs to the domestic consumption category.

This definition of reef fishery is getting outdated now as the traditional reef fish category is gaining equal importance as tuna. Early reef fish statistics was grouped into tuna and reef fish categories based on the traditional definition of reef fish. Although presently some large pelagic fish have been removed from the category that is generally assumed as reef fish, the category is still a mixture of demersal reef fish and non-reef fish species. Please note that in this paper also the mixed group has been referred to as reef fish

Commercial reef fishing is often carried out using handline from mechanised and sailing *vadudhonis,* mechanised *masdhonis,* and sometimes *bokkurns* with or without outboard engines. Longlining for reef fish is rare. Fishermen sell their catch to the island families, tourist resorts or salt and dry the catch to sell to exporters. The catch consists mainly of snappers *(Luthjanidae),* emperors *(Lethrinidae),* groupers *(Serranidae),* jacks *(Carangidae),* and reef sharks. Reef fishing is done in all the atolls, but fishing is more widely carried out in atolls where tuna fishing is poor. In tuna fishing atolls, reef fishing serves as a secondary activity.

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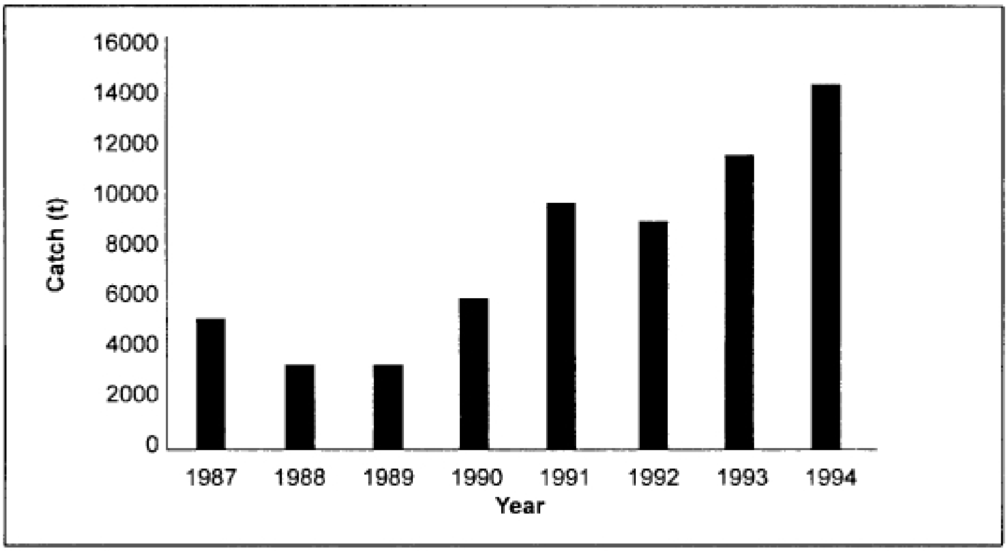
Until recently Maldives carried out reef fisheries on a very small scale. The establishment of convenient international sea and air transport connections between Maldives and other parts of the world, and development of tourism led to the widening of reef fish exploitation. From the 1970s there has been a significant increase in reef fish catch to cater to the local tourism industry and export markets. Reef fish catch in the period 1987-1994 also shows an overall increasing trend (Fig. 1). Reef fish catch is mainly exported in salted dried form, irrespective of species.

Fig. 1 Total reef fish catch 1987-1994.



But today, in addition to the salted and dried form, reef fish are also exported chilled and frozen. Unlike earlier practice, fisheries are now targeted at particular species; for example the grouper fishery. Fishing for high valued species and the discrimination between high-valued and low valued methods of processing is a step forward towards rational exploitation of reef fish resources.

3.2 **Grouper Fisheries**

Groupers are popular marine food fish of high market value in many parts of the world including Kuwait, Indonesia, Malaysia, Singapore, Japan, China and Mexico. Their habitats are coral reefs and stony environments. Because of their voracious feeding habits and shallow habitats, these fish are easy targets for small-scale fishermen.

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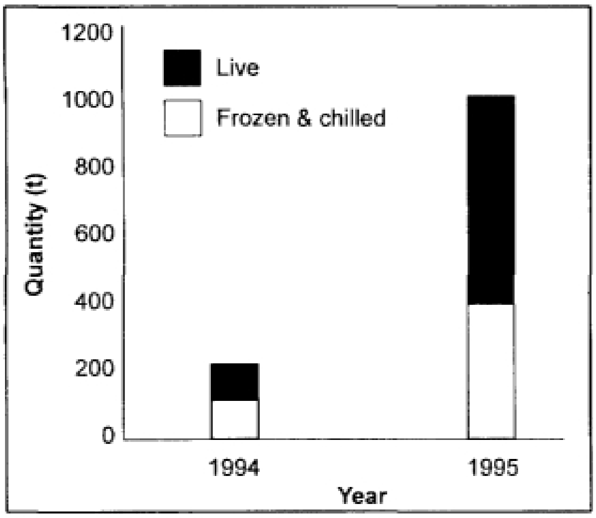
Groupers have also been farmed in the coastal waters of tropics and subtropics for a longtime.

About 40 species of grouper of the subfamily Epinephelinae has been recorded from Maldivian waters (Randall and Anderson, 1993) and a few are currently being exported.

At first grouper fishing was concentrated in central atolls-Alifu, Vaavu and Meemu. The fishery has now spread to all over the country. Fishing is carried out in all types of fishing boats: rowing boats (bokkura), sailing or mechanised trolling boats (vadudhonis), and mechanised pole-and-line fishing boats (masdhonis). Two to three people go fishing in a Bokkura, 3-4 in vadudhoni, and 4-8 in masdhoni. The usual fishing grounds are island reefs, ring reefs and patch reefs. Handlines, the most widely used gear for reef fishing in the Maldives, are also used to fish groupers. Handlines are normally baited with livebait, particularly Gold band fusilier (Mas Muguran), Pterocaesio chrysozona. Though less preferable than livebait, cut pieces of tuna and big eye scad (Mushimas), *Selar crumenophthalmas*, are also used as bait. Daily catches of a sailing vadudhoni and a mechanised masdhoni range 50-80 and 100-170 fish respectively.

The grouper catch is kept alive in dhoni holds. Large tuna-fishing masdhoni hold groupers in the same manner as livebait holding. To maintain constant circulation of good quality water, seawater is allowed to enter through the inlet openings at the bottom of the vessel and water is bailed out by a petrol pump. Smaller vessels, vadudhoni and bokkura, circulate seawater in the same way as tuna fishing vessels. The main difference is that in this case, instead of using a mechanical pump, a hand pump or bailer is used to discharge water.

Fig. 2 **Export of groupers**



During the fish holding operation, which lasts from the moment of catch till transfer to cages (about 5-10 hours), the mortality constitutes about 5-20% of the catch. The groupers caught by the fishermen are sold

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live to exporters or their agents. These fish are stocked in cages for later live or chilled export. The estimated export of grouper in 1995 was about 1000t. (Fig. 2)

4. REEF FISH STOCKS

4.1 Total Reef fish Stocks

To have an understanding of reef fish resources, a two phased exploratory fishing survey was carried out during the periods 1987- 1988 and 1989- 1991 (Van der Knaap et al 1991; Anderson et al 1992). North Male Atoll was the target of the first phase, and Shaviyani, Alifu and Laamu were the targets of the second phase. Fishing was carried out from a modified 'second generation' dhoni, using mainly handlines and longlines. In each target atoll, the following major habitats were surveyed:

— the atoll basins;
— the shallow reefs inside and outside the atolls; and
— the deep reef slope outside the atolls (50-210m)

Using catch data from longline, Anderson et al (1991) calculated the standing stocks for atoll basins and deep reef slopes. The standing stock figures were then converted into potential maximum sustainable yields using Gulland's formula. The maximum sustainable yield for shallow reef habitats was calculated by applying reef fish yields from coral reef areas in other countries to the Maldivian reef situation (Table 1).

Table 1. Estimated reef fish stocks and sustainable yields in the major habitats surveyed (Anderson et al., 1992)

Habitat	*Stock size*	*MSY (t/yr)*
Atoll basins	1600,000 ± 80,000	24,000 ± 11,000
Shallow reef areas	?	5,250 ±1,750
Deep reef slopes	5,800 ± 2,500	500 ±100
Total	>200,000 ±100,00	30,000 ± 13,00

The total annual yield of all commercially valuable reef fish from the Maldives has been estimated by Anderson et al. (1992) at roughly 30 000 t ±13 000 t.Catches of demersal reef fish in 1991 were estimated to be less than 5,000 t per year. The reef

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fish resources, therefore, seemed to be underfished. However, it should be emphasised that this estimate is rather crude, so due caution should be exercised in using it.

4.2 Grouper Stocks

Based on the total reef fish and grouper catch in the exploratory survey and using similar methods as employed by Anderson at al. (1992) to calculate maximum sustainable yield of reef fish, Shakcel(l994) did stock assessment of groupers. The maximum sustainable yields of grouper for the three major habitats are given below in Table 2. The total yield is broken down in proportion to reef areas of atolls, and shown in Table 3.

Table 2. Estimated sustainable yields of grouper

Habitat composition	*MSY (t/yr)*	*Percentage of grouper in the survey catch*
Atoll basins	810 ±370	15.80
Shallow reef areas	960 ±320	4.15
Deep reef slopes	60± 15	17.91
Total MSY	1800 ±700	7.95

It should be emphasised that as total sustainable yields of reef fish, these figures are somewhat crude and serve only as guidelines. Hence due caution should be exercised whenever they are used.

5. DISCUSSION

Until recently Maldives has been commercially exploiting mainly pelagic fish that have no or little association with the reef, particularly tuna. In the past, reef resource exploitation was carried out on a small scale, and mainly on a subsistence basis. Therefore, the exploitation of reef resources posed no significant threat to the fisheries or the environment. Today the resources are being more intensively exploited for commercial purposes. Coral mining, one of the most ancient forms of exploiting reef resources, has expanded to meet the increasing demand for corals in the construction industry. The existing reef fisheries have also expanded to cater to both the local tourist and export markets. While the multi-species reef fisheries continue to expand,

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export-oriented species-specific fisheries, such as the grouper fishery, have started to gain importance. The increased commercial exploitation of reef resources have resulted in two major threats: conflicts among resource users and over-exploitation of resources.

Tourism sometimes finds itself in conflicting situations with itselfand the fisheries sector. Tourism has created a huge domestic market for reef fish. Tourists prefer reef fish, while the majority of local people prefer tuna. “Dive-tourists” love to see the fishes freely roaming in the water, without hooks or lines projecting from their mouths. Night fishing tourists would like to celebrate their successful fishing excursion with barbecues. “Dive-tourists” complain about groupers, aquarium fish and reef sharks being caught from popular dive sites. On the other hand fishermen complain that they are disturbed by divers during reef fishing or baitfishing.

Although the reef fish resources seem in general to be underfished, some fish species (for example groupers), and other organisms (such as sea cucumbers), are under the threat of overexploitation. The grouper fishery, which started in the central atolls. has now spread to all over the country. This fishery has already started to show signs of overfishing: relatively poor catch, higher price offers. and quick shifting of fishing operations from one atoll to the other. The estimated export of grouper in 1995 was about 1 000t. Assuming that there was amortality rate of 20% both during fish holding in dhonis and cages, an export figure of 1000t represents a total catch of‘ 1600t in 1995. Taking into account the crude nature of the maximum sustainable yield (MSY) of 1800t/year and the requirement that this yield should be tapped from all over the country, it can be concluded the fishery reached MSY in 1995. Up to 1995 the fisher) was mainly in the central atolls, This region must have experienced a very high fishing pressure, and it now urgently requires a crop rest. Therefore it is advisable to close these atolls for at least one year and impose a minimum size restriction on the fishery.

One reason for f&t stock depletion ofreef resources is the small stock size ofindividual species. Coral reef environments arc generally rich in variety, but poor in abundance of individual species. Therefore, with its small abundance, a particular species or genus cannot support an unmanaged commercial fishery The giant clam and sea cucumber fisheryhave shown us this reality.

The peculiar characteristic of the Maldivian environment -- rich variety and poor abundance — should be considered when developing reef fisheries. If reef resource exploitation is allowed to continue unmanaged, it will adversely affect fisheries and tourism. These sectors provide more than 70% of total government revenue, create

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Table 3. Breakdown of potential yields from the three zones

A. Northern atolls

Geographical atoll	*Shallow reef area*		*Atoll basin*		*Deep reef slope*	
	Area (km)	*Potential yield (t/yr)*	*Area (km)*	*Potential yield (t/yr)*	*Area (km)*	*Potential yield (t/yr)*
Ihavandippolhu	55	14	220	10	70	1.5
Thila-Miladhunmadulu	370	97	3510	163	410	9.07
Makunudhoo	50	13	75	3	70	1.54
Alifushi	3	0.79			10	0.22
N. Maalhosmadulu	180	47	1000	46	170	3.76
C. Maalhosmadulu	26	7	115	5	60	1.33
S. Malhosmadulul	175	46	770	36	130	2.88
Faadippolhu	90	24	600	28	120	4.65
Goidhoo	40	11	65	3	45	1
Total	989	260	6355	294	1085	25.95

B. Central atolls

Geographical atoll	*Shallow reef area*		*Atoll basin*		*Deep reef slope*	
	Area (km)	*Potential yield (t/yr)*	*Area (km)*	*Potential yield (t/yr)*	*Area (km)*	*Potential yield (t/yr)*
Kaashidhoo	5	1			15	0.32
Gaafaru	20	4	65	2	40	0.87
N. Male	270	60	1250	40	170	3.71
S. Male	120	27	430	14	100	2.19
Thoddu	2	0.44			10	0.22
Rasdhoo	19	4	40	1	30	0.66
Ari	385	117	1880	289	220	5
Felidhoo	290	64	810	25	170	3.72
Wattaru	24	5	25	0.79	30	0.66
Mulaku	213	47	745	23	140	3.06
N. Nilandhe	188	42	420	13	100	2.19
S. Nilandhe	175	39	540	17	110	2.4
Total	1711	410.44	6205	424.79	1135	25

A. Northern atolls

Geographical atoll	*Shallow reef area*		*A toll bus in*		*Deep reef slope*	
	Area (km)	*Potential yield (t/yr)*	*Area (km)*	*Potential yield (t/yr)*	*Area (km)*	*Potential yield (t/yr)*
Kolhumadulu	220	32	1450	7	160	3.3
t laddunmathi	180	27	680	3	130	2.68
t luvadhoo	365	54	2900	14	260	5.37
Foa-Mulaku	5	0.74			20	0.41
Addu	50	7	95	0.44	60	1.24
Total	820	120.74	5125	24.44	630	13

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Table 4. Minimum maturity lengths of commercially important grouper species.

A. Medium size groupers

	Max total length reported in literature cm	*Max total lngth caught during exploratoryfishing survey cm*	*Max total length of maturedfish caught during exploratoryfishing survey, cm*	*Theoretical maturity length, cm*
Aethaloperca rogaa (Forsskal, 1775)	60	43	28	30
Anyperodon *leucogrammnicus* (Valenciennes, 1828)	52	44	26	26
Cephalopholisargus Bloch and Schneider, 1801	55	36	27	27.5
Cephalopholis miniata (Forsskal, 1775)	40	37	23	20
Cephalopholis sexmaculata (Ruppel, 1830)	48		24	
Cephalopholis sonnerati (Valenciennes. 1828)	57	53	32	28.5
Epinephelus areolatus (Forsskal, 1775)	40	42	25	20
Epinephelus caeruleopunctaius (Bloch, 1790)	59			29.5
Epinephelus chiorostigma (Valenciennes, 1828)	75			37.5
Epinephelusfasciatus (Forsskal, *1775)*	40			20
Epinephelus longispinis (Kner, 1864)	54*			27
Epinephelus ongus (Bloch, 1790)	31			*15.5*
Epinephelus spilotoceps Schultz, 1953	31	46	23	*15.5*
Epinephelus macrospilos (Bleeker, 1855)	50*			*25*
Epinephelus melanostigrna Schultz, 1953	33			16.5
Epinephelus miliaris (Valenciennes, 1830)	53	54	35	26.5
Epinephelus rnorrhua (Valenciennes,1833)	73			36.5
Epinephelus octofasciatus (Griffin, 1926)	80			40
Epinepheluspoecilonotus (Temminck and Schlegel, 1842)	63			31.5
Epinephelus retouti Bleeker, 1868	*50*			25
Epinephelus tauvina (Forsskal, 1775)	75			37.5
Gracila albomarginata (Fowler and Bean, 1930)	38			19
Mean	52.65	44.375	27.375	26.295
Standard deviation	15.277	6.566	4.240	7.273

*Total length calculated based on actual standard length

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B. Large size group

Species	Max total length reported in literature, cm	Max total length caught during exploratory fishing survey cm	MAn total length of matured fish caught during exploratory fishing survey, cm	Theoretical maturity length, cm
Epinephelusfuscoguuatus (Forsskal, 1775)	95			47.5
Epinephalus (Bleeker, 1849)	75	58	39	37.5
Epinephelus flavocaeruleus (Lacepede, 1802)	80			40
Epinephelus multinotatus (Peters, 1876)	100			50
Plectropomus areolatus (Ruppell, 1830)	68*	60	39	34
Plectropomus laevis (Lacepede, 1801)	125	82	62	62.5
Plectropomus pessuliferus (Fowler, 1904)	63	59	37	31.5
Variola albimarginata Baissac, 1952	47	38	22	23.5
Variola louti (Forsskal, 1775)	81	58	41	40.5
Mean	83.25	59.166	40	40.777
Standard deviation	23.8 13	13.948	12.806	11.423

*Total length calculated based on actual standard length

C. Small size group

Species	Max total length reported in literature, cm	Max total length caught during exploratory fishing survey cm	MAn total length of matured fish caught during exploratory fishing survey, cm	Theoretical maturity length, cm
Cephalopholis aurantia (Valencicnnes, 1828)	30			15
Cephalopholis boenak (Bloch 1790)	26			13
Cephalopholis leopardus (l.acepede, 1802)	20			10
Cephalopholis spiloparaea (Valenciennes, 1828)	22			11
Cephalopholis urodeta (Forster, 1801)	28			14
Epinephelus merra Bloch, 1793	32			16
Mean	26.33			13.17
Standard deviation	463			2.32

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D. Extra large size group

Species	Max total length reported in literature, cm	Min total length caught during exploratory fishing survey, cm	Min total length of matured fish caught during exploratory fishing survey, cm	Theoretical maturity length, cm
Epinephelus lanceolatus (Bloch, 1790)	231	204**		115.5

**From MRS musium records

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a large number of jobs in the central and outer atolls, and attract foreign investments. Therefore, the reef resources need to be urgently managed so that reef fisheries develop in parallel with the tourism sector. In its development, the tourism sector has also to take into account the traditional dependency of the country on fisheries and other living marine resources. This is easier said than done.

The fisheries sector and intersectoral co-development is complicated by a number of issues, including insufficient resource knowledge, insufficient trained manpower, lack of specific statistics; lack of integrated management approaches, introduction of even short term management measures without causing an imbalance to the livelihood of the people, and the involvement of diverse interest groups.

Resource use conflicts and stock depletion problems are totally new to Maldivian fishermen, who have been fishing freely all over the country throughout their life. They need time and guidance to get used to today's changing situation.

6. RECOMMENDATIONS

6.1 General Reef Fish Fishery

6.1. I. Informing MOFA When Starting New Commercial Fisheries

At the present level of exploitation, there is still room to expand the traditional multi-species reef fishery. As this fishery is found all over the country and involves many species, the chances of localised overfishing of any one species are very small. On the other hand when a fishery targets a single species, it is possible to overfish the species quickly in the locality where the fishery has first started, as anew fishery tend to remain in its place of origin until it has become acceptable in other parts of the country. For this reason it is important that MOFA be informed when starting a new commercial fishery, particularly a single-species fishery. When MOFA have this information at the very beginning of the fishery, the Ministry can get ready to take management measures at the appropriate time. Under the present system of open fishing access to Maldivian nationals in the country’s territorial waters, MOFA often gets to know about new fisheries at a very late stage. Often by that time urgent management measures are already required. For example, take the giant clam, and Napoleon Wrasse fisheries. Informing MOFA and getting the Ministry’s consent about new commercial fisheries

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can be made a prerequisite to starting new fisheries. However, MOFA should see that this prerequisite does not discourage the starting of new fisheries and make clear to all parties that they start new fisheries at their own risk.

6.1.2 Improving Reef Fish Catch and Effort Data Collection

In the present system of catch and effort data collection, reef fish enters into the category "Fish other than tuna". If reef fish catch is required an estimate has to be made based on the data for the "other fish category". When we give high priority to reef fish stock assessment, we also should obtain reliable catch figures for reef fish to compare with the stock figures. Therefore, it is recommended to collect reef fish statistics separately so that we know the contribution of reefs to fisheries with some accuracy. This information is important to fisheries management and to decision-making such as allocating a particular reef in a region for diving or fishing.

6.1.3 Increasing Awareness

Reef fishing, or the exploitation of other forms of reef resources, involves some or other by-catch, or environmental damage. This by-catch and damages may be in the forms of undersized fish, giant clams removed with mined corals, or broken corals during baitfishing and lobster fishing. The undersized fish and clams can still survive and later contribute to fisheries if they are put back in the sea. To make the fishermen respect marine life and reduce the by-catch and environmental damage, it is necessary to increase fishermen's awareness.

6.1.4 Gear Restriction

It has been shown that handline is the most effective gear for reef fishing in Maldives. Traps, which offer the advantage: of little damage to fish, break a considerable amount of corals during their operation. If a trap is lost, it will continue to deplete the resources by "ghost fishing". When developing and managing reef fisheries, MOFA should decide on the gear that are to be allowed for reef fishing.

6.1.5 Enforcing Regulations on Protected Dive sites

All fisheries activities except baitfishing with traditional methods have been prohibited in the protected dive sites. However, the enforcement of this and other rules still remains a problem. An effective mechanism of enforcement will bring about better harmony between the fisheries and tourism sectors.

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6.1.6 Improved Co-ordination and Co-operation

Improved co-ordination and co-operation among government Ministries, and between the Ministries and private sector, are required to address challenging issues of fisheries development, and the management needs of today.

6.2 GROUPER FISHERY

6.2.2 Open and Closed Atolls and Regions; Totally Open and Closed Periods

For effective management of grouper fishery, the northern and southern atolls from Male can be opened and closed on an alternating basis; when one region is open for fishing the other region can be closed for fishing at least for one year. During this crop-resting period, groupers will grow and reproduce, with only a small fishing pressure caused by general reef fishing.

Grouper fishing should also be restricted in atolls of the open region, based on their estimated sustainable yields. When fishing in an atoll has reached these figures, the atoll may be closed for grouper-targeted fishing for at least one year. This measure is aimed at preventing localised overfishing. If all the atolls in the open region have been simultaneously overfished, the open region also has to be closed. By this time if the previously closed region has not been opened, the whole country will remain closed for grouper fishing.

Another alternative of the open and closed measures is to close the whole country for grouper fishing for a definite period and reopen later, to be closed again in due time.

As the opening and closing of an area depend on the intensity of fishing, fishermen themselves can regulate the duration of the open and closed periods and the frequency of closing and opening by adjusting the fishing intensity.

6.2.4 Size Restriction

For commercial use, the removal of groupers less than the average maturity length of 12 inches from the medium size group and 16 inches from the large size group (Table 4) can be prohibited. The small and extra-large size groups contain no commercial species either because of small size or rarity. Catching a fish larger than 12 inches from the small size group will do no harm as the members of this group will get matured at the lenth of 6 inches. The extra-large group contains one very rare

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species that is not caught in commercial fishery. These two size restriction measures are expected to catch 80% of commercial and potentially commercial grouper species after spawning at least once in their life.

6.2.5 Aquaculture

Grouper aquaculture should be experimented with as a long term measure for increasing grouper production and as a tool for the management of the grouper fishery. The Marine Research Section of MOFA has already initiated such experiments.

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PAPER 4

EXPLOITATION OF REEF RESOURCES — BECHE-DE-MER, REEF SHARKS, GIANT CLAMS, LOBSTERS AND OTHERS

BY

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ABSTRACT

The Reef Shark fishery, Sea Cucumber fishery and the Giant Clam fishery are some of the major fisheries that have gained economic significance in the Maldives during the past 15-20 years because of their high demand in the export market. During their peak years these fisheries contributed significantly to the export earnings ofthe country. Annual revenues exceeding MRf I million for the giant clam fishery, more than MRf 14 million for the shark fishery and more than MRf 35 million for the beche-de-mer fishery, were secured during their time. Unlike the above fisheries which were export-orientated, turtles and lobsters were exploited to cater to the local population and the tourist industry for food as well as production ofjewellery.

The development and evolution of each fishery exhibit classic trends and offer valuable information for future management options. The Reef Shark fishery which developed in the mid-'70s seems to have been maintained at moderate levels without major cause for concern as far as stock levels are concerned. However, exploitation in the tourist zone risks serious conflict with shark-watching divers. The Sea Cucumber fishery proved to be a typical boom and bust fishery. It commenced in the mid eighties with exports of bech-de-mer reaching a peak of 746 Mt. by 1990 and rapidly decreasing to less than 70 Mt. by 1994. By 1991, the species composition of the catch had completely changed; the low valued species dominated catches and the high-valued species became harder to access. Results of management measures which have relevance for reef resources management are discussed largely on the basis of an analysis of the Sea Cucumber fishery. The giant clam fishery lasted only for two years during which period more than 20 Mt. of clam representing more than 125,000 clams had been exported. Fears of severe resource depletion as well as conflicts with tourism resulted in a ban on exports from 1991 and a subsequent ban on harvesting giant clams since July 1995. A proper study of the lobster fishery has not been carried out, although it has become a significant fishery.

One common problem associated with all these fisheries was inadequate monitoring of the fishery. Catch and effort data were not collected regularly in any of the fisheries. While limited catch statistics is being recorded at present in some of the fisheries (e.g. shark and lobsters), these have their own limitations. Another important issue was that the development of-some of these fisheries resulted in conflicts with the tourism industry. Limited management measures are in place for most of the fisheries. However, monitoring and implementation of these measures have proven to be difficult.

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1.0. INTRODUCTION

Exploitation ofrecf-associated resources for commercial purposes is of recent origin in the Maldives. Traditionally, Maldivians have depended on tuna and tuna-like species from the coastal waters for home consumption as well as export. reef associated resources not being popular among the local population as a source of food. However, the reefs and reef resources have gained significance in the past 20 years or so both as a tourist attraction and as an export product. “Motorised transport and the demand for exotic seafood by the tourist industry as well as the international markets, have had serious effects on coastal reef-associated resources” (Manik 1994). In addition the traditional tuna fishermen of the Maldives are extremely adept at turning their hands to any other fishery (either part-time or full-time) that has the potential to increase their income, thus affecting the rate at which non-traditional reefresources are tapped.

The revenue from reefproduct exports have increased from MRf 3.8 million in 198 1 to MRf36.71 million in 1994. Meanwhile the products exported diversified from mainly dried recffish and shark products to include chilled frozen and live reef fish as well as invertebrates such as seacucumber and giant clam.

Giant clams, sea cucumber and reef sharks are some of the major reef-associated resources exploited because of their high demand in the international market and lobsters arc fished to cater to the tourist industry locally. In addition to managing each fishery for long-term Sustainability resource managers face the task of resolving conflicts between conflicting user groups.

Comprehensive studies on most of the major fisheries of the Maldives have been carried out whenever a fishery gained commercial importance. While these reports include detailed descriptions of all aspects of each fishery, a short review of the different fisheries, highlighting important management issues may be more helpful from an integrated resource management perspective. Such a review would be useful in identifying similar trends in the different fisheries while presenting the unique characteristics of each fishery. This review aims to highlight the important issues associated with each fishery which would aid resource managers to identify issues to be addressed in an integrated reef resources management plan for the Maldives.

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2.0. THE SEA CUCUMBER FISHERY

2.1. Introduction

The fishery for sea cucumber is a non-traditional fishery in the Maldives. It is one of the examples of a scarcely exploited resource being rapidly used up once its income earning capacity was realised, in this case solely as an export product. The first reported export of beche-de-mer from the Maldives was in late 1985 when a trial shipment of' prickly red fish *(Thelonata ananas)* was made to Singapore.

The fishery went largely unmonitored in the initial years except for export statistics which was compiled by customs. A short study of the fishery was conducted in 199 1 with the aid of BOBP, to review all the relevant issues associated with the fishery including the need for management of the resource and further development of the fishery. This review is based on the above sources of information, the most comprehensive of which is the study carried out by L. Joseph in 199 1 for BOBP. The information sources used by Joseph (1992) were mainly interviews with fishermen and export agencies, data from customs and export agencies and some first hand observations of the fishery. It is assumed that the customs export data reflects the catch since sea cucumber products are rarely utilised within the Maldives. In addition, questionnaires were sent to all the inhabited islands in 1992, to be filled by the island development committee in order to obtain their views towards various management options available.

2.2. Development of the Fishery

The processed product of sea cucumber, beche-de-mer, was first exported from the Maldives in 1985 as result of interest shown by a party in Singapore through a Maldivian residing in Singapore. By 1986 there were two exporters in the trade and the fishery had spread to most of the atolls both in the north and south of the country.

The beche-de-mer exports increased rapidly since 1985, reaching a peak of 745 t by 1990, just five years since its inception. By 1994, it had declined to 66t (Fig 2.1.), just as rapidly as it had grown by 1990. The total value of exports peaked in 1988. earning more than MRf 39 million in that year.

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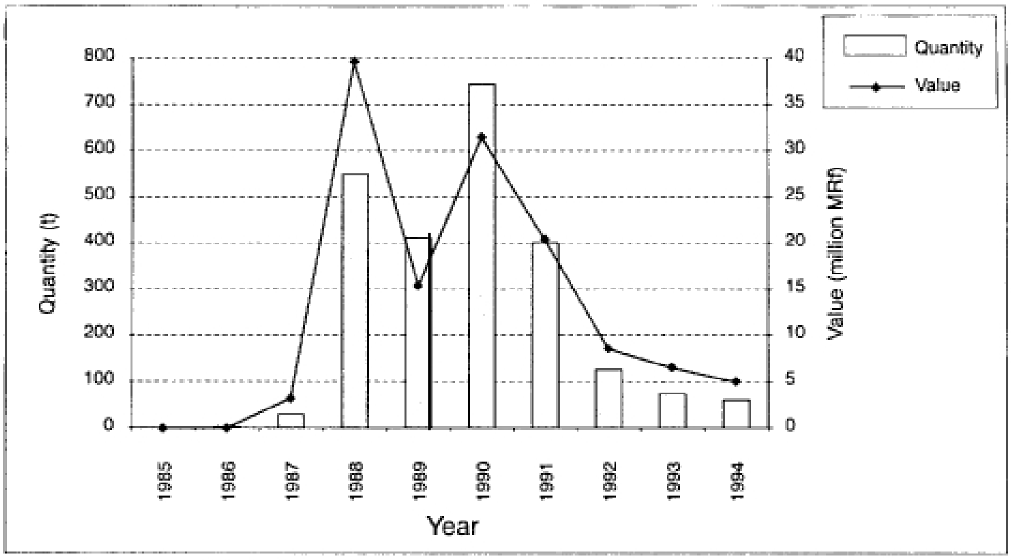
Figure 2.1. Beche-de-mer exports from the Maldives 1985 -1994.



The average price per kg of beche-de-mer exported was the highest in the first three years of the fishery, ranging from MRf 71/kg to MRf91/kg, when the beche-de-mer exports were dominated by high-value varieties. It subsequently decreased to MRf 38/kg in 1989 and again increased reaching MRf90/kg in 1993 (Table 2.1.). The low average price/kg from 1989 to 1991 is attributed to the increase in the amount of low valued varieties in the exports. The average prices per kg in 1993 and 1994 are similar to those of the first few years when high-value varieties dominated exports.

Table 2.1. Average export price/kg beche-de-mer

Year	*Price/kg*
1986	71.09
1987	91.94
1988	71.38
1989	38.45
1990	42.34
1991	*50.67*
1992	70.66
1993	90.63
1994	76.00

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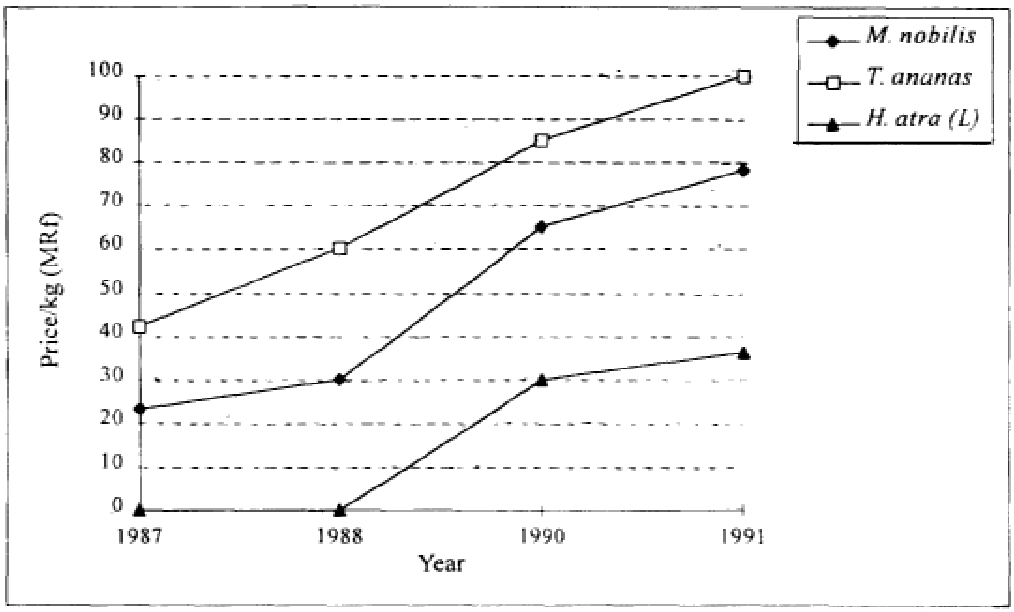
Unlike the average price/kg of exported beche-de-mer, the price/kg paid to the fishermen for various species individually increased steadily over the years (Fig 2.2.). The price paid to fishermen for the *M. nobilis* increased from just MRf 23/kg in 1987 to MRf 78/kg in 1991. Similarly the price paid for *T ananas* increased from MRf42/kg to MRf 100/kg in the same time period.

Figure 2.2. The price/kg paid to fishermen for different varieties of sea cucmber.



Source: Modified from Joseph (1992)

As the fishery evolved, the species composition of the exports also changed (Fig 2.3.) Initially only the high value species like *Thelenota ananas* (prickly red fish) and *Micro the/c nobilis* (white teat fish) were exported. However five years later, by 1990, catch composition had completely changed, with exports being dominated by the low-valued *Halodeima atra* (lolly fish). It is suggested that the level of exploitation of this species clearly reflects the state of the sea cucumber fisheries in the various islands. It is believed that fishermen tend to leave this species without exploitation as long as other species are available (Joseph, 1992).

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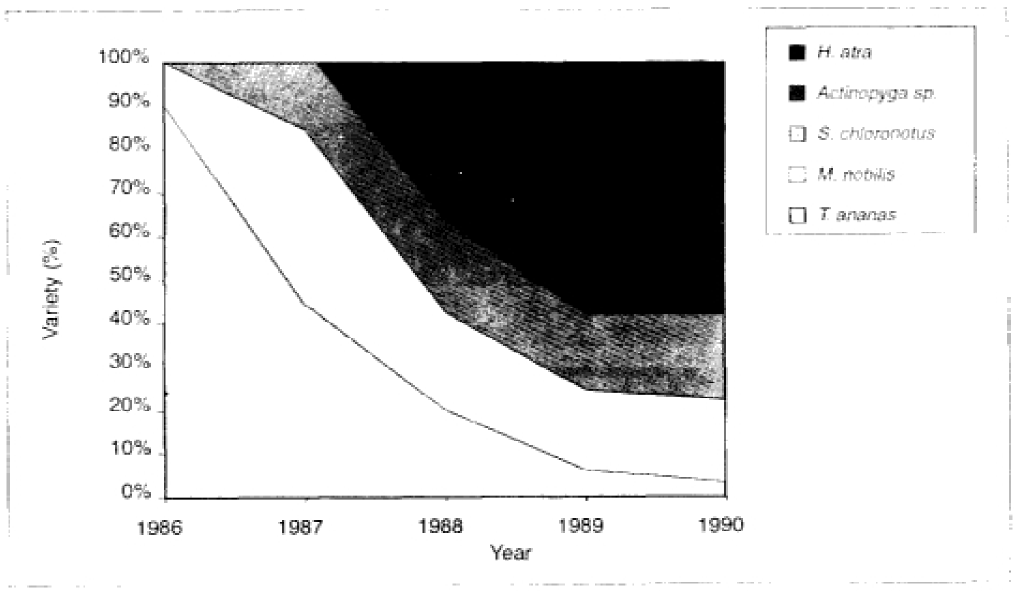
Figure 2.3. Species composition of **heche-de-mer exported from the** Maldives.



Source: Mod ified from Joseph (1 992)

During the initial stage of the fishery, sea cucumbers were harvested by hand picking during low tide **from** the intertidal region and from shallow water lagoons less than one meter deep. When increased exploitation resulted in depletion of resources in these easily accessible areas fishermen adopted other methods and areas of collection. Snorkeling, spears and use of line w ith hook and sinker helped exploit the resources in the deeper waters up to 1 5-20 meters. A few people who had access to SCUBA gear utilised these to selectively harvest the high-valued species like T. *ananas* and **M.** *nobilis* from depths up to 30 meters. One such group had 1 7 divers diving for sea cucumber 1 5—20 days a month for 9 months of the year (Joseph, 1992) during the peak years of the fishery. It is believed that the production of the high-valued M. *nobilis* was maintained after the first few years of the fishery due to the development and expansion of SCUBA diving. Further, it was suggested that in spite of this practice the production of 77 *cinanas* could not he maintained due to overexploitaion of the resource (Joseph and Shakeel, 1991). At present SCUBA diving for sea cucumber is prohibited by law in the Mald ives.

When the sea cucumber fishery was at its peak it was a most popular fishery among fisherfolk, second to the major tuna fishery of the country. It replaced the other reef fisheries and became the major reef fishery during the non-tuna season. Joseph (1992) found that among 16 islands surveyed, 5-6% of a total of 2500 fishermen were involved in sea cucumber fishery full time and the remaining were involved part-time to varying degrees in the fishery. Most fishermen went on day trips for sea cucumber. However, some would be away from their home islands from 1-4 weeks for sea cucumber. During these long trips the catch was processed largely in the uninhabited islands (Joseph and Shakeel, 199 1).

During the initial years of the sea cucumber fishery, income from this fishery exceeded that from the tuna fishery in some islands. The monthly income of a fisherman varied from MRf 500 to MRf 3000 in 199 1. depending on the fishing effort and the availability of the resource (Joseph and Shakeel. 1991). The importance of the fishery to the fishermen during its best years was well summarised by a fisherman: "We have been able to build or renovate our houses, construct attached toilets and water tanks, purchase household items and even reclaim land from the sea with the income from Huifilada" (Joseph and Shakccl, 199 1). However, at present very few fishermen are involved in this fishery.

During the peak years of the sea cucumber exploitation there were at least six exporters of beche-de-mer operating in the country. However, at present there are only two major exporters.

2.3. STOCK STATUS

Very little biological information is available about the holothurian resources of the Maldives. No stock assessment studies have been carried out to date. However an idea about the relative abundance of the different commercially important species was provided by Joseph (1992). Following is an account of the biology of commercially important species prepared by Joseph (1992).

Microthele nobilis (White teat fish)

This species was reported to be the most valuable species in the beche-de-mer market. It is known to occur in two colour morphs of which the white teat fish is more valuable and is reported to occur in waters from 3-30 meters in coral sand in reef passages and in sea grass beds. The black form is found on clean sandy bottom in shallow waters of 3 meters depth. This species was being harvested from deeper

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waters and outer surf areas and was believed to be very rare in some of the islands by 1991. At the beginning of the fishery, between 400 and 500 numbers of this species were collected per day by a single boat. However, by 1991 the daily collection could be as low as 5 to 6 per boat. It was believed that collection by SCUBA divers targeting white teat fish exclusively was responsible for maintaining the level of production after the first 2-3 years. The average length of the processed M: *Nobilis* fell within 14-l 6 cms.

Thelonata ananas (Prickly red fish)

This species which is found to grow up to 700 mm in length is reported to be found at depths of 2-30m in clean sandy bottoms of the reef enclosed lagoons and beside coral heads. It is believed to be very rare in most of the islands as a result of resource depletion due to selective harvesting. Small amounts were reported to be available only in deep waters of 20-25 meters. At the beginning of the fishery some fishermen collected as many as 700 per boat per day but were harvesting only 10-15 per boat per day by 199 1. The average length of the processed product fell within 16- 18cms.

Stichopus chloronotus (Green fish)

Reported to occur in shallow waters of the lagoons and reef flats with broken rubble in depths up to 2 meters and grows to 400 mm. Large specimens have been taken from depths of 9- 10 meters. Although quite abundant in many islands, thought to be of little value commercially. The processed average length fell within 10 - 11 cms.

Halodeima atra (Lolly fish)

Reported to be the most abundant species in the Maldives, the lolly fish is also one of the largest, and can grow up to 600 mm. The smaller individuals were observed in large numbers in shallow waters, in ankle deep water in sandy reef flats. Inside the reef they are reported to be found at depths up to 6 m and reach a length of 300 mm. Larger animals of 600 mm were observed in deeper waters outside the reef. The processed average length fell within 6-7 cms.

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Actinopyga mauritiana (Surf red fish)

This species is commonly found where the surf breaks on the outside of the reef, firmly attached to the substrata. Fishermen who were aware of their habitat claimed that it is easily taken as it is very conspicuous. Grows to about 300mm live length and the processed average length is between 11 to 13 mm.

Other Species

The rest of the Actinopyga species exported were grouped together. The species in this group include: *A. miliaris,* which is said to occur in shallow waters of more than 2 meters in clear water on reef flats and on algal beds; *A. lecanora* which is reported to be found at 2- 1 Om depths, often on underside of stones and on coral sand with sea weeds and grows up to 400 mm length; *A echinites* which is reported to grow to 300mm and generally found in deeper waters up to 30 meters, on sandy bottoms and among live coral s. The other exported sea cucumber species, M. *axiologa* (Elephants trunk fish), *T. anax* (Turtle shell), and *Bohadschia marmorata* (Amber fish) were not harvested in,large amounts.

Based on information provided by fishermen, Joseph (1992) ascertained the relative abundance of the commercially important species in some islands on a scale of : “very common”, “common”, " rare” and “very rare” (Table 2.2,). The most abundant species were identified as *H. atra, S. chloronotus,* and Actinopyga spp. The species reported to be the least abundant were *T. ananas, M. nobilis* and *A mauritiana.* It is not clarified whether this was the relative abundance at that point in time when the resources had been exploited considerably or in general at the beginning of the fishery.

Table 2.2. - Relative abundance of commercially important sea cucumber species in the Maldives

Species	*Islands*														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
T ananas	-	—.-_	-	—	-	-	—	—	—-						
M. nobilis	+							-		-	-	-	—	—	—
A. mauritiana	+	-	—	+	-	-	-	+	+	-	+	+	-	+	+
S. chioronotus	++	++	+	+	++	+	+	++	+	++	++	+	+	+	+
Actinopygasp.	+	-	+	++	+	+	-	+	+	+	+	+	+	+	+
B. marmorata	+	-	+	+	+	+	-	-	-	+	+	+	-	+	-
H. atra	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++
M. axiologa	- -+	+	+	+	++	+	-	-	-	-	-	+	+	+	-
T anax	+	+	+	++	+	+	+	-	-	+	-	+	+	+	-

+ Common ++ Very common - Rare Very rare

Source: Modified from Joseph (1992)

2.4. ISSUES RELA TED TO THE FISHERY

Interactions with the tuna fishery. Tuna is the main fishery ofthe country. Resources (craft and manpower) were diverted from this fishery to the sea cucumber fishery during the peak years from 1988-1991. In some islands the income from sea cucumber fishery was greater at certain times than from the tuna fishery and fishermen preferred to go for sea cucumber even during the tuna season. However, some fishermen preferred remaining with tuna fishing since they believed the sea cucumber fishery involved more work (Joseph, 1992). No conflicts with other activities or resource users have been reported.

Uncontrolled Expansion of the Fishery. Uncontrolled expansion ofthe fisheiy resulted in rapid depletion ofresources, especially the high-valued less abundant species like *T ananas* and *M nobilis*. Too little regulatory measures were taken too late. By the time a regulatory measure was taken in 1993, more drastic measures were called for. In addition, the regulatory measure declared (i.e. prohibiting collection using SCUBA) is not implemented properly.

Uneconomic utilization of the resource. Bad processing procedures resulted in poor product quality, especially in the beginning of the fishery, which resulted in loss of export revenue to the country. Proper techniques for processing sea cucumber had not been demonstrated to the Maldivian fishermen at the beginning. It was believed that that revenue from exports could have been increased by about 30% if the beche-de-mer quality had been better (Joseph, 1992).

2.5. PUBLIC VIEW OF MANAGEMENT OPTIONS

The view of the island development committees on different management options available were sought in 1992 through a set of questionnaires. However, the response to the questionnaires was not analysed until recently. The two options that received the most support were for banning collection of sea cucumber using SCUBA (76%=yes) and setting a size limit for H. *atra* that is allowed for collection (79%=yes). Collection of sea cucumber using SCUBA was banned in 1993 although not necessarily in response to the results of the above mentioned questionnaires. The most unpopular options proved to be declaration of closed and open areas both in the North and South of the country and having them opened and closed alternatively. Half the respondents chose this as the option they did not want implemented. The second most unpopular option was to determine and establish collection zones. Establishment of these zones considered the size of the zone, the abundance of sea cucumber in the area and the size of the population of the area. Collection of sea cucumber within the zoned area was to be restricted to islanders residing in that area. It is also of interest to note that although the option for allowing only people belonging to each administrative atoll to collect sea cucumber from that atoll was presented, it was not particularly popular. This would probably have relevance when considering management options for all reef fisheries. Appendix-l provides the details of various options presented in the questionnaires and the responses. A separate background paper (Shakeel and Ahmed, 1996) is available with details of the management options provided and the analysis of the response from the various islands.

2.6. RECOMMENDATIONS

The following recommendations were put forward in 1991 to promote long-term sustainable exploitation of the sea cucumber resource, Joseph and Shakeel (199 1) and Joseph (1992):

a) A moratorium on the catching and export of T. *ananas* for 4-5 years to be declared, in order to rehabilitate resources depleted by heavy fishing pressure.

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b) A complete ban on the collection of all sea cucumber species using SCUBA in order to protect the spawning populations of high-valued T. *auanas* and M. nobilis in the deeper waters,

Action Taken - Banned since 1993. However it is not monitored and implemented properly, thus not effective.

c) A minimum size limit (e.g. above 6" processed length) be placed for H. *atra, so* that maximum economic benefits can be derived from the resource.

d) Fishermen in different atolls be allowed exclusive use of resources within their own atolls, which would also lead to a more regulated fishery with better monitoring.

e) Training and demonstration of proper processing techniques be given to fishermen so that economic benefits are maximized.

f) Data collection and monitoring system be set up to obtain catch (export) and effort data pertaining to the fishery. It was suggested that the government officials responsible for fisheries matters in the islands gather data on the number of fishermen and craft involved in the fishery on a periodic basis and at the same time have exporters keep records of quantities and varieties of beche-de-mer obtained from the different islands.

g) Establishment of sea ranching programs with the active participation of fishermen.

Action taken - Some work being done by a private enterprise in collaboration with the Marine Research Section.

3.0. THE REEF SHARK FISHERY

3.1. Introduction

The Maldivian shark fishery which was traditionally based on the demand for shark liver oil has developed and diversified tremendously in the past 15-20 years. Currently three main shark fisheries exist in the Maldives. An offshore longline and handline fishery for oceanic shark, which yields fins and meat for export. An inshore gillnet,

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handline and longline fishery for reef and other atoll-associated shark, which also yields fins and meat for export. And an offshore longline and handline fishery for Gulper Shark which yields high value oil for export. Of these this review is concerned with the fishery for reef and other atoll-associated shark. The fishery targeting reef sharks seems to have expanded in the mid 1970's and maintained since then.

The reef shark resource of the Maldives is very valuable, bringing in revenue both through fisheries and tourism. Shark-watching is a major attraction among tourist divers and shark products bring in export earnings. Problems arise due to conflicting methods of resource utilization by the two sectors. Reduced shark numbers in popular shark-watching sites due to fishing, lead to complaints from the tourism sector. Thus resolving the conflicts between resource users as well as managing the fishery for long-term sustainability are management issues faced by the concerned authorities.

The objective of this review is to provide an overview of the fishery for reef and other atoll-associated sharks in the Maldives, highlighting the various management issues associated with the fishery.

This review paper is mainly a summary of the study carried out by Anderson and Ahmed (1993) "The Shark Fisheries in The Maldives". Most of the information about the fishery is therefore from the time of the above study which was in 1992. It is assumed that the general characteristics of the fishery are still the same although some estimates (e.g. number of boats involved in the fishery, catch rates) may have changed. In addition some information has been updated using customs data and estimation methods used by Anderson and Ahmed (1993). Likewise managerial measures taken subsequent to the study by Anderson and Ahmed (1993) are included in order to update this review.

3.2. Development of the fishery

The Maldivian shark fisheries was traditionally based on the demand for shark liver oil used for regular maintenance of wooden boats. Traditionally two main species were targeted by two related forms of shark fishing. These were; maa keyolhu kan which targeted Tiger shark (Galeocerdo cuvier) and madu miyaru keyolhu kan which targeted the deepwater Six-gill Shark (Hexanchus griseus): This age-old pattern of fishing started to change in the early 1960s with the introduction of longlining into the country. During this time pelagic shark longlining started to spread in the country replacing maa keyolhukan in the process. The next big change came in the mid- 1970s with the widespread motorization of fishing craft, the introduction of gillnetting and

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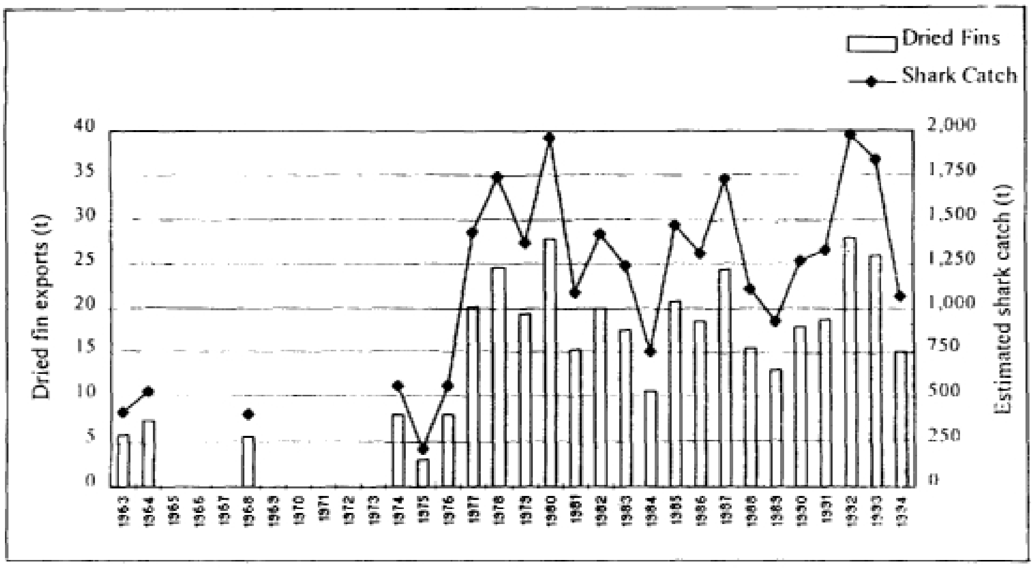
an increase in prices paid for shark fins. This lead to a boom in shark catches which has been maintained since then.

The reef and atoll-associated shark fishery is mainly based on the export of dried fins most often to Singapore. The meat is dried and exported as a valuable byproduct to Sri Lanka. The jaws of valuable species are dried and sold to tourist shops. Very rarely is the skin dried and exported.

It is difficult to follow the progress of the reef and atoll-associated shark fishery as an independent fishery. There are no separate catch statistics available for the different species or categories. The data sources available to estimate the shark catches are the Customs export data for dried fins. However the dried fins exported include both those of reef and other atoll- associated shark as well as oceanic sharks lumped together. Thus any catch statistics provided is an estimate that includes oceanic sharks as well. Figure (3.1.) gives the shark fin exports from 1963 to 1994 and the total catch estimated (Anderson and Ahmed, 1993) using this data.

Figure 3.1. Dried shark fin exports and estimated shark catch from 1963-1994.



Source. Modified from Anderson and Ahmed 1993.

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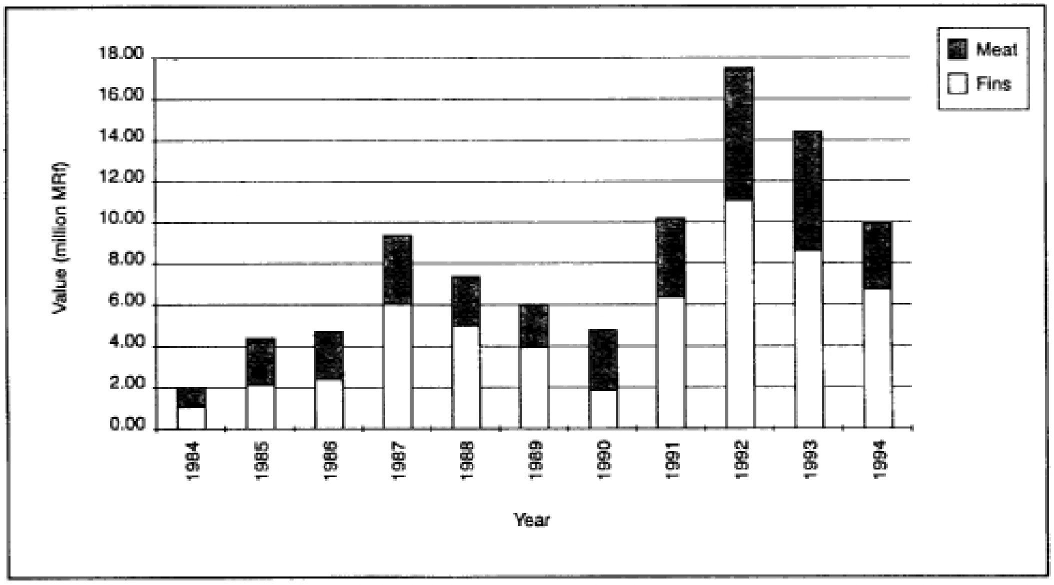
Prior to 1977 the total shark catch (reef and other-atoll associated sharks, oceanic sharks) was relatively low as estimated from shark fin exports. For the years for which data are available catches appear to have averaged an estimated 460t/year. In 1977 there was a sudden increase in shark fin exports. This is believed to be attributable to 3 factors:

- Introduction of gilinetting.
- Motorization of local fishing boats.
- Increase in price paid for shark fins.

The average annual shark catch since 1977 has been about 1388 t!year. There has been considerable variation about this average value but without any obvious trend.

The total revenue from shark products (dried fins and salted dried meat) export exceeded an estimated MRf. 4 million/year in the past ten years with the revenue exceeding MRf. 10 million/year in the past four years (Fig. 3.2.). It must be stressed that all the above data include oceanic sharks as well as reef sharks

Figure 3.2. Export Value of Dried Shark Fins and Dried Shark Meat



Source: Modified from Anderson and Ahmed, 1993

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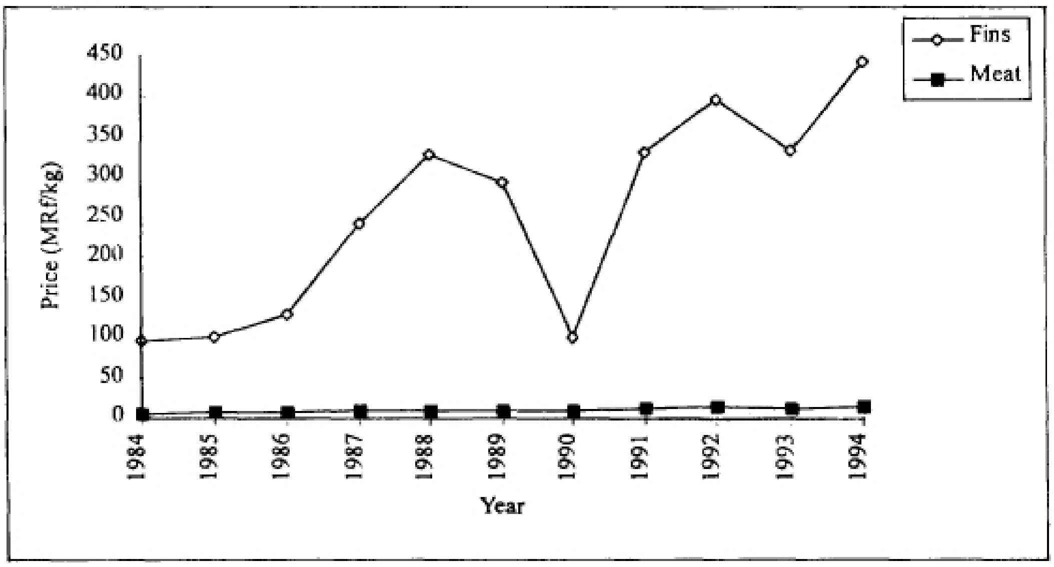
The value of shark meat is an estimate since Customs data combine dried shark meat with the rest of dried reef fish and thus do not provide a direct measure of the value of shark meat exports. The method of estimation is from Anderson and Ahmed (1993).

The price/kg of both shark fins and shark meat have increased in the past ten years (Fig 3.3.)

Figure 3.3. Export **price of salt dried shark meat and dried fins from 1984 to 1994.**



Source: Modified from Anderson and Ahmed 1993.

The estimated average annual export price of salt dried shark meat (Anderson and Ahmed 1993) has slowly but steadily increased over the years from about MRf 4.00 in 1988 to about MRf 13.00 in 1994. In contrast the export price of dried shark fins increased rapidly over the years from about MRf 95.00/kg in 1984 to a high of more than MRf 400/kg by 1994 thus maintaining the high demand for the product.

3.3. Fishing Methods, **Catch and Catch Rates**

Reef sharks and other atoll-associated sharks are fished throughout the Maldives by gilinet, handline and longline.

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Bottom-set gillnets are most commonly used to fish reef sharks in the Maldives. They are locally made, in panels of about 2.53.0m depth and 45-60m length with meshes of about 23-25 cms. Full-time shark gillnetters use nets made up of 7-9 such panels. Fishing trips of 14-18 days are made during the Full Moon period. During these trips generally two nets are set every evening and hauled in the morning. The nets are set perpendicular to the reef, down the slope, on the outer reefs of the atoll and on the atoll floor, between or adjacent to reefs, within the atolls.

The major species caught include the Blacktip Reef *(Carcharhinus melanopterus),* Grey Reef *(C. amblyrhynchos),* Silvertip *(C. albimarginatus),* Spottail *(C. sorrah),* Whitetip Reef *(Triaenodon obesus),* Nurse Shark *(Nebrius ferrugineus)* and the Smalltooth Sandtiger Shark *(Odontaspis ferox).* Of these the Blacktip Reef Shark is more commonly caught from shallow lagoons and the Smalltooth Sandtiger Shark is taken outside the atoll at greater depths. Catch rates vary from 3 to 8 sharks per night and most fishermen involved in the fishery agree that the catch rate has gone down in the past decade, especially in the most heavily fished areas.

Bottom-set longlines are also used to target reef- and atoll-associated sharks. Generally each longline carries 30-40 hooks. The catch composition of bottom-set longlines deployed within the atolls are said to be similar to that of the bottom-set gillnets.

Simple one-hook handlines which are commonly used for reef fishing sometimes take sharks, especially juveniles. Occasionally reef sharks are specifically targeted using stronger lines with wire leaders (Anderson and Ahmed, 1993).

Estimates of number of vessels engaged in shark fishing were made by Anderson and Ahmed (1993).

Shark longlining	(full-time)	13
(bottom-set and drift)	(part-time)	424
Shark gillnetting	(full-time)	47
(bottom-set)	(part-time)	372

3.4. Stock Status

In general shark grow slowly, mature late, have small numbers of young and live long. As a result, there is a direct relationship between stock size and recruitment, with population replacement rates being very low. All these factors mean that shark

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stocks are very easy to overfish. These factors also mean that shark stocks, once overfished, may take years, even decades, to recover.

A proper stock assessment has not been carried out for shark stocks of the Maldives. However, on the basis of export data, knowledge of shark biology, interviews with fishermen and interviews with experienced divers, Anderson and Ahmed (I 993) suggested that the reef sharks were being fished at a moderate level of fishing effort, and were probably sustainable if fishing effort was not increased from the level of 1992.

3.5. Issues Related to the Fishery

A number of important issues concerning the Maldivian shark fisheries were highlighted by Anderson and Ahmed (1993). Of these, a few concerned the reef and atoll-associated shark fishery. Some managerial measures have been taken since the report was published to address some of these issues. Following is a brief account of these issues:

Inadequate monitoring of the fishery. Vital information like catch and effort data necessary for basic management decisions are not collected. Although a 'shark' category has been included in the fisheries statistics since 1992 this does not differentiate between the different shark fisheries — namely, the reef and other atoll-associated shark fishery, the oceanic shark fishery and the deepwater gulper shark fishery.

Conflict between tuna fishermen and shark gillnetters. Pole and line tuna fishing using live bait is the most important fishery in the Maldives. Most tuna fishermen believe that shark-netting 'disturbs' the bait fish in the area resulting in reduced catches. Furthermore tuna fishermen are hostile towards gillnetters coming from other areas fishing on 'their' reefs. Shark gillnetters often move from one atoll to another for fishing. Due to this conflict gillnet buoys are often stolen and the nets tampered with.

Conflict with tourism industry. At present tourism is undoubtedly the most important economic sector in the Maldives at present. Shark watching is a major attraction for tourists that come to dive in the Maldives. At several sites, groups of four to ten or more Grey Reef Shark can be regularly seen in complete safety. Other species that are regularly seen in certain sites include the Whitetip Reef Shark and the Scalloped Hammerhead. An estimated US $2.3 million is spent per year by divers directly on dives at shark watching sites. Further it is estimated that a single Grey Reef Shark at a popular dive site may be worth a hundred times more alive than caught by a fisherman. The same shark is worth about US $ 30 to a fisherman when processed and sold (Anderson and Ahmed, 1993). Thus the vigorous protests made by dive operators on occasions when they have seen shark fishermen operating on popular dive sites is understandable. In 1995 fifteen sites were declared as protected areas but open for diving, several of these are popular shark watching sites. It is hoped that this would help, bring an end to shark fishing in these popular dive sites.

Several tourist resorts offer recreational night reef fishing excursions to their clients. Small sharks are sometimes caught during these trips and most of the time they are killed and wasted instead of throwing them back to the sea live. Returning the shark alive would potentially allow them to

— be caught again by tourists;
— be caught by commercial fishermen;
— be seen underwater by divers, and/or
— grow to maturity and reproduce.

3.6. Recommendations

The recommendations pertaining to the reef shark fishery made by Anderson and Ahmed (1993) after studying the shark fisheries of the Maldives are given below. Subsequent and related management measures taken are also provided.

1) The country's most outstanding shark watching site (Fish Head) to be considered for protection.

   At the same time it was suggested that such protection may not be entirely effective by itself since shark can and do move considerable distances.

   Action taken - Protected from June 1995.

2) Other popular dive sites to be listed for possible protection.

   Action taken - 15 sites protected from June 1995.

3) The use of gillnets within the tourism zone to be reviewed.

   Ministry of Fisheries and Agriculture to give careful consideration to the future of shark netting particularly within the main tourism zone. In view of the fact

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that two major shark-netting islands are in this zone, banning of shark-netting in this zone by fishermen from other atolls to be considered as a first step.

4) Ban landing of sharks by night fishing resort groups.

5) Detailed information (catch, effort, species, size etc.) on shark fisheries to be collected.

Action taken - Since the end of 1992 a shark category has been included in the fisheries statistics, However this does not differentiate between the different shark fisheries existing in the Maldives and as such cannot be used as an indication of the condition of a specific fishery. If the data is to be of any use it should at least be compiled by gear category, namely gillnet, drift longline, bottom-set longline and multihook handline.

6) Marine Research Section staff to be trained in fields related to fishery stock assessment and management.

Action taken - limited training.

7) A fisheries biologist to be assigned full-time for shark resource monitoring and management, as trained manpower becomes available.

8) Extension material to be prepared to inform fishermen of the dangers of overfishing in general and of the problems of shark fisheries in particular. The potential of offshore shark longlining and correct shark processing techniques to be disseminated.

4.0. THE GIANT CLAM FISHERY

4.1. Introduction

There are two indigenous species of giant clam in the Maldives, *Tridacna squamosa* and *Tridacna maxima.* The local term *Gaahaka* is used for both the species. *T. maxima* is a small species reaching a maximum size of about 35 cms in length. The giant clam fishery in the Maldives was entirely based on *T. squamosa* as this is the larger species, growing to an average size of about 45 cms. Maldivian fishermen mistakenly believed

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that *T. maxima* were juvenile *T. squamosa* and thus would grow to replace the larger *T. squamosa* harvested.

4.2. Development of the fishery

The fishery started in June 1990 when a local buyer started exporting giant clam adductor muscles to the Taiwanese market. Around the same time a second local buyer started stockpiling both dried adductor muscles and mantle tissues with the hope of obtaining an export licence. A total of 20 mt of frozen clam meat was exported representing more than 125,000 clams, within two years from the Maldives (Table 4.1.)

Table 4.1. Exports of frozen clam meat (1990-1991).

Year	*Quantity (tonnes)*	*Value (MRf)*	*Estimated numbers of clams fished*
1990	8.8	1,088,529	52,800-61,600
1991	12.1	1,247,816	72,600-84,700
TOTAL	20.0	2,336,345	125,400-146,300

Source: Maldives Fisheries Statistics, 1990-1994; Anderson R C - Unpublished Report.

T. squamosa were selectively harvested as the Taiwanese buyers would not accept adductor muscles weighing less than 100 g when frozen. The fishermen skin-dived to collect the giant clam from the reefs. The major centre of this fishery was R atoll Ugoofaru. At the start of this fishery, the fishermen from this island collected clams from the lagoons of the local islands. Later they moved on to the shallow areas as they realised that the large clam also occurred in this area. However, they again had to move back to the deeper waters as the number of clams diminished in the easily accessible areas.

When one reef was wiped off the fishermen moved on to the next. As they moved on further and further from the base island, fewer clams were collected in a day because they had less time for fishing.

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4.3. Stock Status

The Marine Research Section of the Ministry of Fisheries and Agriculture conducted a stock assessment survey of giant clams and their potential for culture in 1991 (Barker, 199 1).

The stock assessment survey compared fished and unfished areas for abundance of clam. As giant clams were not traditionally harvested in the Maldives the unfished reefs was assumed to represent virgin stocks. On a survey of six heavily fished reefs *very* few *T. Squamosa* were observed. *T. squamosa* were seen during only five of the 15 tows (33 percent). The mean number of *T. squamosa* for all fished areas surveyed was 3.4 clams/ha. On the other hand *T. squamosa* was seen during 14 of the 15 tows (93 per cent) on unfished areas where 44,050 m of reef were sampled. In areas where *T. squamosa* was found, densities ranged from 2.8 clams/ha to 65.6 clams/ha. The mean for all the unfished reefs in the area assessed *was* 10.6 clams/ha. *T. maxima* was adequately abundant in all areas surveyed. The average density being 29.9 and 39.6 clams/ha on fished and unfished reefs respectively.

4.4. Issues Related to the Fishery:

Exploitation rate: *T. squamosa* was fished at a very high rate in certain atolls of the Maldives during 1990 and 1991. There were genuine fears that if a management measure was not taken promptly the exploitation of giant clams would have brought the clam stocks below a critical population density, whereby natural recruitment would be threatened.

Conflict with the tourism industry: The tourism industry is one of the major industries in the Maldives. The income generated from the clam fishery was insignificant when compared to the tourism industry. The damage caused to the reef when harvesting giant clams and the removal of too many clams brought these activities in conflict with the tourism industry.

Accession to Convention of International Trade in Endangered Species (CITES): Tridacnids have been listed in Appendix II of CITES among globally threatened species. Although Maldives is not a member country the authorities knowing the importance of protecting this species decided to stop all trade in giant clams. Therefore the culture of giant clam is important if Maldives is to export giant clams in the future.

4.5. Management Measures

The giant clam fishery was very unsustainable in nature. Ministry of Fisheries and Agriculture decided to ban the fishery through the Ministry of Trade and Industries. In July 1991, Ministry of Trade and Industries stopped issuing new licenses for the export of claim products. the existing export licenses were not renewed once they expired. Collection of giant clam was declared illegal from June 1995 onwards.

4.6. Culture of Giant Clams

Barker (1991) discussed the possibility of establishing a hatchery facility for giant clams in the Maldives. Marine Research Section of the Ministry of Fisheries and Agriculture has now started to do experiments on giant clam culture. The aim of these experiments is to work out giant clam culture techniques suitable to the local condition of the Maldives, based on the already existing techniques in other parts of the world.

5.0. THE LOBSTER FISHERY

5.1. The Fishery'

Lobsters, locally known as ihi, are commercially exploited for the tourist market. Local consumption is limited. Five species of spiny lobster are reported from the Maldives. They arc;

Panulirus longipes
Panulirus penicillatus
Panulirus ornatus
Panulirus versicolor
Panulirus polyphagus

Lobster are collected mainly at night by the lobster fishermen by swimming with lights, diving along the reef face and also walking on the reef flat.

The data collected by Ministry of Fisheries and Agriculture shows a steady increase in the number of lobster harvested with the exception of 1990 and 1993 in which

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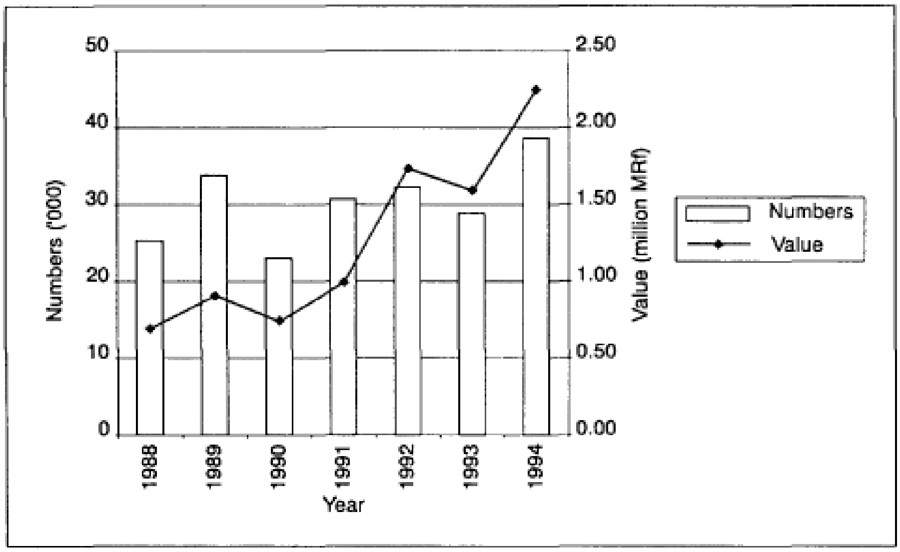
years the number decreased considerably (Fig. 5.1.). The recorded number of lobsters harvested reached 38,110 in 1994.

The value of lobsters has increased rapidly with the unit price increasing from *27.5* MRf/lobster to 58.8 MRf/lobster over a seven year period At present lobster prices are reported to be in the range of MRf 80 to MRf 150 per lobster.

Figure 5.1. Reported lobster catches and value (1988-1994)



5.2. Managerial Measures

It is believed that tropical reef associated spiny lobsters are difficult to overexploit. Sometimes the reef topography helps to control the catch rates as it provides a suitable habitat for lobsters where they are hard to access, thus establishing natural lobster sanctuaries which provide a stable breeding population that supply recruits to reef systems down current. It is feasible that there can be no recruitment due to exploitation of all the breeding individuals. But because most reef systems rely on inter-reef larvae transportation for new recruitment to the lobster population, it is unlikely for the lobster resource to be overexploited in the Maldives. (Wright 1992)

- Ministry of Fisheries and Agriculture has been collecting lobster catch data since 1988.

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— The Maldivian government declared a size limit on collecting lobsters with carapace length less than 25cm, and a ban on exploiting berried lobsters in 1978.

5.3. Issues Related to the Fishery

— A proper study has not been carried out on the lobster fishery. Therefore not enough information is available on this fishery.

— The lobster reports filled in by the Atoll offices for fisheries statistics purposes inquire about the number of lobsters caught in three categories, namely: shallow water lobsters, deep water lobsters and others. These categories are not recorded separately and there is considerable doubt whether the officers know these details. At the same time the validity of the earnings reported on the same form is doubtful as they do not agree with the reported number of lobsters caught. (Parry & Rasheed 1995).

5.4. Recommendations

A desktop study was carried out by Wright (1992) on the lobster fishery. His recommendations were to:

1) Establish sanctuaries for the breeding population that can provide new recruits to the lobster population in the reefs open to lobster fishing.

2) Establish a set season for lobster fishing. However, it was suggested that this may conflict with tourism.

3) Expand the already existing system of reporting lobster harvests to include species composition and diver effort from the atolls.

4) Improve the field component to carry out resource surveys of fished and unfished reefs to determine the stock status.

5) Recommend fishery management options based on resource surveys..

6) Provide training for MOFA employees to collect, analyse and record information to assist fishery planning and resource management.

7) Ban collection of lobsters using SCUBA,

8) Accomplish a buyer collection information system to include the island or atoll of the lobster, quantity, prices paid, etc.

6.0. THE TURTLE FISHERY

Turtles have been exploited traditionally in the Maldives. Five species of marine turtles are observed in the Maldives. They are:

Chelonia mydas	Green Turtle
Eretmochelys imbricata	Hawksbill Turtle
Dermochelys coriacea	Leatherback Turtle
Care tta care tta	Loggerhead Turtle
Lepidochelys olivacea	Olive Ridley Turtle

The most common turtles that are exploited are the green turtle and the hawksbill turtle. They are caught for their meat and eggs which are rich in protein. The hawksbill turtle is specially exploited for the shell which is used to make expensive jewellery for the tourist trade. About fifty years ago thousands of turtles nested every night on the beaches of the Maldive Islands. But now the number has decreased to a few every month.

Taking of all species of turtles was banned by MOFA for ten years from 25th June 1995. It is illegal to import turtle and turtle products from 1 st August 1995. And the export of turtle and turtle products and the sale within the country was banned from 1st January 1996.

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Appendix-l

Percentage of yes and no answers for different options on sea cucumber management questionaires (N= 196).

No:	Questions	Yes (%)	No (%)
4	Do you believe that banning collection of sea cucumber using SCUBA is good ?	76	24
5	Do you think that banning collection of sea cucumber using SCUBA gear only in the tourism zone (A, K,V - atolls) and allowing collection in the other areas is agreeable ?	19	81
6	Do you agree with banning fishing for sea cucumber using spears ?	46	54
7	Do you agree with banning fishing for sea cucumber using hook and sinker ?	47	53
8	Do you believe that closing the sea cucumber fishery for a period and then opening is good ?	52	48
9	If you agree with q. 6 how long a period would you recommend ?		
10	Do you agree with having a closed and open area in the Not-them Atolls as well as the Southern Atolls and having them opened and closed alternatively ?	34	64
11	If you agree with q. 7 how do you suggest that the areas be divided ?		
12	Do you agree with having a special zone for collecting sea cucumber, where people from that zone only can fish there and people from islands outside that zone have to obtain a permission from the islands belonging to that zone if they wanted to fish there ?	56	42
13.	If you agree to a zonation system which option of the two below do you prefer ?		
	— Zone according to the administrative system which already exists.		
	— Zone after taking into consideration the size of the area, the abundance of sea cucumber 'in the area, and the population of the area.		
14	Do you agree with banning collection and sale of *T. ananas* and *M. nobilis* for a period ?	43	57
15	If yes to q. 14 how long a period would you suggest ?		
16	Do you agree to having a size limit for *H. atra* which is legal for collection and sale ?	79	21
17	If yes which size would you suggest ?		

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Percentage of islands which assigned the management measures suggested below as their first option to be implemented (N=l96)

No:	*Suggested Management Measure*	%
01	Ban collection of sea cucumber using SCUBA	64
10	Set a size limit for *H. atra* (Holhi lada) which is legal for collection and sale.	34
05	Close the whole sea cucumber fishery for a period	33
02	Ban collection of sea cucumber using SCUBA only in the tourism zone (A, K, V atolls) and allow it in all the other atolls.	20
07	Allow only people belonging to each administrative atoll to collect sea cucumber from that atoll.	17
03	Ban collection of sea cucumber using spears	16
04	Ban collection of sea cucumbers using hook and sinker	16
09	Ban collection of T ananas (prickly red fish, alanaasi, molhu) and M. nobilis for a period.	16
06	Determine a closed and an open area both in the North and South of the country and have them opened and closed alternatively Determine closed and open zones in the North and South	12
08	Determine a zone for collecting after taking into consideration the size of the area, the abundance of sea cucumber in the area. and the size of the population of the area and then allow people from the islands belonging to the zone only to collect sea cucumber from that zone.	11

Percentage of islands which assigned the management measures suggested below as their choice which should not be implemented (N=196)

No:	*Suggested Management Measure*	*%*
06	Determine a closed and an open area both in the North and South of the country and have them opened and closed alternatively	50
08	Determine a zone for collecting after taking into consideration the size of the area, the abundance of sea cucumber in the area, and the size of the population of the area and then allow people from the islands belonging to the zone only to collect sea cucumber from that zone.	49
07	Allow only people belonging to each administrative atoll to collect sea cucumber from that atoll.	39
09	Ban collection of T. ananas (prickly red fish, alanaasi, molhu) and *M. nobilis* for a period.	38
02	Ban collection of sea cucumber using SCUBA only in the tourism zone (A, K, V atolls) and allow it in all the other atolls.	36
04	Ban collection of sea cucumbers using hook and sinker	36
03	Ban collection of sea cucumber using spears	34
05	Close the whole sea cucumber fishery for a period	34
10	Set a size limit for H *atra* (Holhi lada) which is legal for collection and sale.	16
01	Ban collection of sea cucumber using SCUBA	10

PAPER 5

STATUS OF CORAL MINING IN THE MALDIVES: IMPACTS AND MANAGEMENT OPTIONS

BY

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1. INTRODUCTION

Coral rock is the main aggregate for most construction purposes in Maldives. In 1986 the demand for coral aggregate for the construction industry in Male Atoll, the industrial center of the country, was estimated at 0.5 million cubic feet/year. Although no recent estimates have been made, it is thought that demand is probably at its limit now and according to predictions, the current methods of mining would exhaust the coral buildings in N. Male Atoll within a maximum of 30 years if coral mining is not controlled. There are many problems associated with the current mining practices. Biological surveys of mined sites indicate that the coral diversity and abundance have been decreased dramatically. In addition to this, little recovery was seen at sites intensively mined over 16 years ago.

2. MALDIVES — A BACKGROUND

2.1 Location and Physical Structure

The Republic of Maldives form the central and the largest part of the Chagos-Laccadive Ridge, which extends from west of India into the Indian Ocean and consists of atolls and associated coral structures (Fig. 1.). The archipelago (07” 07’N to 00°42’S and 72° 33’E to 73° 44’E), consists of about 1200 low-lying islands forming 21 natural atolls and represents one of the largest coral atoll groups of the world.

Although its territorial area is considerable (90,000km^2), a relatively small proportion of the total area (=300km^2) is dry land. Of the 1300 or so islands only 202 are inhabited. The total length from north to south is 753 km while the widest point correspond to 118 km.

The physical setting of the Maldivian atolls varies from open structures with numerous islands, faros (ring-shaped reefs) patches and knolls in the atoll lagoon and around the rim to almost closed structures with few lagoons, knolls and patches. Faros are ring-shaped reefs emerging during tidal low water each with their own sandy lagoon and are separated by deep channels. They generally have a rim of living coral consisting of branched and massive types. Patches rise to 40 meters above the lagoon floor and are topped by robust wave-breaking corals. Knolls do not reach the surface and often support profuse coral growth, as do the reefs associated with many of the islands.

In geological time the filling up of the lagoons of faros by reef sediments has resulted in the formation of coral reef islands. The geomorphology of these islands varies tremendously in different atolls and it is influenced by a variety of factors such as location, climate, currents, tides, sea level change and also human factors. The islands are thought to be situated on top of layers of beach rock (about lm thick), underlying the islands at about 30cm to 60cm above present mean sea level (Preu & Engelbrecht 199 1). At the edges of the islands the beach rock dips slightly seawards and forms a platform on which the beach sediments are seasonally transported around the islands. Within the atolls, the water depth is about 60 meters, but just outside some atolls the depth can go up to 3000 meters.

The traditional lifestyle of the people had almost negligible impact on the marine environment, but recent socio-economic developments have led to marked deterioration of the environment. With the increase in population growth and increased wealth from tourism and fishing, the pace of development have increased at a significant rate in the country, during the last two decades.

The need for land led to land reclamation programmes. Harbours are dredged to facilitate economic growth in islands. The demand for building materials in the form of coral nodules has increased steadily and coral mining has become a major environmental concern in the country. In addition to this the country is faced with localised environment impacts as a result of tourism and waste discharges.

2.2 Economy

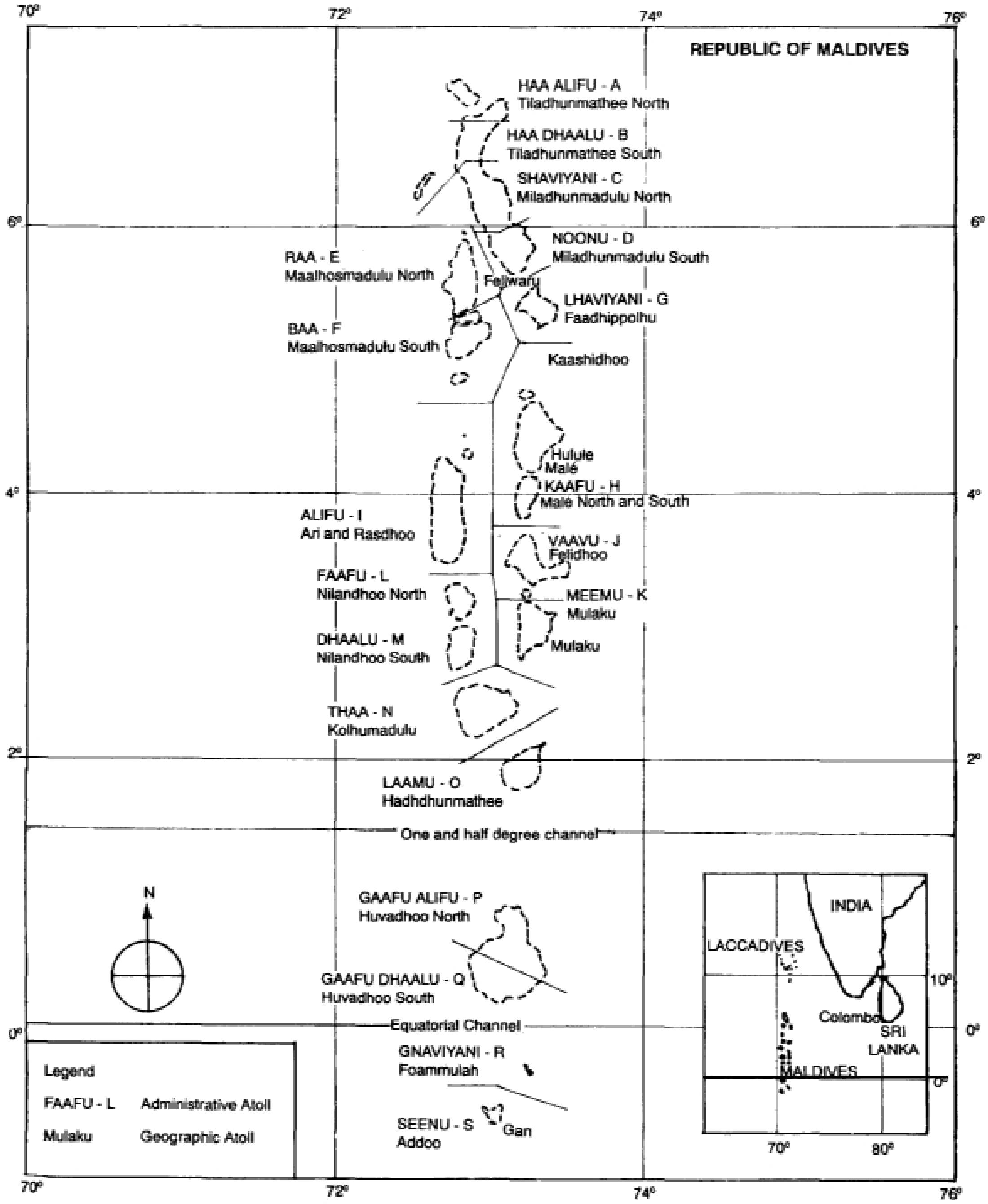
Being a country with more territorial sea than dry land, the Maldivians depend on resources almost entirely from the sea. The coral reefs which built the country play a vital role in the economic and social well-being of the country.

Fishing and tourism are the two main industries in the Maldives. Both these industries are very promising with potential for growth. They both rely on healthy reefs for their survival and continuity . The majority of fish caught are tuna and tuna-related species. Other reef dependent species of fish and invertebrates are also exploited.

2.2. 1 Tourism

Tourism was introduced to Maldives in 1972 with the opening of Kurumba Village Resort in North Male Atoll. After two decades there are 73 beach resorts scattered in

Fig 1. Map of Maldives



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North and South Male Atolls and Ari Atoll. Tourism now represents the largest industry in the Maldives.

The physical setting of atolls and associated small coral islands allow uninhabited islands to be chosen for resort development in the Maldives. Hence one island is one self-contained resort with its own facilities.

In the 70's and 80's significant quantities of coral were used in the construction of resort islands. Current tourism regulations discourage the use of corals for building purposes at resorts. Even so maritime structures such as breakwaters, jetties and groines are still constructed using corals.

The coral reefs around the resort islands (house reefs) and reefs in their proximity represent the basis of tourist activities and hence are very important economically for resorts. Fishing and mining from resort house reefs are discouraged by all resorts.

2.2.2 Fisheries

Tuna fishing is the second largest industry in the Maldives. With the mechanization of fishing vessels in the early 70's, and the establishment of freezing facilities the fishing industry has developed at an enormous rate. Catches of tuna and tuna like species have tripled from 30,000 MT in 1970 to 100,000 MT in 1994. The principal fishing atolls are: Haa Alifu, Raa and Baa, Faadhippolhu, Kaafu (Male), Thaa, Laamu and Gaafu, representing 75% of the total fish landings.

The main composition of fish catch is skipjack tuna (Katsuwonus peIamis), representing 50-75% of the total catch. The second most important species caught is the yellowfin tuna *(Thunus* albacaraes). The main fish products exported are: frozen skipjack tuna, canned fish, dried fish and salted dry fish.

The tuna fishery is based on pole and line fishing and significant amounts of baitfish are used during the process. Baitfish for the tuna fishery are collected from coral reefs. The bait used are relatively small (4-8 cm length) and about a dozen species are caught along reef edges. Bait fish are essential for the tuna fishery and reduction of bait catches will have adverse effects on the tuna fishery.

It is believed that coral mining disturbs the baitfish populations and currently coral mining is banned from common bait fishing reefs.

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3. CORAL MINING INMALDIVES - BACKGROUND

3.1 Introduction

Coral mining is an important activity in Maldives having long-lasting impacts on reefs. Coral is virtually the only building material available in the country and coral mining is widespread. The demand for coral has increased at an enormous rate during the **last** decade owing to increased development in the country. Recent studies had led to concerns over the sustainability of the reefs subject to coral mining activities.

Coral reefs in Maldives represent strategic natural offshore sea-defense. They are also important as habitat for baitfish and a primary source of building material. Coral blocks have been historically used for buildings and road construction. The coral blocks are extracted from shallow reef flats at 1-2 meters depth, with the help of iron bars to break up the living coral.

3.2 History of Mining

Corals had been mined in Maldives for decades. Coral mining is a labour intensive activity and hence it is relatively expensive to obtain compared to other forms of building materials. Furthermore imported cement or lime (produced by burning coral rock and coral rubble) is required to hold coral pieces together in the construction of coral walls and structures. Both cement and lime are expensive to buy. Historically the local communities used coconut leaves and variously locally available timbers to build houses. Corals were only used then for more important constructions such as in tomb stones and for mosques. In most cases large *Porites* heads were collected for such works. The old mosques and monuments in the country built a hundred years back indicate how extensively massive corals especially *Porites* may have been mined.

With the mechanization of the fishing industry in the early seventies with more money being generated within the island communities, construction of coral houses became the first priority for any land owner. It was simply a luxury to have a house built of corals and coral aggregates in contrast to a house of predominantly coconut products.

To own a coral built house was also considered prestigious and a reflection of good living. As a result coral mining expanded year to year.

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With the introduction of tourism in the country in the early seventies and with the increased development in Male the construction industry grew at a tremendous rate with demand increasing exponentially. The prediction of demand for coral is that the limit will be reached in 2015 A.D. Suitable reefs had become scarce and the government had imposed tentative regulations for coral mining activities in the country.

3.3. Uses of Corals

Corals are mined in Maldives mainly for the construction of houses and buildings. The common species of corals mined are massive corals such as ***Porites.*** Massive corals are crushed by manual labour into irregular and smaller pieces and used to build walls. Lime, cement or concrete are used to bond the coral pieces together to form walls and other building structures.

Another major use of corals is in the making of lime. For many islanders it is cheaper to produce lime locally than buying imported cement. Coral and coral debris collected from the reefs are burned in a pit in the ground with locally available firewood. Coral rock are converted to lime by this high heat treatment and are used to bond coral pieces to build houses and other constructions.

To a minor extent, corals are used as ornaments and jewellery (black corals) and for decorative purposes.

Groins, solid jetties breakwaters and sea walls which are common features in many resort islands as well as in some local islands are constructed from corals. The huge amounts of coral used for these artificial maritime structures should not be underestimated.

3.4. Coral Mining Areas

Until quite recently, corals were usually mined from the reef flats of islands house reefs. In many islands the reef is reasonably close to the island and it is simply a matter of collecting and loading a small boat to carry the corals to the island. Current regulations do not allow coral mining from island house reefs. People who mine corals as an income-generating activity choose accessible shallow ring reefs locally known ***as faros,*** to mine corals. Mining is carried out at the rims towards the inside of the reefs. In atolls with few ring reefs it is more common to find mining activity at lagoon side of outer atoll rim reefs.

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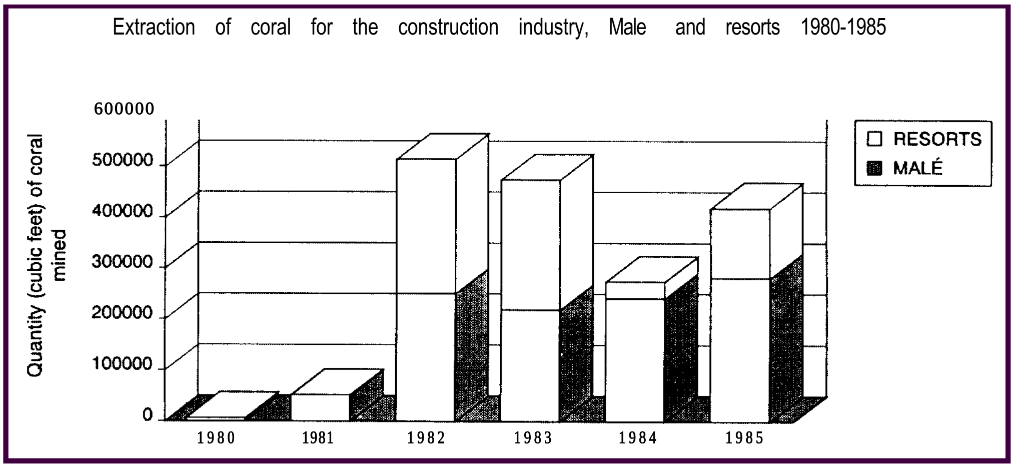
3.5. Methods of Coral Mining

Coral mining methods and techniques are manual and labour intensive. Having chosen a suitable reef the miners travel to the site on a small dhony (a wooden boat). Mining starts from the inner edge of ring reefs. Corals are dug and broken up with iron bars to manageable sizes. Some massive corals may be small enough to be mined without breaking. The corals are lifted by hand on to the boat. When the boat is full it is carried to the island, where the coral lumps are left for a period of time to dry and clean by sun and rain.

3.6. Trends in Demand for Corals

With the increased pace of development in the country especially in Male Atoll, the demand for coral rock for construction works is at its limit. Demand has increased tremendously during the last decade. Figure 2 shows the quantities of corals mined in Male atoll in the period 1980-1985. The extraction figures for coral mining given by Brown & Dunne (1986) showed that corals were been mined at the rate of 0.5 million cubic feet per year, where the industrial needs were the most responsible by the numbers of coral rock extraction. This figure is based on only Male Atoll and is likely to be much higher now.

Figure 2. Quantities of coral mined in Male Atoll in the period 1980-1985



Reproduced form: Brown, B.E. & Dunne, R.P. (1986)

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3.7. Mining as a Commercial Activity

Coral mining is not a country-wide commercial activity except for one or two atolls in the country. Mining is carried out at a minor scale in many of the atolls. Large scale commercial mining is only carried out at one atoll adjacent to Male Atoll. In this atoll (Ari Atoll), in two islands in particular *(Fenfushi and Maamingilli),* coral mining represents a major income generating activity. They work under contracts for the Male construction industry, tourist resort islands and also for many other atolls country-wide. Recent harbour improvement projects in many atolls of the country had led to an increase in the demand of corals for harbour wall constructions. *Fenfushi and Maamingilli* island miners work under contracts for these islands too.

In the early eighties, the cost of coral rock varied between 0.33 and 1.10 Rf per cubic feet. A typical size “dhony” (local wooden boat) load is approximately 200 ft^3 and therefore would cost between 66 and 220 Rf (1 US$ = 11.72Rf). A group of miners working 8 hours a day can mine one dhony load of corals. They can therefore earn up to 6000 Rf for a month for a single dhony. In most cases this figure can be much higher because depending on the site proximity to the target area more than one dhony load can be collected for a day, which is more normal. The current prices of corals are much higher and vary between 500 and 600 Rf per 200 cubic feet.

Clearly coral mining is an important source of income at least for a few atolls. The government is aware of the financial loss of income to these miners when it seeks alternatives for coral mining. But it is concerned about the scale of mining activities at present.

3.8. Existing regulations regarding coral mining

The government is worried about the environmental implications of coral mining. Prior to 1992 there were very few regulations as to where people could or could not mine corals. It was then simply a matter of protecting properties such as islands belonging to individual owners. In 1992 preliminary regulations were introduced to combat uncontrolled mining activities. The following controls are now in effect in the country.

1. *Mining cannot to be carried out on island house reefs.*

2. *Mining cannot be carried out on atoll rim reefs and common baitfishing reefs.*

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3. *Applications are required to be submitted to the atoll offices through island offices by any one needing corals to build any structures and permissions need to be granted by the atoll office before any mining can be carried out.*

4. *The island office is required to estimate the quantity of corals required,for the applied construction work and hence should ensure that only the required amount is grunted.*

5. *Every island is required to keep a log book* **of** *the amount of cornls mined*

The Ministry of Fisheries and Agriculture is the responsible government authority for the formulation of regulations regarding coral mining: The ministry has been working for sometime to formulate a comprehensive coral mining regulation and more stringent controls are expected, sometime in 1996.

Under the new regulations coral mining will be restricted to specific areas marked on maps and mining activities will be monitored very closely.

4. ENVIRONMENTAL IMPACTS OF CURRENT CORAL MINING ACTIVITIES

Coral mining represents the most important threat to the reefs in the Maldives. Population growth, and increased wealth from tourism and the fishing industries, has created a steadily increasing demand for building materials in the form of coral nodules and stand.

The biological and physical impacts of coral mining on reefs in Male Atoll, Maldives were investigated by Brown and Dunne (1986; 1988). They reported that live coral cover on reefs subject to coral mining was very low compared to unmined reefs. Response to reef associated fish to coral mining was reported by Shepherd *et al.* (1992) and Brown *et* ml. (1990). Fish community structure was compared on mined and non-mined reef flats and their adjacent slopes. Abundance of reef fish was found to be low on mined reefs compared to non-mined reefs.

Biological surveys of mined sites indicate that coral diversity and abundance decreased dramatically. In addition to this, little recovery was seen at sites intensively mined over 16 years ago. Of particular concern is not only the apparent failure of mined reef flats to recover but the consequent loss of both coral and associated reef fish resources to the economy (Brown et al. 1990).

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Coral mining is highly destructive and is carried out at a high cost to the reef environment with a very small return of corals as building material. It was estimated that 1 ha of reef flat corresponds to 3000m^3 of coral rock (Brown et *al.* 1990). Assuming that approximately 10m^3 of coral aggregate are required to build an average local house (20-30m^3 or two to three storey buildings), 80m^3 to construct 8 groynes of 1 Oxlxlm each, at a tourist resort island, it is not difficult to estimate how much it takes to exhaust 1 ha of reef flat. Coral jetties, groynes and seawalls are common structures in many resort islands as well as in local islands.

4.1 Biological Impacts

Coral mining represents a questionable activity for the maintenance of the reef equilibrium. Brown and Dunne (1988) indicated clearly the high disturbances to coral reefs in the Maldives as a result of coral mining. Even though the targeted species were usually massive corals, the process of mining disturbs many other coral species in the area primarily as a result of trampling and sedimentation. Mined areas of the reef were simply wiped out. However, it must be noted that the effects are very localised on the reef itself. Mining is carried out only at the reef flats and hence there is little effect at the slopes of such reefs.

4. I. 1. Corals and reef-fishes

Live coral cover was greatly reduced at mined sites as observed by Brown and Dunne (1986). Table 1 shows the history of 8 sites investigated by Brown and Dunne (1988) in North Male Atoll and Fig. 3. shows the live and dead coral' cover at these sites.

Live coral cover was obviously very low at mined sites. Rehabilitation and recovery of reefs subject to mining activity was found to be extremely low.

The main reason for this was the chronic substrata disturbances which resulted from the mining procedures. It seems that as a consequence of the rubble mobility from the mining activities, the mechanical abrasion and higher water-movement limit the coral larvae settlement. Loose rubble prevents any successful settlements for quite a long time. Sites which have been mined since 16 years ago, presented very low coral cover (approximately 0.5% total cover). However a site which has been mined for only 5 years already shows a very low coral cover (l%), as well.

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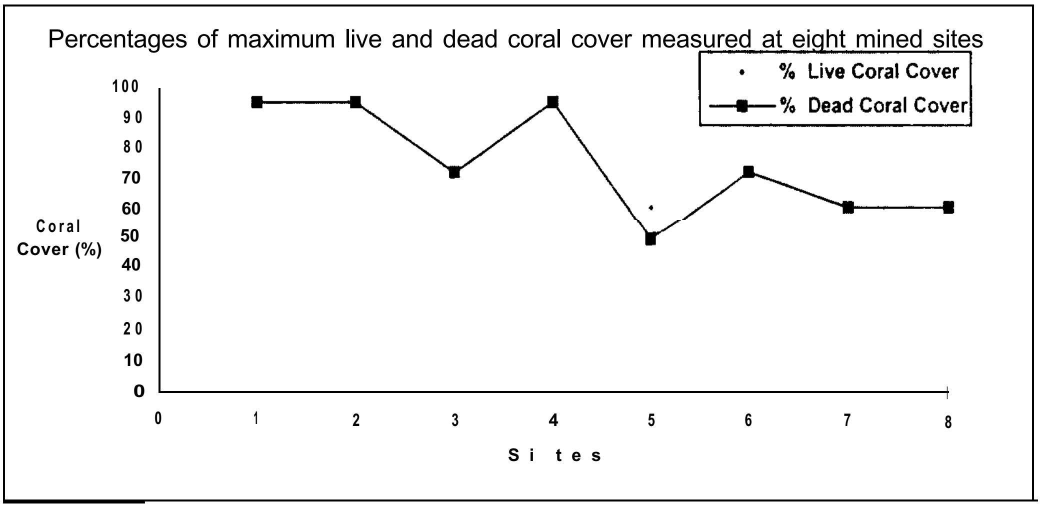
Table 1. Summary of the Histories of Sites Examined in North Male Atoll.

Site No.	*Description*	*History*
1	Submerged reef N. Male Atoll	Used for coral mining at least 16 years earlier
2	Submerged reef N. Male Atoll, S. Kuda Bandos	Used for coral mining at least 10 years earlier
3	Submerged reef N. Male Atoll, N.Villingili	Used for coral mining in recent years
4	Submerged reef N. Male Atoll	Control: not used for coral mining
5	Submerged reef N. Male Atoll	Control: not used for coral mining
6	Submerged reef N. Male Atoll	Control: not used for coral mining
7	Submerged reef N. Male Atoll	Control: not used for coral mining
8	Submerged reef S. Male Atoll	Control: not used for coral mining

From: Brown and Dunne, 1988

Figure 3. Percentages of live and dead coral cover recorded at mined and non mined sites



From: Brown and Dunne, 1986

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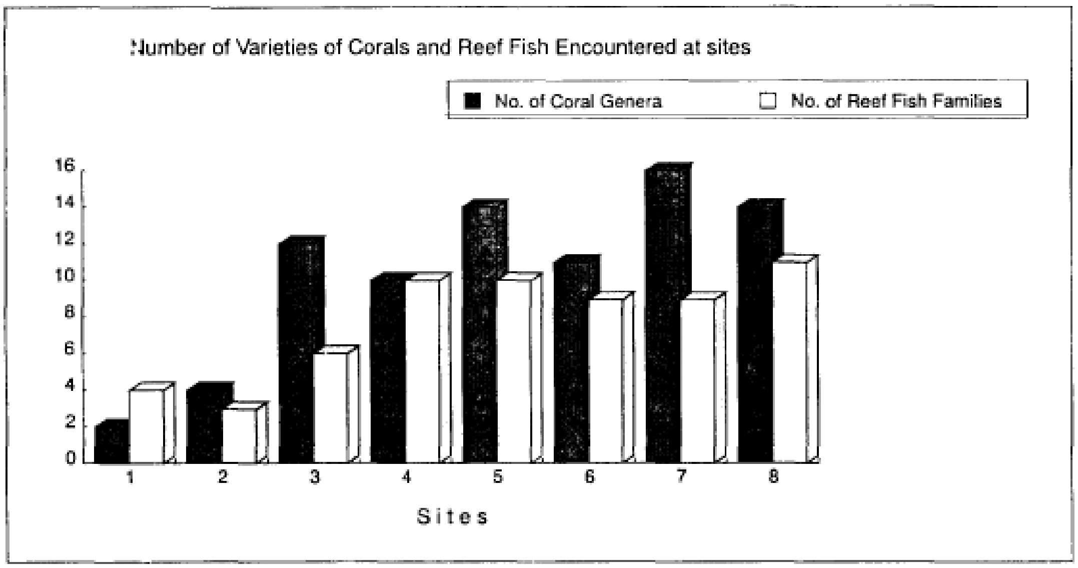
Diversity of corals, live coral cover and resident reef fish abundance are very low at mined sites, where the main coral species collected constitute in *Porites lutea, Goniastrea retiformis* and *Platygyra lamellina* (Brown & Dunne (1986). Figure 4 shows the fish counts and coral genera encountered at sites mined to various levels with sites not mined at all as observed by Brown and Dunne (1986).

Figure 4. Numbers of coral genera and reef fish families encountered at mined and non-mined sites



The presence of reef fishes follows the same pattern as for coral reefs. Low fish diversity characterizes the mining sites, where the dominating species are herbivorous *pomacentrids* and *acanthurids.*

Although the number of species of reef fish are greatly reduced at mine sites this does not have much of an effect on the reef fisheries as a whole. Commonly exploited reef fish inhabits the reef slopes which are normally out of reach of the coral miners.

It is known that the growth rate of massive corals such as *Porites* is extremely low. Ilence the removal of such corals will have long term consequences on the diversity of reefs with a long recovery time. There may be many factors affecting the growth of corals on mined areas as a result of alterations in conditions such as light, sedimentation, wave energy, nutrients and degree of exposure.

Brown *et* (1990) reported that mined reef flats had a significantly lower presence of fish. A visual census of mined and non-mined reef flats showed 60% reduction of fish species at mined sites. There was a positive correlation between rugosity index and diversity and biomass of fish. Coral mining on reef flats resulted in low rugosity (structural complexity) and, consequently, lower diversity and biomass of fish.

The effects were more evident for corallivores *(Oxymonacanthus Zongirostris, Chaetodon trifaciatus, Chaetodon triangulum),* and benthic herbivores and aquarium fish *(Acanthurus leucosternon, Oxymonacanthus. longirostris, Pygoplites diacanthus).*

The reduction of corallivorous species is explained by the destruction of corals, which are their primary food sources and a retreat for them as well. Benthic herbivores use the reef structure in order to find shelter from predators. Common species of aquarium fish declined because of the loss of habitat. The abundance of bait fish *Chromis atripectoralis* was also reduced at the mined sites, possibly as a result of loss of shelter in the area and reduced abundance of zooplankton. It is thought that bait stocks, principally the baitfish *Chromis atripectoralis,* may be affected by habitat disturbance. The schools of bait fish live close to coral reefs, where they find food and protection against predators.

If live bait supply is reduced by habitat disturbances due to coral mining, the tuna fishery may be severely affected. The supply of bait fish is essential for the pole and line tuna fishery, which in turn is important for the economic and social well being of Maldives.

4.2 Physical Impacts

Physical impact of coral mining depends on the type of reefs in question. No immediate effect may be observed with coral mining at an isolated ring reef. However if house reefs of islands are subject to mining activities there may be adverse effects. Island house reefs act as physical barriers, protecting the coral islands against wave action, by dissipating most of the energy in the incoming waves before they reach the beach line. Mining corals from the reef flats effectively remove this physical barrier and leave the islands prone to increased wave action, swells and storm surges and consequently beach erosion. The sediment dynamics of coral islands may be altered too as a result ofaltered flow regimes.

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5. ALTERNATIVES FOR CORAL MINING

5.1 Use of concrete blocks

Concrete blocks form a more environmentally sound and cheaper alternative to coral mining. Sand needs to be mined for the construction of concrete blocks. It is thought that sand mining may be less destructive than coral mining. Sand mining, however, should be carried out at sand banks or from shallows of isolated reef systems rather than from island beach systems.

Concrete blocks are made from a mixture of sand and concrete. The mixture is put into mould to obtain the required shapes and sizes. An indicative mixture for foundation is 3 parts of sand for 1 of cement, while for wall, the mixture is 5: 1. The coral sand have to be very well washed whit fresh water, in order to extract the salt. The cost of hollow concrete represents 80% of the cost for coral nodules.

It is believed locally that hollow concrete blocks are not strong enough to construct buildings. As a result many people prefer coral rock to concrete blocks in construction work. However, experts believe that if the right mixing levels are employed for sand and cement together with the right size of coral sand, concrete blocks could prove to be as strong as corals and would constitute a viable alternative to mine coral rock.

There are small-scale concrete blocks manufacturers in Male and other Atolls. It is also common to find more and more people resorting to use of these blocks simply because obtaining coral rock is becoming more and more scarce and prices are high.

5.2 Use of imported aggregates

Imported aggregates are preferred to locally available materials in the construction of large buildings in Male.

Consideration may be given to the tax levied on imported aggregate so that more people could effort to buy such materials.

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5.3 Mining an entire reef

An alternative proposed for the current methods of coral mining is the use of a special dredger, to quarry an entire single reef. The implications are that this would improve supply, as well as stop the current destructive mining activities at least in Male Atoll. Such an activity was already carried out some years ago by the Royal Air Force at the Atoll in South Maldives.

Brown and Dune (1986) looked into the impacts of coral mining on the reefs of Maldives and one of their recommendations as an alternative to coral mining was to consider selecting a single faro knoll or patch within and atoll and dredging such a faro up to the lagoon floor. The indications were that an average size reef of 2000 ft diameter would yield enough aggregate for the construction industry for more than a hundred years.

Blasting and dredging a single faro (submerged reef) with an average size of 30 ha and 15m depth, can produce $1.5x10^3$ of coral rock. If the same area is exploited from the lagoon floor the material resultant is about 10 million m^3. These values represent a tremendous increase of material compared with the traditional method, which represents only 5000-7500m^3.

The advantage of mining an entire faro is the higher efficiency and supply of material for more than a century, according to the needs projection ofthe development planning of Maldives. The suggestion was that it is better to loose onefaro (reef) than all economically important reef flats in any given Atoll.

6. CONCLUSIONS

Coral reefs are economically important to Maldives in terms of revenue and ecosystem services, particularly as a buffer to shorelines from wave action and other oceanic processes.

Coral mining is a questionable activity with respect to maintaining the reefs in equilibrium.

The successful management of coral mining activities is based upon a strong legal foundation, which defines the environmental standards related to coral mining.

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The government of Maldives is concerned with the environmental implications of coral mining and is determined to control mining with legislation.

An alternative source of building material needs to be identified in order that coral mining be completely banned.

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PAPER 6

TOURISM AND THE ENVIRONMENT: CURRENT ISSUES FOR MANAGEMENT

BY

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INTRODUCTION

The tourism industry grew to be the most dominant sector in the economy during a period of only 10 years, marking a new epoch in the economic history of the Maldives. The industry increased its capacity from about 200 beds in 1972 to over 11,300 beds in 1982, distributed among over 74 resorts, 50 guest houses and 40 yachts. The Maldivian tourist product is primarily based on sea, sand and sun. Thus, over 90% or 10,300 beds are on island resorts. Tourism now contributes over 17% to GDP, generating 70% of all foreign currency earnings and 40% of the government revenue.

Government, aware of the potentiality of the industry, institutionalized the industry in the 1980s. Since then Maldives has been cautious in tourism expansion. The prime reasons for controlled developments are to avoid flooding of the markets with Maldives tourist products and to avoid deterioration of the quality of services. This will ensure that the rate of acculturation does not exceed the society's absorption capacity and to avoid non-sustainable exploitation of natural resources.

Tourism development in Maldives has been based on sustainable exploitation of resources. Natural capital is to be managed so that a stock of natural resources, no less than that which was inherited from previous generations, is left for the use of future generations. The same principle applies to the intangible resources that are sold as part of the tourist product: the peace and harmony of the society, local culture, arts and crafts, traditions and livelihood. Hence, strict measures are taken to minimize the negative impacts to society and the environment but the economic goals of employment and income generation are not compromised.

However, such measures, especially those aimed at protection and proper management of the environment, require adoption of greener technologies. These measures often have short term costs. Therefore, in formulating regulations that require investments, government follows a policy of gradual enforcement. Regulations are developed over time and are implemented progressively, to the extent that the industry can adjust to these measures.

With only one exception, each island in the Maldives hosts a single resort. Hence, each resort is an autonomous unit that provides its own power, sewage and garbage disposal arrangements and water supply. Ecologically, Maldivian islands are at the stage of island formation where the crust or the original volcanic core has been completely submerged, leaving only the collection of unconsolidated coral sand over the reef above the surface of the ocean. Consequently, these islands are

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extremely dynamic systems. Even without anthropogenic interference they are often unstable.

Continued growth of reefs and healthy existence of the surrounding marine life is essential for the existence of the islands. Reefs provide the supply of coral debris and sand to the shores, sustaining the littoral processes (long shore drift and beach drift) which result in accretion and erosion around the island. In this process, a part of the sediment is retained by the vegetation and results in growth of the islands. A loss to the sediment budget due to retention of sand is compensated by the supply from the reef. This is an extremely complex process involving a number of contributing factors including coastal currents; waves; climate; location of the island on the atoll; health of the reef and its habitats; configuration of the coastline; type and size of the reef flat; depth, size and biological environment of the inner lagoon; and type of coastal vegetation.

In an imbalanced accretion and erosion process, deposition and accretion may occur within the inner lagoon; on the reef flat or even may cause sediments to fall over the reef edge while the island experiences sever erosion. This in turn may change the existing coastal process because of a change in one or many of the factors that keep the island and reef ecology at an equilibrium.

MAJOR ENVIRONMENTAL ISSUES

The ecology of the islands and the reefs is extremely delicate. Therefore, the general ability of the environment to withstand stress, or what will be referred to in this paper as the environmental threshold, is relatively low in these islands. With the development of a resort, or even by habitation, major environmental problems arise. Both the severity and time lag for the problem to arise depend on the carrying capacity of the island. This is once again dependent on a number of factors such as the natural coastline, size and location of the inner lagoon, location of the island on the reef and the atoll, wave climate, current flow patterns of the coast, size and type of island, health of the island vegetation and their interrelationships. In sum, although the island and reef ecosystems are in general delicate, carrying capacity will vary between areas. This has implications for management, and these implications have been taken into consideration by the Maldives in developing the management measures described in the next section.

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In general, the most common environmentally detrimental effects of tourism or habitation of islands are as follows.

1) **Effects of construction of coastal structures.** For development of a resort, it is vital to have easy access to the island and safe berthing facilities for boats. Hence, at a minimum, a jetty has to be built in the inner lagoon and a passage deepened through the reef. The following represents known effects that have occurred in the Maldives from construction of coastal structures.

    a) movement of sand around the island is obstructed from the construction of coastal structures such as rockfilled jetties. This causes accretion on the updrift and erosion on the down drift side of the structure, severely effecting the island.

    b) alteration of the current movements largely by creation of ripple currents, is often caused by dredging of the inner lagoon for harbor development.

    c) greater sedimentation on the coral colonies occurs during the process of dredging of the inner lagoon for harbor development. causes. Corals are literally suffocated by sedimentation.

    d) destruction of the habitat of many marine creatures from reef blasting. In addition to the physical damages, reef blasting affects the existing current movements and wave climate. Changes to these factors may affect the erosion, accretion patterns of the island, and water quality. This also negatively affects the visual quality of reefs which is one of the most important features of the Maldives tourist product.

2) **Developers are often compelled to construct additional structures to minimize damage caused by coastal structures as described in 1, above.**

    As described above in 1, severe effects to reefs and islands occur from construction of coastal structures, including jetties, seawalls, detached and submerged breakwaters and groins. Most of these structures, although protecting a certain locality, severely affect other parts of the island when they disrupt the existing coastal process. Consequently, additional structures are required which in turn worsen the situation. Because of the many factors involved and the irreversibility of the effects to the coastal and marine processes, it is very difficult to solve the problems without hard engineering solutions. These engineering works reduce

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the aesthetic integrity of coral islands, which is also an important feature of Maldivian tourist products.

3) Destruction of reefs from coral and sand mining in the development of the first generation resorts.

Destruction of the reefs adversely affects the island, and undermines their biological role as a fishery area and repositories of biodiversity. Mining also reduces the capacity for the reefs to act as a natural sea defense. This **is** because the natural combination of plants on the coastline is the most effective in stabilisation of the island.

4) Coastal vegetation is removed or the natural ecological succession of the vegetation is altered during construction of tourist facilities.

This change of the coastal vegetation adversely affects erosion and accretion patterns. As when the protection of the roots to sediments are removed, it accelerates the sediment movement process.

5) With habitation, the island ecosystem is loaded with solid and liquid waste.

Sewage and liquid waste disposed on the island seep through the aquifer and into the lagoon. Sewage can contaminate the aquifer by its nutrients and fecal choliform bacteria. As the assimilation capacity of islands is limited, the known effects include:

chemicals and nutrients in pesticides and fertilizers contaminate the aquifer and may reach the lagoon and the reef flats causing eutrophication. Eutrophication occurs with increased nutrient loading from sewage and waste. Eutrophication causes changes in the original biological environment, including reducing species diversity and increasing marine floral bloom and habitation of undesirable species. Undesirable species in the Maldives include sea grasses. Seagrass and algae start to grow near the effluent discharge sites, depending on the current flow patterns and depth of water. Though seagrass beds may be important as a natural habitat for many marine creatures in other marine ecosystems of the world, seagrasses are not typically found in the Maldivian ecosystem. In fact, sea grass beds are an indication of an area with an altered nutrient flow. In addition, these areas are not aesthetically pleasing because they make the sea beds ‘dirty’. The growth of sea grass beds, with their capacity to retain sediments, reduces the sediment budget of the shore and contributes to island erosion.

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6) **Conflicts that arise between fisheries and tourism in resource exploitation** are another major environmental issue of this sector, and one of the major issues identified for addressing under the Integrated Reef Resources Management Workshop and Programme. Although this was not so pronounced in the past, with the development and expansion of reef fisheries such as grouper and ornamental tropical fish, this problem has been exacerbated.

MANAGEMENT MEASURES

The ecological formation of Maldives makes resource management extremely difficult. Further, as inhabited coral islands are relatively few globally, literature on the subject is also limited. Undertaking in-depth technical studies to determine the carrying capacity and impact of construction and development is extremely costly and difficult due to absence of site-specific historical data. Acknowledging these difficulties, the government is optimistically cautious. The Government of Maldives has taken a precautionary approach to island development. For example, tourism development is currently confined to certain atolls and its expansion is limited to selected islands. In 1996, only 74, or 10% of the country’s 1190 islands were developed as resorts. Although there has not been a “cap” on island resort development, islands developed for resorts during the past 10 years have not exceeded 10% of the country’s total islands. This stable trend may not last. It is expected that within 20 years, resort islands will grow to about 20% of the total islands. However, for each island developed into a resort, one island must be left as a reserve.

The Ministry of Tourism, together with other Government Ministries, has undertaken initiatives to address the environmental issues affecting and related to tourism described earlier. These can be largely grouped into initiatives and legislation that address: Resort Development; Environmental Controls; and Multi-use Conflicts.

RESORT DEVELOPMENT

The Tourism Ministry imposes strict regulations and guidelines for resort construction and operation. It is particularly concerned with the carrying capacity of the islands. Measures to limit the number of people in a resort island below the environmental threshold include;

a) limiting the maximum built-up area to 20% of the total land area;

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b) the maximum height of the building has been limited two stories provided that there is vegetation in the island to conceal these buildings.

c) in construction of tourist accommodation, all rooms should face the beach and 5 linear meters of beach line has to be allocated to each tourist in front of their rooms. Only 68% of the beach length can be allocated to guest rooms as 20% has to be allocated to public use and 12% left as open space; and

d) constructions on reef flats and lagoons are discouraged. However, as over-water bungalows are very popular among tourists they are permitted construction provided equal open space is left on the land for each building developed on the lagoon.

1) Environmental Controls

In management of the environment, an important aspect that the Government envisions is preservation of the original ecological processes. To meet this end, removal of indigenous vegetation, disruption of marine ecology, redirection of original current patterns, and distortion of the wave patterns within the lagoon by construction of structures is discouraged. Some of the environmental standards and controls in this area include:

a) control and mandatory replacement for each tree that is cut down (certain rare and large trees have to be avoided when constructing a building). All buildings have to be located well away from the peripheral vegetation - at least 5 meters away from the shore line to ensure that the peripheral vegetation most important for coastal protection is preserved;

b) allocating space for vegetation between each building. This is to ensure that substantial areas of indigenous vegetation are left untouched;

c) all coastal works and larger projects have to be commenced after a through environmental impact assessment. Hard engineering solutions for dynamic coastlines are discouraged;

d) construction of rockfilled jetties and grovnes are controlled. Design of boat piers and jetties should be in such a way that they do not obstruct the original flow of currents or disrupt the wave climate within the lagoon;

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e) construction of seawalls, detached and submerged breakwaters are restricted. Instead, promotion of greater coral colonization on the peripheral reefs and other natural methods to protect shorelines are encouraged;

f) coral and sand mining. from resorts and inhabited islands and from their house reefs are strictly prohibited. More recently certain specific locations have been allocated for sand and coral mining. Construction of structures with coral is now being controlled;

g) spear, poison and dvnamite fishing are strictly prohibited. Net and trap fishing are controlled and confined to certain areas. Removal of shells, fishing of turtles and tortoise, juvenile and gravid lobsters are strictly prohibited;

h) all resorts are required to have incinerators, bottle crushes and compactors, Solid waste has to be burnt, metal cans compacted and bottles crush before disposal. Some of the resorts are now using organic waste as fertilizers;

i) sewage disposal through soak pits into the aquifer is discouraged (permission to do so is determined by the size of the island and amount of use of the aquifer). Sewage disposed should be below government approved standard of biological oxygen demand less than 20 mg/l; Ammonia nitrogen 2-4 mg/l and suspended solids 20 mg/l; and

j) other environmental regulations include architectural controls. To preserve the aesthetic integrity of resort islands, height of buildings is restricted to the height of the foliage of the vegetation. They have to be well integrated into the island, hence use of local materials is encouraged.

MULTI-USE CONFLICTS

In the Maldives, the multi-use conflicts in the reef areas are primarily between the two major uses — tourism and fisheries.

To solve problems that arise due to conflict of interest between the tourism and fisheries sectors in exploitation and use of the marine resources, 15 important divesites have been declared as protected areas where anchoring, and fishing except for traditional baitfishing, is strictly prohibited.

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PAPER 7

STATUS OF THE COMMUNITIES IN THE FOUR ATOLLS: THEIR PERCEPTIONS, PROBLEMS, AND OPTIONS FOR PARTICIPATION

BY

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ABSTRACT

This paper finds that communities in Vaavu, Meemu, Faafu, and Dhaalu atolls are generally well-aware of major issues on reef resources and are concerned with the depletion of some of these resources.

This paper also recognises that there are major implications in sharing resources and potential conflicts between the grouper fishery and the baitfishery. The sharing of resources is creating social problems and conflicts.

Communities believe that coral mining destroys reef resources and island environments. Some solutions to this issue include appropriate regulations, coral culture, availability of improved quality and increased use of bricks for construction purposes.

Extension of tourism activities into new areas must consider ways of sharing reef resources with fishing communities.

Issues concerning over-exploitation of reef resources are related to rapid growth of population and lack of sustainable development. As such, control of such factors including the even distribution of population is also necessary to avoid pressure on reef resources in one single area.

Atoll and island administrations require additional personnel and facilities to play an effective role in monitoring and management of reef resources.

INTRODUCTION

Purpose and Objectives

The purpose of this paper is to contribute necessary information in order to achieve the workshop objectives of developing approaches for implementing the Integrated Reef Resource Management (IRRM) programme and sharing relevant information.

The following are objectives outlined for the purpose of this paper.

1. Present the status of the communities in the four atolls (Vaavu, Meemu, Faafu and Dhaalu), in relation to the reef fish fishery, bait fish fishery, coral mining, and tourism/fishery interactions — four major issues associated with the integrated management of reef resources.

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2. Identify the communities' perceptions and problems associated with those major issues.

3. In light of the status, perceptions, and problems of the communities and also in view of experience related to development programmes, provide options for community participation in the management of reef resources.

Limitations

We obtained information on island communities through local administrations. This was done for a number of reasons. First, it is the administrators and community leaders in those institutions who would eventually play a major role in managing the resource. Secondly, in contrast to the individual person such institutions are in a position to grasp the overall picture in relation to those issues.

The scope of the paper is also restrained as a result of the limited time available to undertake an in-depth study. In the discussions on the status of the communities we have limited ourselves to a broad based discussion of those major issues identified above. It is assumed that the relevant sectoral agencies directly responsible for each issue would be addressing these issues through more in-depth studies.

Methodology

A basic interviewing methodology using structured telephone interviews and face-to-face interviews was adopted to study these issues. In addition, we used some secondary sources of data in writing this paper. This includes literature on fisheries and tourism and reports and appraisals concerning implementation of community-based management programmes.

Structure

This paper will firstly describe the characteristics of the issues of the reef fish fishery, bait fishery, coral mining, fishery and tourism interactions, and management of these issues. Next, it presents the status of the communities and their perceptions and problems in relation to these issues. As part of these discussions, the paper will identify some implications for each of the major four issues. This will be followed by a conclusion and recommendations on approaches to address the issues.

CHARACTERISTICS OF THE ISSUES

The issues such as coral mining, reef fish fishery, baitfishery, and fishery and tourism interactions vary in the degree of importance in the four respective atolls. These are activities related to the livelihood of island communities.

Fishing is a major occupation and its products are the main sources of protein. Communities are attracted towards some types of reef fish fishery partly because it fetches high profits.
Tourism is also a major economic activity which directly and indirectly affects these communities.

One important characteristic of these issues is that they are interrelated. Coral mining and certain types of reef fish fisheries are believed to have an adverse effect on baitfishery and tourism activities. This gives rise to conflict of interests within fisheries and between fisheries and tourism. However, fisheries can also complement tourism.

The use of reef resources is often not effectively controlled and therefore, tend to be over-exploited. This has serious implications to the existence of delicate reefs and their environments. Impacts of coral mining in the past are now visible from the erosion of the islands and depletion of marine resources.

STATUS OF THE COMMUNITIES, THEIR PERCEPTIONSAND PROBLEMS

This paper describes the perceptions of the communities in the eyes of the atoll and island administrators. The study is not based on statistical analysis, but on the perceptions of the communities with regard to these issues and as such what the community perceives (as related by interviewees) may or may not conform with the facts. If any such difference is identified, this implies the need to carry out information campaigns. They can serve as valuable feedback that can be used in devising programmes and methods for their implementation.

This is one of our expectations from the workshop, that is to find how much community perceptions vary from facts that would hopefully be provided by other workshop participants directly involved in Fishery and Tourism.

Although the atolls are widely classified as having a certain major occupation, this is not likely to be true for individual islands.

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The following illustrates the perceptions and problems of communities in relation to baitfishery, reef fish fishery, coral mining, and tourism and fishery interactions, The suggestions mentioned on the management of reef resources is included as well.

Baitfishery for Tuna Pole and Line Fishery

The main occupation in Meemu Atoll has historically been tuna fishery and still remains so today. Some fishing communities in Meemu Atoll are concerned over the scarcity of baitfish. They attribute this to over-exploitation of other reef resources such as groupers and coral mining. This is an indication of potential conflict of interests among different types of fishery. The main baitfishery locations used by fishing groups from the atoll are also used by those from Thaa Atoll.

In Dhaalu Atoll too, tuna fishery is the main occupation. There are over 150 major locations used for baitfishery which are also used by people from Thaa Atoll. Here too, some island communities have noted scarcity of baitfish which they also attribute to grouper fishery as is the case in Meemu Atoll. In addition, some have noted that schools of baitfish are becoming more and more unstable and “wilder” as a result of changes in the method of catching them. That is, fisherfolk now dive with nets to catch baitfish.

In Faafu Atoll tuna fishery is the second major occupation. Here, in the atoll there are 10-15 major baitfishery locations which are also shared with fishing groups from Dhaalu Atoll. Some communities believe that schools of baitfish are moving into deener locations as a result of the grouper fishery.

In Vaavu Atoll tuna fishery is limited and is affected by tourism activities. The 12 registered fishing vessels are mainly used for reef fish fishery. Fishing groups from elsewhere come here for the baitfishery. Fishing communities from three of the five inhabited islands believe that the baitfishery resource is being depleted.

Implications and Sub-issues

From the above illustration of status of communities and their perceptions and problems in relation to baitfishery the following implications are identifiable.

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1. *Sharing of resources*

   In a situation where communities have identified scarcity of a resource, the sharing of it with fishing groups from elsewhere may become a major issue in the future. The existing social customs and regulations in most of the atolls do not limit access to the fishery. Atoll residents are not restricted to fishing within their atoll. The question therefore remains, is there a need to impose such limitations now? It is time to think about this and avoid future conflicts. Similar problems in relation to reef fish fishery have been experienced in Vaavu Atoll. These will be explained later.

2. *Potential conflicts among different types of fishery*

   Since grouper fishery are believed to affect baitfishery there seems to be conflict of interests between these two types of fishery. However, the situation is not so bad as it may appear to be as fisherfolk engaged in both types of fishery can be the same. For example, in Meemu Atoll the same fishing groups from Maduvvari and Dhiggaru engage in both reef fish fishery and tuna fishery. When tuna fishery is low fisher-folk shift to reef fish fishery. As such, the reef fish fishery is often a seasonal activity.

3. *Effects of changes in the methods of fishery*

   Diving with nets to catch baitfish is more frequently done now, and this is believed to frighten schools of such fish. This may be because it is the natural instinct of small baitfish to flee from large creatures including humans. With the increased presence of people, schools of baitfish may frequently be on the move rather than being stationary. Perhaps this is why it is difficult to catch baitfish, as stated by one interviewee.

Reef Fish Fishery

This fishery is considered as the second major occupation in Vaavu Atoll, and provides employment for some 250 people. It is an important source of income and therefore, the number of undertakings for this activity have been increasing. Reef resources of the atoll are also being used by people from elsewhere, which is a serious issue. Communities believe that the stocks of reef fish, and especially groupers, are decreasing. Compared to those in the other three atolls, communities here are more concerned over these issues.

The reef fish fishery in Meemu atoll is substantially undertaken by fishing groups of three island communities — Dhiggaru, Maduvvari and Mulaku. It is difficult to say that reef fish fishery is an important occupation-except in these three islands. This is because some communities in Meemu are said to believe that reef fishery does not have as much potential as tuna fishery. They do not engage in this as a full-time activity. Even in Dhiggaru and Maduvvari fisherfolk go for reef fish fishery when tuna fishery is seasonally low. Although not a full-time activity, reef fish fishery is an important source of income. This is because some types of reef fish can fetch higher prices. Fishing groups from Faafu and Dhaalu sometimes fish in Meemu Atoll.

Communities in Meemu Atoll believe that the reef fish fishery damages the reefs and their environment and that it reduces the baitfishery.

This is the major occupation in Faafu atoll with a fishing fleet of 40-50 vessels, each having 5-7 crews. The number of undertakings for this activity have increased lately. Fishing groups from Meemu, Faafu, Vaavu, Thaa, and Male Atoll are known to fish from here. Communities in Faafu Atoll are well aware of a decline in certain types of reef resources, particularly groupers.

In Dhaalu Atoll, the reef fish fishery is generally considered as the second major occupation and as such it is an important source of income. In fact, it is the main occupation in some of the islands. Few vessels from Meemu and Faafu occasionally come here for fishing. Although the fishing community here is well aware of the depletion of the resource, people are still attracted towards its potential high profits.

Implications and Sub-issues

The implications of the reef fish fishery are similar to those identified for the baitfishery. This includes sharing of reef resources and potential conflicts among different types of fishery. Sharing of reef resources is a major issue in Vaavu Atoll where conflicts arise not only within the fishery, but between fisheries, coral mining and tourism.

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Further explanations of these sub-issues are as follows:

1. *Sharing* **of** *resources.*

   Although the atoll communities have no problems in sharing tuna fishery, the same may not be true for the reef fish fishery. Communities in one atoll do not voice reservations about others fishing in their atolls. This is not true for Vaavu. The issue is complicated in this atoll as fishing groups from other atolls not only over-exploit reef resources, but are also reported to vandalise other resources of the atoll, There are also reported cases of confrontation between fishing groups from different atolls.

2. *Potential conflicts.*

   As noted earlier, the over-exploitation of groupers is believed to affect baitfishery. This also creates social problems among fishing groups from different atolls.

Coral Mining-

Similar to the other three atolls, the communities in Faafu mine coral for personal use. They are aware that coral mining damages reefs and their environment and affects the baitfishery. Coral mining is decreasing with the introduction of bricks and cement as alternative building materials.

In Dhaalu it is the same story. Communities are aware that coral mining causes island erosion and creates problems for the baitfishery. In addition, they also believe it is a laborious activity. However, communities still mine it as they believe coral is the cheapest building material for which most people have easy access. One of the causes of the problem is the demand for infrastructure development. According to one respondent from the atoll office the extent of coral mining in the atoll is not as extensive as it was a few years ago. However, one island administrator believes that the extent of coral mining is higher in the island as there is increased demand for housing.

It is difficult to say whether the extent of coral mining in Meemu has changed lately. With the introduction of cement and bricks as alternative building materials the use of coral would have been reduced. This is because people now use cement as a building material instead of lime. On the other hand, people believe that the available bricks are of poor quality and as such they prefer coral. In addition, some infrastructure such as “breakwaters” require coral for their construction as there is no other suitable material. For these reasons the extent of coral mining would have increased in the case of some island communities.

The communities are well-aware of the negative effects of coral mining on the environment. Many of them are also known to be aware that it creates problems for reef fish fishery and baitfishery.

In Vaavu Atoll the extent of coral mining has decreased lately; this may be due to the use of bricks for construction.

Sub-issues and Implications

I. Factors contributing to the issue: Population growth as a factor is more obvious in the case of coral mining. As implied in the above description there is increasing need for infrastructure that can be attributed to population growth and development. Although home-reefs are protected by present regulations, mining still damages distant reefs. This means that a comprehensive management programme for the reef resource should consider the factors of population growth and sustainable development.

2. Finding suitable alternatives. Another observation on coral mining is about community beliefs on the suitability of bricks as an appropriate alternative to corals. Although bricks and cement are being used for building purposes, the extent and popularity of bricks are not as high as one would like it to be. There are reasons for this. Firstly, many communities believe that the available bricks are of low quality. Secondly, some communities have voiced concern over the difficulty of transporting construction materials from Male. Transportation is one of the major factors hindering development activities in the country.

However, it is still possible to address the problem by producing better quality bricks.

Tourism and Fishery Interactions

Since Faafu, Dhaalu and Meemu do not have tourist resorts, issues on the interactions between tourism and fishery are not visible in these atolls. However, this is not so in Vaavu where there are two resort islands. For this reason the discussions on fishery and tourism interactions are confined to Vaavu.

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Many of the reefs in Vaavu are used for both fishing and diving — giving rise to conflicts. Tourists dive to see reef fish and other resources of the reef. However, fishing may deprive the reefs of such varieties. Sometimes fishing results in making good diving spots obsolete. For example, shark observation is a major attraction for the tourists, and the shark fishery has severely reduced the shark population in the reefs.

The situation is further complicated as the reef fish fishery in Vaavu involves fishing groups from outside the atoll. As explained earlier, this is a major issue in this atoll. It was reported that fishing groups from elsewhere have been engaging in the shark fishery in areas close to resorts. Tourists have also complained about this.

However, the reef fish fishery can be complementary to tourism. Some communities in Vaavu engage in reef fish fishery to cater to the tourist industry. Night-fishing is also a major activity enjoyed by tourists. This indicates that it is the over-exploitation of certain types of resources in areas used for diving, that often give rise to conflicts.

Conflicts between fisheries and tourism are difficult issues to solve as reef resources are important for both fishery and tourism - two major economic activities of the country. Reef fish fishery is the second major occupation of communities in Vaavu Atoll. The communities think that diving and fishery locations should be identified and both types of activities should be confined to those allocated areas.

Management of Reef Resources

The existing situation as described by those interviewed is that there is no comprehensive programme for the management of reef resources. Communities as well as their administrators are said to have concerns over the depletion of certain reef species. They are also aware of and are concerned with the effects of coral mining.

Regulations on the use of reef resources are difficult to enforce as a result of lack of personnel and facilities.

In view of the existing situation, atoll and island administrations propose the following measures as part of management of reef resources. This includes suggestions to control over- exploitation of those resources, defining roles for all parties who are involved with reef resources, and improving the capacity of institutions in the atolls.

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1. *Control Over-exploitation of Reef Resources*

The following are suggestions to control over-exploitation of reef resources.

A. Allocate certain locations for the fisheries within the atolls. In addition, some of the islands and atolls recommend to specify a number of areas and allow the fishery in each area only in different seasons.

B. Define sizes of fish that can be harvested considering the type of species that are being over-exploited.

C. Limit export quotas.

D. Define the quantity of catch and or resource per person or party. The Atolls Development Advisory Board is in the process of formulating appropriate regulations on the use of coral in the construction of boundary walls. There is a range of suggestions for the purpose.

E. Temporary ban on certain types of fishery and or resource exploitation to revive the resources.

F. Confine the use of reef resources within an atoll only to its resident communities which is suggested by Vaavu Atoll.

G. Explore alternatives including mariculture and fish farming.

2. *Specify Roles*

The government departments in Male should plan and formulate a management programme and appropriate regulations, with the cooperation and consultation of the atoll and island institutions. In the same manner, these authorities should also define roles for atoll and island institutions. Once such roles are formulated atoll offices should play a central role to ensure that the responsible parties effectively perform their roles and activities. Such a monitoring role by atoll offices is appropriate in view of their position in the existing administrative structure of the atolls.

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3. *Improving the capacity of local institutions.*

One of the problems identified with enforcing regulations on the use of reef resources is the lack of capacity in atoll and island offices. A number of administrations in the atolls have raised concern over the lack of adequate and trained personnel as well as necessary facilities that are required to effectively monitor the resources.

RECOMMENDATIONS ON APPROACHES TO ADDRESS THE ISSUES

The following recommendations are made from the limited research done on the major issues:

1. Directly involve local institutions in the management of reef resources.

2. Improve efforts to control population growth and population concentration in one location, in order to find appropriate solutions to these issues. An increase in the population or rapid development puts more pressure on the reef resources.

3. Improve the capacity and capability of island and atoll administrations.

4. Strengthen the legal and regulatory framework to limit over-exploitation of resources and to avoid future conflicts as experienced in Vaavu.

5. Take steps to initiate and or accelerate farming of reef species.

6. Enable access to more quality bricks and promote them as appropriate alternative building material.

CONCLUSIONS

Island communities are aware of the depletion of reef resources and see the need to sustain them. There are no suitable alternatives for coral as a building material. Over-exploitation of reef fish fishery resources must be controlled by means of stringent regulations. Period ban should be imposed on over-exploited species such as groupers and sea-cucumber for their revival. More reefs need to be established as marine reserves, for the purpose of regeneration of corals and baitfish.

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This can be complemented with coral culture. Regeneration can be applied to home reefs as well.

Future extension of tourism into other atolls should consider interactions with fishery and settle any likely conflicts in sharing the reef resources. Population pressure should be distributed equally, to avoid over-dependence on a reef resource in one area.

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PAPER 8

ENVIRONMENTAL CHANGES IN THE MALDIVES: CURRENT ISSUES FOR MANAGEMENT

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ABSTRACT

The aim of this paper is to present an overview of the current issues for environmental management in the Maldives. In the past, the lifestyle of Maldivians was very simple and had almost negligible impact on the environment. However, recent socio-economic developments and growing population have led to a marked deterioration in the environment. With a very fragile and delicate ecosystem, vulnerable to the threat of global warming and sea level rise, the need for environmental management and planning is clearly demonstrated.

In this paper particular attention is paid to the environmental problems to which the government has given priority action. Issues considered include beach erosion, coral mining, population issues, freshwater resources, waste disposal and sewage disposal.

The present environmental management structure in the country is also considered in the paper, The institutions, legislation and agendas developed for environmental management are presented along with the environmental impact assessment procedure for new development projects. As the Maldives is actively involved in bringing environmental issues to the forefront of the global political agenda, the role played by Maldives in the international arena is also briefly stated.

1. INTRODUCTION

This paper is prepared by the Ministry of Planning, Human Resources and Environment to be presented at the Integrated Reef Resources Management Workshop, 16 - 20 March, 1996. In the paper, problems such as over-exploitation of marine resources and conservation of species is not considered as these areas represent the subject focus for other papers to be presented in the Workshop.

The environment of Maldives comprises a delicate and complex series of ecosystems that are unique to the tropical world and many have found it a pleasure to gaze upon. The Maldives has a rich biodiversity and the coral reef ecosystem is one of the most productive ecosystems with linkages ranging from microscopic plankton to the giant sperm whale.

The Maldives is very vulnerable as well. The very small size and virtual isolation of the islands make their ecosystems, both on land and the sea, particularly fragile. Until

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recently the lifestyles of Maldivians had been so simple that its impact on the environment was minimal. However, the rapid socio-economic development and fast growing population have greatly contributed to the degradation of the environment.

Current environmental issues stem in large part from the high population density which is aggregated onto relatively few islands in each atoll. The problems of a number of the more densely populated islands and some tourist resorts have reached critical levels in terms of environmental management.

2. PRESENT ENVIRONMENTAL ISSUES

2.1 Beach Erosion

The islands of the Maldives are very transient, building and eroding at a rapid rate, and thus beach erosion is a very widespread problem. Severe cases of beach erosion have been reported by 57 inhabited islands and several resort islands. In an evaluation of coastal engineering issues in the Maldives (Readshaw, 1994), it was found that causes of erosion very greatly from one location to the other and the causes identified include: loss of a source of sand; increased exposure to the incident wave climate due to historical mining of the house reef; changes in the near shore current patterns, either due to natural causes or man made changes, such as construction of coastal infrastructure; changes in the natural sediment balance; and up drift impoundment of sand behind coastal structures built without pre-filling.

Construction of groynes and other such structures helps in bringing about sand deposition and beach consolidation. However, it also often leads to further complications, especially if the constructions are improper. As a consequence of a lack of investigation of local current and wave regimes prior to construction activities, a number of breakwaters and defense structures have been damaged by normal wave and current action resulting in expensive repair and re-design.

2.2 Coral Mining

In the Maldives, living coral is exhaustively stripped from shallow reef tops of faros by miners to supply the construction industry. The problem is particularly serious in the Male and Ari zone supplying Male and tourist resorts where there is a considerably higher demand for construction materials. Over a six year period the volumes of coral landed in Male rose from 7,000 to 400,000 cubic feet. Statistics are no longer kept. Mining corals reduces coastline protection against normal tide and wave-induced erosion and sand movements and increases coastal susceptibility by effectively increasing water depth. One consequence is wave set-up, thereby increasing the possibility of storm-induced erosion and flooding. At intensively mined sites, diversity and abundance of coral reef fishes are also markedly reduced, with some reef fish species commonly used as baitfish entirely absent (Dawson Shepherd et al., 1992). Brown & Dunne (1988) carried out biological surveys on mined reefs and evaluated the impacts of coral mining in the Maldives.

2.3 Dredging

Dredging is normally associated with harbour deepening, land reclamation, and mining for construction material. Harbour deepening has been ongoing since 1985 and by the end of 1995, about 45 islands had dredged entrances and harbours.

Dredging physically disturbs or removes the bottom substrate, deposits sediments on the substrate, suspends sediments in the water column, reduces light penetration, changes circulation, reduces dissolved oxygen and increases nutrient levels in the water column. Dredging also results in the direct elimination of benthic habitat in the dredged area and a reduction of associated dernersal species. Many coral reef communities are sensitive to both suspended and accumulating sediments and require long time periods for recolonization (Rogers, 1990). Sediment loads also can have a major effect on the distribution of coral species and thus, the composition of the reef community.

The extent and significance of the impacts of dredging have not been properly assessed in the Maldives. Such activities may have significant impacts both locally and down current. The problem was identified as being significant by Kenchington (1985) and UNEP (1986). Engineering Geology & Tropical Coastal Management (1987) reported that discharge waters from construction sites in Male carried out significant quantities of fines to the coastal environment and were smothering corals.

2.4 Land Reclamation

Reclamation which in the Maldives usually means the creation of new land represents a capital intensive solution to increasing the physical carrying capacity of a particular island. It results in an increased susceptibility of the island as a whole to flooding by covering the reef flat which faces the ocean. The protective value of the unmodified

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reef flat may be calculated in terms of its replacement by alternative means and if added to the costs of the reclamation work provides a more realistic cost/ha of such land than merely the reclamation costs alone. Such activities occur on both large and small scales and are usually associated with human population centres and as a by-product of harbour dredging.

2.5 Population Growth, Distribution and Life Styles

The total population of the Maldives as enumerated in the 1995 census was 244,644. The annual population growth rate between 1977 and 1985 was 3.2% per annum. Between 1985 and 1990 this had increased to 3.4%, and according to the 1995 census preliminary results, the current growth rate between 1990 and 1995 has dropped to 2.75% per annum. Though the current growth rate represents a significant decrease in the rate of growth since the 1990 census, it would still result in a doubling of the population giving in excess of 400,000 people in the first decade of the next century. A failure to address this problem rapidly and directly will negate all other efforts to achieve sustainable development.

The population of the Maldives is not equally dispersed, but aggregated onto 200 of the 1,190 islands. This traditional settlement pattern automatically concentrates some human-induced environmental problems, which become unmanageable when population exceeds the carrying capacity of the islands concerned and has occurred in some rural island communities. Problems of land shortage, over-crowding, solid waste, sewage disposal, declining freshwater quality and quantity are characteristic of these islands. The rapid growth in Male's population associated not merely with the birth rate but also with a drift from more isolated areas in search of education, health and other services has resulted in the environmental problems of Male reaching a crisis. At present 25.7% (62,793) of the population live in Male. Without population regulation it may be expected that similar problems will develop in other centres of attraction.

In addition to the unsustainable growth and distribution of population, the changing lifestyles are also creating environmental problems. The lifestyles of the North are being mimicked and unsustainable consumption pattterns are slowly becoming a local phenomenon. Between 1982 and 1994 the number of vehicles rose from 18,103 to 55,808. The number of cars, lorries/trucks and pickups have risen from 326 to 914; 156 to 455; and 46 to 526 respectively between 1982 and, 1994. A significant proportion of these vehicles are based in Male contributing to significant compaction of the road surface and consequent reduction in natural aquifer recharge. Similar problems are emerging in other islands where the number of vehicles are growing.

2.6 Solid Waste Disposal

Solid wastes include domestic and industrial wastes of organic and inorganic origin and variable size, ranging from small tins to whole cars. A comprehensive survey of solid wastes in Male was carried out in 1989, and a per capita generation rate of 0.32 kg/day and an average waste density of 280 kg/m” was found (Lidkea, 1993). Waste quantities in Male and in the Maldives will generally increase as the population increases, but will also increase on a per capita basis as the standard of living improves. Higher percentages of paper, plastic, glass and metal can be anticipated.

Disposal via dumping untreated waste results in marine pollution problems; use as landfill contaminates groundwater resources, whilst incineration results in air pollution and leaves unanswered the question of disposal of non combustible wastes and ash residues which may contain potentially toxic materials including heavy metals from marine paints, and batteries.

2.7 **Sewage Disposal**

Sewage poses a series of potential problems depending on the mode of disposal; discharge of raw, untreated sewage into the marine environment causes nutrient enrichment, algal blooms, deoxygenation and human health problems depending on the siting of the outfall. Such conditions adversely affect coral growth. Sewage-related problems are of concern around the densely populated islands and some tourist resorts.

2.8 Waste oil disposal

Waste machine and lubricating oils associated with small-scale machine shops present a problem in Male; current disposal seems to be simply into the ground around the workshop concerned, resulting in contamination of groundwater supplies. Under the International Convention for the Prevention of Pollution of the Sea by Oil, reception facilities for waste oil and oil separated from bilge water has to be provided. Such facilities do not currently exist and neither do facilities for oil disposal. Recently, bins have been placed in Thilafushi for dumping waste oil.

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2.9 Freshwater Availability

High density human populations affect freshwater aquifers in two ways: by increasing the volume of daily water removal, and by restricting aquifer recharge. Freshwater resources are currently critical in a number of islands - both inhabited (particularly in the northern atolls) and some resort islands.

Most groundwater assessments conducted to date have been only for Male, and the volume of untapped groundwater resources on other islands is unknown. One of the attractions of Male for original settlement was the extensive and deep freshwater aquifers. However, it has been progressively depleted, leading to the installation of desalination plants to supply drinking water to the residents. Calculations for Male suggest that at the current rate of overdraw the aquifer will be exhausted in the next few years, and similar problems are likely to continue to arise in other heavily populated islands.

Changes to aquifer resources also affect the carrying capacity of the island with respect to vegetation, both natural and agricultural crops. Saltwater intrusion and salination of freshwater supplies is known to be a problem in several islands. Poor sewage disposal has resulted in the contamination of groundwater in the past, resulting in a high incidence of cholera and shigella, with major outbreaks in 1978 and 1982.

2.10 Soil Degradation

Continuous removal of leaf litter and dumping or destruction by burning interrupts the cycle of nutrient replenishment in the soil, resulting in reduced soil fertility and hence vegetation growth rates. This problem is severe in heavily populated islands and some tourist resorts, where the remaining vegetation may also be stressed through increased salinity of groundwater aquifers.

2.11 Inadequate Environmental Database

Numerous reports have commented at length on the inadequacy of existing data sources and the need to establish a central database for information relating to all aspects of environment of the Maldives. Some reports have made recommendations concerning the nature of such a database and its establishment. Without such a database, quantification of environmental problems is difficult and identifying solutions impossible.

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3. ENVIRONMENTAL MANAGEMENT

3.1 Institutional Structure

Under the existing government institutional framework, the key authorities involved in the protection of the environment are the National Commission for the Protection of the Environment, the Ministry of Planning, Human Resources and Environment, the Ministry of Fisheries and Agriculture, the Ministry of Tourism, the Ministry of Construction and Public Works and the Ministry of Atolls Administration.

The environment sector was formally recognized as an entity within the Government in 1984, with the creation of an Environmental Affairs Division in the Ministry of Home Affairs and Social Services. During late 1988, environment was given an elevated status, being combined with the then Ministry of Planning and Development to form a new "Ministry of Planning and Environment". The rationale for this move being that environmental considerations needed to be fully and efficiently integrated into development planning within the country. In the government reorganization in 1993, the Ministry was given the additional responsibility of human resource development, and was renamed the Ministry of Planning, Human Resources and Environment, thus reflecting the Government's commitment for sustainable human development.

The Ministry of Planning, Human Resources and Environment is responsible for developing all aspects of environmental policy and enforcement of Environmental Protection and Preservation Act, 1993. The Ministry also acts as the secretariat for the National Commission for the Protection of the Environment. The Environment Section within this Ministry deals with all issues of the environment including global environmental issues. It administers and coordinates with other government offices, advises on environmental aspects and undertakes programs to raise public awareness on environmental issues. Environment Section also acts as the focal point for both national and international activities. The Environment Research Unit of the Ministry is charged with assembling the necessary environmental information required for planning and management.

The National Commission for the Protection of the Environment (NCPE), which was appointed by the President in 1989, advises the Minister of Planning, Human Resources and Environment on issues related to the responsibilities stated above. The mandate of the NCPE includes: involvement in assessment, planning and implementation of activities of the Maldives that affect the environment and activities

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to protect the environment, advising on tackling environmental problems, and ensuring that the environmental protection component is included in development projects. The NCPE consists of officials from various government offices. The President of the NCPE is the Minister of Planning, Human Resources and Environment.

3.2 Environmental Legislation

The Environmental Protection and Preservation Act (4193) enacted in April 1993, established a framework upon which regulations and policies can be developed to protect and preserve the natural environment and resources for the benefit of future generations. In brief, Act 4/93 consists of:

clause 2: concerned government authorities shall provide necessary guidelines and advice;

clause 3: MPHRE is responsible for formulating policies as well as rules and regulations

clause 4: MPHRE shall identify and designate protected areas and nature reserves

clause 5: mandatory Environmental Impact Assessment for any new projects

clause 6: power to terminate developments causing significantly detrimental environmental impacts

clause 7: disposal of waste, oil and poisonous substances shall be regulated

clause 8: disposal and transboundary movements of hazardous wastes banned

clause 9: fines for damage to the environment

clause 10: compensation for environmental damage that may take place.

3.3 Local Environment Agendas

In 1989, the National Environment Action Plan was developed through a national workshop to address the planning and management needs of the country. The Action Plan contains the overall strategy of the Government in the environment sector which

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represents a combined approach to managing and solving existing problems and establishing the mechanisms and procedures for future sound management of the environment.

The principal aim of the National Environment Action Plan is "to help the Government of Maldives to maintain and improve the environment of the country, including the marine and ocean area contained within the Exclusive Economic Zone, and to manage the resources contained therein for the collective benefit and enjoyment of present and future generations."

In the near future a National Agenda 21 will be developed as a follow up to the United Nations Conference on Environment and Development (UNCED) and Agenda 2 1. Work on Health and Environment Chapter has already begun and a report is expected by the end of June 1996.

3.4 Environmental Impact Assessment System

The Environmental Impact Assessment System (EIA) in the Maldives was established through the Environmental Protection and Preservation Act of Maldives (4/93), which came into effect in April, 1993. The legislation provides the basic framework for the EIA process in the country and the EIA procedures are laid out in the form of guidelines. According to article 5 (a) of the Act, an impact assessment study shall be submitted to the Ministry of Planning, Human Resources and Environment before implementing any activity that may have an impact on the environment.

Article 5 (b) states that the principles of EIA and the projects that require an EIA shall be determined by the Ministry of Planning, Human Resources and Environment. To streamline and facilitate the EIA process in the country the Ministry developed a set of guidelines outlining the procedures for EIA and these were approved by the Cabinet in December 1994.

In the Maldives, the rule setting agency that has the authority to specify rules, procedures, and standards governing the EIA process is the Ministry of Planning, Human Resources and Environment (MPHRE). MPHRE is also the responsible agency mandated to prepare the EIA or have it prepared for a proposed action. There are various licensing agencies authorized to issue an official permit to the action proponent to implement the proposed action. The main licensing agencies in the country are: Ministry of Trade and Industries; Ministry of Fisheries and Agriculture; Ministry of Tourism, and Ministry of Atolls Administration.

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3.5 Environmental Awareness and Education

Raising public awareness on environmental issues has been given a high priority by the Government. To accomplish sustainable development and lifestyles, environmentally sound actions at individual, household and community level need to be initiated. A number of Government agencies and NGOs have been involved in promoting environmental awareness. Wall posters, television and radio programmes are used to disseminate information on specific issues of concern. These programmes attempt to inform the public on the state of the environment within and outside the country including impacts of human activities.

Environmental education programmes have been incorporated into primary and secondary school curriculums; this has proven to be very effective. Younger generations are becoming more aware of the delicate nature of our ecosystem and its vulnerability to natural and man-made changes.

3.6 International Cooperation

The Maldives has been at the forefront of international developments in the field of environment. His Excellency President Maumoon Abdul Gayoom has been instrumental in bringing the issues of climate change to the global political agenda. He raised the concerns of small island nations at the United Nations General Assembly, the Commonwealth Summit and at various other international and regional fora.

In 1989, the Maldives hosted a ministerial level meeting of small island states concerned with sea level rise. This meeting led to the formation of the Small Island Group which eventually at the Second World Climate Conference became the Alliance of Small Island States (AOSIS).

During the preparations for the Earth Summit in Rio de Janeiro in 1992, the Maldives played a prominent role in modifying the language of Agenda 21 to ensure that the particular concerns of small island states were taken into consideration. In addition to participating in internationally high profile activities, the Maldives continues within the limits of finance and manpower, to play a small but important role in various ongoing international programmes and activities. The Maldives is party to several international conventions including:

United Nations Framework Convention on Climate Change;
Convention on Biological Diversity;

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Base1 Convention on the Transboundary Movement of Hazardous Waste and their Disposal;

Vienna Convention for the Protection of the Ozone Layer;

Montreal Protocol on Substances that Deplete the Ozone Layer; and

International Convention for the Prevention of Pollution of the Sea by Oil.

3.7 Management Issues

A major issue in environmental management is the inability to utilize existing environmental information. Innumerable studies have been undertaken to investigate environmental problems and many reports have been prepared. No archive of all these studies exists for reference and those available in country are found in different agencies. Another area of concern is the complete absence of certain environmental information. There are number of areas where scientific information is lacking and these include information on coastal processes, habitats and species.

The absence of qualified people is a major constraint in addressing current management problems. There is the need for education and training at all levels. The lack of trained manpower, equipment and institutions has hampered development of an indigenous research capability and hence slowed development of adequate environmental management and planning.

Lack of plans of action, guidelines and procedures poses great difficulty in the implementation of policies. The first Environment Action Plan was developed for 1990-1992, and preparation of a local agenda 21 is scheduled for 1996. In 1994, procedures for environmental impact assessment were developed. Work is being undertaken for the preparation of guidelines on waste management and sewage disposal. Codes of Practice need to be developed for the construction of coastal defense structures.

The country's wide spread, together with the dispersed population, results in difficulties of control and enforcement. Laws passed in Male are enforced through Atoll Chiefs operating via individual islands chiefs leading to lengthy chains of communication and delays in response at both ends of the system. Sectoral division of responsibilities also leads to frequent duplication of effort in some areas.

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4. CONCL USION

Fully aware of its dependence upon the marine environment, the Maldivian society had learnt to co-exist with nature. However, with the beginning of commercial exploitation of resources and an accelerated pace of development, the environmental situation has changed considerably. Because of population growth and increasing stress on the limited resources environmental issues are today in various stages of emergence.

The Government is aware of the urgent need to manage the resources and protect the environment. The government has developed institutional framework for environmental management and environmental legislation has been passed by the Citizen's Majlis in 1993. To collate and manage information an Environment Research Unit was established in 1990.

At present, the major constraints in environmental management are the lack of trained manpower, scientific equipment and research facilities, as well as severe limitation or lack of funds.

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PAPER 9

EXISTING LEGAL SYSTEMS AND INSTITUTIONAL STRUCTURES IN THE MALDIVES : OPPORTUNITIES AND CHALLENGES FOR IRRM COORDINATION

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1. BACKGROUND

The Maldives comprises about 1190 low-lying islands of which 200 islands are inhabited. Physically, the country owes its existence to the coral reefs which provide the living base on which these fragile ecosystems are established. In an atoll environment, the ocean resources underpin the traditional lifestyle and the development of the cash economy. The modern economy of these small island communities has to depend heavily on a narrow resource base, dependent on the direct exploitation of the marine resources for its peoples livelihood. Constraints of reef resources development and management in small archepelagic states such as the Maldives differ considerably from those of continental coastal states with large land areas as well as those of high island nations.

The Maldives lie on the crossroads linking the historical trade routes between South-east Asia/China and the East African Coast line. History (Maniku,l988; Mills, 1970; Gray, 1882) confirms that Maldives have had a number of differing ethnic contacts with the Indian Ocean rim countries dating as far back as the 5th Century BC. The unique ocean space occupied by the Maldive Archipelago, and the favorable climatic conditions away from the storm belt of the Bay of Bengal, during the south-west monsoon and that of Asia in the north-east monsoon provided favorable conditions for maintaining a regular trade and transport. Thus seafarers, merchants as well as travellers have interacted with the various atolls at various periods. Exchange of goods, ideas and culture have assisted in the development of micro-communities in these small low-lying islands within a larger atoll system. (Maloney, 1980; Bell, 1940)

These contacts influenced greatly those communities that began to emerge with collective ideas - religious and political - as well as art and craft, transforming them to be adaptive to the local environment. Ethnic technologies were developed to cater for the influx of traders. Processing of tuna meat — the well known Maldive-Fish — have been well documented by Chinese travelers during the 12th Century AD (Mills, 1970; Bell, 1940). Tuna resources thus remained a common property of the Atolls, while the reef resources have remained very much part of the island common property.

By the time Maldives embraced Islam, during the mid-twelfth century, it developed a unique form of governance highly adapted to the archepelagic conditions of the country. Each atoll had a highly developed autonomous governance, whereby the resources are shared within the immediate community as well as the state. This structure, locally known as Vaaru, is a form of taxation accrued due to public funds

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in restoring a collective identity-the Maldives as a Nation. The system of governance is well documented in copper plates during the period of conversion (Anon, 1982; Bell, 1920; Forbes, 1983).

As Islam was a newly emerging religion in the Saudi Arabian peninsula, it had a number of prescriptions laid out to unite Bedouin communities of the desert environment. These prescriptions fitted well with the island communities of the Maldive atolls. It was well accommodated by the Sultanate structure that emerged after the Buddhist era. No natural resource within the confines of an island, or atoll or a group of atolls remained unprescribed. Reef resources remained very much within the confines of an autonomous atoll structure. Linkages existed between atolls, between islands; total control of communication centered through the site of the sultanate was loose but effective.

The coming of the Europeans in the 15th century was a significant period for the old countries to become new nations (Bell, 193 1). The largely self-sustained and tightly interwoven economic, political and cultural identity began to unravel. Following the process of colonization of the Indian Ocean rim states, the natural resource base of nations had to accommodate the extra demands placed on them by the colonial masters. Cowrie trade, which flourished among the Asians as well as the African coastline countries, was sustained by the strong management structure adapted then (Heimann).

The legacy of the past hints at what might be possible for future development of an Integrated Reef Resources Management (IRRM) structure (Hockly, 1935). There are some new forces now at work, which have opened up a world of far-reaching opportunities.

By the turn of this century, three developments have been significant within the context of an IRRM structure for the Maldives. They are:

1. Loosening of the colonial powers which led to the formation a forma1 structure among nations; the birth of the United Nations. After the Second World War, nations started to rebuild their national identity; in doing so, most countries institutionalized management and development to the core government machinery.

2. Secondly, the cultural heritage of the Maldives, not only being historic and rich in itself, was a considerable development asset. Maldives has never been an “isolated traditional society facing the modern world,” but rather it has had a

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successful history of adapting to changing conditions while upholding the integrity of the nation against external influences. The shift of fishery markets away from the neighboring Sri Lanka in the '70s towards Japan and Western European Nations, and the development of a highly successful large scale tourist sector, all points to this flexibility (Fitzgerald, 1984).

3. The new concept of fisheries in the Maldives, introduced with the newly established fishery legislation (Law No. 5/87); Fisheries is defined as any extractive activity that is targeted at the living marine resources of the country.

With the strengthening of international organizations, community development and management of natural resources that have existed at the national level have been globalised (Agenda 2 1; SIDS Conference, 1994). Prescriptions for efficient management of the resources have been developed without proper review of the traditional systems that have evolved in various communities; thus promoting the concept of uneven development. Uneven development is rooted in the central processes of capitalist development. It does incorporate, but goes far beyond the problems of depletion to include the valuation and devaluation of resource-based production complexes resulting from technological and social changes. The problems of uneven development exist alongside, and frequently overshadow, the tragedy of the commons (Roberts and Emel, 1992).

Due to globalization of resource management strategies, small island communities have undergone significant socio-economic and cultural changes. The main reason being the result of institutionalizing into larger national and international ecological and economic processes (Pomeroy, 1994). Modem communities are being structured by global conventions thus significantly altering the relationships both within communities and among nations. This has become the mainstream of the dynamic transition.

This paper will not try to detail the legal system nor the structure. However, it will try to provide an overview of the responsible bodies, national policies and problems in the structure, and identify the challenges and opportunities for development of an integrated reef resources management strategy.

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2. *RESPONSIBLE BODIES*

In identifying the responsible bodies for the development and management of an Integrated Reef Resources Management Program, it may be useful to identify some of the multiple uses that the reefs are subjected to. The multiple uses of this zone definitely create overlap which result in a wide array of problems for resource users, managers and decision makers; this state of affairs can be better understood by identifying some of the broad uses as given below:

Terrestrial developments: Due to the size of the islands, and the dynamic nature of the coastal processes acting on the shore-line, urban settlements, industrial developments, waste disposal as well as shore protection works have a direct impact on the surrounding reef systems.

Harbor development: Due to the rapid development and the changes in the usage of sea-going craft, deepening of the boat harbors is an essential part of the island economy.

Reef Fish Fishery: Utilization of reef fishery resources has direct implications.

Coral and Sand Mining: An activity that is becoming an increasingly significant activity affecting the reef system.

Recreation and Tourism: Tourism in the Maldives is a marine based activity, relying heavily on maintaining a healthy reef system.

Thus the key institutions involved in the development and management of the above activities can be grouped into four government departments, namely:

1. Ministry of Planning, Human Resources and Environment
2. Ministry of Fisheries and Agriculture
3. Ministry of Tourism
4. Ministry of Construction and Public Works, and
5. Ministry of Atolls Administration.

Environmental issues that reflect a joint responsibility are sometimes discussed at the National Commission for the Protection of the Environment.

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3. LAWS AND REGULATIONS

The laws relating to the reef resources can be stratified into three broad categories:

Customary Laws

A number of traditional management systems are still practised in the outer atolls where the reef systems have had some economic activity, such as collection of cowrie shells, fishing off scads or horse mackerel schools in the inner lagoon of inhabited islands, collection of bait fish, etc. Some of these practices have been incorporated as rules in accordance with an article in the fishery law.

Constitutional and legal instrument

Legislative power is vested in the Parliament or the Citizens Majlis. A Bill passed by the parliament becomes a law on the signature of the President. A Bill may be vetoed by the President or referred to the parliament with recommendations for amendment.

The two relevant framework laws in the context of IRRM are:

i. The Fisheries Law of the Maldives. Law No. 5/87

ii. Environmental Protection and Preservation Act of Maldives. Law No. 4/93

The framework laws give provision to the concerned Government departments to formulate and administer regulations on matters relating to the relevant laws.

International Environmental Conventions and Treaties

An international convention Maldives is party to is the Convention on Biological Diversity (Rio de Janeiro, 1992). Agenda 2 1 Chapter 17 provides the framework for establishing the programs.

4. POLICIES

The National Development Plan of the Maldives provides national policies for various sectors. At the same time each government department has to develop a set of policy

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guidelines which have to be written down and informed to the public. To identify the relevant policy guidelines for the development of an IRRM Program, the National Development Plan remains the main document that could be referred to.

5. ISSUES

For the development of an IRRM Program, Maldives needs to review in detail the present legal and institutional structure. This may need to be addressed immediately and would require coordinated efforts between various government departments as well as non-governmental organizations.

5.1. COMPREHENSIVE LEGAL RECOGNITION OF RESOURCE USER RIGHTS

Management of Reef Resources in the Maldives is quite complex, mainly due to the dual legal system of ownership which was put in place after the system of government was changed from a sultanate to a Republic in 1968. Prior to this new system of government, the Maldivian system of resource ownership was strongly based on the communal system of Vaaru, whereby each atoll had a major role to play in managing its immediate resource, thus enabling the atoll chief advised by the elders of the community to control the resources as a common property of that atoll. With the change of Government from a Sultanate to a Republic, the total authority the atoll had on the resources was.being challenged by modern law. This system is seen as a constraint to development as well as reef resource management.

The present framework laws on Fisheries and the Protection of the Environment, however, offer some opportunities for streamlining and delegating some of the. customary rights which different atolls have been practising. The institutional structure now exists with the atolls administrative structure to provide advice to the concerned government departments responsible for establishing a more comprehensive legal system.

5.2 OVERLAPPING RESPONSIBILITIES

Overlapping of responsibilities between various government departments has some negative impact on the management of the reef resources. To cite an example, mangrove ecosystems are very important breeding grounds, nurseries as well as feeding areas for many of the living reef resources. The Ministry of Fisheries and Agriculture has no control over reclamation; in fact these areas are viewed as a hindrance to the development of the island.

5.3 USER CONFLICTS

Since reef resources are gaining in economic importance, a number of traditional practices, such as bait fishing and coral mining, have become sensitive issues, causing major conflicts among users.

5.4 LACK OF COMPLIANCE

Non-compliance is induced by factors such as the dual system of resource right ownership, clashes between the traditional law and modern laws, different interpretation of the fisheries law and the environment laws, lack of funds to enforce laws and regulations and most importantly, lack of prior consultation as well as accessibility on the part of the various stakeholders to the ever-increasing rules and regulations developed under the framework laws.

5.5 ILLEGAL FISHING PRACTICES

Employment of illegal fishing methods is becoming an increasing problem. This includes the use of destructive gears, SCUBA gears as well as lethal chemicals.

5.6 IMPLEMENTING NEW REGULATIONS

The fisheries sector continues to be confronted by the fishermen and the exporters with regard to implementation of new regulations. There are a number of problems associated with this state of affairs. One important aspect is lack of consultation with the various stakeholders before a regulation is implemented. Another major problem is the lack of a central mechanism or depository where all laws and regulations could be referred to by the users or potential users.

5.7 LACK OF RELIABLE DATA

For the fisheries sector, to implement regulations, reliable and convincing data is needed to support its submission. Unfortunately, the mechanism for the collection of such data is lacking in the Atolls, administrative system'.

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5.8 ONSHORE ACTIVITIES

Due to the size of the islands, any human-related activity, such as use of chemicals in agriculture, clearing or vegetation, dredging and reclamation, and waste dumping in urban centers are increasingly becoming a concern. A few cases of algal blooms near areas where recent dredging have taken place have been recorded by the Marine Research Section. Lack of regulations over the control of onshore activities may be viewed as not so serious at this stage but its adverse'impact on the reef resources, specially on sedentary animals, cannot be ignored for too long.

6. FUTURE

An institutional and legal mechanism needed to implement an Integrated Reef Resource Management Program needs to be geared towards co-management between the atoll communities and the various government departments. Consultative processes have to be designed whereby the positive aspects of community-based management could be implemented. These processes need to take into consideration the scientific information provided by the research officers working on various resources.

Finally, it should be understood that IRRM problems and issues cannot be solved by laws alone. Sound policies, administrative decisions and directives, enforcement of the law, participation and community action become just as important.

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PAPER 10

OUR PERFORMANCE INDICATORS FOR INTEGRATED REEF RESOURCES MANAGEMENT

BY

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ABSTRACT

Overfishing and pollution mining of coral reef resources tend to cause shifts from long-lived to short-lived organisms, from mature to immature individuals, and from higher to lower trophic levels. Conceptually, management goals might be to reverse these trends; i.e. simultaneously maximise species diversity, longevity and abundance, and raise the trophic level of populations in exploited and protected areas. Four potential indices incorporating these elements of community structure are proposed for monitoring trends in coral reefs and fisheries.

INTRODUCTION

The Maldives' National Workshop on Integrated Reef Resources Management reflects a widespread recognition of the need for integrated approaches to natural resource management. This workshop follows closely upon an international conference on 'Ecosystem Management for Sustainable Marine Fisheries' organised by the National Research Council (USA), and the material presented here is a modified version of a discussion paper submitted to that conference (Done and Reichelt 1996).

The ultimate measure of a country's success in management of renewable natural resources will be the realisation of the first four goals of ecologically sustainable development (ESD) as described by the Bruntland Commission: i.e.

1. improvement in material and non-material well-being;
2. equity between generations;
3. equity within generations;
4. maintenance of ecological systems and biodiversity.

Principles and tools for achieving these goals include,

5. global issues including international trade and co-operation; and
6. dealing cautiously with risk, uncertainty and irreversibility of impacts.

The principles provide a context for defining ecological, economic and social objectives for resource management, and are being reflected increasingly in the objectives of regulatory agencies around the world. However there are major difficulties in transforming the written objectives into effective action.

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Some of the greatest difficulties have been in attempting management of coral reefs and marine fisheries in ways that ensures maintenance of ecosystem processes and biodiversity. Part of the difficulty stems from limits of understanding about ecosystem processes and biodiversity. Without serious scientific input, such concepts provide little if any guidance for management actions meant to sustain them.

Another, perhaps more important factor as seen from the fisher's perspective, is that words such as 'sustaining ecosystem processes and biodiversity' are simply that...words. They have no meaning in the context of the realities of day to day life.

Dealing with the limits to scientific understanding calls for

i) improved assessment of ecosystem values and the threats which humans and nature pose to those values, and
ii) incorporation of these assessments into the decision making processes ofresource managers.

Effectiveness in real life calls for 'ownership' of the ESD principles by the fisherfolk and, where they exist, the industry organisations and government agencies who co-ordinate and/or regulate there activities. 'Ownership' of the ESD principles, in particular principles 4 and 6, means understanding of, and commitment to ideas which are non-existent in the minds of most people, and vague even in the minds of most scientists and resource managers.

Many authors (see Pauly and Christensen 1995) note that over-fished tropical shelves and coral reefs are characterised by shifts from long-lived to short-lived organisms, from mature to immature individuals, and from higher to lower trophic levels. Conceptually, management goals for multi-species fishery managers might aim to reverse these trends; i.e. simultaneously maximise species diversity, longevity, and abundance, and the trophic level ofpopulations in the protected area. These properties would need to be qualified as biological reference points for ecosystems in the same way that percentage of virgin biomass is used in fish population dynamics. Suggested indices are described later in this paper.

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ABSTRACT

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INTRODUCTION

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METHODS

Incorporating ecosystem concepts into fisheries management: a first attempt

In 1992 a regional committee of fisheries managers (Australia and New Zealand's Standing Committee on Fisheries and Aquaculture) outlined a framework for implementing the principles of ecologically sustainable development in fisheries. It led to development of the concept of Fisheries Ecosystem Management, which includes:

- public awareness and education programs,
- long term monitoring of environmental factors, stock assessment, and adaptive management approaches,
- ensuring proper linkage between the usually separated activities of coastal zones management, total catchment management and fisheries management,
- developing strategic management plans, consistent with ESD principles, and focusing on rationalising fishing capacity in over-exploited fisheries.

An Assessment Proforma for implementing Fisheries Ecosystem Management is given in Table 1. It includes a description of the fishery in terms of its resources, description and assessment of current management (including jurisdictional) and research regimes, evaluation of stake-holders' interests and evaluation of integration of environmental and economic factors.

Application of Fisheries Ecosystem Management

The proforma in Table 1 was intended to be relatively all-encompassing and to encourage fisheries managers and the fishing industry to see their activities and responsibilities in the broadest possible context. Needless to say, this aroused serious suspicion among those who thought that their jurisdictional boundaries were being encroached upon or threatened by this notion of managing resources from the ecosystem perspective.

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Table 1: Categories of information used to characterise fisheries with a view to implementation of Fisheries Ecosystem Management Protocols

1. Fishery description
2. Jurisdiction
3. Role and Management and Research Agencies
4. Enforcement agency.
5. Major stakeholders (extractive, non-extractive)
6. Detailed features of fishery (catch, value. employment, bait, bycatch, discard, etc).
7. Biological information about the resource
8. Economic information (e.g. stakeholders, regional economy, economic efficiency)
9. Environmental information (climate, oceanography, pollution, habitat, status, impact of fishing)
10. Management arrangements
11. Current priorities (for industry, research and management)
12. Consistency with the fisheries ecosystem management framework (a: education, b: data collection and research, c: inclusion of cross sectoral issues and impacts, d: structured management mechanisms)
13. Review mechanism (to evaluate priorities regularly)
14. Any other significant issues not addressed in the above.

Source: Chesson et al, 1995.

The fisheries ecosystem management proforma was used for a tropical fisheries region that spanned most of the Northern Australia and include a set of diverse fisheries including fish, crustaceans, sharks and molluscs (pearl and trochus). The draft paper was prepared for the Bureau of Resource Sciences in Canberra and is not published. It highlighted the high diversity of the region and the complexity of the jurisdictional and regulatory arrangements in place for some of the resources.

A national. workshop to review the idea of fisheries ecosystem management was convened and the proceedings published (Chesseon et al, 1995). This report highlighted a few of the difficulties confronting fisheries managers adopting this approach:

- difficulties in defining appropriate spatial scales;
- lack of information in many areas;
- lack of resources to either complete the proforma or to provide the necessary information in the future;
- insufficient emphasis on the environment (i.e. non-fisheries elements);
- difficulties in interpreting the proforma in a consistent way.

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Clearly the management agencies have had difficulty in fully embracing the idea. The principal obstacles are political but lack of knowledge of the ecosystems that sustain particular fisheries is also a critical problem.

Notwithstanding these difficulties, there has been considerable reform in Australian fisheries management over the past few years. There has been a steady increase in involvement of fishing industry representatives in the process of stock assessment and development of management plans. There has been an increase in the use of reference points in management, and also a move towards education rather than enforcement as the most effective method of resource management.

Performance indicators - comprehensible and ecologically meaningful

Education includes educating the educators. One challenge is for someone to come up with simple measures of ecosystem well-being for use across the diverse tiers of groups and individuals involved in resource science, use and management. In communications between scientist and manager, both parties need those values to be soundly based (i.e. on agreed properties of the ecosystem) and to be measurable in monitoring programs.

The precision of the measure and areas of uncertainty need to be identified 'up front'. In communications between manager and legislator, the scientific bases of the measures is less important than their relevance to international treaty goals and national production targets. In communications between manager or legislator and resource user, there needs to be acceptance that the measures are legitimate, even if their underlying basis is only vaguely comprehended. For example, through television, most Australians understand that a positive value for the 30 days mean of the Southern Oscillation Index is a 'good thing' (rain likely), though few are aware of the basis or significance of its calculation (ratio between atmospheric pressure at Pappette and Darwin).

Communicating scientific advice to resource managers

Here, we present some indices, as vet untried, in which a high value is meant to reflect 'a good thing' in terms of ecosystem well-being. New protocols which may have broad applicability were recently put forward for assessing biodiversity and ecosystem processes on coral reefs (Done 1995a; Table 2; Fig 1). The goal was to develop a single index which reflected the most obvious manifestations of biodiversity

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and ecosystem processes. The index components are assigned subjectively, on five point scales, in rapid ecological assessments (REAs), but they have an underlying quantitative basis (Table 2, Eq. 1 and Eq. 2) which could allow assessments to be verified or modified using quantitative surveys when, for example, there are conflicting demands for the use of a particular place. The utility of the index and its components are currently being assessed by the Great Barrier Reef Marine Park Authority.

For biodiversity (Eq. 1, Table 2), the index describes representativeness (low scores) or uniqueness (highscores) of the species composition and species abundances at a site (areas from say 0.1 to 10 hectares) in the context of the *region (e.g.* the reef, archipelago, tract) of which it is a part. Sites are discriminated by assigning different weightings to species which are common, rare, and previously unreported in that region, and by incorporating an estimate of abundance of each species in the site.

For ecosystem processes, a ‘bioconstruction’ index (Eq. 2, Table 2) was developed, because it was seen as a measure of the quintessential outcome of ‘successful’ ecosystem processes - i.e. the extent of the contribution by living corals to the wave-resistant reef framework. This approach assumes that assessing an outcome of ecosystem processes is a legitimate surrogate for assessing the processes themselves. In coral reefs, longevity of individuals (say decades to centuries) at a site is manifest as the ‘framework’ mode of bioconstruction (i.e. incorporated into the reef matrix in, or close to, their position of growth). In other coral-dominated areas, more ephemeral coral species (years to decades) contribute to the ‘sedimentary’ mode of bioconstruction. i.e. they are broken and eroded into sedimentary particles from sand to block sizes, and are often transported into sedimentary ‘sinks’ by gravity, waves and currents. A ‘framework’ area is considered dysfunctional if it is dominated by more ephemeral, non-reef building biota such as algae and/or many soft coral species. The tricky part is determining when such states are symptomatic of anthropogenic degradation, and when they are a normal part of an ecological disturbance/succession cycle (Done 1992).

Given the importance of longevity, the index incorporates the age frequency distribution of all macroscopic benthos (not just corals) in the site, **plus** an estimate of the abundance of each age class in the area. Another way of viewing this index is as a measure of replacement time, in the event of complete destruction of the living community. This view brings it into line with successional thinking in the rest of the ecology, in particular, the conservation values associated with ‘old growth’ forest ecosystems. Whereas in coral reefs, ‘old growth’ equates most conspicuously with ‘bioconstruction’, it may also, as it does in terrestrial ecosystems, equate with enhanced

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ecosystem processes, diversity and symbiosis among less conspicuous components of the biota (Done et al. 1995).

Biodiversity and ecosystem process indices for coastal fisheries?

In a fishery context, a biodiversity type of index which reflects status of safe, vulnerable and endangered species (target and non-target) might be more useful than the 'representativeness/uniqueness' variant of biodiversity index described above (Eq. 1, Table 2). A 'conservation status' index (Eq.3, Table 2), could be applied to catch records and to assessments of other benthic and pelagic habitats by using taxa whose taxonomy and conservation status are sufficiently well known. The three categories 'common', 'rare' and 'previously unreported' (Eq. 1, Table 2) could be replaced by the six Red List categories for conservation status (IUCN 1994): 'least concern', 'near threatened', 'conservation dependent','vulnerable','endangered' and 'critically endangered'. These would be given increased weightings from 0 to 3 in increments of0.5 on a log,, scale (Eq.3, Table2). These values give 'order ofmagnitude' increases in importance given to the presence of the more vulnerable and endangered species in assessments of ecosystems and multi-species stocks.

Age structure of populations has long been used in areas such as forestry and fisheries to provide an indicator of the population dynamics. A 'community age-trophic structure' (CATS' index, Eq.4, Table2) which is loosely analogous to the 'bioconstruction index' (Done 1995a), could be used to discriminate among potential protected areas and/or fisheries, and to monitor and report their progress under management. The x axis on Fig.2 shows how this index would be at a maximum at tomes and places where large predatory species, and by implication, their prey, were in abundance. It would be at a minimum where predators and omnivores were absent. Fig.2 shows how this index could be used in combination with the 'conservation status' index. The composite index could be useful in a manager/use? context. A score of 1 is 'bad' by both criteria, and a score of 5 is 'good' by both criteria. The fact that scores o, 2,3 or 4 can come about by different combinations of 'good' and 'bad' scores on the two axes is a positive feature in the sense that it specifies the areas in which stocks are deficient or improving.

Use of indices by resource managers: value versus risk

The Bruntland Commission's 6th principle, the 'precautionary principle' also has major practical implications. Regional risk analysis approaches (e.g. Suter 1993, p 365) can be used, for example, to assess threats which onshore activities pose to various ecosystem values. Projected loadings of sediments, nutrients and contaminants at the point of discharge into the sea are linked with physical and biological transport and fate models to assess the likelihood that critical biological thresholds will be exceeded at places at varying distances and directions from that point. The critical biological thresholds may relate to human health (e.g. E. coli concentrations), or, as in this case, the human values ascribed to ecosystems measured by Conservation Status and CATS indices. The range of knowledge and technical skills needed to do these assessments is very broad, and provides a strong case for interdisciplinary teams of biologists, oceanographers, sedimentologists and engineers. Indeed, this section essentially describes the scope of work covered by an entire research program assessing status and threats to coral reefs in the Great Barrier Reef (CRC Reef Research Centre 1994).

Table 2: Indices which reflect Biodiversity, Bioconstruction, Conservation Status, and Community Age / Trophic Structure. 'Bioconstruction' is a key outcome of ecosystem processes on coral reefs

Index	Explanation
1) Biodiversity Index $V_b = \Sigma (c_j . \alpha^{j-1})$	c_j = the proportion of colonies, plants or bottom cover with j = 1 for common: j = 2 for rare and j = 3 for previously 'unreported, and α_i = a constant, here arbitrarily set at 10 so as to produce a minimum V_b of 1 when 100% of colonies, plants or bottom cover in the area common, and a maximum V_b of 100 when 100% of colonies, plants or bottom cover in the area are previously unreported.
2) Bio-construction Index $V_c = \Sigma (c_j . m_j)$ yrs	a_i = age class i (in years) m_i = proportion of individuals or of defined area covered by individuals of age class i.
3) Conservation Status Index $V_{cs} = \Sigma(c_j . \alpha^{j-1})$	c_j = the proportion of biomass with j = 1.0 for 'least concern'; j = 1.5 for 'near threatened'; j = 2.0 for 'conservation dependant'; j = 2.5 for 'vulnerable'; j = 3.0 for 'endangered', and j = 3.5 for 'critically endangered', and α = a constant, here arbitrarily set at 10 so as to produce a minimum V_b of 1 when 100% of biomass is 'least concern' and a maximum V_b of 100 when 100% of biomass is 'critically endangered'.

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4) Community age/ Trophic Structure Index	c = the proportion of organisms with j = 1 .0 for juvenile primary consumers and 1.5 for mature primary consumers; j = 2.0 for juvenile omnivores and 2.5 for mature omnivores, and j = 3.0 for juvenile predators and 3.5 for mature predators, and
$V_{cats} = \Sigma\ (c_j \cdot a_j)$	α = a constant, here arbitrarily set at 10 so as to produce a minimum Vcats of 1 when 100% of sample are immature herbivores or planktotrophs, and a maximum V_{cats} of 100 when 100% of sample are mature predators.

Source: Done 1995a for first two indices. The third and fourth are newly proposed here.

Remediation as an element of ICZM

Measures to control land runoff, including point and defuse sources of freshwater, sediment and pollution, may be an important component of coastal zone management in support of direct fisheries management (Done 1995b). Managers and policy makers need to assess the likely efficacy of remediation measures by addressing questions such as

a) over what spatial scales will the beneficial outcome be obtained, and
b) over what time frame can the outcome be expected?

Again the general approach of ecological risk assessment (ERA; Suter 1993) provides techniques and tools for such assessments. However in complex coastal environments, there may be major uncertainties in estimating dispersion of deleterious inputs into the sea, or the area benefiting from removal of a source of pollution (Wolanski 1994). In addition, there is a dearth of data on environmental boundary conditions necessary to support the desired benthic and/or pelagic communities.

For benthic communities, the success of remediation in the long term requires there is a long-term natural supply of larvae of appropriate invertebrates, plants, and fish from ‘source’ areas. This suggests that the most prudent strategy for policy makers and coastal zone managers is to implement networks of protected areas, taking ecosystem structure into account and crossing national boundaries if necessary. The success of remediation should be reflected in gradual increase in Biodiversity, Bioconstruction, Conversation Status and CATS indices, which would be computed from data derived from long term monitoring programmes.

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DISCUSSION

The specific issues raised by this paper are:-

- Does the Australian Fisheries Ecosystem Management (FEM) approach have applications in the Maldivian IRRM programme?
- Are indices such as those proposed here seen as potentially useful by managers?
- Do the particular indices facilitate accurate communication of meaningful ecosystem properties among different stakeholders?
- If they do not, are there others available, or can they be modified?

Recommendations on approaches to address the issues, and implications for researchers, managers and policy makers

These issues of the applicability of both FEM and the indices can both be addressed by field testing, in a broad sense. i.e the Proforma can be completed as far as possible for fisheries outside Australia, and the value of the information in development of action plans can be assessed. As for the indices, none of which has been used, it is up to researchers and stock assessors to assess their practically, and for managers and educators to assess their usefulness in communicating among parties.

We believe the concepts of FEM and performance indices have great potential both in providing the information base for resource managers and in education, If the specific examples we have provided do not stand up to rigorous scrutiny, that does not necessarily mean the concepts themselves should be discarded.

CONCLUSION

Recent recognition of the need to preserve biodiversity and ecosystem processes as well as production is now being reflected in fisheries and ICZM legislation and management plans. This paper suggests that, while stock assessment and management is an advanced scientific discipline with clear goals, ecosystem goals and paradigms for management are much less settled. Indices developed to reflect valued ecosystem attributes of coral reefs may have direct application to benthic marine protected areas. Derivations of these indices reflecting conservation status and community structure, as yet untested, may be useful in describing valued attributes of the fishery itself. At an administrative and action level, any program of IRRM which embraces an ecosystem approach should be integrated with fisheries management initiatives focused in traditional catch/effort areas.

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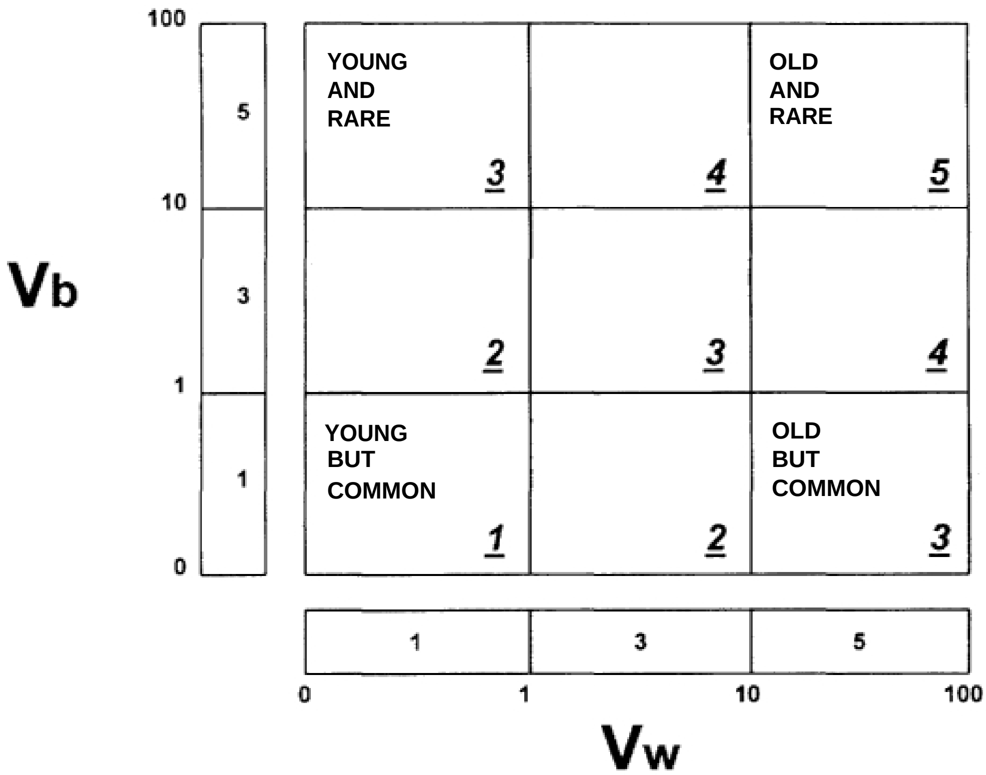

Figure 1. Suggested 5 point scales for coral communities. Value based on biodiversity as sole criterion for value (x axis), bioconstruction as sole criterion (x axis), and a composite of biodiversity and bioconstruction as joint criteria (matrix). The two indices of value are: V_b(based on the abundance, in the area of interest, of taxa which are endemic or rare either regionally or globally) and V_w,based on both the age structure and the percent cover of taxa in the area (Table 2). Value for composite criteria are the niean of V_b and V_w

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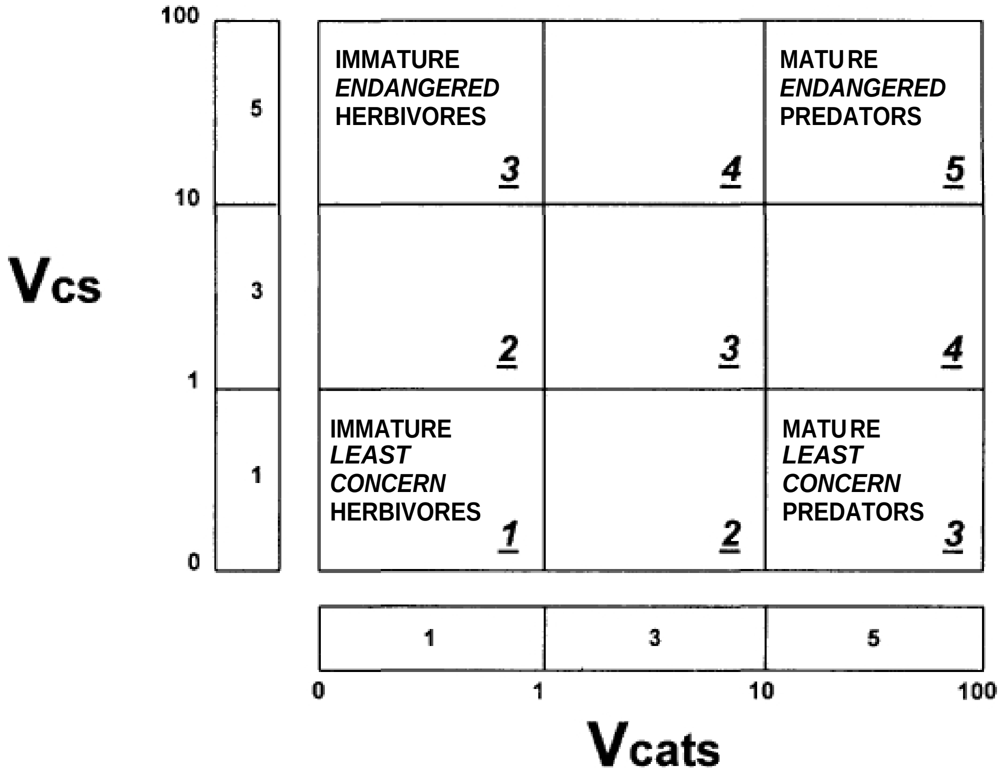

Figure 2: Conservation Status index V combined with index for conventional herbivore/planktivore-omnivore-predator food chains Vcats which incorporates age structure in each trophic level. The text in each box ofthe matrix describes the biomass which most influences the value of the index. The terms 'least concern' and 'endangered' refer to Red List conservation status (IUCN 1994).

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PAPER 11

COLLABORATIVE AND COMMUNITY-BASED MANAGEMENT OF CORAL REEF RESOURCES: LESSONS FROM THE SRI LANKA AND THE PHILLIPINES

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ABSTRACT

Integrated management of coral reef resources is being tested in several Asian countries with useful lessons for the Integrated Reef Resources Management Programnme in the Maldives. In the early 1980's several Philippine projects developed coral reef management regimes on small islands which have continued to the present. These management regimes were developed by and for island residents dependent on their coral reef resources. They set up marine reserves and sanctuaries around their islands which have continued to the present. These management regimes were developed by and for island residents dependent on their coral reef resources. They set up marine reserves and sanctuaries around their islands in a manner which stopped all destructive and illegal fishing and so that sanctuary areas were declared off limits to all fishing. Monitoring of the effects of the sanctuaries documented improvements in the abundance and diversity of fishes on the coral reef and in fish yields to the island fishermen. The process for implementation of the management regime included several steps: integration into the community; education; core resource management group building; and formalizing and strengthening organizations for sustainable resources management.

In Sri Lanka, a similar process is being adapted to more comprehensive coastal resources management in "Special Area Management" sites. Communities, local and national government are working together to develop and implement management plans for sustainable use of their coastal resources. "Special Area Management Coordinating Committees" for the site include all stakeholders in the process of planning and taking responsible action for implementation. Monitoring of physical and socio-economic effects on the environment and human community is performed by several research organizations and through local participation.

Results from the Philippine and Sri Lankan examples include stewardship of coral reef and other coastal resources, and functioning formal management organizations comprised of both community members and government. Also, both national governments recognize the value of locally-based action and decision-making in coral reef conservation.

INTRODUCTION

The Maldives, with over 800 small vegetated coral islands in the Indian Ocean, is dependent on its marine and coastal resources for livelihood (Shepherd 1995). Tourism

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and fisheries are the largest foreign exchange earners, and are equally dependent on the environmental quality of the reef and marine ecosystems and waters. Although tourism is increasing rapidly and currently provides 23.8 percent of the government revenue, fisheries have traditionally provided the main source of employment and protein in the country. Tourism and fisheries are economically and environmentally interdependent. They will increasingly require integrated management approaches to maintain sustainable yields of fish products and the overall environmental quality needed to support both fisheries and tourism.

The Government of the Maldives is responding to the coastal resources management challenge through the initiation of an Integrated Reef Resources Management (IRRM) Programme. Resource stakeholders, concerned about changes in fishery use of reef resources, trends in the tourism industry, and the sustainability of the reef resources, will be part of the IRRM Programme. This policy of collaboration between private and government sectors in managing coastal resources is far-sighted and a prerequisite in addressing the issues of environment degradation. Since the IRRM Programme is still new in design, lessons from other parts of Asia may be useful in refining it.

Experience from outside the Maldives indicates that the only viable manner to institute integrated coastal resources management is with the involvement of resource users and government together in a collaborative arrangement (White et al 1994). And, management regimes must be closely connected to the ecosystem and resources of concern so that actions are appropriate and linked to actual needs. Public participation in the decision-making process helps to ensure that long-term implementation will continue after initial planning.

This paper highlights lessons being learned in the Philippines and Sri Lanka concerning the implementation of coral reef and coastal resources management which are relevant for the development of the IRRM Programme in the Maldives. A case study of 3 islands in Central Visayas, Philippines illustrates the process of organising and monitoring a community-based program for coral reef conservation. Another case study from Sri Lanka shows how Special Area Management is being implemented with the collaboration ofnational and local governments and with full participation of community stakeholders organizations. It also shows how a localized management program must be part of a larger, more comprehensive national planning and management effort, for long term success and sustainability to occur.

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CASE STUDY CENTRAL VISAYAS, PHILIPPINES

Background

Fisheries are an important sector of the national economy of the Philippines which is ranked 13th in the world fish production. Approximately 10 to 15 per cent of the total yield of fishes in the country is taken from coral reefs (Murdy and Ferraris, 1980). About 27,000 sq km of coral reef area exists which is only considered pristine in a few remote areas but seriously degraded or destroyed in many other areas of intense fishing (Yap and Gomez 1986; White 1987a; Arquiza and White 1994).

The country with its extensive coastline and concentration of people in coastal areas is experimenting with various forms of coastal management. One approach which has proved effective for coral reefs surrounding small islands and along some large island shorelines is a marine reserve and sanctuary model which encourages local communities to be responsible for their fishery and coral reef resources. This reserve model includes limited protection for the coral reefand fishery surrounding the entire island and strict protection from all extraction or damaging activities in a small "sanctuary" normally covering up to 20 percent of the coral reef area (White 1988a; Christie et al 1994). This reserve and sanctuary approach has provided real benefits to local fishing communities through increased or stable fish yields from coral reefs which are maintained and protected (Alcala and Russ 1990; White 1989).

The results of a two-year program on three islands that initiated a community-based management program in 1985 which is still functioning without significant outside support is described. The Marine Conservation and Development Programme (MCDP) was designed to enable local communities to protect and/or enhance their marine resources. At the heart of the project was the initiation of local marine management programs, in the form of marine reserves and sanctuaries, in three fishing communities — on Apo Island, Negros, and Pamilacan and Balicasag Islands, Bohol (White et al 1986; White and Savina 1987a).

Silliman University in Dumaguete, Negros, implemented the MCDP which grew out of a similar program initiated at Sumilon Island in 1974 (White 1987b; 1988a; and Alcala and Russ 1990).

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The Problem

Destruction of coral reef habitants, over-fishing and a consequent decline in fish catches plague small-scale fishermen throughout the Philippines (White 1987a). The households on Apo (88), Pamilacan (168) and Balicasag (62) were all suffering from deterioration of their marine environment in 1985 at the outset of the MCDP (White et al 1986). Although each island had a different set of specific problems, in general, fishing methods, usually by outsiders, using explosives, fish mesh nets, scare-in techniques, poisons and spears were common on their coral reefs. Fish catches were declining along with disposable income derived from sales of valuable fish. Increasing poverty was forcing people to use more efficient and destructive fishing methods (Savina and White 1986).

The approach taken by the MCDP is based on the premise that resource management. and conservation must be rooted in local communities. The general objective of the MCDP included (White et at 1986);

1. Implementation of marine resource management programs at the three sites by setting up marine reserves with fish sanctuaries and buffer areas surrounding the islands to prevent destructive fishing; increase the abundance and diversity of coral reef fish at the island; and increase long-term fish yields.

2. Community development programs to establish working groups of local people for accomplishing marine resource management; alternative livelihood projects; and a community education center and rest area adjacent to the marine sanctuary for local education, reef monitoring and recreation-tourism.

3. An outreach and replication component to extend programs to several neighbouring fishing communities and establish linkages with other local and national organizations and individuals concerned with marine conservation/ management problems and solutions.

Management Solution and Implementation

Implementation at the three project sites of the MCDP included five groups of activities (White and Savina 1987a). The activity groups provide a framework for the community development plan leading to marine resource management and aid in clarifying the progression of events (Figure 1).

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Figure 1. Phases and activities in community-based marine resource management (Buhat 1994)

Basis for Change >	*Process of Change*			>	*Desired Change*
Preparation >	Integration wfth Community	Community > Education	Reserve Establishment	Strengthening/ > Supporting Project and Management	Evaluation and Phaseout and Replication
Protocol	Courtesy calls	Feedback from surveys for validation and planning	Core group formation	Refinement of management schemes	Feedback of results and assessments
Collection of prelimnary data	Establishment of working relationships and trust	Continual community education via interaction and forums	Feedback from surveys fo validation and planning	Broadening of conservation strategies	Reflection sessions
Conceptualization of project	Comunity integration	Training and seminars on leadership	Formation of **subcomitees** based on identified needs and tasks	Training of second-liners	Community evaluation
Project proposal preparation	Project orientation and dialogue with people	Formal and informal presentations on ecology and environment	Continual community education	Advanced training for first-liners	Agency evaluation
Tapping of resources (financial, technical, and legal)	Project launching	Completion and validation of baseline data	Formulation of management schemes	Building alliances linkages, and networks	Long-term planning
Hiring of staff	Clarification of roles between the community and line agencies, formalization of working relation		Implementation of plans for projects	Other livelihood options	Formal turnover of responsibility
Training and orientation of staff	Participation in community life		Training and seminars on leadership	Extension to adjacent communities using core group	Modified relations between community and agency
	Collection of baseline data		Formalization of the group	Continuing outside institutional mural support	
	Identification of potential leaders		Updates or additions to baseline data		

1. Integration into the community. The Project had a three-month initial period. The field workers moved into the community, introduced the project, met with community leaders, attended community meetings and generally became acculturated to the island situation with its particular problems. Baseline data for later project evaluation were collected. Carried out were socioeconomic and **demographic surveys; a pretest of environmental and resource knowledge** and **perceived problems of local people; and an environmental survey to document the status of the coral reefs by means of substrate cover, fish diversity and abundances of several other indicators. This integration process provided information necessary for planning ongoing project**

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activities particular to each site, both with respect to the community and the marine environment.

2. Education. Education was continuous throughout the project but emphasized in the initial stages. Most forms of education were non-formal, in small groups and by one-on-one contact. Focus was on marine ecology and resource management rationale and methods.

3. Core group building. Identifying existing community groups and facilitating the formation of new groups was a central focus of MCDP field activities. During the education process, community problems and their potential solutions emerged. Also, the logical manner to implement management solutions was through special island work groups with close ties to the existing traditional island political structure. Since the project intended to provide funds for a community education center adjacent to the marine sanctuary, the first group to emerge was the one responsible for the center construction. Similarly as the concept for the marine reserve took shape, those individuals interested in the problem of marine conservation formed in each island an organization called the "marine management committee" (MMC). The MMCs matured into working groups with community respect once it was decided to implement a marine reserve management scheme for the island.

4. Formalizing and 5. **Strengthening organizations.** These last two steps are difficult to separate. The main theme was to provide continuing support, in real and symbolic terms, to the core group and its management efforts. This was accomplished by helping the group identify new projects such as reforestation, placing giant clams in the fish sanctuary for mariculture, refining the marine reserve guidelines, training of MMC members for guiding tourists to the island, collecting fees for entrance to the sanctuary and initiating alternative income schemes such as mat weaving. In addition, Apo has become a training site whereby the MMC helps conduct workshops by sharing their experiences from the Apo success with the fishermen groups. This activity has truly strengthened the core group and solidified support for the marine reserve among the community.

The results of the MCDP have been substantial. Three island-wide marine reserves with municipal legal support exist. The reserves with some local variations are demarked by buoys and signs and managed by island-resident committees which patrol for rule infractions by local residents or outsiders. Municipal ordinances, tailored by the communities in conjunction with the MCDP expertise to suit their particular

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needs and their coral reefs, are posted on the islands in the local language and published in a brochure.

Enforcement varies on each island. Its effectiveness depends on individual and group dedication. On each island, some active, but mostly moral, support has been received from the Philippine police and Silliman University.

Community education centers function and serve as a meeting place for the MMCs **and** other groups. On Apo Island, a typhoon destroyed the community education center in 1989 which has since been rebuilt with community labour and some outside assistance with materials. Diving tourism to both Apo and Balicasag Island has increased significantly in response to the sanctuaries which are teeming with fish.

Fishermen members of the three island MMCs in 1992 all said that the marine reserve and sanctuary on their island had caused no decrease in fish catch or personal income since establishment of the reserves, and most believed the sanctuary had significantly improved fishing. They all said that the sanctuary served as a "semilyahan" (breeding place) for fish (White and Calumpong 1992). Fish yield studies in the fishing areas outside the sanctuaries indicate that yields have been at least stable and probably increased at Apo Island which had a yield of more than 30 tons per sq km in.1986 more than the yield measured by a similar study done in 198 1 (Alcala and Luchavaez 1981; White and Savina 1987b).

Comparison of baseline data of 1985 and 1986 with a survey made in 1992 shows an increase in fish diversity and abundances within the fish sanctuary at Apo Island (Table 1). Equally, the coral reef bottom substrate cover in the sanctuary and non-sanctuary areas of the three islands has remained stable and improved slightly since 1984 which is generally not the case for other coral reef areas in the Philippines.

Table 1. Increases in species richness and abundance of selected reef fishes for 500 sq.m. of reef sampled in the Apo Island marine sanctuary in 1986 and 1992*

	1986	*1992*	*Percent increase*
Species richness	*52.4*	*56.0*	*6.8*
Abundance			
Food fishes	1286	*2352*	*83*
Total fishes	*3895*	*5153*	*32*

Data from: White 1988b; White and Calumpong 1992
* Samples consisted of 19 families of fish and totals representing the mean of 5 replicate samples in both years using the same methodology by the same observer

Lessons Learned

Many lessons have emerged from the MCDP experience in small-scale coastal management, but it is uncertain how broadly they can be applied. The small island and community setting may be critical to the success of such a program. Nevertheless, a summary of pointers drawn from the MCDP will be of value for similar programs.

1. It is possible to manage small island coral reef resources in a manner which benefits local users and those interested in sustainable resource use. Benefits measured in terms of fish catch and quality of the coral reef can be accrued with the installation of a regime which: (1) prevents destructive uses of the resource and insures that only ecologically sound fishing methods are permitted; (2) limits the fishing effort by establishing a marine reserve inclusive of a sanctuary where no fishing or collecting is allowed; and (3) monitors the impact of the management and feeds back the results to the resource users in the form of understandable information and real life benefits (White and Savina 1987a).

2. Small islands provide a geographical advantage to marine resource management because of decreased access to people not living on the island. In addition, the island community can more easily identify with its own marine resources, as it becomes a territory over which it has some control. This advantage is lost on mainland coasts unless each segment of the coast is parcelled out to local residents (White et al 1986).

3. People must see some immediate results from their management efforts if they are to continue a management program intended to improve their marine environment. Education can provide the initial understanding of why a program is needed, but only observable results can sustain a program (White 1989).

4. Complete and practical environmental and resource use surveys and analyses are a prerequisite to helping a community decide on a feasible management plan which can offer tangible results (Calumpong 1993; Christie and White 1994).

5. Local fishermen can decide on the size and location of a marine sanctuary with the assistance of community organizers and technical inputs from marine scientists in a mutually supportive and open manner for discussion and negotiation.

6. Local residents must understand how a management program will solve a problem they think is important. For example, if they see no links between a physically disturbed coral reef habitat and decreased fish catches, they will not take action to improve the reef quality. This obvious point is not trivial since most people on these islands believed initially that corals were just stones!

7. Formation of capable and respected community groups is critical for successful implementation of community resource management projects. This means more than simply a village chief approval. It requires groups working together on projects with real outputs.

8. Any coastal management project needs to consider linkages among all potential participants-community leaders, town mayor and council, local law enforcement officers, private business with local interests and national government organizations like tourism and fisheries.

9. Baseline data and monitoring of the coral reef resources are required to illustrate to fishermen the condition of their environment and to reinforce their management participation. Data on the increase in fish abundance and diversity have been used to convince policy-makers and government officials, both local and national, about the-effectiveness of the marine reserve management.

10. Apparently successful management for small-scale settings such as the island coral reef fisheries is vulnerable to changes in local politics. Results are also sometimes dependent on moral and physical support from outside entities not obvious during the initial phase (White and Calumpong 1992; White 1987b).

CASE STUDY; SRI LANKA

Coastal Management in Sri Lanka

Unlike other Asian countries with extensive coastlines, Sri Lanka has a national coastal zone management program which is best described in the *CoastalZone Management Plan* of 1990 (CCD 1990). This plan, supported by the Coastal Conservation Act of 198 l, mandates the Coastal Conservation Department (CCD) to manage a coastal strip 300 m wide on land and 2 km out to sea. The thrust of the plan is to allow development within this narrow area while preventing unnecessary environmental degradation, pollution and erosion. This is accomplished through a regulatory system which governs most activities in the coastal zone.

Thus, Sri Lanka has a coastal program which protects the coastal environment, mostly through prevention of physical and polluting influences. But its plan does not cover the management of all coastal resources nor can the CCD coordinate coastal management among agencies with jurisdiction over resources outside of the legal coastal zone (Lowry and Sadacharan 1993). Now this is changing with a new set of policies, adopted by Cabinet in 1994, that promote a broader and more integrated coastal management system (Olsen et al 1992).

Broad Lesson from Coastal Management Efforts in Sri Lanka

One lesson which is emerging from the coastal management activities in Sri Lanka is that one or more successful area models are needed which produce tangible field results through sustainable management of coastal resources in one site. Key features which make up the field level intervention portion of an integrated effort for tropical Asian coastal programs and in Sri Lanka are to (Tobin and White 1992):

a. Select and support field implementation and intervention sites which test strategic interventions: act as models for replication; and inform policy.

b. Build capacity of individuals and institutions through 'learning by doing', training and national policy dialogue;

c. Develop a coastal environmental, socio-economic and legal-institution profile;

d. Develop a draft management plan for the site which is accomplished early through community and non-government sector participation with time for learning and refinement so the plan becomes a living document;

e. Encourage strategic information collection for management which is ongoing and focused on supplying the management plan with required supporting data;

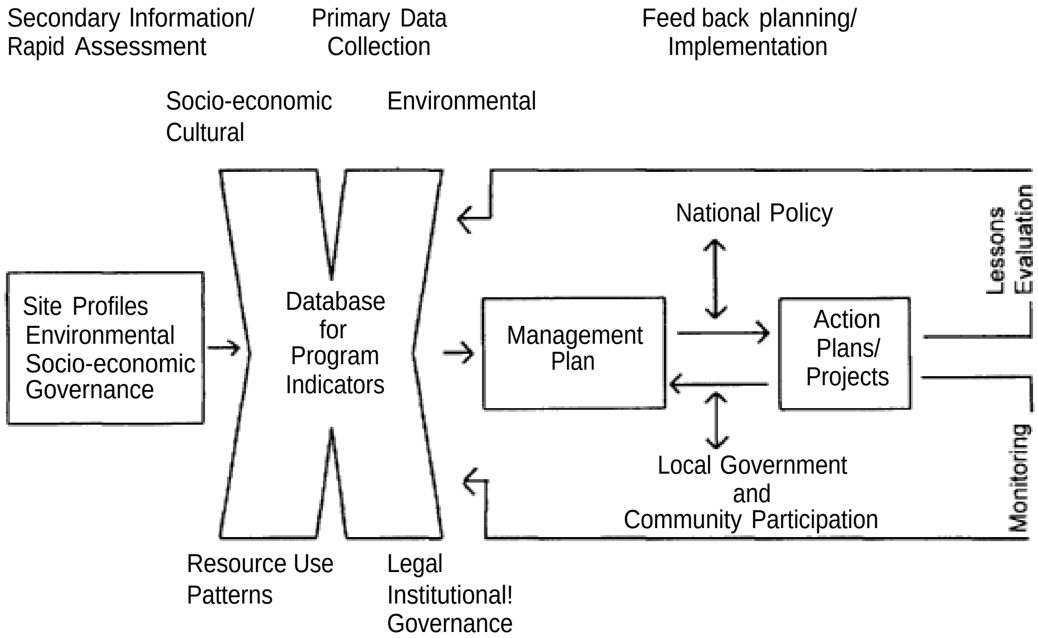
f. Continue consultation with local government, communities and other relevant institutions during the course of the management program, as a basis for sustainability;

g. Promote feasibility studies and training of personnel for community projects and economic development alternatives;

h. Implement pilot projects, refine plan; and,

i. Evaluate and promote full community and national government assumption of responsibilities for continuous management efforts and replication in new sites in a manner which emphasizes monitoring.
Information flow is essential for an integrated coastal program which is designed to learn by doing and to refine the management plan through a monitoring and evaluation mechanism. It shown in Figure 2. This general system is functioning in Sri Lanka.

Figure 2. Cyclical **coastal resources management data collection, monitoring, planning and implementation process (White and Lopez 1991)**



Special Area Management for Sri Lankan Coastal Resources

Although Sri Lanka has a head start on integrated coastal management (ICM), it is striving to improve. The Coast Conservation Department and other agencies are concerned with mobilizing and gaining the support and commitment of the local community for implementation (White and Samarakoon 1994). Inadequate participation by local communities in the planning and implementation processes has contributed to poor results in the past. Also, the financial and social benefits of improved resource management have not been understood or demonstrated. Hence, local communities do not perceive themselves as beneficiaries. Finally, program

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implementation by state officials who do not communicate well with local leaders is often viewed as interference by outsiders (Wickremeratne and White 1992). These problems have led to experimentation with “Special Area Management " (SAM) which is being adopted (see Box 1).

Box 1. What is Special Area Management?

“SAM is a means to achieve resource management within a defined geographical setting. It can resolve user conflicts and provide predictability for decisions affecting conservation and development interests. It allows integrated management which includes complex ecological and institutional settings not possible to deal with in a larger context. It can use and apply criteria for management of resources which are sustainable because the cause and effect factors can be understood within the geographical, ecological and institutional scope of concern.

“The basic premise of the SAM process is that it is possible to organize local communities to manage their natural resources and that they will continue to do so if they perceive that they derive tangible benefits from better management. The planner, the planning agency or the organization group play only a catalytic role In organizing the local community. They can provide technical and financial support for the management effort which is formulated and implemented as a local community and/or local government effort.

“Community participation is possible in SAM planning and implementation to a degree not possible in border area planning. Whether SAM planning is initiated by an outside national or local government or private organization it must inherently involve people living within the SAM site. It looks at and considers the total ecosystem including the communities and their potential role in the process ofplanning and implementation. For successful management of natural resources within the context of a SAM site, implementation and monitoring becomes a local responsibility and reduces the need for outside support in the long-term” (White and Samarkoon 1994).

Special Area Management Process in Hikkaduwa

The densely developed Hikkaduwa tourist area is approximately 100 km south of Colombo and 150 km from the International Airport. The 4 km coastal strip bordering Hikkaduwa town is known for its coastal reefs, beaches, waves and relatively clean marine waters. An area of about 100 ha with coral reef and marine life comprise the Marine Sanctuary, one of two in the country. Other attractions are the pleasing physical and social environment of the town and people. These resources attracted more than 300,000 guest-nights to Hikkaduwa in 1992 (White et al 1996).

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Although tourism in Hikkaduwa has been successfully developed over the last three decades, recent trends of arrivals to Hikkaduwa are discouraging. The most important reason is that Hikkaduwa has not maintained the quality of its natural coastal environment. Unplanned and uncoordinated development is causing degradation of the coral reef, declining coastal water quality, sedimentation of the reef, inadequate solid waste disposal, coastal erosion, inadequate anchorage facilities for fishing boats, increasing traffic congestion and conflicts between different user groups (Nakatani et al 1994). In addition, coral mining, a socio-economic and environmental problem, continues outside of the marine sanctuary but near Hikkaduwa.

A recent study indicates that the marine sanctuary is still suitable for recreational use and for the healthy growth of corals. But, a continuation or increase of present levels of pollution will threaten the water quality and its recreational value (Nakatani et al 1994; De Alwis et al 1994). Surveys in 1985, 1992 and 1994 assessed the condition of the coral reef and found that the effects of anchoring boats within the reef lagoon, use of glass bottom boats, discharging waste water from hotels and prevalence of reef walking have adversely affected the coral reef (Rajasuriya 1994).

The overall outcome is degradation of environment, lowered biodiversity and losses to the tourism dependent economy. The environmental problems are decreasing the competitiveness of Hikkaduwa with beach resorts elsewhere in Sri Lanka and Asia.

In 1992, Hikkaduwa was selected as one of two Special Area Management sites under the Coast Conservation Department and the Coastal Resources Management Project of the University of Rhode Island. The planning process is locally based and participatory. An economic valuation was made of the local tourism industry costs and benefits, and the key coastal resources, to develop a framework for justifying managing the coastal resources which support tourism.

As part of the overall intervention package for Hikkaduwa, Special Area Management has been applied to develop and implement an integrated coastal management plan. This process included the development of an environmental profile; collecting essential data; educating and organizing the local community; developing a collaborative management plan and incorporating resource economics as a tool for developing management policy. The SAM planning process integrates the local community at the center of the planning and implementation effort, thereby making them the custodian of the resources being managed.

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The ongoing process for the Hikkaduwa town and marine sanctuary focuses on the collaboration of the local communities and government with national government agencies in the formulation of a management plan for the area. The plan includes short-term implementation projects deemed desirable by all participants. The process mediates amongst the competing users and builds a consensus on what use(s) can be harmonious and in accordance with national policies for coastal management. Steps in the process of the ongoing SAM planning in Hikkaduwa are shown in Figure 3 and include:

a. **Agreement on need for SAM process at national level.**

b. **Compile an Environmental Profile of the area and determine the priority management issues.**

c. Enter the community with full-time professional facilitators and community organizers to liaise with community stakeholders, organize education programs, facilitate the planning process and to organize core resource management groups on a case-by-case basis.

d. **Conduct planning-cum-training workshops in the SAM site.**

e. **Organize resource management core groups.**

f. **Draft management plan through community involvement,** determine indicators for monitoring and conduct cost-benefit analysis.

g. **Implement pilot projects while planning continues.**

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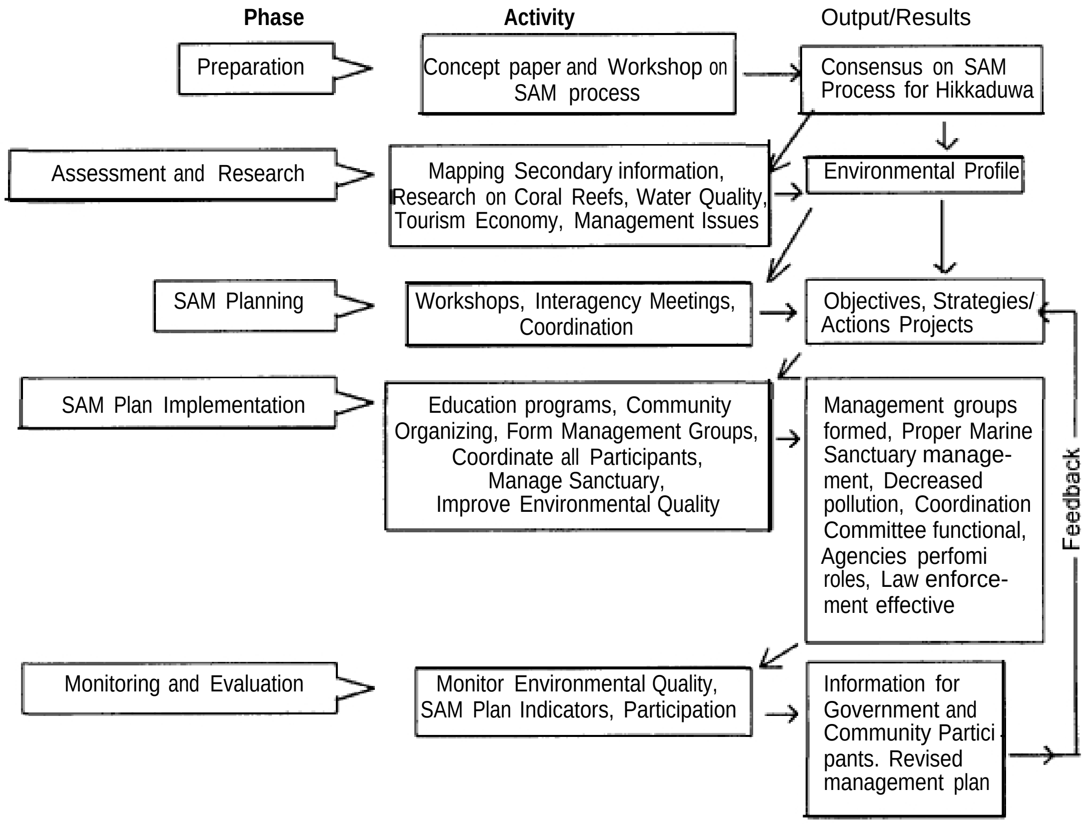
Figure 3. Special Area Management process for Hikkaduwa (White et al 1996)



h. Refine management plan from experience and broaden implementation.

i. **Review and refine institutional arrangements for implementation** that can only evolve as part of the SAM process because they are closely tied to the local situation for a given place and time.

The planning focus for Hikkaduwa is on improved management of the marine sanctuary, the beaches, town infrastructure and development oftourism. Stakeholders active in the planning process include large and small tourism establishments, fishermen, tourist guides, glass-bottom boat owners, local government and national agency representatives. The “Hikkaduwa Special Area Management/Marine Sanctuary Coordinating Oommittee”, meets monthly to refine the plan and to coordinate implementation of pilot projects.

Lessons from Special Area Management in Sri Lanka

Hikkaduwa and its marine sanctuary are representative of the issues facing many coastal areas in tropical Asia where tourism and coastal development have nearly ruined valuable coastal resources. Visitors say that they want a clean and ecologically healthy environment, otherwise they will go elsewhere. The question answered favourably in the Special Area analysis is whether or not the tourism industry, the town and the national government can economically justify the rehabilitation and conservation of the coastal environment of Hikkaduwa (White et al 1996). Also, a process for implementing this rehabilitation program is ongoing along with the economic analysis intended to bring more policy and financial support to management.

The potential of SAM as part of a national ICM.program is that it can manage complex situations and consider the whole ecosystem including its human participants and political forces. The SAM plan can grapple with management concerns for a given geographical area, such as in Hikkaduwa, in a systematic and focused manner. Although new to Sri Lanka, the SAM process of joint efforts by national and local government working collaboratively with community groups holds a large potential for improved coastal management.

Special area management in Sri Lanka offers no single recipe for success. Yet, it holds potential for promoting an agenda of sustainable development that ensures that stakeholders, government and non-government are part of the decision process. It also enables a systematic analysis of the total environment and its resources to be incorporated into a management plan for action. The plan is then economically evaluated in a manner which clearly shows its viability. In the case of the Hikkaduwa SAM plan, wise planning and action combined with community, national and international support is leading to sustainable win-win outcomes.

Recommendations for the IRRM Programme in Maldives

The two case studies suggest design considerations and actions which will be important for the long-term success of the IRRM Programme in the Maldives. Major implications include:

1. **Fishing communities will not necessarily take on the role of resource managers without some assistance and encouragement.** Although economic and social benefits are often key motivating factors, these may need to be ‘triggered through

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a number of interventions and actions before communities can conceptualize and perform resource management functions. Interventions which strengthen community motivation and capacity for reef management will include (White et al 1994):

- Research and documentation of popular knowledge of resource management and ecology that exist.

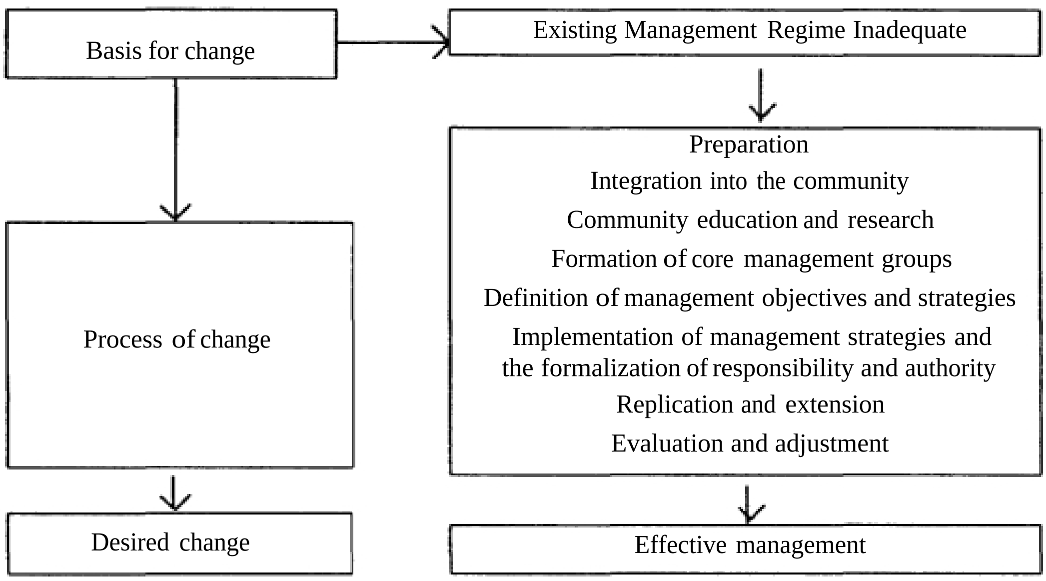
- Definition and establishment of the legal instruments that formalize community responsibility, preserve traditional rights of use and access, and enhance local benefits.

- Promotion of community participation, representation, and involvement in planning and decision making related to reef management.

- Building and developing community institutions and awareness through organization, training and technical assistance.

2. A process of change within a resource user and management community must be guided and monitored to achieve effective reefconservation. This process is summarized in Figure 4.

Figure 4. Framework for community-based marine resource management (White et a! 1994)



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3. Collaborative management implies that government agencies work together with and are supportive of community groups in their role to implement a management regime.

4. Success should be measured through monitoring of both process and ground results to determine whether there is movement towards sustainable use of reef resources. Possible parameters for documentation and measurement with community involvement in the process include: condition and health of the coral reef (substrate cover, fish diversity and abundance, density of indicator species such as butterflyfish species and fish yield from a particular reef area); changes in family income levels and patterns of livelihood or reef resources use; presence of legal and institutional instruments for management; level of participation in the resource management process; changes in the level of knowledge about the coral reef/island ecosystem and its management; and presence or absence of threats to ecosystem condition and management status.

A key factor for success of the IRRM Programme will be the development of goodwill between the national government agencies in the Maldives and the local government, village chiefs and community fishermen organizations. This goodwill will necessarily include working together for mutually shared objectives of coral reef conservation. Benefits of reef conservation must serve both local and national interests. Management actions must be tailored to the site-specific situation, given variations in human capacity, motivation and the needs of the local coral reef/island environment.

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PAPER 12

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ABSTRACT

Cooperative management of marine resources in the Pacific islands is developing rapidly. Some of the resulting lessons are discussed in the hope that some might be useful in the Maldives. One clearly emerging lesson is that there is a great need for a new kind of fisheries extension officer, one whose training focuses on management and two-way communication, rather than on development and one-way instruction. Another is that local people offer the first and most effective line of defense against destructive fishing practices - provided that they have secure tenure of their fishing grounds.

INTRODUCTION

Can the Maldives learn anything useful about cooperative management reef and lagoon resources from the experiences of other tropical islands? Since I have never been to the Maldives before, I am not in a position to answer this question with confidence. But, in the hope that the answer is "yes", workshop organizers asked me to describe locally based marine resource management in such Islands. And since the bulk of my experience relates to the tropical Pacific Islands of Micronesia, Melanesia and Polynesia, I shall concentrate on these.

The tropical Pacific islands and their peoples have much in common with the Maldives. Many of the islands are small and isolated. The inhabitants are excellent fishermen and seafood figures very prominently in their livelihoods and their diets. Their marine resources are also very similar to those in the Maldives. Coral reef fish and invertebrates are usually the main component of nearshore catches, and tuna dominate offshore catches.

As in the Maldives, nearshore fisheries are typically small-scale and based in small rural communities. Catching methods and target species in the Pacific Islands also overlap considerably with those in the Maldives.

But there are also important differences. Unlike the Maldives, where reef fisheries have become important only in recent years, Pacific islanders have for many centuries relied primarily on their reefs and lagoons for their livelihoods and food. (For them, fishing for tuna and other pelagics although not uncommon, was seldom as important as reef fisheries)

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Accordingly, some of the islanders developed an encyclopedic knowledge of their reef fish - especially of their seasonal movements, feeding behavior, and spawning seasons and locations (e.g. Johannes, 1981).

Coral reefs are much easier to overfish than continental shelves. So the results of overfishing became obvious to the islanders long before continent-dwellers. And, in consequence, Pacific Islanders developed all the basic marine conservation methods used by modern fisheries managers today centuries before western scientists even realized the need for marine conservation (Johannes, 1978). These measures include closed seasons, closed areas, and size limits. Most importantly they also included limited entry in the form of what is often called customary marine tenure or traditional fishing rights - that is, the right to exclude outsiders from their fishing grounds.

Human populations have shot up during the past two generations in the tropical Pacific, placing accelerating pressure on marine resources. New technology has been introduced and export markets developed. The introduction of commercial fishing, the rise of trochus, beche-de-mer, pearl shell as important exportable resources, and the introduction of new fishing gears and faster boats have all brought new management challenges with which traditional arrangements have not always been able to cope.

In addition, colonial governments were generally ignorant of traditional management structures and institutions and they introduced various types of ineffective centralised natural resource management policies which often greatly weakened local authority (e.g. Dashwood, 1991). All these changes put heavy pressure on traditional management of marine resources and its effectiveness declined.

At the same time this was happening, western-trained government fisheries managers tried to apply scientific management ideas, imported from very different sorts of fisheries in western temperateione countries. The results were typically dismal.

Classical textbook management methods require more data than it was economical or even possible to collect in most such fisheries. It gradually became obvious that it was not just a matter of time before adequate data became available. It is now obvious that the necessary data will never become available for rigorous management according to scientific principles, except perhaps for a few easily studied benthic invertebrate3 like giant clams and trochus.

In addition, there was often little communication between government fisheries managers and fishermen. Fishermen were often oblivious to the reasons for government fishing regulations, considering them arbitrary and irrational. Moreover, villagers were not provided with adequate biological information on which to base contemporary management decisions. Toloa et *al* (1991) identified the issue:

"The people of Tokelau (an island group in the central Pacific) feel that the traditional conservation system has served them well over the centuries. They are also aware, however, of the need for modification of the system to reflect recent changes. . . . . . Although the output from (marine biological research in Tokelau) has been utilised to some extent, a mechanism should be established so that the results are more fully incorporated into the Council of Elders' 'management plans."

Villagers such as these did not always understand the need for certain types of management. Or, if they did, they sometimes did not know how to formulate management plans to address that need effectively.

This ignorance was reciprocal; government managers were often oblivious to vital information about the fishery which only the fishermen possessed. Johannes (1993) documents a case where, despite extensive government research, a looming and very serious fish stock decline, of which fishermen were well aware, was unknown to government fisheries managers.

Government actions were also often culturally inappropriate. Fisheries development schemes based on the mistaken assumption that profit would adequately motivate island fishermen failed repeatedly (Johannes 1989). Fishing cooperatives designed by government personnel rather than by fishermen also routinely collapsed.

The failures of modern management and the decline of traditional management have triggered a reevaluation of marine resource management in the islands. Here, as elsewhere, it became obvious that sophisticated textbook objectives of management — e.g. maximum or optimum sustained yield — are unrealistic. Less elegant but more realistic objectives are to prevent serious overfishing, to ensure reasonably satisfactory allocation of resources and to minimise conflict. We now realize that to achieve even the first of these objectives can be looked upon as a major accomplishment in any fishery.

It has also become obvious that centralized government departments generally cannot carry out effective enforcement on the fishing grounds. Once again, the costs usually greatly outweigh the economic benefits. Often the only thing that keeps such activities alive at all is copious foreign aid.

This has prompted government resource managers in the Pacific Islands to give increasing consideration to the decentralization of management, that is, to formally hand back significant management responsibilities to traditional village authorities.

But how is this going to work if the traditional systems of management are in decline? The answer is by shoring them up, with better targeted government assistance. This being done in several ways:

1. giving greater formal legal recognition and support to traditional management.

2. giving villagers the information they need to manage effectively today, and

3. listening to fishermen and integrating their knowledge with modern scientific knowledge to generate a more comprehensive understanding of local fisheries than is possible for either local or scientific bodies of knowledge operating in isolation.

These last two initiatives require a fourth one, that is,

4. **redefining of the purpose and function of fisheries extension activities.**

Here I will provide some examples of these initiatives. Then, using their results as points of departure, I will then discuss the kind of training that is needed to enable fisheries researchers and managers and extension officers to take better advantage of the opportunities that cooperative management provides for preventing serious overfishing.

COOPERATIVE MANAGEMENT IN VANUATU

Vanuatu's Fisheries Department realises that managing most of its coastal fisheries from Port Vila is impossible (Amos, 1991). The costs of research, monitoring and enforcement in the multitude of small fisheries associated with Vanuatu's several hundred coastal villages would outweigh the benefits by orders of magnitude. But the Department has played a vital indirect role in management by working in the villages to help combine local knowledge and management potential with research-based knowledge in order to improve village management.

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Cooperative management began modestly in Vanuatu in 1990 when Moses Amos, a trochus specialist with the Fisheries Department, announced over Radio Vanuatu that the Department would provide advice on trochus management to fishing rights owners who requested it. (The shell of this large reef gastropod is used in making expensive shirt buttons, and is the single most important source of cash in many Vanuatu villages). Response was enthusiastic, and Mr Amos and his team began to carry out trochus surveys on village fishing grounds. They also gave the villagers basic information on trochus life history and advice on such things as why minimum size limits on trochus are desirable, where trochus refuges might best be situated, and if, and for how long, their trochus fishery should be closed in order to rebuild stocks.

Amos (1991) gives a brief description of these activities. Mr Amos ensured that information flowed in both directions. Learning from villagers about observed temporal trends in their trochus populations was useful in formulating management strategies. For example, fishermen's information on local near-shore currents helped him decide if and where to suggest that they set aside trochus breeding preserves.

He did not try to force upon the villagers rigid management plans based exclusively on biological considerations; he recognised the importance of leaving final decisions to be worked out locally, by people who needed to balance the constraints set by trochus population dynamics with local social and economic concerns. In choosing the length of a ban on trochus harvesting, villagers sometimes knowingly opted for a shorter period than would be biologically optimum in order to obtain cash for a planned community project or to rebuild after a cyclone.

During late 1993 I carried out interviews with 27 coastal villages in three areas of Vanuatu in order to investigate the results of Mr. Amos' efforts. The questions I set out to try to answer included:

1. How well has this advice been received and what have been the practical consequences in terms of improved management?

2. What scope is there for expansion of this approach to other marine resources?

3. What are some of the features of customary marine tenure that influence the effectiveness with which marine resource management can be carried out in such communities?

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4. What lessons can be learned from Vanuatu's experience that might be useful to other countries?

For centuries each village in Vanuatu has claimed the exclusive right to harvest marine resources from the adjacent shallow waters, through its chief or its constituent clans or families. All reef flats are thus owned and Vanuatu's constitution upholds these traditional rights.

I concentrated on determining how and when, recent local fishing regulations or "taboos" had been designed and implemented, the problems encountered, and the attitudes of village leaders toward the continuing use of this approach to marine resource management.

The interviews revealed that village-based marine conservation experienced a truly remarkable upsurge in Vanuatu beginning in 1990 when the Vanuatu Fisheries Department's village-based trochus management program began. In the majority of the villages surveyed, explicitly conservation-based fishing taboos had been applied for the first time in living memory only since then.

Education for marine conservation in the villages by the Fisheries Department had focussed largely on trochus. The results of implementing trochus conservation were so obvious to the villagers, however, that soon, and of their own accord, they introduced regulations controlling the harvest of many other species. In short, the Department's efforts were favored by a large multiplier effect.

These new village-based fisheries regulations can be divided into those that involved the total closure of fishing grounds and those that were species or species-group specific.

TROCHUS HARVESTING CLOSURES

The Fisheries Department usually advised villages to implement trochus closures for a period of two to three years. Three years is the approximate time from larval settlement to the attainment of legal harvestable size.

Village closure periods for trochus ranged from one to five years, Where one-year periods were chosen, the decision was based at least in part on villagers' unwillingness to be deprived of income from trochus for longer periods. Four and five year closures seemed to be based on villagers' reasoning that if two or three year bans are effective, then longer bans should be even better.

CLOSURES FOR OTHER INDIVIDUAL SPECIES OR SPECIES GROUPS

Rock lobsters are an important commercial resource in some villages. To complement government size limits for rock lobsters and its prohibition on taking berried females, two villages had imposed closed periods on their lobster fisheries.

Octopus constituted important components of the some villages' catch. Three villages employed specific closure periods for octopus . Other marine animals for which specific closure periods were reported were limpets, parrotfish, rudderfish, shore crabs and mangrove crabs.

RESTRICTIONS ON SPECIFIC METHODS

Gillnetting was prohibited in some villages. The explanations given were uniform: "it catches too many fish"[2] Night spearfishing using underwater flashlights was banned in some villages because it enables fishermen to deplete stocks of certain fish, especially large parrotfish which sleep in shallow water at night.

While a basic awareness of the relation between excessive fishing pressure and declining stocks is lacking in villages in some Pacific island areas (e.g. Carrier, 1980; Johannes and MacFarlane, 199 1; Cook et al, 1993), such awareness was quite apparent in many of the Vanuatu villages I visited, and may have had traditional roots in at least a few of them. A few, for example, had employed explicitly conservation-based fishing closures for periods ranging from several decades to as long as anyone could remember. But it was also clear that the recent dramatic upsurge in villagers' interest in fisheries conservation was due in large measure to the educational efforts made by the Fisheries Department.

Many villagers are convinced of the benefits of the recent regulations on fishing, judging not only by their enthusiastic comments, but also by the ways in which these regulations are evolving. A number of villages decided on the basis of their initial

[2] Uncontrolled gillnetting has devastated certain reef fish stocks in a number of other Pacific Islands (e.g. Johannes, 1993) and villagers elsewhere in Oceania have similarly banned the use of gillnets (Johannes, 1982; Hviding, 1992).

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experiences to extend the length of closures. For example, the period of total closure of fishing grounds at one village had been increased from three months to seven months, then to a year. In another village the trochus closure had been extended from two years to five.

SOME GENERALIZATIONS ARISING

Vanuatu's example suggests some strategies and conditions that would favor the success of government-supported, village-based management of small scale fisheries in other Pacific islands[3] These include:

1. Publicize in fishing communities the government's willingness to collaborate with villagers on management issues, and invite requests for assistance from interested villages.

2. Start small, not with a comprehensive plan to address many types of fisheries or many villages.

3. Concentrate initially on villages where local marine tenure and local authority are strong and the community is cohesive.

4. Concentrate initially on villages where fishing ground geography facilitates effective surveillance by villagers.

5. Focus initially on a single type or limited number of fisheries - preferably ones that have the following characteristics:
    a. They are important commercially or in the subsistence catch.
    b. They are relatively easy to obtain useful management information about - e.g., benthic invertebrate species whose populations are comparatively simple to monitor, such as molluscs (e.g. trochus, tridacnid clams), or echinoderms (e.g. beche-de-mer, sea urchins).

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[3] I do not intend to imply that Vanuatu is the only Pacific Island country where government-supported village-based management is being undertaken. It is also occurring in several other countries in the region. But I know of no other country where such numerous and varied examples of it exist, nor where so much might be learned from it by researchers.

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Where management measures are more urgently needed for other species one may prefer to ignore this last criterion. For some groups, such as groupers, focussing on the monitoring of spawning aggregations offers a short-cut to useful management information (Johannes, 1980). (The author is currently developing a management plan for groupers in Palau based on the monitoring of and control of fishing on grouper spawning aggregations.)

6. Ensure that national law supports local authorities in their regulation of fishing by means of village-based prohibitions and enforcement mechanisms, but does not define these procedures too narrowly.

Elsewhere I describe the results of this survey in more detail (Johannes, 1993a). Here I simply want to point to Vanuatu as providing an example of cooperative management that seems to be working well. It should, moreover, work even better in future; training government fisheries personnel for modem extension work focussing on cooperative management was introduced in 1995 and is reported to have been very enthusiastically received by the fisheries staff (F. Hickey, pers. comm.).

COOPERATIVE MANAGEMENT IN PALAU

In 1991 at the invitation of the Palau Marine Resource Division I carried out a perceptions study of village fishermen regarding the state of their marine resources and their opinions concerning management needs.

During these discussions I sought information and opinion in four basic subject areas:

1. what fishermen considered to be the most important marine resource conservation problems.
2. how well existing traditional rules and government laws that address these problems have been working in recent years,
3. what new laws seemed desirable, and,
4. what mechanisms seem most practical for improving the enforcement of marine conservation laws and the observance of relevant traditional customs.

Recently, with the encouragement of Palau's Division of Marine Resources (DMR), there had been a resurgence in the use of traditional measures by villagers to control

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fishing in their traditional waters. A bul, or traditional prohibition has been placed on certain fishing grounds seasonally in order to prevent the taking of groupers in their spawning aggregations. (The concern about grouper conservation was triggered by the destruction of a major multi-species spawning aggregation of groupers by a Hong Kong-based live reef fish fishery. In the space of only three years it completely obliterated a large spawning aggregation involving all three of the most commercially important groupers in the country.) The ***bul*** are designed and enforced by villagers with significant advice from the Division.

At the meetings we held, village fishermen eagerly volunteered a series of sound suggestions for regulations, some of which would clearly entail sacrifices on their part. For example, there was a widespread call among fishermen for a law restricting the use of small mesh nets. Most of the many fishermen throughout Palau who brought up this recommendation had nets that would be become illegal under such a law. Nevertheless, they felt so strongly about the need for this law that they were willing to give up these nets (after a phase-out period) provided they were confident that everyone else had to do likewise.

They also called for a ban on the commercial sale of grouper and rabbitfish during their main spawning seasons, a size limit on lobsters, a closed season on mangrove crabs and a ban on spearfishing with scuba.

Subsequently a comprehensive new fisheries law was passed which was designed with very significant participation of fishermen in its design.

Other examples of Pacific islands where an indigenous recognition of the need for marine conservation can be found and harnessed by governments include the Solomon Islands (Hviding, 1992, 1993), the Cook Islands (e.g. Sims, 1990) and Fiji (Fong, 1994).

REDESIGNING FISHERIES EXTENSION WORK

Village fishers are strategically placed and highly motivated to judge the effects of their management measures. In Vanuatu they were quite willing, as my interviews revealed, to modify management by means of trial and error. But Some important aspects of the biology of target species are unknown to them, knowledge of which could greatly reduce the number of management trials that would be needed before a satisfactory management regime was established. For example, until Mr Amos advised Vanuatu villagers that trochus take three years to grow from settlement to commercial

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size, they had little idea of how fast the species grows and thus had rather hazy notions of how long a closure should last to be effective as a conservation measure.

In addition, some principles of fisheries management cannot be easily learned simply through experience on the fishing grounds. For example, unless it is explained to them, fishermen can hardly be expected to know that decreases in catch per unit effort or the mean size of individuals in the catch are not necessarily signs of overfishing. Clearly, then, they could benefit from advice on a wide range of subjects How can fisheries departments improve their performance in this regard? They can start by redesigning their fisheries extension programs (the techniques for which in the tropics are literally decades behind those used in agricultural extension.)

Fisheries extension work in the tropics has focussed largely on instruction for fisheries development. For the purposes of cooperative management, however, a supportive extension program must employ different skills and knowledge. Extension workers must learn how to ask and listen as well as talk and demonstrate — and these are not simple skills to learn well, as any anthropologist knows. Extension workers need to be taught how to gather and evaluate information on villagers' perspectives and on their practical knowledge concerning marine resources.

(My brief inquiries in the Maldives indicate that tuna fishermen, tuna bait fishermen, aquarium fish collectors and grouper fishermen all possess valuable knowledge that cannot be found in any scientific treatise. A concentrated effort to collect and record this knowledge would undoubtedly enrich our knowledge of the Maldives' marine resources and the history of their exploitation.)

Extension workers must also learn how to provide the complementary biological knowledge and education that villagers need in order to manage their resources better. Villagers often want answers to questions such as "What management measures are there for us to choose from, and where, when and for how long should we apply them?" To handle these responsibilities fisheries extension officers need not only different training, but a lot more training than they typically get now.

An appropriate extension program must, moreover, be concerned not only with transferring technology and explaining conservation to villagers, it must also be concerned with explaining village fishermen's customs and knowledge to the rest of the Fisheries Division.

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GATHERING TRADITIONAL KNOWLEDGE

A great deal of lip service is paid today to the value of local knowledge. Nevertheless little effort is being made to actually record (let alone act on) it. Why is this? At least in part it is because fisheries researchers are not taught to seek knowledge from people; they have been trained to go first to books, then directly to nature for their answers. This has to change, and appropriate training is essential in order to change it.

Admittedly questionnaires are sometimes given to fishermen, but these can be a real barrier to effective communication. Questionnaires addressed to randomly selected fishermen are fine for obtaining some types of valuable information. But they are quite inappropriate for the study of local knowledge about the state and nature of marine resources (Johannes, 1993b).

EXPERIMENTAL MANAGEMENT

The valus of experimental marine resource management research is increasingly recognized (e.g. Alcala and Russ, 1990; Hilborn and Walters, 1992). Whereas conventional fisheries management requires gathering data on catch, effort and stock sizes literally endlessly, while formulating management principles based on extrapolations from this data, experimental management, in contrast, is an iterative pragmatic process which involves trying out various management strategies and basing subsequent management decisions on the results. It is based on a practical learning process which we refer to by the unglamorous term “trial and error” The “trial” in trial and error means *taking action now,* rather than delaying until after years of data collection.

Trial and error remains the most important rational decision-making strategy used by our species. But it has been wrongly denigrated in some scientific circles in this century because of the superior decision-making strategy of scientific hypothesis-testing. Superior, that is, when it is applied to a limited, although important, range of issues - a range which does not, I stress, include most of the issues confronting natural resource managers.

Experimental management, starting with *taking action now* is vital in seriously threatened fisheries. Unfortunately very little experimental management research has been done around the world, despite widespread recognition of the need for it.

Opportunities have been few; it is hard to find, or establish, suitable experimental conditions and controls because this usually requires persuading or forcing fishermen to carry out the experiments.. But the small size of many managed village fishing grounds and the management control afforded by local marine tenure and traditional authority make them exceptionally attractive for this purpose. I am confident that many Pacific Island villagers would welcome such projects in their waters if they were presented to them and carriedout with appropriate sensitivity and in a genuine spirit of collaboration. The likely responses of Maldivian villagers is something concerning which I am not qualified to comment.

Simple before-closure-and-after surveys of species abundances would be very useful, although many other valuable research projects are conceivable under these conditions.

Studies of effects of experimental management on beche-de-mer stocks are needed (e.g. Preston, 1993). Research on the effects of closures of varying lengths on finfishes, rock lobsters, mangrove crabs, giant clams, and other species that are important in large areas of the tropical Indo-Pacific would also be of particular value.

Fisheries departments could also profitably devote more time to synthesizing published information on the life histories and responses to exploitation of various important local species. Such analysis would help us present villagers with rough cost/benefit calculations for management and provide improved advice concerning optimal duration of closures and the desirability of other forms of management — all without the need for further expensive and time consuming data collection.

VILLAGERS' ATTITUDES TO WARDS CONSERVATION

Some Pacific Island peoples clearly possess a traditional conservation ethic, by which I mean an awareness that they can deplete or otherwise damage their natural resources, coupled with a commitment to reduce or eliminate the problem (e.g. Johannes, 1978a). Other Island peoples apparently perceive little or no relationship between their activities and the state of their natural resources (e.g Carrier, 1980; Johannes and MacFarlane, 1991). Still others appear to have had a traditional conservation ethic, but one which has been eroded by external influences (Johannes, 1978a).

Determining whether or not a traditional conservation ethic exists in particular area is important when developing cooperative management. Where such an ethic exists, it provides an excellent foundation on which to build resource management programs;

they can be planned around accepted local values and associated customs. Where a traditional conservation ethic is weak or non-existent, fisheries extension workers need to be aware that a big education job lies ahead.

The fact that this ethic is widespread in Oceania but not so in the Philippines may help explain why culturally sensitive, low cost, short term efforts on the part of single extension workers, such as Moses Amos in Vanuatu, can have a major impact on locally based management, whereas teams of dedicated people typically have to work for years in Philippines villages (see White, this volume) to achieve similar results[4].

In my experience people who have never been faced with marine resource limitations in their history tend not to recognize the importance of marine conservation. Indeed, how could they be aware of its importance if their marine resources have always been functionally unlimited? I hope I am wrong, but I would hazard a guess that Maldivians would tend to fall into this category. The reason is that, unlike many Pacific Island peoples, they have probably never, until very recently, been confronted with serious marine resource limitations. It would not have been possible for them to have overfished their pelagic tuna stocks, and their reef and lagoon resources were only very lightly exploited .

PROBLEMS INIMPLEMENTING COOPERATIVE MANAGMENT

It is dangerous to extrapolate lessons learned in one location to another. Cultural, political, social, economic and environmental variations loom too large. How much and what kind of responsibility should devolve from governments to fishing villages will vary from place to place - even within a single small island group.

If at all possible, fisheries extension programs should work through existing social structures and institutions rather than idealized community structures. Attempts to promote community based action have greater chances of succeeding the greater the previous history of collective action in that community and the authority and public support of its leadership. If an extension program does not have a healthy sociopolitical structure through which to work, attempting to create one is fraught with problems. The widespread failure of fishing cooperatives, typically planned from the top down, is a well-known example.

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[4]Two other important differences: In the Philippines reef and lagoon resources arc severely overfished, and local control over the fishing, grounds was not observed until very recently..

Other problems include:

- inappropriate attitudes of government staff - arrogance, lack of communication skills
- lack of coordination between government agencies
- middlemen controlling the actions of the fishermen by controlling their finances
- politicians and businessmen flouting environmental regulations and interfering with rational resource management

Duriong my short visit to the Maldives it has become abundantly clear that fisheries managers here have to contend with the last of these problems, especially as it relates to uncontrolled, ill-designed dredging and filling projects. Tourism developers are slowly but surely killing the goose that lays the golden egg.

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PAPER 13

TRADITIONAL MARINE RESOURCES MANAGEMENT SYSTEMS IN THE ASIA-PACIFIC REGION: DESIGN PRINCIPLES AND POLICY OPTIONS

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ABSTRACT

The aim of this paper is to present an overview of current issues for environmental management in the Maldives. In the past, the lifestyles of Maldivians were very simple and had almost negligible impact on the environment. However, recent socio-economic developments and growing population have led to marked deterioration in the environment. With a very fragile and delicate ecosystem, vulnerable to the threat of global warming and sea level rise, the need for environmental management and planning is clearly demonstrated.

In this paper particular attention is paid to the environment problems to which the government has given priority action. Issues considered include beach erosion, coral mining, population issues, freshwater resources, waste disposal and sewage disposal.

The present environmental management structure in the country is also considered in the paper. The institutions, legislation and agendas developed for environmental management are presented along with the environmental impact assessment procedure for new development projects. As the Maldives is actively involved in bringing environmental issues to the forefront of the global political agenda, the role played by Maldives in the international arena is also briefly stated.

1. PRINCIPAL CHARACTERISTICS OF MANAGEMENT SYSTEMS

For any fishery, four actual or potential foci of problems that require management exist:

- *The flow* of *the* resource (its continued, regular availability);
- *Stock externalities* (the economic, and therefore social, impacts of harvesting interactions among users or user groups);
- *Technological externalities* (the mutual incompatibility of various harvesting technologies); and
- *Allocationproblems* (competition for access to a resource[s] distributed unevenly in space and time).

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The way in which these problems are addressed in coastal fisheries demonstrates convincingly the special characteristics of traditional, community based common property coastal resource management systems.

The crucial difference is that whereas the “conventional” management approach focuses on fish stocks and stock externalities and assumes an open access resource regime, traditional community-based common property systems of marine resources management focus and base management on the three interrelated factors of stock externalities, gear externalities and allocation problems, and base implementation on geographical areas, with defined boundaries, to which access is controlled (Ruddle 1995). Conventional fisheries management has focused on modelling the biological and physical flow of fish resources onto and through fishing grounds, and in implementation on attempting to manage the resultant stock externalities. In other words, it focuses on trying to manage what is unknown (and perhaps inherently unknowable) and *thus unmanageable* (Ruddle 1995).

Traditional management systems, in contrast, make no such attempt. Rather, they are focused on resolving *gear externalities* and *allocation problems,* are implemented based on *defined geographical areas* and *controlled access, are* self-monitored by the local fishers based on local knowledge systems, and are enforced by local moral and political authority. In other words such systems focus in an mtegrated manner on human ecological problems which are inherently manageable. This implicitly accounts for the complex multi-species and multi-gear nature of the resource, thereby avoiding inherently unresolvable issues (Ruddle 1995).

Both the problems of gear externalities and assignment are overcome in traditional community-based management systems at the first level by:

- control of a fishing area, as a strictly bounded *common property,* and
- establishing exact social boundaries, by rights, to define who has access *rights* to that area.

At the second level boundaries are set by of *rules of operational behaviour* that then specify assignments of time and place within that space and group having access.

The first level is sustained by rights of exclusion, or limited access, that maintain the private area of a community of local fishers against outsiders. The second level, intragroup operational rules, is sustained by local authority that has the power to invoke sanctions on offenders. In a great many systems sustainable harvesting practices are enforced, thereby leading to resource conservation (Ruddle 1995).

2. UNDERLYING CHARACTERISTICS OF LOCAL KNOWLEDGE SYSTEMS

The sets of rules that comprise a fisheries management system derive directly from local knowledge and concepts of the biological and physical environment and resources on which the fishery is based. Thus local knowledge is fundamental to the continuity of sound community-based management practices and to the design of new systems of sustainable resource management (Ruddle 1994a).

Local knowledge systems are empirically-based and practically-oriented. Some are complex and highly organized. Important commonalities characterize corpuses of local knowledge of coastal-marine environments and resources in many widely separated parts of the world. The principal ones are that they are (Ruddle 1994a; 1994b):

- based on longterm, empirical, local observation, that they are adapted specifically to local conditions, embrace local variation, and are often extremely detailed;
- practical and behaviour-oriented, focusing on important resource types and species;
- structured, which makes them somewhat compatible with Western biological and ecological concepts through a clear awareness of ecological links and notions of resource conservation; and
- often dynamic systems capable of incorporating an awareness of ecological perturbations or other changes, and of merging this awareness with a local core of knowledge.

Local knowledge may be gendered, because men and women usually have distinct economic, resource bases and social constraints, types of local knowledge vary between them. There are at least main four types of gender differences in local knowledge systems (Norem ***et al.*** 1989):

- different knowledge about similar things,
- knowledge of different things,

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- different ways of organizing knowledge, and
- different ways of preserving and transmitting knowledge.

Some local knowledge of environments and natural resources is exclusive to females, and some bodies of local knowledge may have complementary male and female components, Both must be understood to comprehend particular aspects of resource production and environmental management. For example, knowledge of aggregations for a number of fish species includes that on spawning behaviour, especially that important for capture. Among the Marovoans of the Solomon Islands, for example, women have an extensive knowledge of the lunar and seasonal rhythms in the occurrence of eggs and milt in many species, as they usually gut the fish brought home by men. They thus assist in decision-making regarding the use of particular fishing locations. An intricate knowledge of seasonal variations in the occurrence of crustaceans and molluscs is also possessed mainly by women, the usual collectors of these resources. The timing and locations of aggregations of land crabs, mangrove crabs, mobile molluscs, as well as factors such as "red tide" that influence the edibility of molluscs, are intimately known to them. Similar knowledge, though limited to fewer species, is possessed mostly by those men who dive for commercial shells such as trochus, pearlshell, greensnail and thetabu shell, and for beche-de-mer (Johannes and Hviding 1987).

On the other hand, other bodies of specialized knowledge are possessed only by one gender (or age set). This pertains to the cultural roles of one gender, and often may not be available to the other. Further, in some societies specific bodies of knowledge are held only by particular office holders. This occurs, for example, among fisheries "magicians", such individuals also often being religious leaders.

3. DESIGN PRINCIPLE3 OF MANAGEMENT SYSTEMS

In many parts of the Asia-Pacific Region coastal fisheries are or were managed traditionally by community-based systems of property rights and associated regimes of rights and rules that closely reflect social organization and local power structure. Since property is a social relationship that defines its holder's security of claim to a resource or to the services or benefits it provides, such systems reflect a correlation among property, property rights, and social organization (Ruddle 1988).

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In these traditional community-based common property systems of marine resource management an individual's sea rights depend on his or her social status within a corporate community, which ranges from villages through clans, sub-clans, and lineages, to the family. Resource territories and user groups are defined. Resource use is governed by rules and controlled by traditional authorities who mete out sanctions and punishments for infringement of regulations. Conservation for sustainable resource use is a widespread objective of these systems (Ruddle 1988; 1994a).

I. Authority

In traditional community-based marine resource management systems resource control and management is usually vested in traditional authority, the nature of which varies according to socialorganization. Four principal types can be recognized: traditional secular leaders, traditional religious leaders, specialists, and rights-owners. These categories frequently overlap, and responsibility is divided and shared. These are:

- ***Secular Leaders:.*** In many societies a group of traditional leaders or an organization, usually some kind of "village council", manages marine resources by regulating the use of community sea space and protecting resources against overexploitation. However, in many Pacific Islands, in particular, land and sea is disposed of by a chief, who exercises his authority on behalf of the entire community ;

- ***Religious Leaders:*** The role of religious leaders in traditional resource management is widespread in the Asia-Pacific Region. These can be both traditional religious leaders, as in Indonesia and in parts of the Pacific Basin, or members of a formally organized church, as in Sri Lanka;

- ***Specialists:*** Commonly, marine resources are managed by fisheries specialists, who function under some form of higher authority, Such "master fishermen" are particularly common in Pacific Island societies; and

- ***Rights-Holders:*** Rights-holders themselves commonly have management authority over marine resources. Frequently, this level of authority is vested in the senior person of a lineage, family, or other small social group.

II. Rights

Under traditional community-based systems marine resource exploitation is governed by use rights to a property. A property right is a claim, consciously protected by customary law and practice, to a resource and/or the service or benefits that derive from it. Such a grant of authority defines the uses legitimately viewed as exclusive, as well as the penalties for violating those rights. The characteristics of property rights may vary situationally. Common characteristics are exclusivity, the right to determine who can use a fishing ground, transferability, the right to sell, lease, or bequeath the rights, and enforcement, the right to apprehend and penalize violators of the rights. The rights of enforcement, and in particular that to exclude the free-riding outsider, is a key characteristic, for without it all other rights are diminished either actually or potentially (Ruddle 1994c).

Almost universal throughout the Asia-Pacific Region is the principle that members of fishing communities have primary resource rights by virtue of their status as members of a social group. Such rights to exploit fisheries are subject to various'degrees of exclusiveness, which depends on community social organization and local culture. Most commonly, traditional fisheries rights apply to areas, but superimposed on these may be claims held by individuals or groups to a particular species or to a specific fishing technology.

Traditional rights to marine resources may be primary or secondary, and may be further classified into rights of occupation and use. The relationships between the two main types, primary and secondary, is an important and complex characteristic of many traditional management systems, in which overlapping and detailed regulations on the use of technologies and particular species are widespread. Individual rights as sub-divisions "nested within" corporate marine holdings occur widely throughout the Asia-Pacific Region. Rights of transfer and loan and shared property rights also occur (Ruddle 1994c).

Primary Rights

Most commonly these are rights to which a group or an individual is entitled via inheritance (i.e., a birthright), by direct descendance from the core of a descent-based corporate group. Primary rights are generally comprehensive, since only they confer access to all resources within a defined territory. Inheritance, ancestral interests, social obligations and cooperative relationships within a social group provide continuity of ownership and rights.

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Secondary Rights

Secondary rights are more limited than primary rights, often being restricted to specific fishing methods. They are acquired through affiliation with a corporate group, by marriage, traditional purchase, exchange, as a gift, or as reciprocity for services. Sometimes they may be inherited. Secondary rights are often given to residents of inland villages lacking direct access to the coast, particularly when such villages have historical and kinship ties with a coastal village.

Systems with "Nested Rights"

In some societies rights to fisheries, which are usually to areas, are overlain by other rights, generally those to species and those to gear types. Most are quite simple, like those to locations with stone fish traps.

One complex and unusual case of such rights is that of Ponam Island, Manus Province, Papua New Guinea, where the system of rights is composed of three main independent and overlapping elements: (1) ownership of reef and inshore marine waters; (2) ownership of species; and (3) ownership of fishing techniques (Carrier 198 1: Carrier and Carrier 1989). There, owners of sea and reef areas do not have exclusive ownership of their tenured waters, owing to strict limits set by these countervailing, nested rights.

The Right of Transfer and Loan

Some traditional management systems permit the permanent, temporary or occasional transfer of rights to other social units. Often, temporary and occasional transfer requires users to compensate rights-owners in cash or, more commonly, in kind, usually with a portion of the catch. In other societies, however, individual fishermen are proscribed by either statutory or customary law from transferring their rights.

Shared Rights

In some parts of the Asia-Pacific Region area1 rights are shared between or among different corporate communities. Commonly shared rights have deep historical roots, and invariably sharing is done only for the most productive waters or where kinship ties are strong.

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111. Rules

Rules give substance and structure to property rights by defining how a right is to be exercised, through specification of required, permitted and forbidden acts in exercising the authority provided by the right. Thus, whereas a right authorises a fisherman to work a specific fishing ground, his options in exercising it are governed by rules which may, for example, specify gear type used or seasonal restrictions, among other limitations. The more complete a set of rights, the less exposed are fishermen to the actions of others (Ruddle 1994c).

Basic rules define the geographical areas to which rights are applied, define those persons eligible to fish within a community's sea space, and govern access of outsiders. Operational rules govern fishing behaviour, gear externalities, assignment issues, as well as specify unacceptable fishing behaviour, conservation practices, and distribution of the catch within the community.

(I) The Definition of Fishing Territories

In the Asia-Pacific Region, the sea territory of a social group is commonly, but not always, defined by proximity or adjacency to its settlement(s), and by lateral and seawards boundaries. As a general principle, the exclusive fishing territory of a community is in the adjacent marine waters, within the reef. But this varies considerably according to both local history and the more recent processes of national modernization.

In most places communities maintain exclusive rights to all known adjacent submerged reefs, which are named and owned exclusively by particular families, clans, municipalities, islands, groups of islands, or atolls, as the local social organization dictates. Seawards of the reefs the degree of exclusiveness of rights gradually declines.

(2) Eligibility Rules

In addition to holding rights, in many societies the persons who can actually engage in fishing are limited by community-based, national or cultural rules. Whereas in a great many societies in the Asia-Pacific Region membership of a corporate descent group, and thus inheritance, and/or residence are the only rules that must be satisfied in order to become a fisherman, in others further preconditions must be met. Such eligibility rules include caste membership, gender and skill level, among others.

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(3) Inter-Community Access Rules

Access controls are applied to outsiders; people from other social groups. There is often boundary permeability between neighbouring groups, a consequence of long friendship, kinship or other close association. Boundaries are less permeable the more distant the "outsider" group is either socially or geographically. But increased commercial resource use often leads to strong access controls, even on close neighbours.

Throughout the Asia-Pacific Region, the rights of outsider fishermen are usually closely specified by rules defining access conditions. However, there is considerable variation in local details. Invariably, such rules require that prior permission be obtained before commencing fishing. Failure to do so is usually regarded as trespass, the penalties for which can be severe. Commonly, rules specify that some form of fee, compensation or royalty be paid once permission has been granted.

In some cases outsiders seeking fish for subsistence are allowed free access, whereas commercial fishermen might be granted access on payment of cash or kind, or prohibited entirely. Almost universally, commercialization and commoditization results in a demand for fees or prohibition, even when the target species has not traditionally been harvested by the "host" community. Species restrictions are sometimes placed on outsiders.

(4) Use Behaviour Rules

- *Gear Rules:* Gear rules are widespread in the Asia-Pacific Region. Gear perceived of as either deleterious to fish stocks or habitats is widely prohibited. Similarly, generally in the interests of equity, gear regarded as being too efficient or as exacerbating socio-economic cleavages within a community is often banned. Many gear rules are established to prevent gear externalities.

- *Temporal Allocation Rules:* In many places rules are enforced to promote both orderly and equitable fishing. Frequently, such rules limit the number of canoes in a line, and ensure that the position of canoes is changed in a specific order, so all fishermen can share equally in the best spots. Lottery systems for allocating space-time among fishing groups are widespread, especially in South Asia.

- *Fishing Bchaviour Rules:* Almost universal are local rules aimed at promoting orderly fishing as well as protecting fish schools. Such rules are detailed and usually locally specific. Examples include the ban on individual fishing with flares, in favour of group efforts, acceptable levels of noise, and the way in which boats and gear must be handled so as not to disturb schooling fish.

- *Species Rules:* Rules are common regarding the harvest of certain species. Widespread, for example, is that turtles are reserved for higher ranking persons, such as chiefs in the Pacific Islands. Other rules forbid the harvesting of totemic and sacred species.

(5) Conservation Rules

The conservation intent within traditional community-based marine resource management systems is controversial (Ruddle 1994c). It is important, therefore, not to assume a *priori* that traditional management systems are intentionally conservationist. Rather, local rationale and possible conservational functions must be examined for in each case.

If community-based traditional marine resource management systems were originally designed as a conservation measure, admittedly an unprovable assumption in most places, they would have been the most widespread conservation measure employed throughout the Pacific Basin. Widespread in the Asia-Pacific Region is the use of “closed seasons” that follow local knowledge about the spawning periods of key fish species and prohibit their capture during such periods, together with other types of customary fishing regulations, often based on a non-ecological rationale such as religious taboos, that appear to have similar conservational implications (Johannes 1978).

Such practices are not static. And some of the new regulations that village communities devise to cope with changing technology and fishing practices are explicitly conservationist.

A wide range of conservation rules was traditionally employed by many communities in the Asia-Pacific Region, and especially in Oceania (Johannes 1978; 198 1; 1982), to ensure sustained yields. Some were clearly designed to conserve stocks, whereas others also functioned coincidentally as conservation devices. Among these were the live storage or freeing of surplus fish caught during spawning migrations; the use of closed seasons (particularly during spawning); the placing of taboos on fishing areas; the reservation of particular areas for fishing during bad weather; size restrictions (although this was uncommon in Oceania); and, in recent times, gear restrictions (Johannes 1978).

(6) Distribution of Catch Rules

Rules defining access to harvested fish are widespread in the Asia-Pacific Region. These are an extremely important set of rules in many societies, since in terms of equity within a community access to fish once harvested can be as or more important than access to fishing grounds (Collier *et al.* 1979; Kendrick 1993). Such rules include those to provision the family and community, those required as subsequent and continual repayment for the acquisition of fishing rights, and those enmeshed in general community sharing and reciprocity and related norms concerning equity and fairness (Ruddle 1994a).

IV. Monitoring, account ability and enforcement

If rights are to be meaningful, provision must be made within the system for monitoring compliance with rules and imposing sanctions on violators. Under community-based marine resource management systems in the Asia-Pacific Region, monitoring and enforcement are generally undertaken within the local community; resource users policing themselves, and being observed by all others as they do so.

For a variety of reasons traditional authorities frequently imposed temporary or permanent bans, as well as spatial, temporal, gear, or species restrictions on the exploitation of marine resources. These commonly took the form of taboos.

V. Sanctions

Sanctions were widely invoked throughout the Asia-Pacific Region for the infringement of fisheries rights and the breaking or ignoring of locally-formulated rules governing fishing and other marine resources uses. Four principal types of sanctions were widely invoked; social, economic, physical punishment, and supernatural.

- *Social Sanctions:* This category includes ridicule, shaming, ostracism, and banishment. Ridicule was widely used in Polynesian societies.
- *Economic Sanctions:* This category includes monetary and in-kind fines, destruction of gear and forced labour, among others.

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- *Physical Punishment:* Physical punishment, including death, was a not uncommon penalty in the region, and especially throughout Oceania, for the violation of rules.

- *Supernatural Sanctions:* These are all-pervasive throughout the Region, and fear of them reinforces the other types of sanction.

4. DESIGN PRINCIPLES OF LOCAL KNOWLEDGE SYSTEMS

The often fragmented and cursory data on subsistence-level societies throughout the world, obtained by researchers from a wide range of disciplines, yield remarkably consistent generalizations about certain structural and processual characteristics of local knowledge systems. These are (Ruddle and Chesterfield 1977; Ruddle 1993):

- There exist specific age divisions for task training in economic activities;

- Different tasks are taught by adults in a similar and systematic manner;

- Within a particular task complex (e.g., gill-netting) individual tasks are taught in a sequence ranging from simple to complex;

- Tasks are gender and age specific and are taught by members of the appropriate sex;

- Tasks are site specific and are taught in the types of locations where they are to be performed;

- Fixed periods are specifically set aside for teaching;

- Tasks are taught by particular kinsfolk, usually one of the learner's parents; and

- A form of reward or punishment is associated with certain tasks or task complexes.

But there have been few comprehensive studies of local knowledge systems. One such system, on Guara Island, in the Orinoco Delta of Venezuela (Ruddle and Chesterfield 1977) is highly structured and systematic, with either individual or small group instruction. Emphasis is placed on "learning by doing", through repeated practice over time rather than by simple observation and replication. Regardless of the complex

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of tasks to be taught, a teacher's first step is to familiarize the learner verbally and visually with the physica elements of the appropriate location. The entire complex is demonstrated over a period of time; proceeding additively and sequentially from simple to complicated steps, the complex is divided into individual procedures that repeat those already mastered. Finally, an entire task complex is learned, with only occasional verbal correction needed. When competent, the learner is allowed to help the teacher, and to experiment and use his/her own initiative, and the teacher gradually eliminates the need to fill that role.

But not all systems are like that. A striking contrast is found on Pukapuka, one of the Cook Islands of Polynesia (Borofsky 1987). In Polynesia most local knowledge is transmitted informally, as on Rotuma (Howard 1973), for example. On Pukapuka, most knowledge transmission occurs in the context of an activity; in a situationally relevant purpose of performing daily tasks. This is similar to the situation on the Polynesian island of Tikopia (Firth 1936), as elsewhere in Polynesia (Ritchie and Ritchie 1979). Thus, for example, place names on a reef and the names and characteristics of reef fishes are gradually acquired as boys accompany their fathers on fishing trips.

On Pukapuka, verbal instruction is rare, and both children and adults learn by observation followed later by imitation, and like Tubuai, another Polynesian island (Levin 1978), where learning is based on close observation, formal instruction is minimal, and questioning, especially by children, discouraged, except where it pertains to concrete situations. Repetition of observation, listening and practice is the principal factor in the Pukapukan transmission of knowledge.

5. POLICY OPTIONS

Some traditional community-based resource management systems will have a future usefulness, both nationally and locally. Equally there will be valid grounds for either diluting, modifying or abolishing outright other systems. Deciding which course to follow will basically depend on national priorities and national fisheries management capacity.

There are three basic alternative policy approaches for community-based fisheries management that consider its relationship to the development of fisheries and other economic sectors:

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- the case-by-case approach;
- dilution policies; and
- reinforcement policies.

The case-by-case option implies that no policy is established and legislated for, and that individual problems are resolved as they arise in terms of the relative costs and benefits to nation, region and local community. This approach has the advantage of political acceptability, since no fundamental changes are required. The disadvantages are that traditional rights-holders incur no obligations, such that development of other sectors will be difficult at best and impossible at worst. Further, because this process is ***ad hoc,*** no guidelines would emerge for the legal iriterpretation of traditional resource rights and their articulation with national development priorities. The case-by-case option is unsatisfactory in the longterm (Ruddle 1996).

A dilution policy requires legislation to strictly define the powers of traditional rights-holders, and to modify traditional management systems to enable the use of some traditional resource rights areas for other economic activities. Some systems would be abolished entirely. The advantages of a dilution policy are that it allows other economic sectors to develop rapidly, clarifies property rights and related issues, and defines the modem rights of traditional rights-holders. Its disadvantages are that it is often politically difficult and numerous implementation problems would arise. In many cases, the losses of rent, administrative costs and problems and possible social unrest would outweigh the economic and other benefits derived (Ruddle 1996).

The reinforcement option has the advantage that it also specifies the scope and power of traditional rights. That this approach would make conventional development difficult may often not be bad, although many would regard it as a disadvantage. But the reduction of the powers of central governments while placing responsibility on the rights-holders would likely be constructed as a disadvantage by vested interests. However, this could be overcome by reinforcing the scope of traditional systems within a concurrently legislated framework of co-management (Ruddle 1996).

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