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EXPLOITATION OF REEF RESOURCES: THE MALDIVIAN EXPERIENCE

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1. Introduction

Maldives is an archipelago of coral islands in the Indian Ocean (Fig. 1). Out of the country's total area of about 90,000 sq. km, only about 300 sq. km is dry land. This land area represents more than 1000 small island which are naturally grouped into 26 atolls; however, for easy administration the islands are grouped into 19 atolls.

The fisheries sector is the largest single source of employment in the Maldives, engaging about 20% of the total labour force. Tuna fishing has always been the most important fisheries activity. However, the exploitation of reef resources started to increase from the 1970s, and today they are being exploited both for local tourism industry and export. Examples of some of the exploited resources are lobsters, sea cucumbers, groupers and other food fish, and aquarium fish. These small scale fisheries, which supplement the traditional tuna fishery, have considerable social and economic benefits. For example, they provide additional employment for the fishermen during the tuna fishing off-season or when tuna fishing is poor. If these supplementary opportunities are not there, fishermen have to look for non-fishery employment during such times.

2. Sea Cucumber Fishery

The sea cucumber fishery in the Maldives developed at a phenomenal rate, from 2 t in 1986 to 745 t in 1990. At first the most high priced species, *Thelenota ananas* and *Microthele nobilis*, were exclusively harvested. However, these species were soon overexploited, so later other species that fetch low market price were added to the harvest. Today, low priced species, such as *Halodeima atra* form a high proportion of the decreasing harvest. No sea cucumber is domestically consumed; the whole harvest is exported. The export trends of dried sea cucumber (Fig. 2) gives a picture of how the fishery developed and finally collapsed as a result of overexploitation.

3. Giant Clam Fishery

The export-oriented giant clam fishery started in June 1990 and came to a stop a year later when the government banned the export of giant clam products. It was believed that further fishing would lead to serious exhaustion of the stocks and localised extinction of clams on some reefs.
A preliminary survey of giant clam stocks and status of the fishery conducted by Barker (1991) showed that only two species of giant clams inhabit the waters of the Maldives: *Tridacna squamosa* and *Tridacna maxima*. The target species of the fishery was *T. squamosa* , as it grows larger than the other one. The study estimated that the mean number of *T. maxima* for fished reefs was 29.9

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clams per hectare and for unfished reefs was 39.6 clams per hectare. *T. squamosa* densities was lower with an average of 3.4 clams per hectare on fished reefs and 10.6 clams per hectare on unfished reefs.

4. Grouper Fishery

About 60 species of fish which are categorised under the family Serranidae have been recorded from the Maldives (Shakeel, 1994). About 40 species are groupers of the subfamily Epinephelinae.

The grouper fishery, which started around January 1993, is concentrated in atolls close to Male': Alifu, Vaavu and Meemu Atolls. The fishermen catch groupers by handlines and keep them alive in fishing boat holds until the end of the day's fishing. After returning to the island, they sell the daily catch to exporters, who stock the fish in floating cages and export them chilled or live.

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.

A preliminary stock assessment of groupers was made by Shakeel (1994) for three habitats: shallow reef areas, atoll basins and deep reef slopes. This estimate is based on data from an exploratory fishing survey (Anderson et al., 1992; Van der Knaap, 1991). The estimated maximum sustainable yields of groupers from the three habitats were as follows:

Shallow reef areas	811 t/yr.
Atoll basins	959 t/yr
Deep reef slopes	62 t/yr
Total: approximately	1,800 t/yr

It should be emphasised that these figures are crude and they serve only as guidelines.

5. Aquarium Fish Collection

The collection of tropical aquarium fish started in Maldives in 1979. The activity is restricted to the reefs in Male' Atoll because the transportation and holding facilities are still concentrated around Male', close to the international airport. Relatively few people are involved in this activity. There are 12 companies licensed to collect and export aquarium fish.

Environmentally friendly collection methods are generally employed. Fish are collected mainly by hand nets. Recently "moxy net" (a cone shaped net) has been introduced which is destructive both to the fish and corals. The use of this net is discouraged. More than 120 species of aquarium fish are being exported, which include species that are rare in the Maldives and are vulnerable to overexploitation .The quantity of fish exported per year has risen steadily since 1980. From 1980 to 1994 a seven fold increase in the quantity of fish exported and 45 fold increase in the export value has occurred (Adam, 1995).

5. Coral Mining

Coral mining is an ancient activity in the Maldives and until recently provided the only source of stone for construction. Coral is extracted from shallow reefs and used to build houses, public buildings and jetties. The search for a suitable alternative building material is continuing. Hollow concrete blocks are widely available, but they are not as strong as corals; high quality cement blocks are too expensive.

The ecological balance of the reef is disturbed as a result of mining and may have long lasting effects on the reef as a whole. Studies into the effects of reef degradation on reef fish communities showed clearly that mined reefs compared to unmined reefs support less varieties and lower biomass of reef fish (Brown et al., 1990; Dawson-Shepherd et al., 1992). Although coral mining creates localised environmental degradation in the shallow reef habitats, it has negligible effects on the deep reef habitats where commercial fishing is carried out. Efforts are being made to manage coral mining. The Ministry of Fisheries and Agriculture (MOFA) has developed a licensing scheme, which specifies the quantities of corals which could be extracted and the location from which they could be extracted.

6. Threats and Challenges

Until recently Maldives has been commercially exploiting mainly pelagic species that have no or little association with the reefs, particularly tuna. In the past, all reef fisheries or other forms of exploitation of reef resources were carried out on a small scale. Therefore, the exploitation of reef resources posed no significant threats to the fisheries or the environment. Hence resource management was not given a high priority at that time. Today reefs are being exploited more intensively. 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 the local tourism markets as well as export markets; while the multi-species reef fisheries continues, particular species, such as groupers and sea cucumbers, have become special targets for export oriented fisheries. The commercial exploitation of reef resources has resulted in two main threats: over exploitation of resources and conflicts among the resource users. If allowed to continue, they will adversely affect the two most important economic sectors, namely fisheries and tourism. Reef resource management is urgently required to avoid these threats.

6.1 Overexploitation of Resources

Although the total reef fish resources of the Maldives seem underfished, the exploitation of particular fish species, such as groupers and Napoleon wrasse, *Cheilinus undulatus,* may not be sustainable. Fishermen report that grouper catch in Alifu and Vaavu Atolls, where the fishery first started, has declined because of heavy fishing. Very high fishing pressure in Vaavu Atoll is likely to result in catch rates dropping to uneconomic levels in a relatively short period. Fishermen and exporters will then shift to other atolls, which may eventually be fished out. Few grouper fishermen sometimes catch Napoleon wrasse and even though this is not yet an established fishery, divers are already complaining about the fish becoming rare in dive sites.

At the present level of exploitation, the aquarium fish collection seems sustainable, although precaution needs to be taken to prevent the overexploitation of rare and endemic species.

Sea cucumbers and giant clams have never formed a part of the traditional Maldivian fisheries. These non-traditional fisheries are directed totally towards the export markets. Sea cucumbers have been grossly overfished in the Maldives. Very few people are presently involved in the fishery because the efforts are not worth compared to the recently started more profitable grouper fishery. The giant clam fishery, which was carried out by a few fishermen who sold clams to two exporters, lasted only for a year. The fishery came to a stop because of banning the export of giant clam products. Since the natural population of giant clams will not be able to support a commercial fishery, clam culture has been recommended to revive the export in the long run.

6.2 Resource Use Conflicts

The fishing and tourism industry both share the marine resources of the country, and they provide more than 70% of total government revenue; tourism is the most important source of foreign exchange earnings. It is important, therefore, that these two sectors develop in parallel and one does not hinder the development of the other.

Conflicts sometimes arise between these two resource users. Tourism itself has created a huge domestic market for reef fish. Tourists prefer reef fish, while the majority of local people prefer tuna. Hence resorts buy reef fish in large quantities. However, the tourism sector is in conflict with the reef fisheries. Dive-tourists complain that groupers, Napoleon wrasse, aquarium fish and sharks are being caught from popular dive sites. On the other hand, fishermen complain that divers disturb them while they fish for groupers or collect bait fish on reefs. Such conflicts are totally new to the Maldivian fishermen, who had been fishing freely all over the country throughout their life. It will take time for the fishermen to get used to the changing situations. Careful planning is required to harmonise the activities of both sectors.

6.3 Resource Management

At different stages of the development of reef resource exploitation, the MOFA and the Ministry of Planning, Human Resources and Environment (MPHRE) have issued a number of rules to address overexploitation, conflicts, and environmental degradation and protection. They include the following:

- ☒ It is illegal to collect black corals.
- ☒ It is illegal to collect sea cucumbers using SCUBA gear.
- ☒ It is illegal to collect aquarium fish from house reefs of tourist resorts.
- ☒ It is illegal to collect giant clams.
- ☒ It is illegal to catch Napoleon wrasse (came to effect in June 1995).
- ☒ It is illegal to catch sea turtles(came to effect in June 1995)..
- ☒ Mining corals from bait fishing reefs and house reefs of islands is to be avoided.

- ☒ Sand can be mined only from lagoons of islands and faros.
- ☒ Permission from the appropriate Atoll/Island Office should be obtained to mine sand or corals. Atoll/Island Office should monitor all mining activities,
- ☒ Mined quantity of sand and corals should be recorded at the appropriate Island Office.

In late 1992 the Marine Research Section (MRS) of MOFA carried out a survey of the Maldivian shark fisheries. It was estimated that over US$ 2 million per year was spent by visiting divers to watch sharks. It was also estimated that reef sharks are worth about 100 times more alive as generators of diving revenue, than they are dead on a fishing boat (Anderson and Ahmed, 1993). It was therefore recommended in 1993 that the top shark-watching dive sites in the Maldives should be protected from shark fishing immediately, and other shark-watching dive sites should be considered for protection in the near feature. There is clearly a sound economic case for protecting reef sharks, at least within the tourism zone. In June 1995 fifteen popular dive sites were designated as marine protected areas. Within these protected areas the following activities are prohibited:

- ☒ Anchoring (except in an emergency)
- ☒ Coral or sand mining
- ☒ Rubbish dumping
- ☒ Removal of any natural objects or living creatures.
- ☒ Fishing of any kind (e.g. for sharks, reef fish or aquarium fish) with the exception of traditional livebait fishing.
- ☒ Any other activity which may cause damage to the area or its associated marine life.

Today Maldives gives high priority to integrated reef resource management. By experience, it has been found that such a form of management will be more effective than trying to manage each fishery in isolation. MRS is now developing an integrated reef resource management programme, which will start at the end of 1995 in Vaavu, Meemu, Faafu and Dhaalu Atolls. The programme is designed to help initiate and develop the following:

- Appropriate data and information systems for management purposes.
- More and better focused research on management issues.
- Reef resources management plans for sustainable production with reduced conflicts and economic wastes.
- Active participation of various stakeholders in the process of negotiating management plans and measures.
- Better co-ordinated management efforts amongst the people and concerned national institutions.
- Recognition of the importance of reefs in coastal zone development.
- Co-operation between the institutions in the Maldives and others in the region and the world concerned with reef resources management.

Large scale exploitation of reef resources is new to the Maldives and the country does not have much experience in the management of these resources. While sharing whatever experience it has got, the country is keen to learn from others and not to repeat their mistakes.

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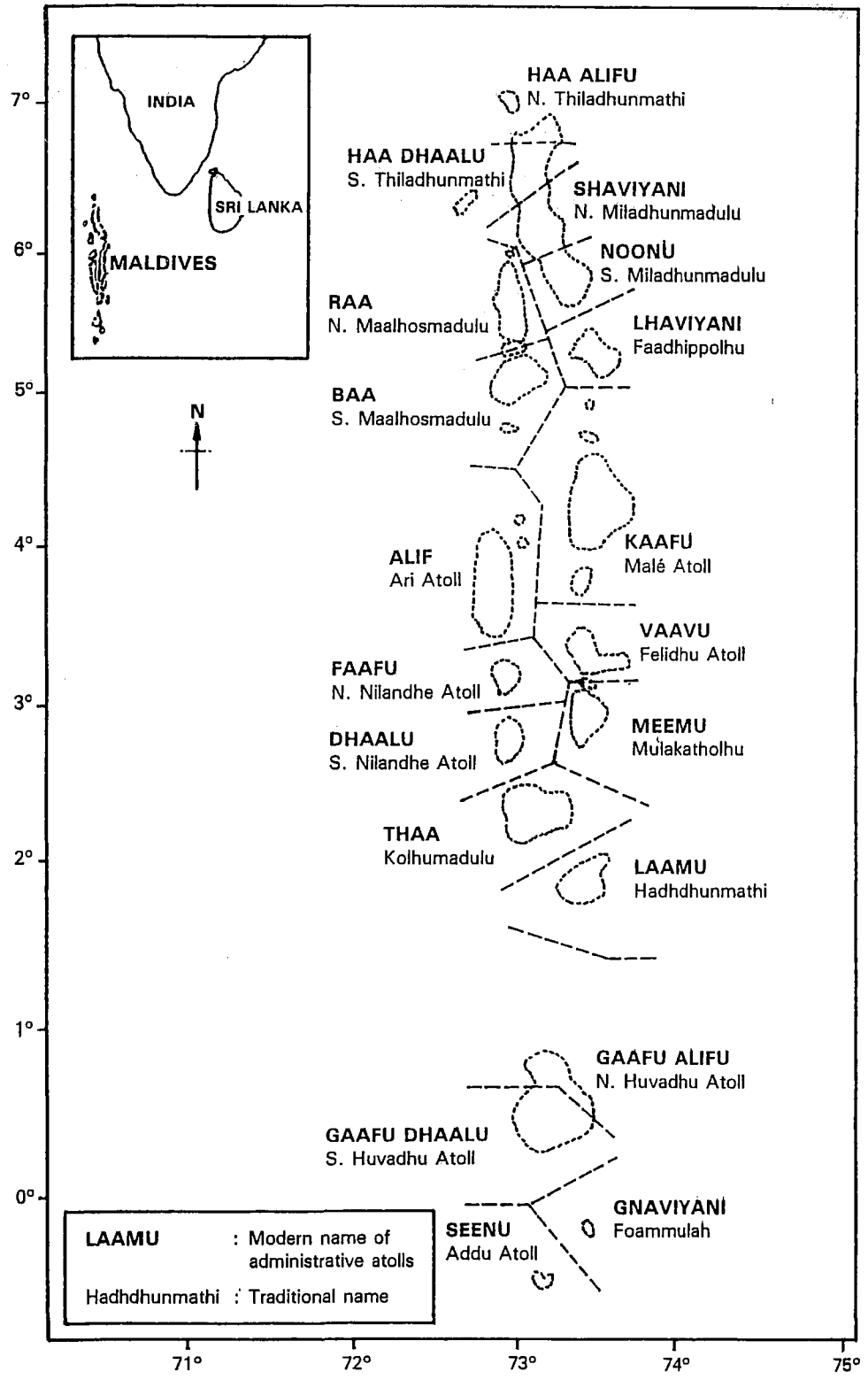
Fig 1 : Map of the Maldives



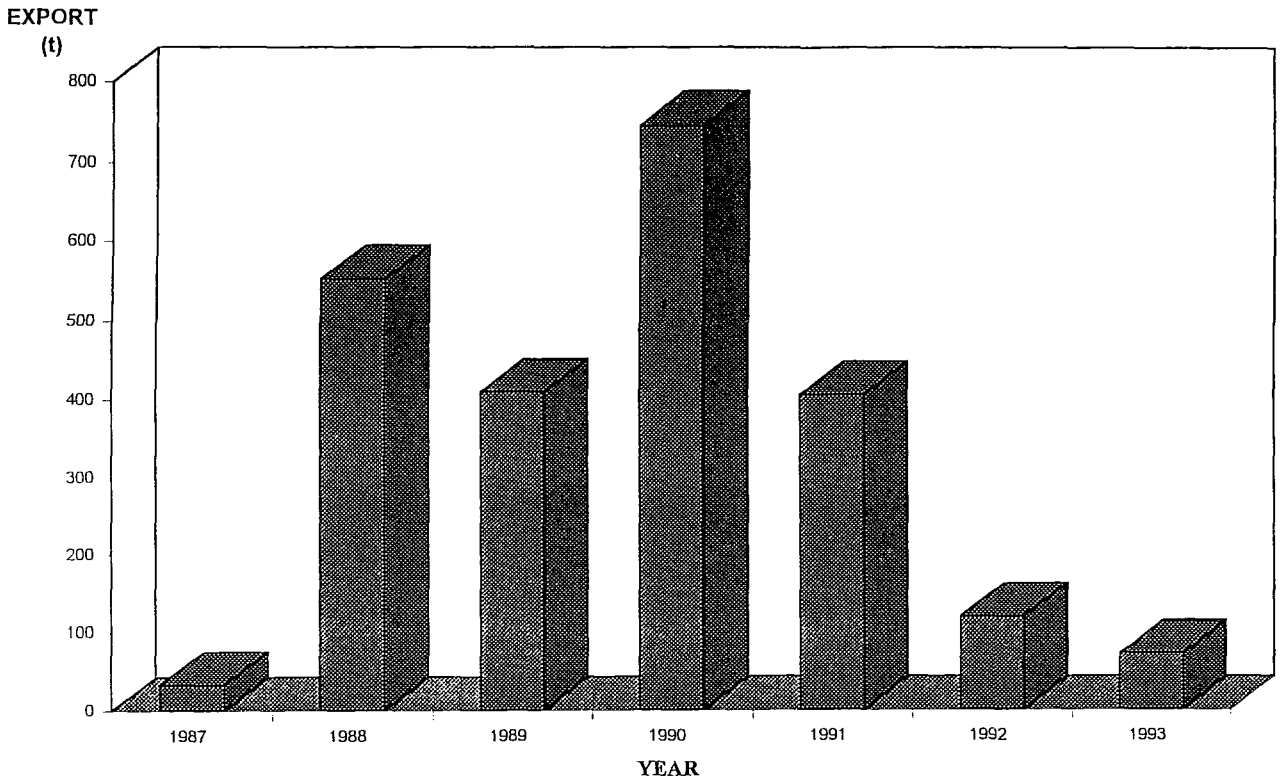


Fig. 2 Export of dried sea cucumber 1987- 1993